Frame of Reference in Iwaidja: Towards a Culturally Responsive Early Years Mathematics Program

Cris Edmonds-Wathen

Bachelor of Arts (University of Melbourne)
Bachelor of Arts (Honours) (University of Western Sydney)
Graduate Diploma of Primary Education (Charles Darwin University)

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School of Education
College of Design and Social Context
RMIT University
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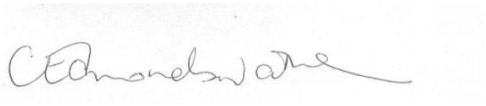
Declaration

I certify that except where due acknowledgement has been made, the work is mine alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.



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List of Australian languages mentioned in thesis

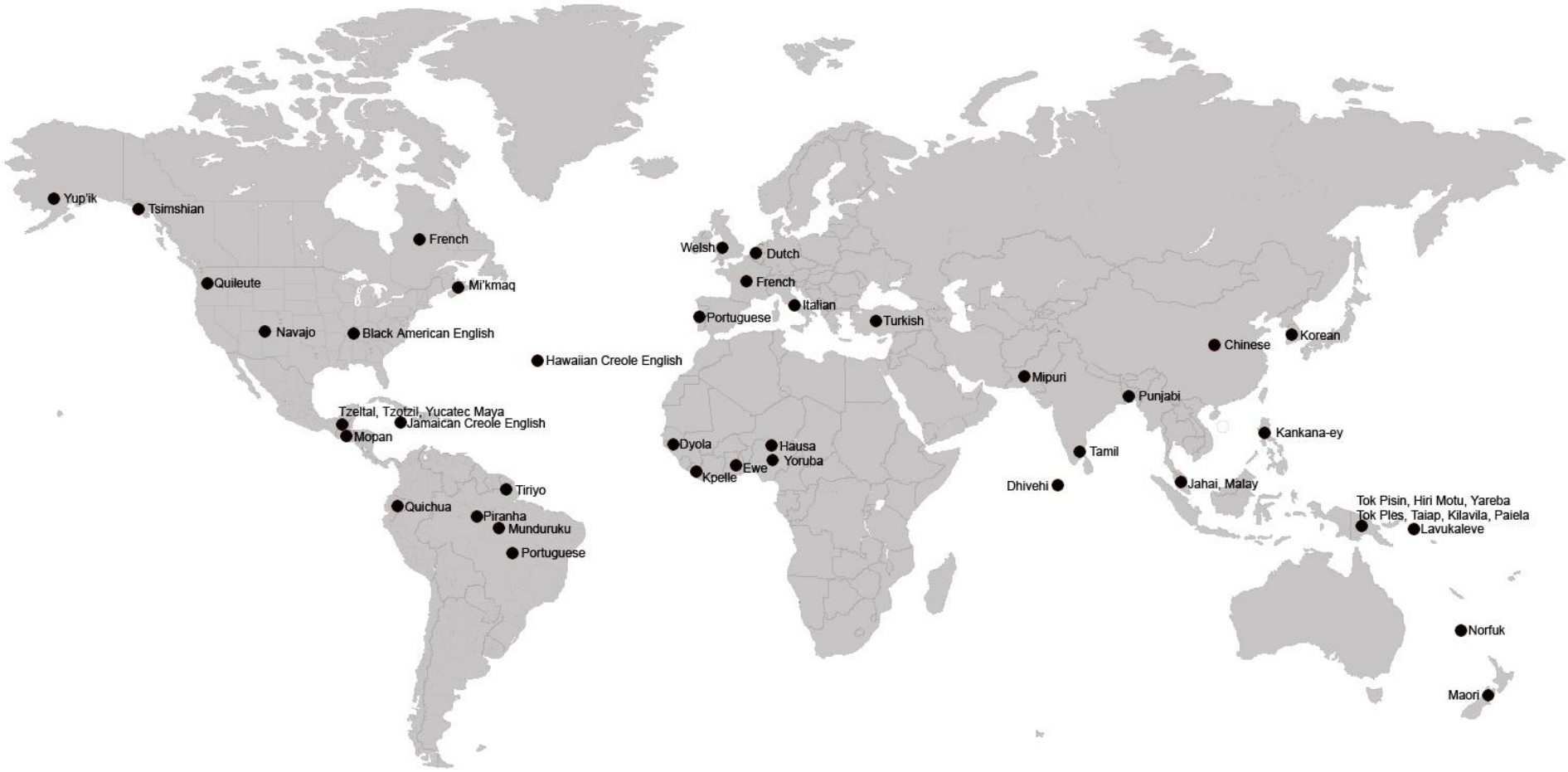
Language	Location	Family
Aboriginal English	Widespread	Indo-European
Amurdak	Northwest Arnhem Land, NT	Iwaidjan
Anindilyakwa	Groote Island, NT	Arnhem
Arabana	Near Lake Eyre, SA	Pama-Nyungan
Arrernte	Alice Springs region, NT	Pama-Nyungan
Djamparrpuyngu	Northeast Arnhem Land, NT	Yolngu Matha, Pama-Nyungan
Standard Australian English	Widespread	Indo-European
Garig ‡	North East Arnhem Land, NT	Iwaidjan
Garrwa	Roper-Macarthur region, NT	Garrwan
Gurindji	Victoria River district, NT	Pama-Nyungan
Gurindji Kriol	Victoria River district, NT	Mixed Gurindji-Kriol
Guugu Yimithirr	Hopevale, Qld	Pama-Nyungan
Ilgar‡	Northwest Arnhem Land, NT	Iwaidjan
Iwaidja	Northwest Arnhem Land, NT	Iwaidjan
Jaminjung	Victoria River District, NT	Mirndi
Kala Lagaw Ya	Torres Straits Islands	Pama-Nyungan
Kriol	Northern Territory, WA	Creole (English based, Pacific)
Kunwinjku (Bininj Kun-Wok)	Northwest Arnhem Land, NT	Arnhem
Kuuk Thaayorre	Cape York, Qld	Pama-Nyungan
Marrku ‡	Northwest Arnhem Land, NT	Iwaidjan? Marrgu?
Mawng	Northwest Arnhem Land, NT	Iwaidjan
Murrinh Patha	Daly region, NT	Southern Daly
Pintubi	Western Desert, WA	Pama-Nyungan
Tiwi	Tiwi Islands, NT	Tiwi
Warlpiri	Victoria River District, NT	Pama-Nyungan
Warrwa‡	Derby Region, WA	Nyulnyulan
Wik Mungan	Torres Straits Islands	Pama-Nyungan
Wurrugu ‡	Northwest Arnhem Land, NT	Iwaidjan
Yanyuwa	Roper-Macarthur region, NT	Pama-Nyungan
Yolngu Matha (group)	Northeast Arnhem Land, NT	Pama-Nyungan

‡no speakers

Map 1: Australian languages mentioned in thesis

List of world languages mentioned in thesis

Language	Location	Family
Black American English	USA	Indo-European, Germanic
Chinese	China	Sino-Tibetan
Dhivehi (Maldivian)	Maldives	Indo-European
Dutch	The Netherlands	Indo-European, Germanic
Dyola	Senegal	Niger-Congo
English	UK, Australia, USA, Canada, etc	Indo-European, Germanic
Ewe	Ghana, Togo	Niger-Congo, Kwa
French	France, Canada, etc	Indo-European, Italic
Hausa	Niger, Nigeria, Benin, Chad, etc	Chad
Hawaiian Creole English	Hawaii, USA	Creole (English based, Pacific)
Hiri Motu	Papua New Guinea	Pidgin, Austronesian
Italian	Italy	Indo-European, Italic
Jahai (Jehai)	Malaysia	Austro-Asiatic
Jamaican Creole English	Jamaica	Creole (English based, Atlantic)
Kankana-ey	northern Philippines	Austronesian
Kilavila	Papua New Guinea	Austronesian
Korean	Korea, East Asia	Isolate (Altaic?)
Kpelle	Liberia	Niger-Congo
Lavukaleve	Solomon Islands	Papuan
Malay	Malaysia	Austronesian
Māori	New Zealand	Austronesian
Mi'kmaq	East Canada	Algic
Mipuri (Pothohari)	Pakistan	Indo-European, Indo-Iranian
Mopan	Belize and Guatemala	Mayan
Mundurukú	Brazil	Tupi
Navajo	USA	Na-Dené
Norfuk	Norfolk Island	Creole (English based, Pacific)
Paiela (Ipili)	Papua New Guinea	Trans-New Guinea
Piranha (Pirahã)	Brazil	Mura
Portuguese	Portugal, Brazil, etc	Indo-European, Italic
Punjabi	Bangladesh	Indo-European, Indo-Aryan
Quichua (Kichwa)	Ecuador	Quechuan
Quileute	northwest United States	Chimakuan
Taiap	Papua New Guinea	Papuan, Isolate
Tamil	Southern India	Dravidian
Thimshian (Tsimshian)	Canada	Penutian
Tiriyó	Brazil, Surinam	Cariban, Taranoam
Tok Pisin	Papua New Guinea	Creole (English based, Pacific)
Tok Ples	Various, Papua New Guinea	Various
Turkish	Turkey	Altaic, Turkic
Tzeltal	Mexico	Mayan
Tzotzil	Mexico	Mayan
Welsh	Wales	Indo-European, Celtic
Yareba	Papua New Guinea	Trans-New Guinea
Yoruba	Nigeria	Niger-Congo
Yukatec Maya	Mexico	Mayan
Yup'ik	Alaska	Eskimo–Aleut



Map 2: World languages mentioned in thesis

Abbreviations

AAMT	Australian Association of Mathematics Teachers
ACARA	Australian Curriculum and Reporting Authority
ACLA	Aboriginal Child Language Acquisition Project
ACER	Australia Council for Educational Research
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
BIITE	Batchelor Institute for Indigenous Tertiary Education
CARG	Cognitive Anthropology Research Group
CDU	Charles Darwin University
CMIT	Count Me In Too
DoBeS	Documentation of Endangered Languages Programme
EAL/D	English as an Additional Language or Dialect
ELAN	EUDICO Linguistic Annotator
ESL	English as a Second Language
HCRC	Human Communication Research Centre
ILSS	Indigenous Language Speaking Students
KGP	Key Growth Point
L1	First language
L2	Second language
MCEETYA	Ministerial Council on Education, Employment, Training and Youth Affairs
MERGA	Mathematics Education Research Group of Australasia
MPI	Max Planck Institute for Psycholinguistics (Nijmegen)
NALP	National Accelerated Literacy Program
NAPLAN	National Assessment Program: Literacy and Numeracy
NSW DET	New South Wales Department of Education and Training
NT	Northern Territory
NT DET	Northern Territory Department of Education and Training
NTCF	Northern Territory Curriculum Framework
PME	(International Group for the) Psychology of Mathematics Education
RSCAM	Remote Schools Curriculum and Assessment Materials
SCATSIA	Standing Committee on Aboriginal and Torres Strait Islander Affairs
TEGS	Top End Group School
TESOL	Teaching English to Speakers of Other Languages

Glossary

Absolute

In the *absolute* frame of reference, the location of the figure is described in relation to a fixed direction or landmark. For example, “the pen is north of the cup”.

Across-axis

In the Man and Tree task, refers to the *Rx2* and *Rx4* cards which show the man and the tree on either the right or left side of the card. Also called the lateral axis.

Arrarrkbi

The Iwaidja word for people, or Aboriginal people, or themselves. Used in this thesis to refer to Iwaidja speaking people and their families. Singular *warrkbi* ‘man’.

Assistant teacher

The role of an assistant teacher varies with school and experience, but includes assisting Indigenous students individually or in groups; assisting teachers to plan and prepare for lessons; assisting teachers to understand Indigenous culture, lifestyle and custom; interpreting between students and teacher; simple clerical work; and liaising between school, parents and community. Assistant teachers are Indigenous and Indigenous teachers in remote communities are not entitled to the support of an assistant teacher.

Australian language/Indigenous language

A language which has its origin in Australia, from an Australian language family, spoken by the Indigenous peoples of Australia. In education in Australia, these are often called Indigenous languages. However *indigenous language* can refer to a language spoken in its place of origin anywhere in the world. In this thesis, *Australian language* is preferred, but *Indigenous language* and *Indigenous Australian language* will sometimes be used. See ***Indigenous language speaker***.

Away-axis

In the Man and Tree task, refers to the *Rx1* and *Rx3* cards which show either the man or the tree in the foreground, and the other further away from the viewer.

Balanda

White or non-Indigenous person. Term used by Iwaidja speakers and other Indigenous people of Northwest Arnhem Land. Also used by non-Indigenous people in this region. Derived from ‘Hollander’ via Indo-Malay.

Capitalisation of Indigenous

In this thesis I have followed the convention of using the proper noun, *Indigenous* to describe Aboriginal and Torres Strait Island peoples and their languages. However, when used as an adjective to describe indigenous people or languages generally, no capital is used. Thanks to Kim Johnstone for clarification of this point.

Deixis

Information internal to the speech situation. Spatial deixis explicitly or implicitly refers to the location of the speech participants. For example, in the instruction "come here!", 'here' refers to the location of the speaker. Adjective: deictic.

Early Years

The early years of school, called Transition to Year 2 in the Northern Territory. Not to be confused with the early years of life which may refer to ages 0-4 years.

ESL

English as a Second Language. Many Northern Territory Indigenous students learn English as a third, fourth or fifth language and so are technically English as an Additional Language [EAL] learners. In this thesis ESL is used as the more widely used term in education in the Northern Territory and includes EAL.

Facing

In the Man and Tree task, refers to the direction in which the man is facing, can use any frame of reference.

Figure

A salient object, potentially moveable with respect to the *ground* (Talmy, 1983).

Ground

Reference object with respect to which the *figure* is located (Talmy, 1983).

Indigenous

In this thesis I have followed the convention of using the proper noun, *Indigenous* to describe Aboriginal and Torres Strait Island peoples and their language. However, when used as an adjective to describe indigenous people or languages generally, no capital is used. Thanks to Kim Johnstone for clarification of this point.

Indigenous language speaker

An Indigenous Australian who speaks one or more Australian languages. Does not include non-Indigenous speakers of Australian languages.

Indo-European

A language family which includes most European languages and the Indo-Iranian languages such as Hindi and Persian. English is a member of the Germanic branch. Throughout the thesis I have referred to Indo-European languages as a technical and historical grouping. In relation to the development of mathematics, this grouping allows me to include the contributions of Indian and many Middle Eastern mathematicians with those of European mathematicians.

Intrinsic

In the *intrinsic* frame of reference, the location of the figure is described with respect to a part or facet of the ground. For example, "the pen is beside the cup".

Non-gender specific pronoun

The plural pronouns 'they', 'them' and 'their' have been used throughout for the singular non-gender specific pronoun.

Relative

In the *relative* frame of reference, the point of view and body of the speaker are used to relate the figure to the ground. For example, “the pen is to the left of the cup”.

Remote

Throughout this thesis I use the term *remote* to refer to communities which are classified *very remote* according to the Australian Standard Geographical Classification used by the Australian Bureau of Statistics. *Very remote* is used occasionally to contrast with *remote*.

Satellite-framed

A languages which packages manner of motion on the verb, with path as a ‘satellite’(Talmy, 1985). For example, English.

Standing

In the Man and Tree task, refers to the location of the man with respect to the tree, can use any frame of reference.

Teacher

A person employed in the role of classroom teacher, registered with the Teacher Registration Board and having a formal teaching qualification, either a degree or a graduate certificate. Although the majority of teachers in the Northern Territory are non-Indigenous, including all the teachers discussed in this thesis, some teachers are Indigenous.

Topology

Topology refers to spatial qualities such as proximity, order, enclosure and continuity but does not include angular or coordinate information. The concepts and definitions of topology in language, psychology and mathematics are interrelated. For example ‘next to’ describes proximity, but does not specify direction. Topological references in language may form a continuum with intrinsic frame of reference terms.

Verb-framed

A language which packages the path of motion on the verb, with manner as additional (Talmy, 1985). For example, Spanish.

Summary

Indigenous Australian language speaking students in remote locations constitute a significant part of the Northern Territory's student cohort. Most of these students are taught in English by non-Indigenous teachers who know little about the languages and worldviews of their students. Differences in home or first language remain inadequately accounted for in mathematics curricula and in compulsory assessments. This thesis is concerned with the mathematical implications of the way Australian languages encode spatial concepts and how this differs from Standard Australian English.

The project was transdisciplinary, traversing linguistics and education. The central hypothesis was that better understanding of the conceptual and linguistic spatial framework of their students would enable teachers to construct and teach a more culturally responsive mathematics program. The study used a two phase model of culturally responsive mathematics education, in which *understanding* elements of the students' culture were seen as necessary to make *responding* possible. In seeking to build on the mathematical knowledge that children bring to school, the study was informed by a socio-constructivist perspective on learning.

Phase I was a linguistic field study of spatial language in Iwaidja, an endangered Australian language spoken at Minjilang, on Croker Island in Northwest Arnhem Land. This phase addressed the goal of understanding. It was founded on the premise of linguistic relativity, which is that the languages people use affect the way that they think. Phase II was an ethnographic case study of Early Years mathematics teaching at Mamaruni School, in Minjilang. This phase contained a teaching program as the response to the understanding from the first phase.

Phase I asked how frame of reference is expressed in Iwaidja. It used the tripartite typology and tools such as the *Man and Tree* task devised by the Cognitive Anthropology Research Group from the Max Planck Institute for Psycholinguistics to investigate spatial frames of reference. The Man and Tree task was conducted with four pairs of senior adult Iwaidja speakers, with five adult Iwaidja speakers (caregivers) and their children or grandchildren, and with five pairs of children ranging from eight to 13 years old. A route description *Map*

task was also conducted with three pairs of senior adult Iwaidja speakers. The data from the senior adults served as a benchmark against which to compare the other data sets.

Iwaidja uses all three frames of reference: absolute, relative and intrinsic, as well as other strategies including deixis. Iwaidja has a range of absolute terminologies including cardinal directions including a sunset-sunrise axis, wind directions and an ocean-land axis. Iwaidja has a relative 'left' and 'right' that has not been documented for other Australian languages. It has a strongly intrinsic 'front' and 'back' that can contradict the relative frame of reference in both lateral and transverse axes. Both the Man and Tree task and the Map task showed a focus on verbal processes rather than nominal objects in Iwaidja.

Differences between adult-to-peer use of spatial reference and adult-to-child use included a reduction in the use of the absolute terminology and an increase in the use of the relative for adult-to-child language. Although the study revealed that none of the children on Croker Island are fluent in Iwaidja, it demonstrated convergences between the dialect of English spoken by the children of Croker Island and the Australian languages Iwaidja and Kunwinjku. Distinctive uses of the intrinsic frame of reference in Iwaidja appear to have been incorporated into the dialect of Aboriginal English spoken at Minjilang.

Phase II asked how understanding spatial language in Iwaidja could be applied towards culturally responsive mathematics education. It used an ethnographic approach that combined teacher interviews with observations to investigate teacher perceptions of mathematics education at Mamaruni School.

The teachers who participated in the study believed the language difference between themselves and their students was a major issue in mathematics teaching. They had inadequate training in English as a Second Language (ESL) methodologies and most of them felt they did not know how to teach mathematics to their Indigenous language speaking students. They had little understanding of possible variation in spatial language between languages.

The study highlighted the fact that little is yet known about the acquisition of spatial language and concepts by speakers of Australian languages. Age-appropriate mathematics learning requires an understanding of the normal progression of acquiring spatial frames of reference in students' home languages. Early Years mathematics curricula often concentrate on first using the "everyday language" of the students in mathematical contexts. Students who begin school with different everyday language to that used in the curriculum and in the school do

not have the advantage of their early mathematics lessons building on the language and concepts which they use at home.

The study showed that the school imperative to teach Standard Australian English and literacy sometimes comes into conflict with teaching mathematics. System pressures on teachers to teach Indigenous language speaking students at an "age-appropriate" curriculum level can lead teachers to implement programs where the combination of mathematics, language and literacy learning produces cognitive overload. In these cases, the students learn below their potential. The study found that with time and training, teachers become more responsive to the linguistic needs of their students. Short teacher tenure negatively affects the school's ability to maintain this teacher understanding.

While other studies have found Indigenous students' strengths in the language of location and direction, this was the first study to apply a frame of reference analysis to an educational context. Differences in preferred uses and acquisition of spatial frames of reference between Indo-European and Australian languages explain some of the discord between the sequencing of location in Early Years mathematics curricula and the understandings of Indigenous students.

The dynamic verb focus of Iwaidja prompted the questioning of both the purpose and the necessity of nominalisation of abstraction in mathematics when working with Indigenous students whose home languages are more verb-focused and dynamic than Indo-European languages.

Chapter 1
Introduction

The Northern Territory has a unique demographic amongst Australian jurisdictions. It has by far the greatest proportion of Indigenous* people, and by far the greatest proportion of these speak one or more Australian languages* (Australian Bureau of Statistics, 2011). Almost half the Northern Territory population live in remote* locations, and most of these people are Indigenous. About 30 percent of all Northern Territory students are Indigenous students who speak Australian languages (Northern Territory Department of Education and Training [NT DET], 2011b). Indigenous language speaking* students in remote locations thus constitute a significant part of the Northern Territory's student cohort.

Non-Indigenous teachers arriving in remote Indigenous communities in the Northern Territory encounter cultures that are radically different from their own. These differences extend through many facets of life, including interpersonal relationships, social values, metaphysical outlook and language. Language is the specific cultural difference which will be the focus of this thesis. In the Northern Territory, there are some bilingual schools where children learn in their home languages as well as in English, but in most schools the language of instruction is English. The non-Indigenous teachers who go to these communities often do not have *English as a Second Language* [ESL]* teacher training nor know anything about Australian languages. They know that part of their role is to teach Standard Australian English to their students. Sometimes these teachers start off thinking that mathematics will be one of the easier subjects to teach, thinking that mathematics is less dependent upon language than other subjects, perhaps because they associate mathematics with the use of mathematical symbols. They soon find that language is a crucial factor in their mathematics teaching.

This thesis focuses on language in mathematics education in the above context, looking at some of the mathematical language and concepts which children might be exposed to outside of school, and how these might be drawn on within the school.

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* see Glossary

1.1 Background

Different languages categorise the world in different ways (Lakoff, 1987). As well as packaging meaning in unique networks of association, languages also vary in what people are likely to say. In 2002, when I took a class in Djambarrpuyngu, one of the Yolngu dialects of East Arnhem Land, I remember another student asking how to say a particular sentence in Djambarrpuyngu. The lecturer, Michael Christie, replied that while you *could* say it, you probably *wouldn't* say it, you would say something else instead.

My interest in Australian languages had begun some ten years earlier, in 1993. While studying linguistics at university, I had the opportunity to work on a language maintenance program for Arabana, an endangered language spoken Central Australia. During that project, I began to learn about Australian languages and their speakers. Passionately interested in languages, I felt drawn to a career where my work would directly and practically benefit people. I found the experience of working on an endangered language saddening and I wanted to work in a part of Australia where Australian languages were strong. This was a significant part of my motivation to move to the Northern Territory and train here as a teacher. I wanted to teach reading, writing and mathematics to Indigenous language speaking students.

The seed for this thesis was planted in 2003 during my first teaching practicum in a remote Indigenous community in the Northern Territory. It was a bilingual school with both English and a local Australian language as languages of instruction. I was participating in a *Learning Together*, a session where Indigenous and non-Indigenous staff work together to share knowledge. The goal of a Learning Together is to provide an opportunity for non-Indigenous teachers to learn more about the culture and community of their students, and the Indigenous staff to learn more about the processes and expectations of the non-Indigenous school system (NT DET, n.d.5). While we were discussing some local cultural concepts, I began to consider Indigenous mathematics concepts and their place in school mathematics. I wondered about the possible mathematical implications of differences in the way that languages encode meaning amongst Australian languages and their speakers.

Although I saw attempts in Northern Territory schools to make teaching and learning relevant and accessible to Indigenous students, I saw little that showed an understanding or application of the way Indigenous mathematical thoughts and practices are expressed. What few mathematics resources targeted for Indigenous students I could find were printed on old yellowed paper and did not link with the current curriculum. It was clear from speaking to other teachers that many did not feel confident to teach mathematics to their Indigenous

language speaking students. There was a need for targeted research in this area to which to which I could bring my combined skills in linguistics, mathematics and teaching.

In 2008, teaching in a school in another remote Northern Territory community, I was able to develop this idea into a research program. Mamaruni School is located in Minjilang Community on Croker Island in Northwest Arnhem Land. It has always been an English medium school and has never had a bilingual program. Most of the students speak Indigenous languages at home with their families. Each class at Mamaruni School is taught by a non-Indigenous teacher* and a local Indigenous assistant teacher*. The assistant teacher has many roles in the school, including cultural liaison and providing educational assistance to individuals and small groups of students. Some of the assistant teachers, particularly those who have been long-term employed in the school, have formal certificate qualifications.

Minjilang is a multilingual community with the most widely spoken languages being Iwaidja, Mawng, Kunwinjku and English. English is spoken throughout Minjilang community in places such as the school, the clinic and the Shire office, but in all these places local languages are also widely spoken. Today there is a greater exposure to English than in the past through television, music videos and DVDs, and some local families now speak English at home. This English tends to be a dialect that is known as Aboriginal English which varies from the Standard Australian English taught in the school in terms of sound system, grammar and vocabulary.

Today Iwaidja is considered to be the language of Croker Island and is the main language of the Traditional Owners. The original language of the island, Marrku, is almost extinct. In practice, Kunwinjku and Mawng are more widely spoken, particularly in the younger age groups and Iwaidja is seriously endangered. Iwaidja speaking people call themselves *Arrarrkbi**, which means ‘people’ or ‘men’ (singular *warrkbi* ‘man’). They also apply this term to other Indigenous people. The word for non-Indigenous person in this part of Australia is *Balanda**. This word has been borrowed from Indonesian, which adapted it from ‘Hollander’. The peoples of Northwest Arnhem Land have had contact with seafarers from the Indonesian archipelago since the 16th century, which is reflected in many linguistic borrowings (Evans, 1992). Both terms will be used in this thesis at times.

As a teacher at Mamaruni School, I found that support for ESL methodologies focused mostly on English literacy, the teaching of reading and writing. The core of the mathematics program was the *Count Me In Too* program (New South Wales Department of Education and Training [NSW DET], 2001) which had not been developed with either ESL nor Indigenous learners

specifically in mind. Not sharing a common first language with my students affected the way I could teach mathematics. Talking about the learning experiences in mathematics lessons presented difficulties when I did not share enough language with my students to draw out the complexities of their thought. My students and I also had different cultural expectations about the role of talk in the teacher-learner relationship (S. Harris, 1987) hence a request to students to explain their mathematical problem solving strategies in English may have seemed nonsensical to them.

In 2008 Mamaruni School used the *Northern Territory Curriculum Framework* [NTCF] (NT DET, 2002), an outcomes based document. Teachers were able to plan their program against the levels at which their students were working, rather than a mainstream determined idea of Year or age level appropriate content. It had an ESL component specifically targeted towards Indigenous language speaking children from non-literate family backgrounds. However the mathematics section had no specific modification for these students. This surprised me considering the importance which is given to mathematics and numeracy in schools. Despite a growing appreciation in the scientific community of the role of language in teaching, learning and doing mathematics, differences in home or first language remain inadequately accounted for in Australian mathematics curricula.

The need for targeted research into the mathematics education of Indigenous students was also evident from the wider media discourse. For a wealthy country with free, compulsory education, the continuing disparity in educational outcomes between Indigenous and non-Indigenous students intrigues, distresses, and at times puzzles educators, researchers, the government and the general populace. A belief that better educational outcomes lead to better wellbeing in a range of areas including employment and health is coupled with a sense of shame and dismay at the failure of the school system to improve Indigenous test scores and university entry. The greatest disparity between Indigenous and non-Indigenous mathematics outcomes in the *National Assessment Program: Literacy and Numeracy* [NAPLAN] occurs in the Northern Territory (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2011a; Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA], 2008, 2009). Since the proportion of Indigenous students in the Northern Territory who speak an Indigenous language as their first language is so much higher than in other parts of Australia, it seemed clear that language is a significant factor in mathematics teaching and learning for these students.

Few Indigenous language speaking students are taught by teachers who share their languages. In remote schools, the Balanda teacher perspective is often that students come to school

without the prior learning and language that mainstream schools assume, which is a deficit perspective. But like children everywhere, Indigenous students have been busily learning since the day they were born. It is just that their Balanda teachers generally do not know what the children have been learning or how to make use of the children's learning in the school. Coming from a socio-constructivist perspective, I believe that mathematics education needs to build on what children already know. However, what Indigenous language speaking students know when they come to school is not necessarily the same as what is assumed in the curriculum.

1.2 Goals and Methodology

My initial questions were: with what mathematical understandings did the students come to school? What mathematical understandings were held in their culture by the elders? Did these understandings concord with the sequencing or content of the Early Years* mathematics curriculum, that is, the first three years of formal schooling? I suspected not. And how could a better understanding of Indigenous mathematics concepts be used by the Balanda teachers to plan and teach mathematics in the school more effectively? Mathematics here refers both to school type mathematical practices, and more broadly to what Barton (1998, 2009) describes as QRS (quantity–relationship–space) systems.

I wanted to investigate Indigenous mathematical concepts in depth, choosing an area of mathematical language on which to focus. I planned to choose one of the languages spoken at Minjilang, and carry out the research there, and at Mamaruni School.

Iwaidja was chosen as the language of investigation for a combination of political and logistical reasons. Iwaidja is endangered today and not as popular among the younger generations as Mawng and Kunwinjku. Educationally, choosing one of the other languages may have been directly relevant to more students at the school. However, as the language of the land, it shows respect to conduct research on Iwaidja on Croker Island. To research Mawng, it would have been more appropriate to go to Warruwi Community, or to Gunbalanya to research Kunwinjku, which are regarded as the places where those languages belong. Since I had already begun to make connections with the community and school on Croker Island through teaching at Mamaruni School, I wanted to build on these connections by carrying out the research there.

There was also the established Iwaidja Documentation Project (see *Iwaidja Inyman*, 2010). Since 2004, a team of Iwaidja speaking elders has been working with the linguist Bruce Birch

to document aspects of Iwaidja language and cultural knowledge. Choosing Iwaidja meant having a team of experienced collaborators with whom to conduct the linguistic research. This project would in turn add to the documentation of this endangered language.

The project thus had dual goals: the documentation of part of Iwaidja, an endangered Australian language, and an application of the knowledge about Iwaidja in a mathematics education context. I also brought two main perspectives to the project: my perspective as a teacher interested in educational equity for a group of low achieving students, and my perspective as a linguist interested in finding new ways to talk about the world. I might add a third perspective here: that of a mathematician, interested in what a different culture and language to my own could add to the body of knowledge and practices that we call mathematics.

It was important to me to investigate a mathematical area that was a perceived mathematical strength of the students. While number systems are comparatively less developed in Australian languages than in many other languages (e.g., Dixon, 1980; cf., S. Harris, 1987), there is a great deal of anecdotal talk in the Indigenous education field about spatial thinking and talking being an area of strength for Indigenous students. Among other research on this topic, a brief article by Laughren (1978) described how spatial terminology in Warlpiri is grammaticalised: every utterance involving location or movement includes compulsory suffixes on the verb which indicate direction.

Laughren's (1978) article was very important for both education and linguistics. It influenced educationalists such as P. Harris (1991) and directly or indirectly many others who talk about an Indigenous spatial strength. It is not always clear what a "strong spatial sense" actually is, nor what are the pedagogical implications of such a strength. It does not necessarily relate to formal mathematical shape. While Australian languages are rich in directional and locational terminology, they do not necessarily have words for shapes, particularly regular two-dimensional shapes which are rare in nature but common in school mathematics (P. Harris, 1991).

Laughren's (1978) article also helped stimulate a cross-linguistic investigation by a group of cognitive linguistics into spatial language and cognition. Members of the Cognitive Anthropology Research Group [CARG] at the Max Planck Institute for Psycholinguistics [MPI Nijmegen] noticed reports by Haviland (1993) and Laughren that speakers of some Australian languages talked about space very differently from speakers of Indo-European* languages (Pederson et al., 1998). Speakers of these Australian languages also seemed to think

about space differently, particularly in their spatial memory (Haviland, 1993). The CARG developed a set of investigative linguistic and non-linguistic tools which individual linguists applied in different communities across the world. These tools were specifically designed to explore relations between language and cognition.

One of the key findings of the CARG was regarding spatial *frame of reference*. Spatial frame of reference is a subsection of the language of space which describes where things are located with respect to each other using coordinate systems or angular specification (Levinson, 2003). There are three main frames of reference in the most widely used typology: *intrinsic**, using features of the objects to relate them (e.g., the man is in front of the tree), *relative**, using the point of view of the speaker to relate the objects (e.g., the man is to the left of the tree) or *absolute**, with reference to external landmarks or directions (e.g., the man is to the north of the tree). While many languages, including English and Iwaidja, have all of these frames of references, they vary greatly in the circumstances in which frame of reference will be preferred. In English, the absolute frame of reference is generally only used in describing large scale situations, such as the location of a city, but not for describing the location of a cup on a table. For table-top descriptions, English speakers prefer to use the relative frame of reference such as 'left' and 'right' (Barton, 2009; Levinson, 2003). In terms of the frame of reference typology, Warlpiri speakers' use of cardinal directions in small scale space (P. Harris, 1991; Laughren, 1978) demonstrates a preference for the use of an absolute frame of reference (Pederson et al., 1998).

Results from the CARG investigations have been used to support the *linguistic relativity* hypothesis (Levinson, 1997, 2003). Linguistic relativity refers is the idea that language affects the way that people think (Whorf, 1956). The relationship between language and thought is crucially important when considering the role of language in mathematics education. If a certain language facilitates thinking in a particular manner, this can have implications for mathematical cognition. However, an analysis of spatial frames of reference has not previously been applied in an educational context. A frame of reference analysis of spatial language promised to be useful in researching mathematics education in a multilingual context because it provides a way in which to describe differences in talking about space between diverse languages.

The choice to investigate a coastal language of the Top End, the northern part of the Northern Territory, offered the opportunity to expand the scope of what is known about spatial language in Australia. Although the perception of a strong spatial sense was widespread amongst teachers of Indigenous students who I encountered in the Top End, there has been

little research on spatial language of coastal languages in Australia. The research that contributed to the idea of an Indigenous spatial strength has generally come from desert regions in the interior of Australia. Frame of reference uses by Iwaidja speakers could therefore be expected to differ both from those of desert people such as the Warlpiri (B. Graham, 1988) and from those of speakers of Indo-European languages.

The central hypothesis of the study was that by better understanding the conceptual and linguistic spatial framework of their students, teachers would be better able to construct and teach an engaging and relevant mathematics program. Relevant means cognitively and linguistically relevant to students' prior knowledge, rather than relevant to, for example, their cultural goals. In this way, the project was designed to be *culturally responsive,* responding to language as a key element of culture. The study used a model of culturally responsive education which emphasised cultural *understanding* as an essential precursor to *responding*. This model, developed for the project, is described in Chapter 2.

The project was designed with two phases which had different and complementary goals. These two phases had separate methodologies and addressed different research questions. The design could thus be described as developmental (Greene, Caracelli & Graham, 1989). The phases were designed sequentially, but conceptually Phase I was in fact embedded in Phase II (Figure 1.1). The broader aims of culturally responsive mathematics education were addressed from a theoretical perspective of linguistic relativism.

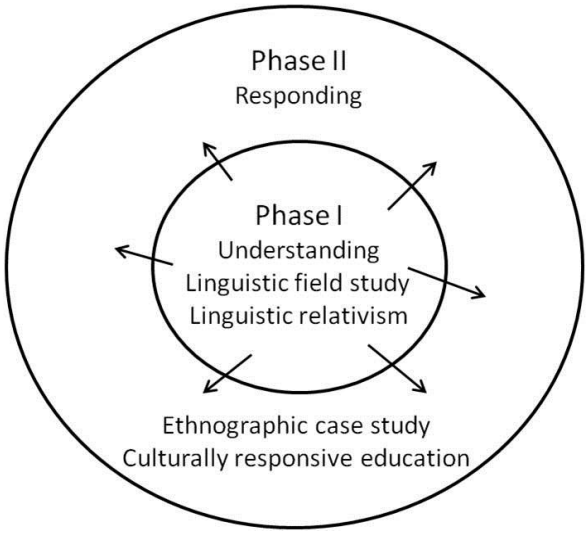


Figure 1.1. Relation of Phase I and Phase II

Phase I was a linguistic field study of spatial language in Iwaidja. This phase addressed the goal of *understanding*. The research question for this phase was:

1. How is frame of reference expressed in Iwaidja?

Phase II was an ethnographic case study of Early Years mathematics teaching at Mamaruni School. This phase was designed as the *response* to the understanding gained from the first phase. The research question for this phase was:

2. How can teachers' understanding of the frame of reference in Iwaidja be used to construct and teach a more culturally responsive Early Years mathematics program?

1.3 Thesis Structure

Chapter 2 will develop the theoretical and contextual background of the project. It will describe the model of culturally responsive education which I developed and used in the project. It will also consider the role of language as a medium of instruction in culturally responsive mathematics education, focusing on cognition and identity and discuss examples of culturally responsive mathematics education where language was a key element. It will provide background information on the Indigenous language ecology in Australia and how this impacts on mathematics teaching in remote Northern Territory schools.

Chapter 3 will focus on how mathematics and numeracy operate in, and interact with, language. It will consider mathematics as a culturally situated set of practices that vary in place and time, with language and with culture. It will consider both ethnomathematics and numeracy as involving mathematical practices in daily life (D'Ambrósio, 2006; National Curriculum Board, 2009). The chapter will also investigate cultural and linguistic variation in spatial language and thought, reviewing the spatial frame of reference literature, to establish the analytical categories that will be used throughout the study.

Chapter 4 will describe the research design and methods used in the study, including ethical and logistic issues involved with research in a remote Indigenous community. The two Phases will be described separately, since they involve different methodologies and different participants. Phase I consists of linguistic and non-linguistic tasks designed to elicit spatial language, particularly uses of spatial frames of reference. Phase II consists of an ethnographic case study of elements of mathematics education at Mamaruni School focusing on language and space.

Chapter 5 will describe the Phase I findings regarding spatial language in Iwaidja elicited from senior adult speakers and analysed according to the frame of reference typology developed by Pederson et al. (1998). It will discuss these findings throughout the chapter with respect to languages of Australia and the world, in reference to the detailed examples presented in the subsections of the analytic categories.

Chapter 6 will present the findings of Phase I regarding spatial language from Iwaidja speaking caregivers working with children and from children working together. In the context of a multilingual community where uses of languages are shifting and where languages are changing, this chapter will compare the caregiver and child findings to the senior adult data from Chapter 5. The data includes children speaking English, Kunwinjku or Mawng, as well as following directions in Iwaidja from adults.

Chapter 7 will report the results from Phase II of the project, combining teacher interviews with observations made from my own insider's perspective. An account of attempts to utilise of the Phase I findings in the Early Years mathematics program is embedded within this report. Although initially conceived as action research, the turnover of teachers in the school during the research period made sustaining an action research type collaboration difficult, hence the evolution of the design of this phase.

Chapter 8 will relate the findings of Chapter 7 to the issues developed in the earlier chapters. It will consider how mathematics teaching at Mamaruni School could be made more culturally responsive as well as some of the local and systemic factors that impede culturally responsive mathematics education.

Chapter 9 will present the key findings of the project in summary, including recommendations for teachers and planners, and directions for future research.

1.4 Acknowledging and Respecting Context

This study attempted to investigate spatial frames of reference and their uses as one aspect of Indigenous mathematics education in comparative isolation from the myriad of interrelated factors that affect teaching in a small remote school. However, the realities of the context necessarily impacted upon the project. Cross-cultural differences in communication and values, the competing priorities of school and ceremonies, the immediacy of language endangerment, and my own role as a Balanda researcher in an Indigenous community all affected the project's direction and outcomes.

It is well known that Indigenous Australians have a shorter life expectancy than other Australians. The effect of early death on a community was felt in the deaths in a single week in May, 2012 of two of the Iwaidja senior consultants, classificatory sisters Rae Girribuk and Joy Malwagag Williams. Their contribution to this project was invaluable, especially that of Joy. As a senior Traditional Owner of Croker Island, Joy encouraged and permitted the research to be carried out on her land. As a translator, she sat many hours with me

painstakingly deciphering mumbled recordings above the hum of cicada and generators, and patiently repeating words so that I could transcribe them. And as a friend she adopted me into the kinship system of Northwest Arnhem Land, giving me an identity so that I could start to become more than just "that *nuna* (white woman) from the school."

Freddy Gabiya, one of the parents who participated in the project, also passed away suddenly in August, 2012. While Girribuk and Joy were "old ladies," this man was barely into his forties and the father of young children. Early deaths are not unusual in Indigenous communities in Australia, and add trauma and grief to the factors affecting children's attendance and performance at school. Teachers who have been in communities for only a few months sometimes complain of children's absence due to funerals without comprehending the impact on family life of short lives within the intricate kinship networks that permeate every aspect of Indigenous community life. Although the families of these recently deceased people will not want to view the videos of their relatives speaking while their grief is still fresh, in time the recordings made for this project may provide a valued connection with the voices and thoughts of those who have been lost.

Every language expresses a cultural worldview and contains unique epistemic treasures. It is urgent to preserve some of these treasures before they are lost by the deaths of speakers of fragile languages and the switch of younger generations to other more dominant languages. I have heard that there are some young, fluent speakers of Iwaidja who live on an outstation far from any community, who do not attend school, and who have little knowledge of English or school mathematics. These children do not appear in this thesis. However, they are learning a way of knowing the world that may have as yet unexplored mathematical treasures. As one of the teachers interviewed for this project said about his Indigenous language speaking students, "I'm sure they've all had mathematical thoughts but not directed by the NTCF or directed towards the NTCF outcomes."

A major tension throughout this project was whether my goal was to use the Iwaidja spatial language to help children bridge to school mathematics, or whether it was to use the Iwaidja spatial language to develop children's mathematical understandings in a broader sense and perhaps to propose curriculum changes. I got the sense that the Balanda teachers at the school favoured the former. My own practice and inclination as a teacher in the school was towards the latter. I am interested in how diverse mathematical worldviews can expand our conception of mathematics and contribute to future innovations in mathematics, and hope that this thesis contributes to this goal.

Underlying this project is the question of the purpose of school education. School education can be emancipatory, providing people with knowledge, skills and resources in order to improve their living circumstances and enabling them in their life choices (Freire, 1968/1970). It can also be a homogenising influence (D'Ambrósio, 2006). Although closing the gap between school achievement of Indigenous and non-Indigenous students (Council of Australian Governments , 2009) seems like a worthwhile goal, a question that must be kept critically in mind is whether school education for remote Indigenous language speakers is operating as a disguised form of assimilationism.

Current pressures on Indigenous language speaking students and their teachers to achieve in mathematics are inequitable and sometimes counterproductive. When children are schooled in their home language, their Early Years mathematics learning can build on the knowledge and language that they bring to school. When they are not given this advantage but instead must learn *in* a foreign language while they are still learning to speak it, it is inequitable to expect the same outcomes in the first years of school. Culturally responsive mathematics education cannot be achieved in a hurry.

Chapter 2
Language in Mathematics Education

This study is concerned with a group of students defined by culture: Indigenous students who live at Minjilang, a remote community in the Northern Territory of Australia. Language is a fundamental element of culture: it is one of the primary means through which people express cultural membership as well as the medium through which they understand, interpret and relate with the world. Hence culturally responsive mathematics education includes taking account of the language used in the mathematics classroom and by the students out of school.

This chapter first describes the model of *culturally responsive mathematics education* that is used in the project, focusing on responding to language as a cultural element (§2.1). The review presented in this chapter will focus on key Australian and international examples which relate to language of instruction, rather than all the research literature on culturally responsive mathematics education, which covers broader topics.

The chapter then discusses *linguistic relativity*, a theoretical stance on the relationship between language and cognition which informed the study (§2.2). It considers the choice of language of instruction in mathematics education from both cognitive (§2.3) and identity (§2.4) perspectives, while providing definitions of language related concepts used throughout this thesis. Finally, this chapter examines the current situation of teachers in remote Northern Territory schools in terms of support for, or constraints on, being responsive to the linguistic context (§2.5).

2.1 Culturally Responsive Mathematics Education

This section describes the model of culturally responsive mathematics education used in the thesis (§2.1.1). I began using the description "culturally responsive" because it seemed to describe my intentions before I considered that the phrase already had a life and identity in the research literature. Hence I developed a personal model of culturally responsive mathematics education for this project which concords with how some other researchers have used the phrase, but I did not seek to apply any predefined theory of culturally responsive education. Underpinning my approach to education overall is a socio-constructivist belief that teaching and learning needs to build on the known (Ernest, 1998). This section then examines how this

might be done in a cross-cultural situation (§2.1.2; §2.1.3). Approaches based on descriptions of Indigenous learning styles are common in attempts to be culturally responsive, so some of that literature is also considered (§2.1.4). However, taking account of culturally shaped learning styles was a minor part of this project.

2.1.1 A Model of Culturally Responsive Education

Culturally responsive education takes account of students' cultural background. This is important in multicultural contexts where the culture of the school or teacher differs from that of the students, or where the education system has been inherited or adapted from another culture. Similar, but related is *culturally relevant education*. However, school mathematics can respond to individuals of different cultural backgrounds without being "culturally relevant."

I developed a model of culturally responsive education to articulate the perspective and purpose of my use of the phrase, rather than to critically analyse and assess the models and perspectives of other authors. There is a great deal of excellent literature regarding culturally responsive education. Many of the key points of culturally relevant mathematics education also apply to culturally responsive mathematics education and I have drawn on literature that uses both terms. Another related term is *culturally competent education*, used in *Make It Count* (Australian Association of Mathematics Teachers [AAMT], 2010–2014), a project to improve Indigenous students' mathematics and numeracy learning. Taking account of students' culture in their education has been the theme of recent collections focusing on mathematics education (Greer, Mukhopadhyay, Powell & Nelson-Barber, 2009) and on Indigenous education (Purdie, Milgate & Bell, 2011). Both these collections include chapters which focus on language (Moschkovich & Nelson-Barber, 2009; B. Devlin, 2011). Recent reviews of approaches to culturally responsive education include Griffiths (2011) and Nicol, Archibald and Baker (2010). However, much of this literature takes perspectives specific to the cultural milieus in which they are situated. My model is intentionally general rather than specific and attempts to consider what culturally responsive education approaches have in common: firstly, an educational environment in which the meeting of two or more different cultures, generally one belonging to the school (or school system) and often the teachers, and the other being that of the students necessitates a response from the school to the cultural difference; and a very broad analysis of what a *response* might be. The key to my analysis of response is to differentiate it from a *reaction*.

The model of culturally responsive education which I developed for this project has two main facets, *understanding* and *responding*. To respond to culture, we need to first understand

something about the culture, since responding without understanding is simply reacting. Two main elements of understanding are *knowledge* and *empathy*. Teachers need to *know* about their students' cultural backgrounds and histories (G. Gay, 2002; B. Graham, 1984; Malloy & Malloy, 1998) and take account of the linguistic environment (Gutstein, Lipman, Hernandez & de los Reyes, 1997; Tate, 1994). Teachers also need to *empathise:* create a positive learning community (G. Gay, 2002) and have a positive orientation towards the students' culture (Gutstein et al., 1997).

Responding then builds on the mathematics that children already know (Bucknall, 1995; B. Graham, 1984; Gutstein et al., 1997), uses the culturally shaped preferred learning styles of the students (Malloy & Malloy, 1998; Tate, 1994) and shapes the curriculum so as to make mathematics learning relevant (Malloy & Malloy, 1998; Tate, 1994; Torre-Velasquez & Lobo, 2004). While curriculum content can be developed to be culturally responsive, mathematics education can also be responsive in terms of sequence, and in terms of resourcing such as appropriate support material.

A *deep* understanding of the students' culture is essential for cultural responsive education. Without deep understanding, what goes under the name of culturally relevant or responsive mathematics "is too often a cheap shortcut that merely replaces Dick and Jane counting marbles with Tatuk and Esteban counting coconuts" (Eglash, 2000, p.20). C. Matthews, Watego, Cooper and Baturo (2005) also warn of presenting "Western pedagogies dressed up in superficial Indigenous motifs" (p. 518). Yunkaporta (2009) commented on the use of superficial cultural responses, saying "Aboriginal perspectives have been confused with Aboriginal themes" (Yunkaporta & Kirby, 2011, p. 210). From a study in Bermuda, L. Matthews (2003) gives examples of teachers attempting to build onto *what the teachers thought of* as prior cultural knowledge, which include eating in a local restaurant and calculations based in local import taxes. The students, however, had little firsthand experience of paying taxes or eating in the restaurant, and what in fact manifested were quite traditional (non-responsive) mathematics lessons.

There are various ways to acquire the knowledge required for understanding, depending on the type of knowledge. What is really crucial about this stage is that knowledge is not assumed. In many cases, this knowledge is best acquired through community consultation and collaboration with families and elders. Because the focus of this particular study is on language and cognition, the study used techniques from cognitive linguistics to acquire knowledge (see §4.3). The remainder of this section presents key examples of culturally

responsive mathematics education in terms of how their model and design might be suitable for this project.

2.1.2 Building on the Known

The approach to learning that influences this project is socio-constructivist (Ernest, 1998). Children construct meaning in an interactive and interpretive socio-linguistic process. Socio-constructivism implicitly underpins the current school system in the Northern Territory. For example, Vygotsky's (1978) Zone of Proximal Development is inferred when the *Northern Territory Curriculum Framework* [NTCF] (NT DET, 2009e) says that "learning is enhanced when learning opportunities are tailored to individual's current levels of readiness" (p. 12). However, the larger body of socio-constructivist literature has not directly influenced this thesis.

"Readiness" can be interpreted to mean both developmental readiness, and appropriate prior knowledge. Remote Indigenous children may come to school with different prior knowledge to that assumed in mainstream mathematics curricula. B. Graham (1984) was one of a group of researchers and educators who worked at Milingimbi, a remote Arnhem Land community, in the early 1980s. The research of this group is particularly relevant to this project due to Milingimbi's cultural and geographic proximity to Minjilang, the site of this study. Graham describes how Western teachers need to make use of what Indigenous children already know when they come to school for learning mathematics. She stresses that care and timing are required to introduce Western concepts and curriculum content. Graham's model (Figure 2.1) demonstrates a way in which an Early Years teaching approach makes use of the students' existing mathematical knowledge and practice.

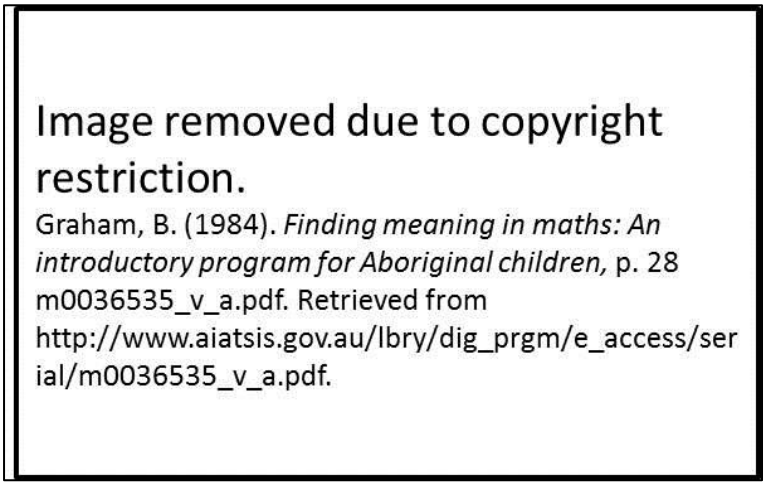


Figure 2.1. From the known to the unknown (B. Graham, 1984, p. 28)

In this model, *known* and *unknown* refer to the knowledge of the Indigenous student, rather than of the Western teacher. Students need many repeated experiences of the unknown Western mathematical content before they begin to use formal strategies with this content. Concurrently, the known Indigenous content can be talked about and recorded, so that the students are able to learn about learning, about the formal strategies of Western education. Critically, the known Indigenous content may be *unknown* for the non-Indigenous teacher. Thus this particular strategy relies upon both the participation and input of the local Indigenous teacher or assistant teacher, and the willingness of the non-Indigenous teacher to themselves be a learner about the Indigenous world, developing their empathy and knowledge. This type of collaboration in multicultural teams is more supported in some communities than in others.

There is a risk that attempts to build on what the child knows will focus only on what the child knows *of school knowledge.* This diagram from the *Make it Count* project (AAMT, 2010–2014) (Figure 2.2) declares the project's focus to be the intersection of child (cultural competency) and school (mathematics and numeracy) knowledges.

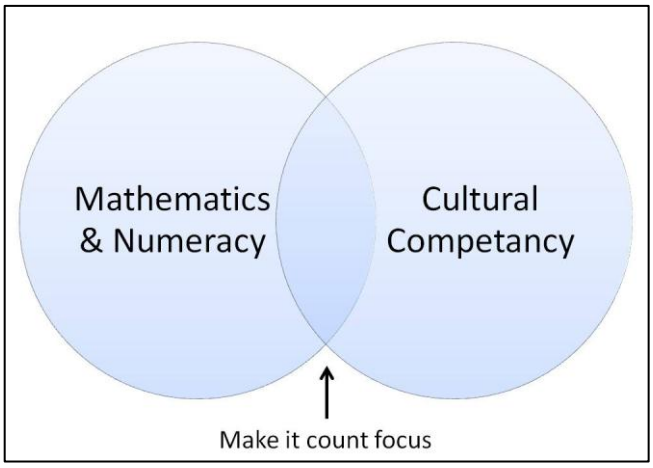


Figure 2.2. Intersection of child's knowledge and school knowledge (after AAMT, 2010–2014)

Focusing only on the intersection of child and school knowledges risks the child's knowledge being seen as deficient. For example, some authors describe Indigenous children as lacking mathematics vocabulary (Jorgensen, 2010; Kimberley Education District, 2000; Warren, Young & deVries, 2007). In order to increase the scope of our cultural responsiveness, we also need to look for pathways from the out-of-school realm of what the child knows into mathematics education (Figure 2.3).

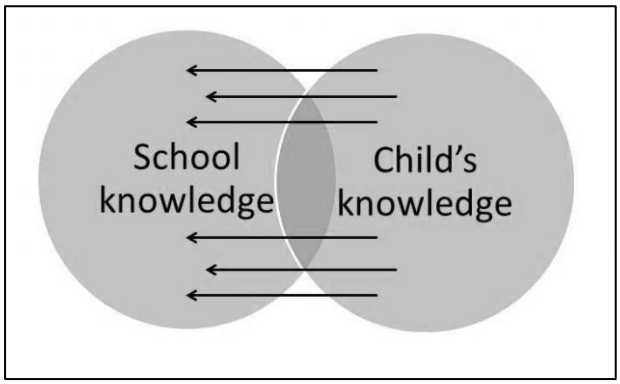


Figure 2.3. Moving from child's knowledge to school knowledge

2.1.3 Case Study: Yup'ik Mathematics Program

A culturally relevant mathematics program that builds on out-of-school cultural practices has been designed for Yup'ik students in Alaska. It is the result of a long term collaboration between university researchers, school based educators and Yup'ik elders (Lipka, 1994; Lipka & Ilutsik, 1995). The program draws on Yup'ik cultural practices such as the construction of fish racks and traditional embroidery designs, and can be taught both by Yup'ik and non Yup'ik teachers. It has demonstrated positive outcomes for students in a quasi-experimental setting using control groups (Lipka & Adams, 2004). Key factors in the success of the Yup'ik mathematics program are support at both community and system level, duration and the relatively large size of the Yup'ik population. This program brings in Yup'ik knowledge in order to improve performance in Western style mathematics. As in remote schools in Australia, the majority of teachers of Yup'ik children are English speakers of European descent (Engblom-Bradley, 2006). However, Brenner (1998) commented that the Yup'ik project "focuses on the cultural tradition dimension of cultural relevance with little consideration of the cognitive dimension" (p. 220). The distinction between *cultural tradition* and *cognition* is an important one for this study, which was oriented towards the cognitive dimension. There is the risk that deep cultural meaning can be stripped from cultural practices when they are used in school (Meaney, 2002; Vithal & Skovsmose, 1997). Using cultural practices in education needs to be done with sensitivity and respect.

2.1.4 Case Study: Native Hawaiian Creole

Brenner (1998) conducted a three phase study aiming to improve mathematics outcomes for Native Hawaiian children in the Early Years. Brenner's theoretical framework included the social and cultural content areas that she believed were being explored by other researchers, but she added the cognitive aspect, which she believed was being neglected: "Native Hawaiian children have culturally specific mathematical knowledge that can be detected by using research methods that tap into a cognitive dimension of cultural relevance" (p. 237).

This cognitive aspect was based around language. Most Native Hawaiian children speak Hawaiian Creole English, but only Standard English is spoken in Hawaiian schools. The first two phases of the study were based on gaining understanding. First, Brenner conducted an ethnographic investigation into the mathematics practices with which the children were coming to school. Then she conducted research with individual children that explored some of their cognitive knowledge and structures. Finally, she planned teaching activities as a response with the classroom teacher, which were then implemented in class.

Brenner had a Hawaiian Creole English speaker work with preschool children and, combined with written sources, found where the mathematical lexicons of Hawaiian Creole English and Standard English differed. She then tested the Hawaiian Creole English speaking children in both Standard English and Hawaiian Creole English, finding that they did better where the Hawaiian Creole English lexicon was used. For example, the children showed a greater understanding of the Hawaiian Creole English phrase *more little bit* than the Standard English word *less*. The main principles in the teaching activities included using Hawaiian Creole English as a bridge to Standard English when introducing new material and sequencing topics to start with children's strengths. Brenner's multiphase model is similar to the design of this study: first a linguistic investigation to *understand* the worldview of the children, and then a *response* to that understanding in relation to sequence and content of the curriculum.

2.1.5 Indigenous Learning Styles

Culturally shaped learning styles can also affect how students learn. While learning styles were not a major focus of this study, research and theory in this area influences many contemporary Indigenous education interventions. For example, Yunkaporta's (2009) *eight ways of Indigenous learning* inform some of the interventions implemented through the *Make It Count* project (AAMT, 2010–2014). The eight ways are:

- story sharing,
- learning maps,
- non-verbal,
- symbols and images,
- land links,
- non-linear processes,
- deconstruct/reconstruct, and
- community links.

Two members of the Milingimbi group, Christie (1985) and S. Harris (1987) influentially discuss learning styles of remote Northern Territory Indigenous students. Harris describes the characteristics of Indigenous learning styles as:

- observation and imitation,
- personal trial and error,
- real-life performance,
- successive approximation of the end product,
- persistence, and
- repetition.

Christie (1985) emphasises that the specific ontology (worldview) of Australian Indigenous students could lead them to have a "ritualistic" attitude towards formal schooling. In mathematics, he warns against hurrying to abstract teaching in mathematics before students are taught the meaning of what and why they are learning.

Based on a study from New South Wales (R. Nichol, 1988), R. Nichol & Robinson (2000) characterise Indigenous learners as:

- holistic,
- imaginal (visual),
- kinaesthetic,
- cooperative,
- contextual, and
- person-oriented.

There is also a small body of research that considers teachers' beliefs about Indigenous learning (e.g., Cooper, Baturo, Warren & Doig, 2004; Howard, 2001).

While the above characterisations can sometimes accurately reflect cultural traits, there is also the risk of overgeneralising and essentialising children's learning styles. The characteristic of "cooperative" learning is related to the characterisation of Australian Indigenous societies as collectivist. However, personal autonomy is another identified Indigenous value (H. Watson, 1988). Researchers were surprised to find very remote Indigenous students in the Northern Territory more competitive and social power oriented than non-Indigenous students and urban Indigenous students in a large-scale quantitative psychometric study (McInerney, 2012). Similarly, while each of the above descriptions include visual learning in some form, Indigenous children could be expected to vary as individuals in their preferences for verbal or visual learning (Bishop, 1980; McGee, 1979). For this reason, culturally shaped learning styles were not a major part of this project.

2.1.6 Conclusion to Culturally Responsive Mathematics Education

The model of culturally responsive mathematics education used in this project is premised on the need for deep understanding of the culture in order to respond rather than react. It requires building on the knowledge that children bring to school, which may not be what the school

wants them to know. Culturally responsive education may need to be creative in looking beyond what in some circumstances is a narrow intersection between school and child knowledges. It is wary of classifying the learning styles of Indigenous students as a group when they may vary as individuals. It seeks to respond to the cognitive dimension of culture rather than what may be superficial manifestations of cultural tradition. While the eventual goal is to assist children in learning, it is predicated on the idea that the researcher and/or teacher first have learn about what the children know.

2.2 Learning through language

This section provides background on the key theories of learning and cognition that formed the foundation of this project. Language is a cultural element which has cognitive impact as well as forming part of cultural tradition. The combined effects of learning *in* a language while learning that language has implications for instructional design in terms of *cognitive load* (§2.2.1). This section also describes *linguistic relativity*, a key theoretical underpinning of the project (§2.2.2). A discussion of linguistic relativity in relation to number is used to analyse some of the literature on Australian Indigenous mathematics (§2.2.3).

2.2.1 Cognitive Load

Language is a key tool for learning but it is also learnt itself. Tomasello's (2009) usage-based theory of language acquisition states that children learn language not through processes of attention and imitation, but also through *intention reading*. That is, children pay attention not just to what adults say, but also to what they intend, a significant point in situations of language shift (§2.4.2). As Simpson and Wigglesworth (2008) point out, there have been few studies of language acquisition in the multilingual non-literate societies in which most Indigenous language speaking children in Australia grow up (§2.4.1). The *Aboriginal Child Language Acquisition Project* (2004–2007, 2008–2012) is a notable exception.

Students who are still learning the language through which they are also learning mathematical content, as is the case with the students of Minjilang, have multiple learning requirements. *Cognitive load theory* provides a tool to analyse the learning requirements in such multilingual learning environments. According to Paas, Renkl & Sweller (2003) learning tasks have three sorts of cognitive load: intrinsic, extraneous and germane. The working memory has a fixed load limit and these types of load have an additive relationship. I am concerned with the earlier versions of the theory that focused on the relationship between intrinsic and extraneous cognitive load (Sweller, 1994; Sweller & Low, 1992). The fixed load

limit of the working memory is an important factor in instructional design, where the goal is to reduce the extraneous cognitive load and free more working memory for the intrinsic cognitive load. This is relevant to the design of mathematics lessons in a language with which the students are not yet fluent. While the main aim of a lesson may be mathematical, the language learning requirements, which could be regarded as extraneous, may take up a great deal of the students' working memory. Where the extraneous cognitive load is too high for the students to actually learn what the teacher plans them to learn, the situation can be described as *cognitive overload*. Cognitive load theory is therefore a useful tool for thinking about how the goals and outcomes of mathematics lessons in these situations might be achieved.

2.2.2 Linguistic Relativity

Language is one of the key elements in defining many cultures (§2.4.1; Lambert, 1974). Language also shapes the way that we see the world. Speech development intertwines with conceptual development: "the speech structures mastered by the child become the basic structures of his [sic] thinking" (Vygotsky, 1934/1986, p. 51). Since different languages have different structures and categorise the world differently, they promote different conceptual developments. The idea that language affects the way that people think, and that people who speak different languages think differently, is known as *linguistic relativity*. This term was coined by the American linguist Benjamin Whorf (1956) and the idea is also widely known as the Whorfian Hypothesis.

The linguistic relativity hypothesis exists in two forms. The strong form is that language *determines* and *constrains* thoughts. The controversial idea that certain thoughts are not possible in particular languages has been explored in various science fiction novels, such as *Nineteen Eighty-Four* (Orwell, 1954) and *Babel-17* (Delany, 1966). The weak version holds that language *influences* our thoughts and behaviour. As Whorf (1956) himself put it, "people act about situations in ways which are like the ways they talk about them" (p. 148). How a language expresses things and what it *must* express thorough the imperatives of grammar, as opposed to what it *may* express, has an impact on what the individual is likely to think and to do. It doesn't mean that people cannot understand concepts that are not commonly expressed in their language. Lucy (1992a) distinguishes *habitual thought* from both *specialised thought* and *potential thought.* He claims that linguistic relativity relates to *habitual thought.* This is relevant to mathematics education, where habitual thought can affect approaches to problem solving. This is a motivation for looking deeply into language for a deep understanding of the students' mathematical background. Specialised thought can also permeate a culture's potential thought. Halliday (2004) states that:

> Scientific discourse has been instrumental in constructing and maintaining extraordinarily complex ideological edifices, and the grammar has evolved to make this discourse possible. In the process, the grammar has been reconstruing the nature of experience. (p. 210)

From this perspective, language affects what we pay attention to in the world, how we conceive it and perhaps how we perceive it.

The linguistic relativity hypothesis is contentious, as shall be seen below (§2.2.3). The argument over which of language or cognition precedes the other can become a "chicken and egg" problem (Christie, 1985). However, Evans (2001) finds in studies of linguistic relativism that "different cognitive preferences snugly follow idiosyncratic asymmetries in the linguistic system" (pp.168–9) in a way that is highly unlikely to be simply co-evolution.

2.2.3 Examples of Linguistic Relativity in Number

Some investigations into linguistic relativity effects regarding number have focused on languages from Australia and Brazil which have very few number words. The debate exemplifies the different attribution of causality that some researchers bring to the issue of linguistic relativity. It also provides further context to this study of Australian Indigenous mathematical concepts.

In some cultures, including many Indigenous Australian cultures, quantification is less important than in others (J. Harris, 1987; Rudder, 1983). In a detailed study of classification by the Yolngu of Elcho Island looking at measurement, number, colour and ethno-biology, Rudder (1983) concludes that the Yolngu favour qualitative over quantitative thinking. Their number names, he claims, are not counting words but rather "these terms enable a precise qualitative description of quantities which require only a cardinal perception of number. There is no necessity for any ordinal perception to precede its establishment" (p. 82).

A 'typical' Australian counting system is seen as one that has number words for 'one', 'two', perhaps 'three', and 'big mob' (e.g., Dixon, 1980). Traditionally, Wik Mungan (from the Torres Strait) had only a single unique number name: a word for exactly 'one' (Sayers, 1983). The words for 'two', 'three' and 'five' ('hand') had approximate values. Fingers and toes could be used to indicate larger number, but without number names. Some other Australian languages spoken in coastal and island Northern Territory with more extensive number systems traditionally used elements of a base-5 system such as in Yolngu (Cooke, 1990) and Anindilyakwa (Stokes, 1982). Tiwi used a decimal system up to 99 (McRoberts, 1990). However, the larger numbers – numbers above three – were traditionally used in few contexts, such as the division of foods such as turtle eggs (Cooke, 1990; Stokes, 1982).

These Australian languages emphasise the use of small numbers through their dual and triple grammatical categories in addition to the single and plural categories of a language such as English (Cooke, 1990; Sayers, 1983; Stokes, 1982). While English makes a grammatical division between one item (singular) and more than one (plural), these languages must specify grammatically exactly two and sometimes exactly three items. Hale (1975) speculates that the small number names in Warlpiri are not counting words at all, but are instead grammatical "determiners" or tags.

Swetz (2009) differentiates between quantitative and qualitative counting. He describes a mother listing her children, using the one-to-one correspondence of their names to count them: "This is an example of qualitative counting where one knows the objects of concern so well that cardinality as a descriptor is irrelevant" (p. 14). It is different from abstract counting which uses pattern recognition and ordering, that is, ordinality. This abstract process, he says, may not be present even in cultures which have developed number words, giving the example of the seven different counting systems of the Thimshian people of Canada, each of which is used for counting a different type of object (cf. §3.4.4.3).

J. Harris (1987) questions Rudder's (1983) interpretation of Yolngu number systems as non-counting, and Hale's (1975) attribution of Warlpiri numbers to a grammatical rather than counting category. He does this out of concern that Indigenous cultures and people will be perceived as deficient in this regard. Traditionally, he says, "Aboriginal and Torres Strait Islander people counted as far as they needed or wanted to count" (p. 35). This is different from not being *able* to count. Rapid cultural change has continued in remote communities over the past twenty or thirty years, and there would today be few Indigenous people who do not use large numbers in their daily lives, particularly with money. Nevertheless, Harris concedes that large numbers and quantification are not strong features of traditional Indigenous culture in Australia.

Experiments in Australia have shown that monolingual Warlpiri and Anindilyakwa speaking children in the Northern Territory are also to match small collections of objects in one-to-one correspondence (Butterworth, Reeve, Reynolds & Lloyd, 2008). Butterworth et al. claimed that these Indigenous children "with very restricted number vocabularies possess *the same numerical concepts* [italics added] as a comparable group of English-speaking indigenous Australian children" (p. 13179). However, a similar ability to match small collections of objects in one-to-one correspondence between groups of people does not necessarily mean that they have the same numerical concepts. Success with small quantities compared to larger ones could be related to having number words for small quantities, or it could because of the

use of *subitisation*, that is, the instant recognition of the size of a small collection without counting. Subitisation is a recognised strategy for students to use in early enumeration and calculation (e.g., NSW DET, 2001).

Similar experiments have been conducted in Brazil. The Amazonian Pirahã people speak a language that has number words only for 'one', 'two' and 'many' (Gordon, 2004; Everett, 2005). The Munduruku, also from the Amazon, have number words up to five (Pica, Lemer, Izard & Dehaene, 2004). Studies into their number abilities show that both the Munduruku and Pirahã are able to match small collections of objects in one-to-one correspondence (Gordon, 2004; Pica et al., 2004). The Munduruku are also able to make evaluations of larger collections in an approximate manner, such as telling which collection is larger than another (Pica et al., 2004). Gordon identifies the Pirahã strategy with small quantities as subitisation, which he calls parallel individuation.

Casasanto (Casasanto & Gordon, 2005) challenged the interpretation of the Pirahã results as a demonstration of linguistic relativity on the grounds of causality, and proposed a historical explanation. Retesting found that although Pirahã performed well on some number matching tasks, language definitely appeared to be a factor in a reduced performance on numerical tasks involving memory (Frank, Everett, Fedorenko & Gibson, 2008). Both Casasanto and Gordon (2005) note the complexity of attributing causality in these matters.

In fact, the Australian language speaking children in Butterworth et al. (2008) used a very different strategy to the English speaking children. The Warlpiri and Anindilyakwa children preferred and were successful with a spatial strategy, reproducing the way the objects were arrayed in the stimulus, rather than using enumeration (Butterworth & Reeve, 2008; Butterworth, Reeve & Reynolds, 2011). The claim is that "counting words, far from being necessary for exact arithmetic, offer one strategy among others" (Butterworth et al., 2011. p. 630). This research demonstrated that people without number words have abilities and strategies for dealing with numerosities. But it is much harder to see how they can be considered to have *the same numerical concepts* as people who count with words.

The converse of this research is the investigation of whether certain types of counting systems improve the ability to perform arithmetic tasks. Some East Asian languages such as Chinese, Korean and Vietnamese have regular, transparent base-10 counting systems. The regularity of these counting systems means a smaller memory load than irregular systems such as in English. This has been found to correlate with arithmetic success (Geary, Bow-Thomas, Fan & Siegler, 1993; Nguyen & Grégoire, 2011; Song & Ginsburg, 1988; Wong, Taha & Veloo,

2001). It is another instance of linguistic relativity. However, other studies attribute arithmetic success among these East Asian cultures to personal, familial and cultural motivation (Swetz, 2009).

Understandably, the claim of a Whorfian effect seems to generate more controversy when it can be used to suggest a deficiency, as in the case of the Pirahã or Munduruku languages, rather than a superiority, as in the case of Korean or Chinese. Since when we talk about languages we are also talking about peoples and cultures, we need to be careful that a claim for an increased or decreased ability is not used to reinforce hierarchical ideas about peoples and cultures. The findings of Butterworth et al. (2011) are important because they show different groups of people using different strategies rather than focusing on a lack or deficiency in one group.

The balance of the evidence shows that people who do not have counting words, perhaps because historically they have not felt the need to invent and use them, have different concepts of number than people who have and use counting words. Although the Pirahã, Munduruku, Warlpiri and Anindilyakwa can all subitise small quantities and match concrete collections, their use of memory in tasks involving quantities differs from that of English and French speakers. People with few number words think differently during these tasks than people who have many.

There is a deficit perspective hidden in some of these investigations into numerical thinking of people who do not use large number words very much. Those two or three numbers of the above language groups sit in the small intersection between child's knowledge and school knowledge that was shown in Figure 2.2. It is difficult to avoid a deficit perspective in a discussion of people not using numbers because Western culture and mathematics education values quantification so highly. Accepting that quantification is not a traditionally valued cultural practice in Indigenous cultures of Northern Australia, I chose not to use number as the mathematical focus for this project. Nevertheless, the studies mentioned in this section help establish linguistic relativity as a firm theoretical foundation for the present project.

2.2.4 Conclusion to Learning through Language

The languages that people speak, particularly those they learn as a child, affect their worldview and their thought processes. Research into numerical cognition from Australia and elsewhere demonstrates this convincingly. However, issues of fluency can contribute to cognitive overload in mathematics lessons where students are not fluent in the language of

instruction. These things need to be taken into account when designing mathematics programs for Indigenous language speaking students.

2.3 Language of Instruction and Cognition

The choice of language of instruction is important to this study because the Indigenous students who are the focus of the study are not being taught in their first language. To begin with, this section provides definitions of *first* and *second language* (§2.3.1) and of *language distance* (§2.3.2) as they are used in the thesis. It then looks at language of instruction in mathematics, considering some of the reasons why school systems choose whether or not to teach mathematics in the students' first language (§2.3.3) and the cognitive implications for students of this choice (§2.3.4).

2.3.1 Definitions of *L1* and *L2*

There are various ways of describing the languages that people learn in different phases of their lives. Some of these assume that people start with one or at most two main languages. The first language that a person learns to fluency is often called their *mother tongue*, their *native language*, their *home language* or their *first language*. This is often abbreviated to L1. In this thesis, I use these terms interchangeably in most contexts. A first, native or mother language is taken to be a language learnt as a child to fluency, in which the person is comfortable communicating in a wide range of contexts, such as at home, in the community and in places of business. Because some families may live in environments where their home languages are not spoken in the community, individuals may nevertheless be fluent in a language spoken only in their home. An *additional language* is often called a *second language* or L2.

However, in societies where multilingualism is the norm, these two main categories may not hold. In Northwest Arnhem Land, people may have a *mother language* and a *father language*. Although they may learn their mother language first, from their mother, they identify with their father language and as adults are expected to speak it fluently (Elwell, 1982). It would be considered their main language, not an L2. The phrase *second (or additional) language* can be used for a language which the individual speaks with a lower level of fluency and comfort than their L1(s). Educationally, they may be in the process of acquiring this language and with time, especially for children, an L2 may become an L1. I shall also use the phrase *preferred language* in some contexts to refer to a language in which a person feels comfortable

interacting, thinking and working. In Northwest Arnhem Land, it is normal for people to be fluent in more than two languages.

2.3.2 Language Distance

Sometimes languages from different families which are spoken in a similar geographic area share both vocabulary and underlying concepts (Evans, 2010). The idea of *language distance* is tool which we can use to understand how the relationship between language and mathematical thinking might work in a multilingual context. According to Halliday (1978) it is "a general principle whereby languages that belong to the same cultural region tend to be alike in the meanings they employ" (p. 199). Halliday also terms it *areal affinity*.

Languages can be understood to be closely related, as in Italian and Spanish, or more distantly related, as in English and Sanskrit, which are both in the Indo-European language family. Languages from different families are likely to have more differences from each other than languages which are descended from a common linguistic ancestor. The more distant or different languages are, the more likely are their concepts to differ. Language distance as used in this thesis refers to how different languages are from each other in meanings. It is used a general way, and should not be taken to reflect a quantifiable distance.

The concept of language distance is sometimes used in language learning situations as a factor in the comparative ease or difficulty in learning an additional language. If the language is more different and thus more distant from those the learner already knows, it may make learning more difficult than one that is quite close (e.g., Elder & Davies, 1998). This is more because of similarity in "ways of meaning" between languages with an areal affinity than in structure (Halliday, 1978). H. Watson (1988) describes Indigenous children who learn traditional Australian languages and English as *radically bilingual* due to the differences in semantic structures between the languages. For speakers of Australian languages

> the conceptual basis of the social processes which grow from the semantic structures of language, and which underlie the form of life, are remote from the conceptual structures of the social processes of European Australia, which grow from the semantic structure of Indo-European languages. (p. 262)

The ways that Australian languages make meaning are very different to Indo-European languages.

Language distance can be used to understand difficulties in learning mathematics in an additional language. J. Berry (1985) describes two types of language related difficulties in learning mathematics in an additional language. *Type A* is a difficulty regarding fluency in the language of instruction: "Remedial strategies are linguistic, not mathematical – the treatment

is to improve the learner's fluency in the instructional language" (p.20). *Type B* difficulties occur when there is a greater distance in the cognitive structures between the languages of the student and of instruction. Research on language in mathematics education which focuses on questions of fluency such as whether students understand the words that the teacher is using are *Type A*. *Type B* difficulties are an effect of linguistic relativity. Both these types of difficulties are relevant to this project. Difficulties related to linguistic relativism, *Type B* difficulties, are more likely in mathematics learning situations where there is a greater language distance between the preferred language of the learner and the language of instruction. Iwaidja and other languages of Arnhem Land are greatly distant from English.

2.3.3 Language of Instruction in Mathematics

Language of instruction is a key issue in education. A standard model of school education has a single language shared by the teacher, the students and the school system including textbooks and examinations. This idealised monolingual model does not reflect the reality in large parts of the word. Teachers and students may not share a preferred language due to different ethnic or geographic backgrounds. Immigrant students are schooled in the language of their new country, not their home country. In other cases, teachers and students may share languages, but schooling may be in different language, especially in countries such as Indonesia where "only the national language can be used in an educational program" (B. Devlin, 2011, p. 49).

English is a language that is often used in schools where it is not the first language of the children. This occurs not only as a vestige of English colonialism, but also because of the role English has assumed as an international language of commerce and of science. English medium mathematics instruction occupies a prestigious position globally. For example, in 2003 Malaysia introduced a policy that mathematics and science be taught in English. Many parents supported this move as they felt it would be to their children's advantage once they reached university, and help them to access international communications such as material on the internet. However, most of the Malay teachers had received their own education in Malay and were not necessarily prepared to teach in English (Heng & Tan, 2006). Many teachers also didn't feel their students learnt best in English and frequently code-switched to use mother tongues – Malay, Chinese and Tamil – in the classroom in addition to English (Lim & Kor, 2011). Code-switching is the practice of multilinguals to switch between languages in conversation and can occur for a variety of reasons. In this case it occurred because teachers felt their students would better understand and learn mathematics in their mother tongues. Because the benefits of learning mathematics in English were seen to be in conflict with the

benefits of learning in the mother tongue, in 2009 Malaysia announced that it would be reversing the policy of teaching these subjects in English (The Associated Press, 2009). However, note that not all Indian Malay students speak Tamil, nor do all Chinese Malay students speak Mandarin, so the code-switching may not have helped these students.

2.3.4 Cognitive Benefits of L1 Instruction

The cognitive advantages of education in one's home language are recognised in Early Years curriculum documents in countries such as Canada, Sweden and New Zealand (Victorian Curriculum and Assessment Authority, 2008). Research shows that where students are trying to learn mathematics in a language in which they are not yet fluent, the outcome may be impaired learning (Cummins, 1979; Dutcher & Tucker, 1997; López, 2000; Pinnock & Vijayakumar, 2009). For example, the difficulty of word problems in mathematics can be exacerbated for those learning in an additional language (Bakalevu, 1999; Lean, Clements & Del Campo, 1990; Menon, 1998). Put simply, "many children who are expected to learn mathematics in classrooms where their native tongues are not spoken simply do not comprehend what their teachers and textbooks are trying to communicate to them" (Ellerton & Clements, 1991, p.33). Similarly, Lowell and Devlin (1998) found that "the use of a language of instruction in which children do not have sufficient competence is the greatest barrier to successful classroom learning for Aboriginal children." (p. 386). Trying to learn the language of instruction while at the same time learning mathematics produces an extraneous cognitive load (Sweller & Low, 1992) which can impede mathematical learning. Cognitively, it is easier for children to learn mathematics in a language in which they are fluent.

The NTCF recognises that consolidating home language skills before learning in another language is also seen as beneficial for the eventual learning of the additional language (NT DET, 2002). The interdependence principle developed by Cummins (1979, 1989) explains that education in the first language aids learning of, and in, a second language: "The level of L2 competence which a bilingual child attains is partially a function of the type of competence the child has developed in L1 at the time when intensive exposure to L2 begins" (1979, p. 233). This is supported, for example, by a longitudinal study of Inuktitut speaking children in Canada's Arctic which showed that first language skills at Year Three were an indicator of future success in English or French (Usborne, Caouette, Qumaaluk & Taylor, 2009). A study that compared the mathematics achievement of bilingual Punjabi, Mirpuri, Italian and Jamaican children learning in English found that "the ability of the child to make effective use of the cognitive functions of his first language is a good predictor of his [sic] ability to reason deductively in English as a second language" (Dawe, 1983, p. 349).

A systematic review of research on Early Years English language acquisition examined the evidence for and against the benefits of bilingual schooling for Indigenous students (Silburn, Nutton, McKenzie & Landrigan, 2011). It found that "the opportunity to learn 'at year level' academic work in L1 benefits minority language children in their long term achievement as well as successful acquisition of a second language" (p. 35).

While learning in English at an early age can help with learning English, it does not assist learning in other areas if English proficiency is low:

> between 4–6 years is required to reach proficiency and parity for English language learners with native speakers. This time is necessary to develop cognitive academic language proficiency and the ability to use a second language for context reduced and intellectually challenging tasks. (Silburn et al., 2011, p. 40)

The issue is not one of whether a child will receive no schooling in English. What is called first language instruction in Australia and similar countries such as Canada generally does not mean education only in the home language, but includes bilingual programs that support the mother tongue while they introduce English or other national language. A common model is a step approach, where the Early Years of school are in the mother tongue and the language of the nation such as English is gradually introduced over a number of years (B. Devlin, 2011; Pinnock & Vijayakumar, 2009; Purdie et al., 2008).

2.3.5 Case Study: Papua New Guinea

In light of the advantages of learning in a first language, Papua New Guinea has made a switch from teaching in English to teaching in many vernacular (local indigenous) languages. The island of New Guinea is perhaps the most linguistically diverse region of the world (Wurm, 1977). The official languages of Papua New Guinea today are English, Tok Pisin (a creole) and Hiri Mutu. Vernacular (local indigenous) languages are known as 'Tok Ples'.

Papua New Guinea inherited an English language education system from its time as an Australian colony. A reform of the education system occurred in the 1990s towards the use of the vernacular in the Early Years of primary school. English was often the third or fourth language of the students, and of the teachers. Learning in English appeared to be disadvantaging the students compared to native English speakers (P. Jones, 1982; Lean, et al., 1990). A step model of language instruction was introduced. Schooling now begins in local languages and a transition to English occurs in the third year of primary school, with the amount of English increasing over the next two years (Department of Education Papua New Guinea, 2004).

The implementation of this has been complex and specific issues related to teaching mathematics in multiple vernacular Papuan languages are discussed in §3.2.4. The switch from teaching only in English to teaching in many languages required training local teachers to teach students from their own communities in their own languages. Through the 1960s and 1970s Papua New Guinea changed from the majority of school teachers being English speaking foreigners to training and employing predominantly local teachers. This required significant political will and systemic support and a major factor in this was Papua New Guinea's development as an independent nation (Philip Clarkson, pers. comm., 28 February, 2012).

2.3.6 Bilingual Programs and Indigenous Teachers in Australia

Australia has also attempted to teach students in some Indigenous languages spoken by small populations. Beginning in 1973, bilingual programs were instituted in some remote Northern Territory schools, using a step model (B. Devlin, 2011). Although there is similarity between Papua New Guinea and northern Australia in terms of multilingualism, there are today very few Indigenous teachers in Northern Territory schools (Fordham & Schwab, 2007). A successful bilingual program requires trained teachers who are fluent in the languages of instruction; with indigenous languages, this generally needs to be local indigenous people, as in Papua New Guinea. In the 1980s there was support in the Northern Territory for Indigenous assistant teachers to qualify as teachers (Santoro & Reid, 2006). Some Indigenous language speaking people from remote communities trained as teachers at Batchelor Institute for Indigenous Tertiary Education [BIITE] and then became teachers in their own communities.

Some of the bilingual programs that were established were also bicultural, separating local Indigenous knowledge and Western school knowledge into distinct domains, known as Two Way schooling (S. Harris, 1990). Part of the motivation for this was the belief that Western schooling might promote values at odds with those of the Indigenous community and people. An example of the Indigenous side of a Two Way program in mathematics is the Garma program from some Yolngu communities in Northeast Arnhem Land, which used the elaborate Yolngu kinship system to explore recursion (Ganambarr Stubbs, Ganambarr Whitehead & Munungurr, 2010; Watson-Verran, 1992). The Garma maths program is widely cited as an exemplar of culturally responsive mathematics education (e.g., Dickenson-Jones, 2008; K. Jones, Kershaw, & Sparrow, 1995; C. Matthews et al., 2005; Robinson & Nichol, 1998). However, keeping the domains of Indigenous and Western knowledges separate, as in the Two Way schooling model, does not encourage the domains to be

responsive to each other. The Western domain remains culturally unresponsive. Christie (2007) reports that Western pedagogies such as the split between teaching and assessing are felt by the Yolngu to be unethical. He questions whether they are necessary at all in teaching mathematics to Yolngu students, advocating a teaching approach that is culturally responsive overall.

There has been erosion in systemic support for bilingual schooling in the Northern Territory (Nicholls, 2005) and very few communities are currently able to sustain a bilingual program. Over the past 20 years there has also been a decrease in the number of Indigenous language speaking teachers trained (Calma, 2008; Simpson, Caffery & McConvell, 2009). This decrease has been attributed to changes in the courses at BIITE:

> BIITE had run in-community remote area teacher training courses, and pre-training courses. Speakers of Indigenous languages had actively been encouraged to train as teaching assistants and teachers and were given support in their communities while training. But when BIITE moved its focus towards becoming a university, its efforts shifted away from helping students in remote areas increase their literacy and numeracy towards recruiting Indigenous students with tertiary-level entry standards of literacy and numeracy. BIITE attracted many students from interstate who did not speak traditional languages. (Simpson et al., p. 17)

Changes to income support for Indigenous tertiary students in 2000 also had a negative effect on Indigenous teacher training enrolments (Calma, 2008).

The lack of political support in Australia for education in Indigenous languages and Indigenous teacher training over the past few decades has meant it has not been possible to provide the majority of Indigenous language speaking students with instruction in their own languages. There are signs of recent increases in support for training Indigenous teachers. In 2008, a joint venture between Catholic Education NT and Charles Darwin University called *Growing Our Own* began training Indigenous teachers in their communities, with visits from lecturers, rather than teacher trainees having to relocate to Darwin or Batchelor (Thornton, Giles, Prescott & Rhodes, 2011). More recently, the Northern Territory Government has implemented the *More Indigenous Teachers* program, the *Remote Indigenous Teacher Education* (RITE) programme and the *Indigenous Teachers Upgrade* program to increase the number of Indigenous teachers (NT DET, n.d.3). These measures will take some time to show their impact on Indigenous education in the Northern Territory.

2.3.7 Conclusion to Language of Instruction

The cognitive benefits of learning mathematics in a first language are well understood. However, knowledge of major world languages, and English in particular, offer benefits to students in terms of access to power and information. Countries make different choices with

respect to these different benefits. Papua New Guinea has implemented the teaching of mathematics in local vernacular languages in the Early Years of school. Malaysia tried teaching mathematics in English but has recently returned to teaching in home languages. Teaching in home languages requires substantial systemic support. This support has been lacking in the Northern Territory, where government policies have valued English over learning in a home language.

2.4 Language and Identity

This section considers the relationship between language and identity in Indigenous Australia, particularly Northwest Arnhem Land, the location of the present study (§2.4.1). Identifying with a language is a major part of how a people distinguish themselves from other people (Lambert, 1974). Frequently, the name of a group of people is the same as the name of their language. This relationship between language and identity is another powerful reason that people may want school instruction in the language of the cultural group. Consideration of this relationship is an important part of culturally responsive education. Since almost all Indigenous Australian languages can be considered endangered (McConvell & Thieberger, 2001), this section also provides necessary definitions of language endangerment and language shift (§2.4.2). It looks at the example of Māori medium mathematics education in New Zealand, where teaching in the language of identity and culture has helped revitalise the language and culture (§2.4.3). This is contrasted with language policy in the Northern Territory (§2.4.4).

2.4.1 Language and Identity in Australia

In Australia, language, identity and land are related. Languages are associated with groups of people and they have geographical associations. Part of Australia's linguistic diversity of can be explained by an active tendency towards language differentiation between quite small groups of people (McConvell, 1988, 1991). The map in Figure 2.4 shows the diversity of languages in Northwest Arnhem Land at the time of first European contact, with over 20 languages spoken in an area only a few hundred kilometres in extent. This includes languages from over five different language families.

Languages in the region are associated with clan membership and land ownership. Because marriage generally occurs outside the clan, a child frequently has parents who speak different languages. Traditionally, these societies are thus inherently multilingual (Evans, 2001). Although a child may learn to speak their mother's language first, they are likely to consider

their father's language to be their own language (Elwell, 1982). Because of the association of language with clan and land, a person's willingness to admit or claim to speak a language is tempered by their right to that language (Evans, 2001). A person may speak and understand a language but be unwilling to claim it due to not having rights towards it. A person may also claim a language, but due to language shift not be able to speak it.

Figure 2.4. Languages of West Arnhem Land (Evans, 2000, p.94)

Information about who speaks what languages is thus not neutral information in these societies. This is relevant at Mamaruni School, where students may have their clan language affiliations recorded with their enrolment data, but this may not be the same as the languages that they actually use. Mamaruni School records data of parent language affiliations for each student. Iwaidja is the most frequently recorded as language of mother, father or both parents, although it is not the most frequently spoken. Gaining an overview of who speaks which languages in the community and school is a complex and sensitive matter. When I asked the assistant teacher in the Early Years class which languages the children in the class knew and spoke, she said I would need to ask their parents. This was not because she did not know, but because she did not have the right to say. Research regarding the language use of children in this context needs to be conducted with the awareness that language use and language ownership is political.

2.4.2 Language Endangerment and Language Shift in Australia

Language shift occurs when a group of people cease to speak a language and begin to speak another. When a language is not spoken by anyone anymore, it is called *language death*. Reasons for language shift are often explored in the situation of *language endangerment*, when such a shift may mean that the demise of the language. Understanding these processes is important for this study since most remaining Australian languages are endangered (McConvell & Thieberger, 2001).

Languages may die because of the devastation of a speech community by war or disease, or because of displacement of a people. Or they may die as a result of *cultural assimilation*, where the new language is associated with prestige, power, economic gain and education (Crystal, 2000; Kulick, 1992; Wong Fillmore, 1991). Note that prestige is a complex notion and some languages which appear to have a low status are quite stable, such as Haitian Creole (Mufwene, 2004). When services are controlled by people who speak one language, others people will need to speak that languages to access the services (Tsunoda, 2005).

The *perceived difficulty* of a language becomes a factor when the above factors conducive to language shift are in play (McConvell, 1991). This occurred with Taiap, a language spoken in just one village in Papua New Guinea, whose decline was the subject of a detailed anthropological study. Taiap speakers regarded their own language as "a little bit hard," and outsiders never learned it (Kulick, 1992, p.196). Many intricate languages are stable in other situations for a long time, and perceived difficulty is probably a lesser factor in language shift than the relative political and economic dominance of the languages (Tsunoda, 2005). However, it is a factor worth considering in Australia, where very few non-Indigenous people ever learn Australian languages.

Language shift can occur over several generations or in just one (Tsunoda, 2005). Many of the Australian languages that are still being spoken today may be in their last generation (McConvell & Thieberger, 2001). In terms of just the languages originally spoken on and around the Cobourg Peninsula (Figure 2.4), Garig, Wurrugu and Ilgar have no speakers left, Marrku is understood but not spoken by one speaker and Amurdak has only a couple of speakers left (Marrala et al., 2008a, cf. Evans, 2001). Those languages which remain are all endangered, but continue to be important to the personal and clan identities of Indigenous people of the region.

An additional factor in language shift that has special significance for education is attitudes towards multilingualism. Wong Fillmore (1991) claims that people are more likely to lose

home or heritage languages through learning an additional language in societies where linguistic diversity is not valued. Evans (2010) states more generally that "it is the belief that humans are monolingual, rather than the presence of world languages *per se*, that is the crucial factor in determining whether communities maintain their own language" (p.213). On the other hand, Kulick (1992) found multilingualism, specifically people's acceptance of being replied to in a different language to the one they are talking in, to be a factor contributing the demise of Taiap in Papua New Guinea. This practice of speaking to people in a language they might understand but not speak is also common in the multilingual communities of Northern Australia (Evans, 2001; Harkins, 1994). McConvell (2008) claims that in Australia language policy in education is dominated by a belief in monolingualism as the norm. This means that Australian languages and English are seen to be in competition in schools where students speak Australian languages.

Australian languages are currently under threat from cultural assimilation. This does not mean that all language shift is occurring from Australian languages to English; in some cases the shift is to other Australian languages (§2.5.1; §6.1). However, the use of a language in school education, among other measures, can assist in reversing language shift or effecting language revitalisation (Crystal, 2000; Fishman 1991; Grenoble & Whaley, 2006).

2.4.3 Case study: Māori Immersion and Revitalisation

In terms of the importance of cognition and identity in choosing language of instruction, the Māori immersion education program in New Zealand is an interesting counterpoint to the examples given in §2.3. In the 1980s Māori language medium schools were established as part of a language revitalisation program, as te reo Māori, the Māori language, was endangered. These were immersion schools where English was banned. However, due to language shift, the first language of most students and teachers had become English. At first, education in te reo Māori potentially put students at a cognitive disadvantage in their mathematics learning due to learning in a second language (Meaney, Trinick & Fairhall, 2011). And after years of schooling in Māori and learning mathematics in Māori, today students may have difficulty with the use of English in mathematics in tests, at university or at another school (Meaney et al., 2011).

Most cultural groups who want education in their own language want it for both identity reasons and for the cognitive advantage of using their home language. For the Māori, the importance of strengthening Māori language, culture and identity was more important than the short term cognitive benefits of using English. From being severely endangered, today a

quarter of Māori aged 15–64 can hold a conversation in te reo Māori (Statistics New Zealand, 2007). This demonstrates that a language revitalisation program with enough local and systemic support can be successful.

2.4.4 Language Policy in the Northern Territory

Literacy and numeracy are skill sets that can be and are achieved in many languages. There is a powerful perception in Australia that numeracy and literacy need to be achieved in English (Commonwealth of Australia, 2000). The measurement of literacy and numeracy in English only, as in the National Assessment Program: Literacy and Numeracy [NAPLAN] tests, helps perpetuate the perception that these are skill sets that are linked to English. The Federal Government's Indigenous languages policy stated that it would support the teaching and learning of Indigenous languages in Australian schools (Garrett & Macklin, 2009). However, the policy juxtaposed its statement of support for bilingual schools with statements about the necessity for Indigenous Australians to learn English, and to improve numeracy and literacy outcomes (Garrett & Macklin, 2009). This conflated improving numeracy and literacy outcomes with learning English.

In 2009 the Northern Territory Government introduced the *Compulsory Teaching in English for the first four hours of each school day policy* (NT Government, 2009). This is also referred to as the *First four hours in English policy*. This policy mandated that all teaching in Northern Territory schools in the first four hours of each day be in English, which effectively banned bilingual education. The policy was explicitly directed towards Indigenous students with the stated aim of improving literacy and numeracy outcomes. As justification, the Northern Territory Department of Education invoked data that supposedly showed lower results in these areas for bilingual schools than for comparable school in which instruction was only in English (NT DET, 2008, cited in B. Devlin, 2010). These data have been criticised as being invalid for comparing unlike schools, being biased in sample choice and ignoring confidence intervals (B. Devlin, 2010, 2011). As already mentioned (§2.3.6), government support for bilingual programs in the Northern Territory had been gradually decreasing since the 1990s despite a lack of hard evidence that they were any less effective than English-only programs in similar schools (B. Devlin, 2011; Nicholls, 2005).

The Northern Government policy contradicted international expectations regarding support for Indigenous languages. In the same year, Australia became a signatory to the United Nations Declaration on the Rights of Indigenous Peoples (2009) which states:

> Indigenous peoples have the right to establish and control their educational systems and institutions providing education in their own languages, in a manner appropriate to their cultural methods of teaching and learning. (Article 14.1)

It further calls for governments to take measures to assist indigenous peoples to do this (Article 14.3).

As we saw (§2.4.2), lack of support for bilingual programs for endangered languages can contribute to the language's demise (Crystal, 2000; Fishman 1991; Grenoble & Whaley, 2006). The need for bilingual programs in endangered languages is different from the needs for bilingual programs in other world languages, such as French or English. French is spoken by millions of people; if it is not spoken in Australia, or Canada, or learnt by Franco-Australian children, it will nevertheless continue as a strong world language. As in Canada, Indigenous languages in Australia are spoken by few people in few communities. If they die out in those communities, it means the total death of those languages (Taylor, Usborne & de la Sablonnière, 2008). As an Indigenous community member said in the R. Collins (1999) report:

> Aboriginal language is Australian. English, French, is foreign, from overseas. Or Chinese. If their parents come from overseas and are in Australia, they can go back to that country and learn it again, or books. If it is an Aboriginal language it is very hard. It is only in human beings. (p. 120)

The history of Australian languages as oral languages without a written tradition increases their vulnerability to rapid death. English-only education only can contribute to children not using home languages whereas their use in education could be a factor in their survival (Fishman 1991; Wong Fillmore, 1991).

Despite research showing that children learn better in their own languages (§2.3.4), use of Australian languages has been perceived by Northern Territory policy makers to be in conflict with the acquisition of English, literacy and numeracy. There was widespread opposition to the *First four hours in English policy* on the part of schools, community members, language experts and others (Standing Committee on Aboriginal and Torres Strait Islander Affairs [SCATSIA], 2012). In July 2012, the Northern Territory replaced the policy with the *Framework for learning English as an additional language policy* (NT DET, 2012a) which states:

> Home/local languages can and should be used where appropriate to support the learning and acquisition of concepts. There will be times, particularly in the early years, when it may be better to introduce concepts using the home/local language. This is good teaching practice and is to be encouraged. This is the Department's approach for English as an additional language learning and one that is used across Australia and internationally. (p.1)

While more supportive of Australia languages and the needs of their speakers than the *First four hours in English policy* was, note that the core goal of the 2012 policy is still the learning of English. The *First four hours in English policy* was in place during the period of research for this study.

2.4.5 Conclusion to Language and Identity

This section has shown the importance of language to groups of people as part of their cultural identity. In Northwest Arnhem Land, the multiple languages that people speak map their social relationships. However, as the majority of Australian languages, most of these languages including Iwaidja are endangered.

The use of people's language in education can an important recognition of their culture and in situations of language endangerment is one factor that can strengthen a language. A good example of this is the Māori immersion schools. However, the Northern Territory policy regarding the use of language in education is focused toward the acquisition of English. The Northern Territory policy has switched towards support for home languages but only in as much as this is regarded as beneficial for the eventual learning of English.

Necessary conditions for teaching mathematics in indigenous languages include qualified teachers who are native speakers and high level systemic support. Countries such as Papua New Guinea and New Zealand have implemented mathematics programs in indigenous languages, despite difficulties, because they have had the political will to do so. In the Northern Territory these necessary conditions do not exist and Northern Territory policy may in fact be contributing to the rapid demise of Australian languages.

A mathematics program using a local language at Mamaruni School was not a feasible goal for this project since no local languages were formally being used for instruction. Research into mathematical aspects of Iwaidja, however, could contribute to the prestige and thus the vitality of Iwaidja. Many children at Mamaruni School who do not speak Iwaidja identify with it as their mother language or father language. The project thus responds to the identity function of Iwaidja in the community.

2.5 Teaching Mathematics in English in the Northern Territory

Mathematics is taught in English in many Northern Territory communities, including Minjilang Community, the site of this study. This section looks at some further language

related factors that affect teachers who are teaching mathematics in English in remote Indigenous communities. Firstly, I consider the way remote Indigenous students learn and speak English (§2.5.1). Then I look at how teachers are prepared and supported to teach in these contexts in terms of training in English as a Second Language methodologies (§2.5.2) and the availability of targeted mathematics resources and programs (§2.5.3).

2.5.1 Indigenous Students Speaking English

Some of the language shift in Australian Indigenous communities is towards another Australian language. For example, some people on Croker Island whose families previously spoke Marrku or Amurdak now speak Iwaidja or Mawng. Some language shift is towards a contact language (creole) such as Kriol. Kriol developed from the contact between English and Australian languages. It has an English based vocabulary and a grammar derived from Australian languages and is spoken by around 10,000 Indigenous people in the Northern Territory (Ethnologue, 2012). And some of the shift is towards English. Where Indigenous Australians are speaking English, it is likely to be one of the varieties known as Aboriginal English, rather than Standard Australian English.

Aboriginal English refers to a variety of distinctive dialects of English spoken by Indigenous Australians. It has been spoken across Australia since early Indigenous encounters with the English (J. Harris, 1984). For many Indigenous Australians, Aboriginal English is their first language. It can also be an additional language for those who speak Australian languages as their home languages, many of whom live in remote communities.

Aboriginal English differs from Standard Australian English in ways that are common to other non-standard varieties of English, for example, using the double negative. It has also been influenced by Indigenous Australian languages. Important Indigenous cultural information such as traditional kinship relations has expression in Aboriginal English but not in Standard Australian English. An example is the use of *cousin-brother* to refer to the son of a paternal uncle or maternal aunt, but not that of a maternal uncle or a paternal aunt (Butcher, 2008). This reflects traditional kinship classifications where the children of men and their brothers are classified together, and the children of women and their sisters are classified together, but the children of sisters and brothers are classified differently. Aboriginal English thus allows Indigenous people to express their own concepts and worldviews in ways that are not possible in Standard Australian English (Konigsberg & Collard, 2002; Malcolm, Kessaris & Hunter, 2003).

H. Watson (1988) locates the languages spoken by Indigenous Australians as types on "a continuum of change in the semantic structure" (p. 257) (Figure 2.5).

Figure 2.5. Spectrum of everyday language of Aboriginal groups (H. Watson, 1988. p. 257)

H. Watson (1988) associated Aboriginal English with urban communities. The Aboriginal English spoken in remote communities is probably closer towards the Australian (Aboriginal) language end of the semantic continuum than urban varieties.

Like many other dialects of English, Aboriginal English is often regarded as sub-standard English both by speakers and non-speakers of the dialect (Butcher, 2008). Creoles are also often regarded as substandard language varieties. For example, Dawe (1983) found that Jamaican Creole was considered to be 'broken English' by its speakers. This view can be shared by some teachers who appear to feel that "the aim of teaching standard Australian English [is] to replace an inferior home language" (Frigo et al., 2004, p. 53).

Labov (1969, 1972) broke new linguistic and educational ground when he argued that Black American English had its own logical consistency and that its speakers were not linguistically deficient. Similarly, Aboriginal English has its own internal rules and logic:

> Aboriginal English is not only an independent linguistic system but also (in many respects) an independent conceptual system in which English words carry distinctive meanings and are used to from patterns of discourse which are interpreted by Aboriginal people according to shared rules and which are not accessible to people outside their culture. (Malcolm et al., 2003, p. 107)

Where teachers do not speak local Indigenous languages, students are likely to use Aboriginal English to communicate with their teachers. Although the Northern Territory Department of Education would like all children to become fluent in Standard Australian English (NT DET, 2011b), there are powerful reasons for Indigenous people to speak Aboriginal English. These include the semantic function (Butcher, 2008), as well as the identity function (Harrison, 2004; Konigsberg & Collard, 2002). In remote communities, Aboriginal English is used between Indigenous people, and Standard Australian English is only used in communication with outsiders.

Angelo (2011) points out that teacher awareness the languages that Indigenous children speak can itself be seen as a continuum. That is, some teachers are more aware than others of language and dialectal differences in their students. Teachers of Indigenous students need awareness of the differences between Aboriginal English and Standard Australian English (Konigsberg & Collard, 2002; Malcolm et al., 1999; Warren et al., 2007). Since Standard Australian English is a foreign language in many remote communities, teachers need to recognise their students' Aboriginal English as a valid dialect, while teaching Standard Australian English as an *additional* dialect.

Although there have been bilingual teaching programs in Kriol and English (R. Berry & Hudson, 1997), there has never been a teaching program specifically in Aboriginal English. Although teachers can be worried that using Aboriginal English in class will impede students' learning of Standard Australian English, careful use and explicitly contrasting between the two dialects can assist students (Frigo et al., 2004; Malcolm et al., 2003; Malcolm et al., 1999). The method of "contrastive analysis" is a bidialectal approach that can increase student's metalinguistic awareness, enabling them to use both Aboriginal English and Standard Australian English (Epstein & Xu, 2003). The NTCF (NT DET, 2002, 2009a) explains some of the similarities and differences between Kriol, Aboriginal English and Standard Australian English in the context of teaching Standard Australian English. It encourages conscious and explicit code-switching between Aboriginal English and Standard Australian English. As a policy document that supported this approach stated:

> For schools to put standard Australian English in an oppositional relationship to the home language, for example, by making it the only recognised vehicle of oral communication in schools, will be to invite resistance, whether active or passive, on the part of Indigenous students. It follows that teachers need to develop an informed understanding of, at least, Aboriginal English to enable them to understand and communicate effectively with Indigenous students. (MCEETYA & Curriculum Corporation, 2006, p. 17)

However Harper (2011) is concerned that categorising Indigenous children who speak Aboriginal English as "non" English speakers can deny them recognition of their English language skills. Nevertheless, recognition of their dialect is necessary in order not to categorise them simply as poor speakers of Standard Australian English.

2.5.2 English as a Second Language Methods and Training

One of the difficulties in remote Northern Territory schools where the teaching is in English is inadequate support for English as a Second Language (ESL) methodologies. ESL support funding for Indigenous language speaking students is lower per capita than ESL support funding for new arrivals to Australia and does not take account of the increased costs

associated with remote locations (Commonwealth of Australia, 2008). Remote schools, even large ones, have not had specialist ESL positions in their staffing (Lowell & Devlin, 1998). Few teachers in remote communities are trained in ESL methodologies (Commonwealth of Australia, 2005; Heslop, 2003). Some teachers receive ESL training through the Northern Territory Department of Education or Charles Darwin University. This training is focused on the teaching *of* English as a Second Language than teaching *in* English as a Second Language, and likely to focus on the teaching of English literacy (e.g., NT DET, 2011b; Charles Darwin University School of Education, 2011). The NTCF section on ESL covers Listening, Speaking, Reading and Writing (NT DET, 2009b). These are the same categories as the English section. As well as improved ESL training, teachers need assistance in applying ESL strategies to teaching mathematics (Commonwealth of Australia, 1995).

Current Northern Territory policy is that all teachers with ESL students should use ESL methodologies (NT DET 2012a). This does not mean that only teachers with ESL training will be employed to teach ESL students. The recent *Our Land, Our Languages* report (SCATSIA, 2012) recommends that all teaching degrees include compulsory English as an Additional Language or Dialect (EAL/D) training, and that all teachers in schools with a high proportion of Indigenous language speaking students also be required to complete EAL/D training.

2.5.3 Assistant Teachers

One way that Northern Territory schools cater for the linguistic and cultural learning needs of Indigenous language speaking students is the provision of local Indigenous assistant teachers who work in a team with non-Indigenous teachers. There is a diversity of skill levels and experience among Indigenous assistant teachers in remote schools. In some classrooms, the assistant teacher is the most experienced educator in the school. In other classrooms, the assistant teacher has no experience or educational expertise. Their role may vary both according to these factors and depending on the school and the teacher with whom they are teamed. One of their main roles is "to make comprehensible to the students the non-Aboriginal teacher's discourse" (Moses and Wigglesworth, 2008, p. 130). The assistant teacher may translate or clarify what the teacher has said. At times the assistant teacher may do this so subtly that the teacher does not even realise they are doing this (Lowell & Devlin, 1998). The effectiveness of the assistant teacher is greatly affected by school level support for joint planning between teacher and assistant teacher (Lowell & Devlin, 1998). In my experience, not all schools provide suitable joint planning time.

2.5.4 Resources

Indigenous language speaking students in Northern Territory remote schools are taught and assessed in English using the ESL curriculum, but they are taught and assessed mathematics against the same English language curriculum as mainstream urban English-speaking students. It is difficult to find support material directed towards teaching mathematics in an ESL context.

Talking Namba (NT DET, 2011c) is a program which was developed to support Indigenous assistant teachers in remote schools teach about number. It includes video materials in Djambarrpuyngu, a Yolngu language and in Kriol as well as English. The program is based on diagnostic probes ideally conducted in first language by Indigenous teachers. It is an outcome of the *Building Community Capital* project which aimed to increase the involvement of Indigenous assistant teachers in mathematics (Siemon, Bradbury, Johnstone & Virgona, 2010). It is unusual in that mathematics resources in Australian Indigenous languages are rare.

Number as practiced in school mathematics is traditionally not a strength or focus of Australian Indigenous language or society (§2.2.3). Because number is comparatively less developed for Indigenous children when they come to school, a common approach is to "remedy" this:

> there is a clear emphasis on developing skills in basic arithmetic at all levels of the primary schools we visited, rather than building on the extensive knowledge of areas such as space and measurement that ... these children bring from their home communities. (Thornton et al., 2011, p. 250)

The focus on number skills is a deficit approach. The Northern Territory Department of Education appears to support this approach through its endorsement of programs that focus primarily on number (NT Government, 2009). Neither of these programs, *Count Me in Too* (NSW DET, 2001) nor *Quick Smart Numeracy* (L. Graham, Pegg, Bellert & Thomas, 2004) was developed with a focus in Indigenous or ESL students.

Count Me in Too [CMIT] (NSW DET, 2001) is a program which targets the number area of mathematics. It links diagnostic assessment with teaching strategies and a detailed range of individual, small group and whole class activities. An Indigenous version was also produced with some minor differences from the mainstream version (Howard & Perry, 2002). It was developed with NSW Indigenous students in mind, who do not generally speak Australian languages (Australian Bureau of Statistics, 2011).

The *Quick Smart* program is designed to improve the speed of students' response and their use of problem solving strategies (L. Graham et al., 2004). It is an intervention which requires

additional trained staff to implement. Many projects which have been designed to quickly improve Indigenous students' performance, and which have done so successfully, have relied on extra resourcing such as small group withdrawal (McRae, 2000). They are not implementable by an individual teacher without extra support.

At the end of 2010, the *Remote Schools Curriculum and Assessment Materials* [RSCAM] (2010) were made available to teachers in remote schools. RSCAM provides lesson plans, curriculum links (NT DET, 2009d) and links to resources for how to teach the content. The materials were trialled across the Northern Territory in 2008–2010. The RSCAM materials form a cycle that covers four years and were designed to take account of the brief tenure of many teachers in remote schools by providing a scope and sequence that could be easily taken up by an incoming teacher. The materials were developed with the multi-age classes of many remote schools in mind and are grouped into four age-related groups: the Ignition Years (Preschool and Transition), Early Primary (Years 1–3), Primary Years (Years 4–6), and Middle Years (Years 7–9). They acknowledge Indigenous students as ESL learners by making reference to the use of home language to explore concepts and reflect on learning. These materials were not yet available when this project was begun, but were used in 2011 by one of the teachers interviewed for the project (§7.2.2.4). Many of the activities require the use of an interactive whiteboard and in many cases also require internet access. Although the resource packs describe the lessons as a "sequence," the *Spatial location and movement* package, for instance, jumps from location to shape and back in a non-sequential manner.

The Northern Territory Department of Education and Training website (NT DET, 2012a) also hosts sets of multi-level mathematics lesson plans targeted towards Indigenous students. For example, within Shape there are four lessons in Location which each cover Key Growth Point 3 (KGP) and Band 1[1] outcomes as well as including advice for providing extra support for pre-KGP3 students. The extra support advice is targeted towards children who do not yet speak English, for example:

> Instructions will need to be limited to one at a time and could require L1 support – this will help determine whether they have the concept and simply need to learn the English words or whether they need to develop the positional concepts in both L1 & English. (NT DET, n.d.4, p. 9)

The lesson plans also include a note on links to the first language:

> Depending on the language, learners may have ready access to vernacular terms describing these directions & positions. If the translated meaning is not exactly the same,

[1] See §3.4.5, Table 3.2 for correlation between KGP and Band levels and school Year levels.

> however, this can be confusing. It is best to develop the vernacular concepts at a different time. (NT DET, n.d.4, p. 9)

How concepts might be developed in the home language, or how teachers might know whether the translated meaning is the same are not elaborated.

The Northern Territory Department of Education and Training website also has a resource a called *Designer Maths* (NT DET, 2005) which describes ten lessons in Shape and Measurement targeted towards Indigenous students. It uses the "Do, Talk, Record" strategy which is an ESL teaching/learning model that involves children first experiencing through sensory activities, then verbalising in order to understand and finally recording in order to organise their learning (B. Graham, 1984). This strategy was also used in *Mathematics in Indigenous Schools* (NT DET, 2000), a set of books with sequential lesson plans that was produced by the Northern Territory Department of Education in the late 1980s and re-released circa 2000.

Some older resources that were developed for use with remote Indigenous students include *Mathematics for young children: a handbook of activities for Australian teachers* (Western, 1979) and *Maths in Context* (NT DET & Bubb, 1993). While these resources contain detailed lessons plans, they don't have links to the current curriculum.

One of few books on the topic, Perso's *Improving Aboriginal Numeracy* (2003) provides thoughtful and well researched suggestions for teaching strategies across the curriculum. It is densely written however, and without lessons and sequencing it is of limited use for the busy teacher. Because teachers in remote schools in the Northern Territory are generally inexperienced and undertrained for the context, they are in need of relevant, quality resources including lesson plans that they can pick up and use, and that link to the curriculum.

The RSCAM (2010) resources, which were not yet available when this project commenced, have tried to incorporate the needs of the remote school context. RSCAM materials suggest talking about concepts in home language, while the older Northern Territory Department of Education resources suggest "It is best to develop the vernacular concepts at a different time" (NT DET, n.d.4, p. 9). However, the process of developing the *Talking Namba* program revealed that in many cases there are no easy translations of school mathematical concepts into Indigenous languages (Bradbury, 2011, 2012). Developing a mathematics register in a language is discussed in §3.2.4. There is still the need for targeted mathematics resources that build on what children know and that respond to the children's linguistic background.

2.5.5 Conclusion to Teaching Mathematics in English in the Northern Territory

In the Northern Territory, most teachers in remote schools teach mathematics in English, a second or additional language for their students. There are both cognitive and cultural identity reasons why Indigenous students learn to speak Aboriginal English rather than Standard Australian English. Few of the teachers are adequately trained for the specificities of this situation. There are limited targeted mathematics resources, and teachers do not always have access to these resources. There is clearly the need for better teacher preparation in mathematics in English as a second or additional language and for more relevant resources.

2.6 Conclusion

This chapter has established the importance of language in culturally responsive mathematics education. Languages shape how we think and different languages facilitate different cognitive strengths. We have seen that using the home language or language of identity as language of instruction is a very powerful element of being culturally responsive. In the Northern Territory, many Indigenous language speaking students are being schooled in English, missing out on the benefits to their learning and identity that could be provided by home language instruction. Until more local Indigenous people qualify as teachers, most teachers in Indigenous communities will continue to be English-speaking outsiders. Furthermore, most of these teachers are inadequately prepared and resourced to teach mathematics in Standard Australian English to students who speak Australian languages. In order for teachers to be more culturally responsive, they need to build on what the children know including their out-of-school knowledge. This requires research into specific mathematics concepts in Australian languages, in order to develop an understanding of the mathematical background of the students. Methods from linguistics are an appropriate choice for this type of research. The next chapter will look at a suitable area of investigation, focusing on finding a cognitive and linguistic strength.

Chapter 3
Mathematics in Language and Culture

While Chapter 2 focused on the role of language in mathematics education, this chapter focuses on mathematics itself, considering how mathematics varies with language and culture, how it operates within language, and how it is affected by the language in which it operates. It looks at both numeracy and ethnomathematics from this culturally and linguistically situated perspective. It considers which mathematical concepts would be a suitable focus for a culturally responsive mathematics program for Indigenous language speaking students, based on reports of a cognitive and linguistic strength in the area of spatial language. It discusses a typological framework of describing spatial language that can be used to compare languages and reviews the literature on variation in spatial language according to this typology. It also demonstrates how the same framework can also be used to illustrate whether the mathematics curriculum does or does not concord with the normal developmental sequence of spatial concepts in different languages.

3.1 Mathematics and Language

The relationship between mathematics and language involves more than the issues of choice of language of instruction and learner fluency in mathematics education which were discussed in Chapter 2. The way that mathematics operates in language and is intertwined with language also has implications for mathematics education (§3.1.1). This section also considers an interpretation of that relationship as one of co-evolution (§3.1.2).

3.1.1 Mathematics Through Language

Although mathematics is often contrasted with natural language, mathematics itself operates in language. We need to use language to perform mathematics and to learn mathematics. As H. Watson (1988) says, "Children learn to do mathematics by learning to mean with mathematics words" (p. 262). The use of symbolism in written mathematics can mask the complex relation between mathematics and language. But the symbols of mathematics are not mathematics itself; rather they are a shorthand for the mathematics (Austin & Howson, 1979; C. Matthews, 2008). C. Matthews (2008) describes the epistemology of mathematics as a cyclical movement of abstraction from perceived reality to the symbolism of mathematics and

critical reflection on whether the abstraction fits the observed reality. This is represented in Figure 3.1.

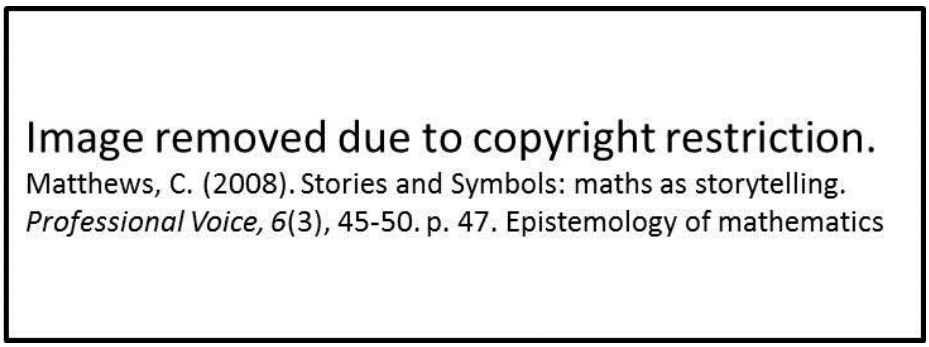


Figure 3.1. Epistemology of mathematics (C. Matthews, 2008, p. 47)

Students need to know that the symbols are not mathematics itself:

> Symbols are the product of the abstraction process and, consequently hold the meaning behind the real-world concept that is being modelled. It is therefore important that we teach the meaning behind mathematical symbols, instead of simply presenting them, so that students can recognise how mathematical concepts are related to their own perceived reality. (Sarra, Ewing, Matthews & Cooper, 2011, p.175)

Written symbolic mathematics is possibly one of the densest forms of communication that humans have developed (Halliday, 1978, 2004). However, the conversations of mathematicians talking maths can be structurally similar to other types of conversation (Barton, 2009; K. Devlin, 2001). Halliday (2007) describes the differences between spoken and written language in terms of density:

> The complexity of speech is choreographic – an intricacy of movement. That of writing is crystalline – a denseness of matter. In linguistic terms, spoken language is characterised by complex sentence structures with low lexical density (more clauses but fewer high content words per clause); written language by simple sentence structures with high lexical density (more high content word per clause, but fewer clauses). We could express this even more briefly, though at the cost of distorting it somewhat, by saying that speech has complex sentences with simple words, while writing has complex words with simple sentences. (p. 77)

Mathematics has a spoken and a written form. One of the key roles of the mathematics teacher is talking: taking the crystalline symbolic language of the mathematics text and expanding it through the use of lengthy and complex sentences (Schleppegrell, 2007). This is distinct from *revoicing*, the rephrasing of student discourse in more technical terms, which is also an important role of the mathematics teacher (Moschkovich, 1999).

Thus even in monolingual teaching environments, the relationship between language and mathematics affects learning. Understanding the mathematics register, "the mathematical use of natural language," (Halliday, 1978, p. 195) and how it differs from everyday speech, is

necessary to do mathematics. Some words used in mathematics have only technical meanings but many have both an everyday meaning and a specific mathematical meaning, for example, "odd" and "right" (Menon, 1998). Confusion about this can be a problem in mathematics learning (Menon, 1998; Schleppegrell, 2007). The phrasing of word problems also influences student performance even in their native language (Laborde, Conroy, De Corte, Lee & Pimm, 1990; Lean et al., 1990; Menon, 1998). Children often try to detach from challenging word problems and get to the solvable number problems (Ellerton & Clements, 1991). Teachers can find it more difficult to revoice for students when the student is trying to express themselves in a language in which they are not fluent (Moschkovich, 1999).

Although the same or similar written symbolic mathematics can be used by speakers of different languages, it can be more difficult for those who speak languages with very different grammar from the grammar of symbolic mathematics. For example, Shimada said that

> in Japan the interaction of language and mathematics education is one of the most important problems, since we use the same mathematical symbolism as yours, which was largely developed in harmony with Indo-European language culture, in a culture having a language with a quite different syntax. (cited in Austin & Howson, 1979, p. 176)

As an example, in English the small joining words such as prepositions are of crucial importance in mathematics (Commonwealth of Australia & Council of Australian Governments, 2008; Dawe & Mulligan, 1997; Jorgenson, 2010; MacGregor, 1990). Many of these words such as 'in', 'on', 'at' and 'by' can be classified as *topological**, relating to concepts such as proximity and enclosure (§3.4.4; §3.5.4). The topological information which is expressed in English in spatial prepositions may be expressed differently in other languages, such as through case marking. In languages that mark case, dependent nouns are inflected, often with a suffix to indicate their relationship to the head noun of a phrase (Blake, 2001). In Arrernte, as in many Australian languages from the Pama-Nyungan family, case is marked as a suffix as in example (2-1).

(2-1)

Artwe amperele aneme.

Artwe-ø	*ampere-le*	*ane-me.*
man-NOM	camp-LOC	sit-NPST

'The man is sitting in camp.' (Wilkins, 2006, p. 30).

In this example, 'man' is the head of the phrase and his location 'in' camp is indicated through the locative case suffix *–le.* NOM indicates the nominative case and NPST is a non past tense marker. A full description of how to read the linguistic examples in this thesis is given in §5.1. Turkish is another language that marks case through suffixes. This has implications for how mathematical concepts are expressed (Barton, Lichtenberk & Reilly, 2005).

Comparing Turkish and Arrernte might be more fruitful than comparing English and Arrernte for the purposes of mathematics education.

The difference in grammatical expression of similar concepts in different languages is likely to have an impact on mathematics learning and teaching. Those who note that Australian languages tend not to have the same range of spatial preposition to use in mathematics as English note it to encourage teachers to be aware of this fact, not to reinforce a deficit perspective of Indigenous students learning mathematics (Commonwealth of Australia & Council of Australian Governments, 2008; Jorgenson, 2010). However, a more equitable approach would be to ask ***how*** *different languages express those mathematically useful spatial concepts* that English and other Indo-European languages express through prepositions.

3.1.2 Co-evolution of Mathematics and Language

This introduces a very important point in the relationship between language and mathematics, namely the possibility of their co-evolution. Different languages lead to different mathematics. We shall look later at some examples of these different mathematics (§3.2.2; §3.2.3). Both H. Watson (1988) and Barton (2009) identify a close relationship between the mathematics of our schools and Indo-European languages. Watson says "Mathematics is intimately associated both with the semantic structure of Indo-European languages, and with the registers which incorporate the written mode of communication" (p. 259). Barton notes the ease with which English moves from using numbers in conversation to using them in mathematics, compared to Māori, Kankana-ey (spoken in the northern Philippines) and Dhivehi (from the Maldives). He concludes that there is a congruence between English and mathematics. This, he says, is more than chance:

> I do not believe that it is coincidence that Indo-European languages just happened to be more consonant with mathematics than other languages. Given that mathematics as we know it today has the major parts of its history within an Indo-European environment, this congruence seems to be good evidence that mathematics is a human creation that is influenced by, and influences, other aspects of human creativity in the same environment. Mathematics and language evolved together. They have affected one another in the past and they are influencing each other in the present. (p. 53)

The co-evolution of Indo-European languages and mathematics as it is taught in schools has important educational implications. Its effects can be seen in curriculum content and sequencing (§3.4.5).

3.1.3 Conclusion to Mathematics and Language

Because mathematics and language are interrelated, the language in which mathematics is done affects how the mathematics is done. The choice is not neutral. Some languages concord more with how mathematics is generally practiced and talked about, because they have co-evolved. Doing and talking about mathematics some other languages can be more challenging.

3.2 Mathematics as a Cultural Construct

Culturally responsive mathematics education considers mathematics as a cultural construct which varies with place and time. This section considers a historical shift from an absolute view of mathematics (§3.2.1) to an appreciation of the cultural variation in mathematics (§3.2.2). One way of labelling "the mathematics practiced by cultural groups" (D'Ambrósio, 2006, p.1) is ethnomathematics. This section examines the way some key researchers see the relationship between mathematics and ethnomathematics (§3.2.3) and how ethnomathematics can be used in the mathematics classroom (§3.2.4). It then presents an example of different ways educational and mathematical responses have been formulated to specific cultural variation in spatial thought and language, specifically having a dynamic rather than static worldview (§3.2.5). Finally it presents another example of cultural variation in mathematical thinking, this time regarding logic (§3.2.6).

3.2.1 Fallibilism and Absolutism

Bishop's (1988) contention that " 'Western' mathematics may be only one mathematics among many" (p. 179) introduced concepts of culture and plurality to a mathematics discourse that had been dominated by absolutism for millennia. Euclid's logic has been taken as "the paradigm for establishing incorrigible truth" for over 2000 years (Ernest, 1998, p.1). Important mathematicians who followed Euclid's model include Descartes and Newton (Ernest, 1998). However, more recent mathematical developments such as Gödel's Incompleteness Theorem and non-Euclidean geometries have contributed to movement in the philosophy of mathematics towards *fallibilism*. Ernest (1998) attributes the first use of this term to Lakatos. With a fallibilist perspective, mathematics becomes subject to critical appraisal and can no longer claim complete certainty. Ernest makes an important analogy with the roles of uncertainty and relativity in modern physics in the move from the absolutism of classical Newtonian physics. We may be intellectually aware that relativity and uncertainty rule at the quantum level, yet find Newtonian mechanics more useful in our day to day life.

Similarly, in many mathematics classrooms, Euclidean geometry and standard arithmetics continue to be taught as if they reflect the truth of the world.

3.2.2 Cultural Variation in Mathematics

The title of Hawking's (2005) popular book *God created the integers* reinforces the idea of mathematics as unitary and perfect. However its subtitle, *The mathematical breakthroughs that changed history*, reminds us that mathematics is the invention of mathematicians throughout history. All of the mathematicians that Hawking includes in this volume are European men, from Euclid and Archimedes, to Gödel and Turing. In contrast, *Mathematics across Cultures* (Selin, 2000) provides an historical overview of mathematics from many significant cultures, including those that have influenced Western mathematics such as Islamic, Egyptian and Indian, and those that have developed more separately such as Chinese.

Bishop (1988) differentiates between big M *Mathematics*, the high status mathematics of the Western academic tradition and small m *mathematics*, the practices of mathematical activities in various forms. Ernest (1991) also points out that cultural impact on mathematics includes imbuing mathematics with cultural values. Bishop elaborates six main mathematical activities which he declares all cultures engage in: counting, locating, measuring, designing, playing and explaining. Barton (1998) further generalises Bishop's mathematics and Mathematics distinction, stating that all cultures *quantify*, express *relationships* and represent *space*. He calls ways of doing this "QRS systems" and calls Western Mathematics "near-universal, conventional mathematics" or NUC-mathematics" (Barton, 2009).

Sometimes cultures have practices that are clearly identifiable as Mathematics. For example, Zaslavsky's (1979) *Africa Counts* contextualises mathematics in culture by showing the variety of numbering practices over a continent. On the other hand, the *Garma Maths* of the Yolngu, based on the recursion in the Yolngu kinship systems, is so far from Mathematics that it extends our definition of mathematics (Watson-Verran, 1992). While Mathematics is not itself static, and continues to evolve and diversify, it has an uneasy relationship with the many other mathematics practiced throughout the world's cultures and communities.

3.2.3 Ethnomathematics

There are other names for this diversity of small m mathematics. The term *ethnomathematics* is attributed to D'Ambrósio (2012) who claims to have first used it in 1977. D'Ambrósio (2006) has called it

> the mathematics practiced by cultural groups, such as urban and rural communities, groups of workers, professional classes, children in a given age group, indigenous

> societies, and so many other groups that are identified by the objectives and traditions common to these groups. (p. 1)

Ascher's (1991) definition was restricted to the mathematics of "traditional peoples." 'Ethnomathematics' as a term has been critiqued for perpetuating an oppositional stance no longer needed now that the cultural situatedness of mathematics and mathematics education is more widely appreciated (Vithal & Skovsmose, 1997).

Studies termed ethnomathematical by their authors or by commentators have ranged broadly in their focus. Two well-known cases from Brazil, that of landless peasants using non-hectare measurement conventions (Alekseev, Barton & Knijnik, 2006), and another of children who sell sweets in the street (Saxe, 1988, 1991) look at practices which are easily recognisable as mathematical, if differing in algorithmic detail from the canonical, school based Mathematics. The ethnomathematical practices in these studies are explicitly contrasted with corresponding school type mathematics.

Gerdes' (1988) approach to ethnomathematics was to uncover the "hidden" or "frozen" mathematics implicit in Mozambiquan cultural practices such as weaving baskets and fish traps and bamboo house construction. Finding the mathematics in traditional weaving patterns and fish traps has also been part of the development of the Yup'ik mathematics program (Lipka, 1994). From some of these practices Gerdes was able to derive alternative versions of well-known Euclidean theorems and Pythagoras' Theorem. The basket weavers who reproduce a known design are not "doing" mathematics, he says, "but the artisan(s) who discovered the technique, *did* mathematics, was/were thinking mathematically" (p. 141).

In this approach, the practices under study are not perceived by the practitioners themselves as (ethno) mathematical; it is the label of the researcher. Barton (1996) incorporated this perspective into his thesis definition: "Ethnomathematics is the field of study which examines the way people from other cultures understand, articulate and use concepts and practices which are from their culture and which *the researcher* [italics added] describes as mathematical" (p. 216). Barton (1996, 2009) has then sought not just to uncover the hidden mathematics in cultural practices but as a mathematician has aimed to explore how the QRS systems of different cultures can inspire new forms of mathematics.

The mathematics that this project aims to uncover might be considered ethnomathematical in the way that Barton (1996) describes, in that they might not be perceived by the practitioners as mathematical, but are defined as mathematical by the researcher.

3.2.4 Ethnomathematics, Language and Education

Culture needs to be considered in teaching mathematics, given that mathematics is a cultural product (Bishop, 1988; Presmeg, 2007). One way to take account of culture is to incorporate local ethnomathematical practices into the classroom. This is not necessarily straightforward.

As we saw earlier, in the 1990s Papua New Guinea switched from teaching mathematics in English to teaching mathematics in local languages (§2.3.5). This included the development of a *Cultural Mathematics* program. Cultural Mathematics is the name of a specific approach in Papua New Guinea that seeks to integrate local mathematical knowledge and practices, such as counting or measurement, into the school program, thus building on the home knowledge of the students (Department of Education Papua New Guinea, 2004). Varied research has been conducted local mathematics systems (Lancy, 1981), including spatial thinking (Bishop, 1979; Lean & Clements, 1981) and measurement (Owens & Kaleva, 2007). The challenge of developing a teaching program in so many languages had in part to be met by individual teachers, at a village level. This was a huge shift in the role of the teacher in Papua New Guinea (Feeger, 1997). Learning mathematics through the local counting system and the local language appears to be benefiting some students, including transferring mathematical practices to English (Matang, 2006).

However, the relationship between local mathematical knowledge and school mathematics is not simple. For example, in some places traditional counting practices that are in decline out of school may now be being learnt in school as academic practices. The students may not perceive the link between the traditional practice and their home life, thus not seeing this mathematics as any more relevant to their lives than other school mathematics (Esmonde & Saxe, 2004). In addition, English remains privileged in mathematics teaching and learning. Code-switching between local Tok Ples languages and English in Year 3 mathematics lessons, the year that the switch to English begins, may privilege English as the language of mathematics (Muke & Clarkson, 2011).

Some languages do not have a mathematics register in which to teach and talk about mathematics. This can be developed with will, care and time (Barton, Fairhall & Trinick, 1998; Roberts, 1998; Meaney, Trinick & Fairhall, 2011). Where mathematical terms do not have a straightforward translation, processes such as metaphorical extension can be used (Meaney et al., 2011). Bradbury (2012) gives an example of developing ways to talk about numbers in a Yolngu language that does not have comparative modifiers such as ‘bigger than’. After extended discussion, a student suggested *djulkmaram* ‘to pass, go ahead,

overtake' could be used for 'bigger than'. Care needs to be taken however to make sure that terms appropriated for mathematics are not stripped of their cultural meanings:

> The use of ethnomathematical practices in mathematics classrooms warrants thoughtful consideration. This is because every activity is embedded within the language of the culture in which it arose. This language will highlight those features of the activity which the culture values. Changing the way an activity is discussed either by using the mathematics register or by changing the language will have implications for how the activity is perceived by the students. It may also change the actual practice itself by focussing on other ideas. ... The development of indigenous languages for describing Western mathematics needs to respect the cultural values of the users of the language and that means using terms which have appropriate connotations both for the mathematics but also for the culture. (Meaney, Fairhall, and Trinick, 2008, p. 62–3)

The lesson from New Zealand and Papua New Guinea is that if ethnomathematical ideas are going to be used in the classroom, they need to be used both carefully and respectfully. In the current project, the goal was increased understanding by the teachers of an Iwaidja way of conceptualising, rather than the use of Iwaidja language in the classroom. How to applying the knowledge and understanding carefully and respectfully is complex, especially when the beliefs about the nature of mathematics of the Iwaidja speaking community have been defined by their own experiences of school mathematics (see §4.2.2.4).

3.2.5 A Dynamic World View: Responding to Grammar

In the Navajo language, shapes are verbs. There is no circle, there is circling. The entire worldview of the Navajo is premised on the dynamic nature of the world, everything is seen to be always changing and moving. The Navajo world is therefore less suited to being divided up into parts than the static Western world (Pinxten, van Dooren & Harvey, 1983). From this linguistic-anthropological description of Navajo spatial language, a teaching program was devised that used cultural practices such as the construction of cultural artefacts such as rodeo arenas and hogans (traditional houses) (Pinxten, Van Dooren & Soberon, 1987). In the description of the teaching program emphasis was given to the fact that these cultural practices should be kept culturally situated even as mathematical abstractions were developed from their construction.

Working with John Mason, Barton (2009) explored mathematical implications of treating shapes as verbs, as actions, calling it *Action Geometry*. For example, the static view of a circle is all the points that are equidistant from a centre point, forming a planar shape. In a dynamic view a circle is movement with a constant speed and with a constant rate or turn: "circling is actually a special case of spiralling" (p. 31). Barton points out that Action Geometry is not an actual practice of the Navajo, but was invented by mathematicians in response to Pinxten et al.'s (1983, 1987) anthropological writings about the Navajo language and worldview.

This raised the question of whether Action Geometry would be a more appropriate starting point in geometry for Navajo children and other people who have a verb-based dynamic worldview. In Mi'kmaq, an Indigenous Canadian language, the focus is also on verbs and actions (Lunney Borden, 2011). Battiste and Henderson (2000) propose that teachers of Mi'kmaw students take this into account:

> Mi'kmaw students are usually taught English noun-based concepts in the primary grades, starting with concrete nouns, numbers and colors. The unreflective theory behind these teachings is that students need lots of concrete nouns to help them make connections with prior knowledge. However, providing many things to name and categorize does not match the first experiences of children whose first language is Mi'kmaq. Children who are raised with the Mi'kmaw language are used to focussing on verbs and relationships, rather than on nouns and things. ... Early childhood teachers of Mi'kmaw students would find the use of events as relational concepts from which experience is derived a more useful tool than the use of nouns and categories. (p. 90)

Lunney Borden (2011) talks about using a *verb based discourse pattern* in lessons with Mi'kmaw children. She describes a lesson involving prisms and pyramids:

> The first moment of verb-based discourse came from the student on the carpet who noticed that the cube could "sit still". It is worth noting here that the word *flat* is one example of a word that has no Mi'kmaw translation. (p. 12)

A *verb based discourse pattern* involves focusing in the active properties of the geometric objects, rather than identifying and naming their parts. It does not necessarily mean using the first language of the students, but of responding to some of the ways meaning is made in their languages. Lunney Borden talks about teaching Mi'kmaw children in English, but targeting her English in a manner that used more verbs to describe things and processes and fewer nouns.

Responses to diversity in spatial language thus can include teaching about and within the cultural worldview (Pinxten et al., 1987), developing new mathematics (Barton, 2009) and responding to discourse patterns to bridge to the Western mathematics (Lunney Borden, 2011). It is important that achieving the goal of better mathematical outcomes for Indigenous students does not come at the cost of Indigenous epistemologies. Hale (1992) compares linguistic diversity with ecological diversity. Just as the diversity of plant life on our planet holds a range of substances as yet unknown to Western medicine, the many languages on our planet hold undeveloped mathematical potentials. The example of Action Geometry shows how investigating linguistic diversity can enrich mathematics and stimulate mathematical innovation.

3.2.6 Other Logics

Logic is an area which is so deeply ingrained in our own languages that we tend to take the logic of our own culture and language as "real." As we have seen (§3.2.1), taking Euclid's mathematical logic as "real" has been a persistent element in mathematical absolutism (Ernest, 2009). In studying child development of logic, Vygotsky (1934/1986), said "grammar precedes logic" (p. 127), meaning that children need to acquire the grammatical logic of their language before they can apply it to their reasoning. This is also the case when learning in a second language. Dawe (1983) found knowledge of logical connectives to be a major factor in deductive reasoning in a study of Punjabi, Mirpuri, Italian and Jamaican speaking children learning in English.

Grammatical and mathematical logic can differ across languages and cultures, with effects on mathematical reasoning. The Kpelle of Liberia have both an 'exclusive or' and an 'inclusive or'. In a study comparing American English and Liberian Kpelle speakers, the Kpelle performed better than the English speakers in tests of disjunction. However, the Kpelle do not have an easy way to express 'if and only if' and performed weaker in tests of implication (J. Gay & Cole, 1967). In *Science and an African Logic*, Verran (2001) describes some of the ways in which Yoruba logic diverges from Western logic, alongside the story of her own disconcertment at the differences.

3.2.7 Conclusion to Mathematics as a Cultural Construct

The appreciation over the past few decades of the diversity of mathematics as a cultural product has accompanied a philosophical shift from seeing mathematical rules governing the world to seeing mathematics as a human tool to model and describe the world. Cultural variation in mathematical practices has also led to the questioning of what is meant by mathematics and how we value different forms of mathematics. My own use of 'mathematics' throughout the thesis broadly covers the diversity of mathematics while paying particular attention to school mathematics. Ethnomathematics as mathematical practices of specific cultural groups may or may not be appreciated by their practitioners as mathematical. Ethnomathematics are important for culturally responsive education because they can form part of the out-of-school "known" which children bring with them to school. However, they may have culturally situated value, such that utilising them for school mathematics must be considered carefully and respectfully. There is also the potential that ethnomathematical practices hold the seed for new and innovative mathematics.

3.3 Numeracy as a Cultural Construct

Numeracy, which is defined in this section as the practice of mathematics in daily life, is highly regarded as a key desired outcome of mathematics education in schools (§3.3.1). School-based tests such as the National Assessment Program: Literacy and Numeracy [NAPLAN] purport to assess numeracy. Low Indigenous NAPLAN achievement is among the motivations for Indigenous mathematics research, contributing to the impetus for this project. It is important to consider what NAPLAN testing measures and whether it is equitable for Indigenous students (§3.3.2). This section introduces the idea that out-of-school ethnomathematical practices can also be viewed as numerate practices (§3.3.3). A culturally responsive approach would look for evidence of ethno-numeracy, that is, a cultural ethnomathematical strength. For the present study, spatial language and thinking is identified as such as strength for Indigenous students (§3.3.4). Educational responses to this as an identified strength are considered (§3.3.5).

3.3.1 Defining and Assessing Numeracy

The National Assessment Program: Literacy and Numeracy [NAPLAN] assesses every Australian student in Years 3, 5, 7 and 9 (approximately eight, ten, 12 and 14 years old respectively) in a written examination. There are four tests. The Reading, Writing and Language Conventions tests assess Literacy. There is a single test for Numeracy. For Years 7 and 9 it has two parts, a calculator part and a non-calculator part; in Years 3 and 5 there is only one part (non-calculator). A high score on this test is equated with being numerate.

The NAPLAN tests were designed to assess a minimum standard at each level. The goal of the Commonwealth is to have 100% of students meet the benchmarks. As well as providing information about individual performance, NAPLAN data enable comparisons to be made between schools or cohorts of students.

Low NAPLAN scores for remote Indigenous students are part of the motivation for research into mathematics education for Indigenous students. Each year, the scores of Indigenous students are compared with those of non-Indigenous students and found to be lacking (Forgasz & Leder, 2012). Indigenous students are therefore considered to be less numerate than non-Indigenous students.

‘Numeracy’ is a term that is widely used in government documents and policies in Australia, often paired with ‘literacy’. When paired with literacy, literacy tends to get most of the attention (Westwood, 2008). Definitions vary but generally involve the application of mathematics to purposeful contexts in daily life (AAMT, 1997; Commonwealth of Australia,

2009; Willis, 1998). There is some debate whether numeracy is the same as what is known as 'mathematical literacy' with the latter sometime being more restricted to the ability to interpret a mathematical problem (Hoyles, Wolf, Molyneux-Hodgson, Kent, 2002; Kemp & Hogan, 2000; Tariq, 2004; Westwood, 2008). The definition that I will use is that from the National Curriculum Board (2009):

> Numeracy is the capacity, confidence and disposition to use mathematics to meet the demands of learning, school, home, work, community and civic life. (p. 5)

Since the daily mathematical demands of life of most of us are more basic than those of an engineer or physicist, numeracy usually refers to applying fairly "basic" mathematical skills (Zevenbergen, 2000). While numeracy and mathematics are different things, to be numerate is to be mathematically successful *in daily life*. Numeracy thus means different things for different people who have different needs (e.g., Zevenbergen & Zevenbergen, 2009).

While the term numeracy is intended to apply to the application of all types of mathematics, it is visibly derived from 'number' (Jablonka, 2003). Using the word may reinforce the idea that numeracy is about the understanding and manipulation of numbers at the expense of other mathematical areas, reducing it to *numberacy* (Gough, 2007). Another term for numeracy is 'quantitative literacy' (e.g., Madison & Steen, 2003; Steen, 2001) which again emphasises the numerical aspects of mathematics. This is a problem because many of the mathematical skills needed in daily life are not to do with number. Decisions involving probabilities; navigation in one's environment and manipulation of objects in space; understanding and using patterns one encounters: these are all applications of mathematics that do not necessarily require numbers.

A consideration of NAPLAN is important because NAPLAN data currently drive school goals and programs. One of the main educational targets of Federal and State governments' *Closing the Gap* program is to improve Indigenous NAPLAN scores (Council of Australian Governments, 2009). Teachers devote time to instructing students in how to take the tests (White & Anderson, 2011). High stake testing such as NAPLAN can both narrow the curriculum to what is in the tests and encourage the presentation of content divorced from context (Polesel, Dulfer & Turnbull, 2012).

A single school based written test cannot assess a student's ability to apply mathematics in their daily life and wider environment (AAMT, 1998). Although the NAPLAN tests frame their questions as problems which attempt to model real-life applications of mathematics, to a large extent these tests actually assess school mathematics. The fact that NAPLAN tests only

assess part of students' numeracy needs to be taken into account in a consideration of Indigenous students' mathematical skills and practices.

3.3.2 NAPLAN, Language and Equity in the Northern Territory

Indigenous students from the Northern Territory score much lower on NAPLAN than non-Indigenous students in all areas (ACARA, 2011a; MCEETYA 2008, 2009). This disparity between Indigenous and non-Indigenous also occurs in the international tests, *Trends in International Mathematics and Science Study* [TIMSS] and *Programme for International Student Assessment* [PISA] (Stacey & Stephens, 2008; Thompson & de Bortoli, 2010). Figure 3.2 shows the NAPLAN numeracy results from Year 3 from 2011. Figure 3.3 shows how to interpret the graph. A similar pattern occurs at all year levels.

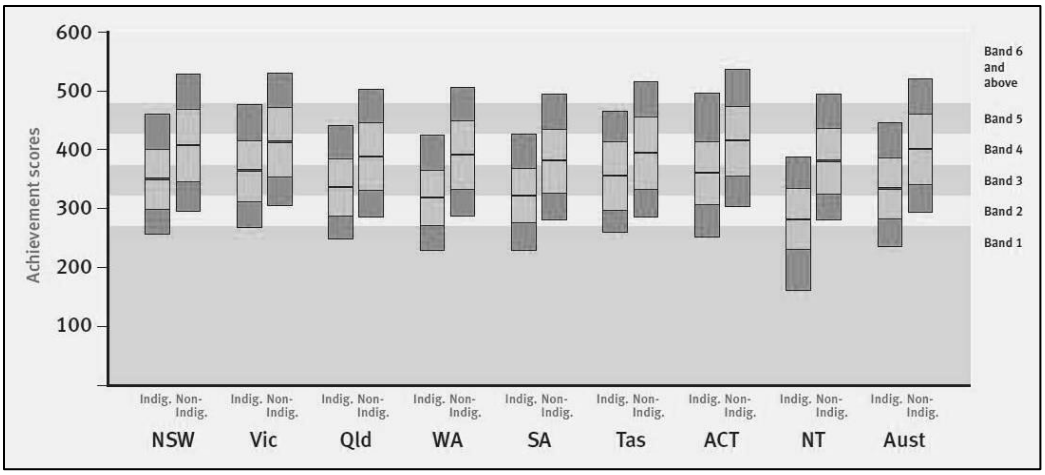


Figure 3.2. Achievement of Year 3 Students in Numeracy by Indigenous status, 2011 (ACARA, 2011a, p. 48)

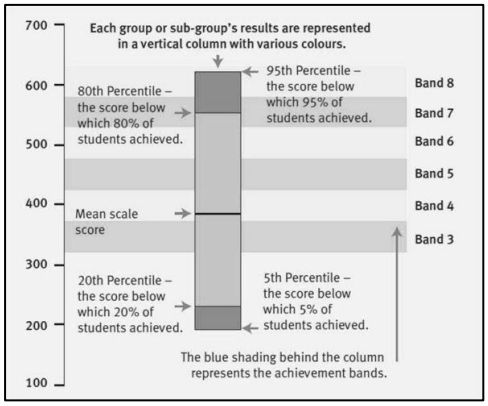


Figure 3.3. How to read NAPLAN graph (ACARA, 2011a, p. v)

Note that the mean of the Northern Territory Indigenous students is very close to the 5th percentile of the non-Indigenous score. By Year 5, the mean of the Northern Territory Indigenous students is well below the 5th percentile of the non-Indigenous score. Only the Northern Territory mean is well below the national mean for Indigenous students.

While the NAPLAN results provide part of the motivation for research directed towards improving the mathematics outcomes of Indigenous language speaking students, it is also important to consider issues of equity in the design of the tests (Australian Council of TESOL Associations, Applied Linguistics Association of Australia and the Australian Linguistic Society [ACTA et al.], 2010; Leder, 2012; Truscott & Malcolm, 2010). Critics contend that the tests may discriminate against Indigenous students by being constructed and written in an ethnocentric manner; assuming that students can speak, read and write in English; and having the content of questions which refer to the life experiences of the white, urban majority (P. Watson, Partington, Gray, & Mack, 2006; Wigglesworth, Simpson & Loakes, 2011). Answering many of the numeracy questions correctly requires control of complex English phrasal structures which are intuitive for native English speakers, but which take many years for language learners to master (ACTA et al., 2010). For example, in the 2010 Year 3 Numeracy test, a question asked "Which spinner is most likely to stop on white?" To answer this question correctly, students need to understand "most likely" and the elliptical reference of "white", which refers the white section of a spinner. Students also need to understand what a spinner is. Finally "these two features are combined in complex clause embedding (*is most likely to stop on*) which require quite advanced English for EAL/D learners but are easily understood by native speakers" (p. 20). ACTA et al. also warn that where students speak English as a second language, teaching to improve scores on these tests may be counterproductive to the students' overall learning.

A longitudinal study of Indigenous students from 13 schools across Australia found that speaking an Australian Indigenous language affected students' numeracy achievement:

> Those who spoke standard Australian English at home performed significantly better than those who spoke Aboriginal English or an Indigenous Language in both numeracy and English literacy across the all three years. Even after accounting for differences in English literacy and numeracy skills at the beginning of school, home language influenced later achievement especially in numeracy. (Frigo et al., 2004, p. 16)

Population data show that speaking an Australian Indigenous language is likely to be a factor in the NAPLAN achievement of Indigenous students in the Northern Territory compared to the other states and territories. Over forty percent of Northern Territory students are Indigenous (NT DET, 2010a), by far the highest of any other jurisdiction. P. Watson et al. (2006) show Indigenous students as percentage of all fulltime students in each jurisdiction in 2002 (Figure 3.4).

Figure 3.4 Percentage of Indigenous students by state and territory (P. Watson et al., 2006, p. 32)

In the Northern Territory, the overall proportion of Indigenous people who speak Indigenous languages is also the highest of the states and territories of Australia: "Over half (56%) of all Indigenous language speakers live in the Northern Territory where 59% of the Indigenous population speak an Australian Indigenous language" (Australian Bureau of Statistics, 2011). Around 30 percent of all Northern Territory students speak an Australian language (NT DET, 2011b). Most students in remote Northern Territory communities speak English as an additional language, which affects their capacity to achieve on NAPLAN tests. Remoteness itself is also a probable factor in school and NAPLAN achievement (Leder, 2012), in part due to the disadvantages that remote schools have in accessing goods and services, including attracting teachers. Forgasz and Leder (2012) point out that when the Indigenous results are disaggregated by geolocation and socioeconomic background, metropolitan Indigenous students perform almost as well as their non-Indigenous peers. Indigenous Australians who live in remote or very remote areas are much more likely to speak an Indigenous Australian language than those who live in major cities or regional areas.

It is widely accepted that students learning another language will take four to six years to be able to achieve academically in that language (Silburn et al., 2011). In fact, the NTCF (NT DET, 2002) states this can take up to seven years. The NAPLAN tests are inequitable in presenting an expectation that children who have been learning English for only two years will be able to achieve the same outcomes as students who have been learning English for seven years. The *Our Land, Our language* report (SCATSIA, 2012) recommends an alternative assessment tool be developed for all students learning English as an Additional Language/Dialect. It also suggests that research is needed that focuses on the mathematics that Indigenous language speaking students can do and what forms of numeracy they practice.

3.3.3 Ethnomathematics as Numerate Practice

Ethnomathematics, using D'Ambrósio's (2006) definition of "the mathematics practiced by cultural groups" (p. 1), can be understood as numerate practices. Ethnomathematical practices are purposeful, whether for marketplace transactions, navigation, making something or playing a game. They answer the demands of daily living. In Saxe's (1988) study of unschooled child street vendors of sweets in Brazil, he found that the vendors had developed non-standard methods of dealing with large numbers compared with non-vendors who were attending school. While the vendors had difficulty understanding the written value of numbers that they used, they were able solve and explain problems involving ratios and money better than the school attending non-vendors. They had "the capacity, confidence and disposition to use mathematics to meet the demands of ... work" (National Curriculum Board, 2009, p. 5). Other ethnomathematical practices which do not involve number, such as the navigation techniques of Pacific mariners (Barton, 2009), weaving geometric designs into a basket (Gerdes, 1988), or calculating the best kin term to use with a new arrival to a community (Ganambarr Stubbs et al., 2010; Watson-Verran, 1992) can also be viewed as numerate practices.

From this perspective, remote Indigenous students who are not achieving benchmarks on the NAPLAN tests may well be acquiring the necessary numeracy for daily life in their communities. NAPLAN tests don't necessarily tell us that Indigenous students are less "numerate" than other students: they tell us that Indigenous students do less well on NAPLAN tests. There is therefore a need for research into the ethno-numeracy of Indigenous students in remote communities.

3.3.4 Space as a Strength in Indigenous Australia

So what is a mathematical area in which Indigenous language speaking students could be expected to show an ethno-numerate strength? There is a widespread perception amongst teachers and researchers that Indigenous students have a strong spatial sense, for example that "Indigenous students in remote settings are likely to have strong spatial experiences" (Jorgensen, Grootenboer, Niesche, & Lerman, 2010, p. 164). But what does the idea of a *strong spatial sense* actually mean and how did such an idea originate?

Place and space are perceived to be important in traditional Australian societies. Swain (1993) characterised Indigenous Australian societies as having a geographic rather than a historical focus: "Aborigines themselves do not, or at least once did not, understand their being in terms of time, but of place and space" (p.2). Mapping is an important part of much Indigenous

Australian visual art (Lewis, 1976). P. Harris (1991) and Lewis (1976) compare these maps with the schematic maps of transport systems such as city rail maps. Mapping and spatial relationships to land can also be communicated through song and dance (H. Watson, Chambers & Turnbull, 1989). For example, the Warramurrungunji story of Northwest Arnhem Land covers 200 kilometres of country and needs to be told in the various different languages of the clans whose land it traverses (Evans, 2010).

Much of the research on this topic is from the central desert areas of Australia. Driven by a hypothesis that the environment in which people live will require them to develop certain cognitive strengths, Kearins (1976, 1981) compared the visual-spatial memories of Indigenous desert children to white urban children. She found the Indigenous children were better able to remember arrays of objects than the urban children, and concluded that the Indigenous children likely used a visual strategy over a verbal one. Thus this early study relates an effect of the wider environment – flat land with few visible landmarks – to memory in small scale space. Other research on the Indigenous use of spatial skills includes Davidson's (1979) investigation of card playing in an Indigenous community. He concluded that people used spatial cues to recognise card combinations rather than number calculations. What Davidson found could be subitising, which Willis (2000) identifies as being a practice which Indigenous people in some contexts prefer to counting. As we saw (§2.2.3), research investigating Indigenous children's use of spatial strategies to recall and calculate collections found that Warlpiri and Anindilyakwa children use and are more successful with spatial strategies than enumeration strategies (Butterworth & Reeve, 2008; Butterworth et al., 2011). Pintubi desert dwellers were found to be expert in dead reckoning – the ability to point to a distant, out of sight location (Lewis, 1976). They claimed to use a mental map. For example, Wintinna Mick said, "I know this north-west direction, not by the sun but by the map inside my head" (in Lewis, 1976, p. 265).

P. Harris conducted an extensive survey about Indigenous measurement concepts, including money (1984a), time (1984b) and space (1991). Most of the people who responded to the survey were not themselves Indigenous, but consisted of teachers, linguists and missionaries working in Indigenous communities. Unfortunately, the completed surveys that comprised her linguistic data are not available. Harris (1991) noted that "Aboriginal languages have a very rich vocabulary for expressing ideas about spatial relations" (p. 44). An important part of her discussion about space involved orientation within space and the use of fixed directions such as the cardinal compass points. She noted the use of the compass points by various Indigenous groups in small scale space, such as body parts or the direction of a baby's crawling.

The use of fixed references such as cardinal directions (more or less north, south, east and west) and river drainage systems (upstream and downstream) occurs in many Australian languages (§3.5.11). In a seminal article, Laughren (1978) found that in Warlpiri, a language spoken in Australia's Central Desert, cardinal directions, north, south, east and west, form a grammatical category and are compulsory in any utterance involving location or direction. Similarly in Yanyuwa, spoken near Borroloola in the Northern Territory, statements of location or movement are "linguistically incomplete until the locative and/or directional information is included (Kirton & Nero, 1982, p. 5). Very young Warlpiri children (under two years old) are noted as understanding these directions confidently (P. Harris, 1991; Laughren, 1978).

However, Australian languages rarely use the terms for 'left' and 'right' for giving directions, generally restricting them to body parts (P. Harris, 1991; Meakins, 2011). These findings relate to Indigenous Australians living in the arid interior of the continent. The situation could be expected to differ for Indigenous people living on the coast (B. Graham, 1988). Those few languages which Harris reported as using 'left' and 'right' for giving directions were all coastal language of Australia's north.

The research mentioned in this section seems to comprise the bulk of the evidence about Indigenous spatial thinking and languages that has influenced education research. There has also been research in the field of linguistics, which will be reviewed (§3.5.11) after the vocabulary of spatial frames of reference has been introduced (§3.5).

3.3.5 Educational Reactions to Space as a Strength

This was a smaller body of research on spatial sense as an Indigenous strength than I expected, given the prevalence of this idea in the education consciousness amongst teachers and researchers (e.g., P. Harris, 1991; Jorgensen et al., 2010; Yunkaporta & Kirby, 2011). It showed clearly that there was a need for more detailed studies on the specifics of spatial language in individual Australian languages, particularly from an educational perspective.

To be culturally responsive, there is the need for a careful consideration of how to *respond* appropriately to these findings (§2.1.1). Knapp and Seagrim (1981), who tested and did not agree with Kearins' (1976) findings, cautioned that "there is a danger in categorizing Aborigines with one cognitive style and Europeans with another because, by doing so, the implication is that teaching methods must be adjusted according" (p. 229). They advised that cognitive differences exist between individuals as much as populations. Hunting and Whitely (1983) emphasised the diversity of Indigenous Australian ethnomathematical practices, and

that "awareness of the nature of prior knowledge by teachers and curriculum planners are essential ingredients for achieving that crucial goal we call successful learning" (p. 22). P. Harris (1991) advocated "an early emphasis on spatial abilities rather than number knowledge" (p. 48). It is worth noting that having a spatial strength in thought and language does not necessarily mean having a similar spatial vocabulary to the Indo-European mathematics register. English spatial prepositions have many important mathematical uses but Australian languages tend to have far fewer prepositions (P. Harris, 1991; Jorgenson, 2010). The *Talking Concepts* resource (Kimberley Education District, 2000) is a tool to assess and teach the language of mathematics in Standard Australian English, including spatial prepositions. While this is within the spatial area, the perceived strength, it in fact is not building on what children know, but as much aimed at identifying what they do not know. Since Indigenous conceptions of space tend not to be quantified, Perso (2003) claims it is "imperative" to introduce quantification, teaching measurement and scale in relation to location. Again, while trying to build on a strength, the focus is actually on a perceived deficit. Willis (2005) states that

> it is ... important that the navigational strengths are recognised and built upon, and that what is typical for the majority culture is not assumed to be the norm for all students, with the consequence that difference is interpreted as deficit. (p. 19)

Teachers may also *react* – act without deep thought – rather than *respond* to the idea of a spatial strength. I have observed various teachers in remote schools turn to the space section of the Early Years mathematics curriculum and start teaching the names and attributes of regular polygons and Platonic solids, which generally do not have names in Australian languages, and are very rare in the natural environment. Even attempts to respond thoughtfully may assume students have a "familiarity with geometrical concepts" (Sullivan & van Riel, 2011, para. 1.). P. Harris (1991) questioned "the appropriateness of the early emphasis on geometric shapes in some mathematics syllabuses, when other types of spatial knowledge are more precisely defined and much more highly valued in the Aboriginal child's home culture" (p. 48).

As mentioned previously (§2.5.4), some understanding of a spatial strength was reflected in materials such as *Mathematics in Indigenous Schools* (NT DET, 2000), *Designer Maths* (NT DET, 2005), *Mathematics for young children* (Western, 1979) and *Maths in Context* (NT DET & Bubb, 1993). However, materials approved by the Northern Territory Department of Education today, such as *Count Me in Too* (NSW DET, 2001), *Quick Smart* (L. Graham et al., 2004) and *Talking Namba* (NT DET, 2011c), all focus on number.

Understanding this spatial strength as related to location and direction, Yunkaporta suggests

> incorporat[ing] the cultural concept of an Aboriginal sense of direction into both teaching and classroom management. Once your students understand directionality as a key part of Aboriginal place-based cultures, you have an Aboriginal perspective in play every time you ask them to 'look west towards the whiteboard', or to 'line up at the south door.'(Yunkaporta & Kirby, 2011, p. 210)

However, as already noted, this "Aboriginal sense of direction" might vary across Australia (B. Graham, 1988). As well as developing the knowledge for *understanding*, there is clearly the need for more work on *responding to* space as a strength. This response might be in the sequencing of teaching, in the content itself, or, as we saw (§3.2.5), in developing new and innovative mathematics.

3.3.6 Conclusion to Numeracy as a Cultural Construct

Although numeracy has a broad definition, its interpretation and assessment can be narrow. A single test of numeracy such as NAPLAN does not take account of the different numeracy needs of different people. Significantly, the NAPLAN numeracy test is not equitable for Indigenous language speaking students (and other students for whom English is not a first language), especially in the Early Years. Spatial language and thinking has been identified as an ethno-numerate strength in Indigenous Australian cultures generally. However, to date, some educational approaches to this strength have been more reactions than responses. This suggests the need to investigate specific ethno-numeracy strengths in Indigenous languages and cultures which are not reflected in numeracy assessments such as NAPLAN. Spatial language, particularly that relating to location and direction, is proposed to be such an ethno-numeracy strength for Indigenous language speaking students.

3.4 Space

Although *space* and *spatial thinking* are widespread concepts in mathematics, they need to be critically unpacked for the elements which are culturally variant. This section first considers the scope of the role of spatial thinking in mathematics beyond what is described in the space section of mathematics curricula (§3.4.1). It then considers space as a culturally situated concept, examining important historical movements in the view of space in the Western philosophic-scientific tradition (§3.4.2), before looking at how space is viewed in some other cultures (§3.4.3). Since the concept of space is culturally situated, it follows that the development of spatial thought and language in children might vary cross-culturally (§3.4.4). Finally it examines the Early Years *Location* area of both the *Australian Curriculum Mathematics 3.0* (ACARA, 2012a) and the NTCF (NT DET, 2002, 2009d) in terms of

whether they are structured to allow for such cross-cultural variation (§3.4.5). *Early Years* in this context refers to the early years *of school*, that is, from the first year of school, which is called Transition in the Northern Territory, to around Year 2, and which correlates to ages 5 to 7 years old, and not to the early years *from birth*.

3.4.1 Spatial Thinking in Mathematics

Space is a fundamental part of many areas of mathematics. In the Early Years of the curriculum, these are *shape* and *location* (NT DET, 2009d). In later years, these areas include graphing, geometry, calculus and mechanics among others (Lean & Clements, 1981). There has been extensive research on spatial thinking and visualisation in mathematics. This section describes key points regarding the significance of spatial thinking in mathematics broadly.

Spatial skills are necessary for mathematical success across mathematics, not just in areas traditionally regarded as "spatial" such as mapping or geometry. For example, when performing complex computations, spatial skills are used for managing information on the page, as well as in the mind (Booth & Thomas, 1999; Wheatley, 1998). Spatial visualisation can be used to solve number and fraction problems (Lean & Clements, 1981). Early research on visualisation of numbers in space was conducted by Galton (1881). Spatial metaphors are used in talking about and manipulating numbers (Edmonds-Wathen, 2012; Lakoff & Núñez, 2000). Sometimes there is a lack of agreement between the spatial metaphors used in talking about numbers and writing them: "a number *higher* than six is actually written *beside and to the right* of it" (P. Watson et al., 2006, p. 24). A spatial relationship between reactions to numbers and the direction of writing has been observed in the Spatial–Numerical Association of Response Codes [SNARC] effect (Wood & Fischer, 2008) and reverse SNARC effect (Zebian, 2005).

Spatial thinking as a part of mathematical ability is often represented as involving the use of images on paper or in the mind, as an aid to problem solving, as opposed to using words (I. Smith, 1964). McGee (1979) describes two types of spatial ability, visualisation and orientation:

> Spatial visualization is the ability to mentally rotate, manipulate, and twist two- and three-dimensional stimulus objects. Spatial orientation ability includes the comprehension of the arrangement of elements within a visual stimulus pattern, the aptitude to remain unconfused by the changing orientations in which a spatial configuration may be presented, and an ability to determine spatial orientation with respect to one's body. (p. 909)

This distinction is used by Diezmann and Lowrie (2009) and Tartre (1990). However, more often the focus is on the visualisation aspect (Bishop, 1979; 1989; Booth & Thomas, 1999;

Presmeg, 1986, 1989, 2006). Presmeg (1989) describes five types of visual imagery: concrete, pattern, memory, kinaesthetic and dynamic (moving). While concrete imagery is incontrovertibly visual, kinaesthetic may be describing a form of spatial awareness that is spatial but not necessarily visual. Owens and Perry (2001) identify language as a factor in spatial ability as well as visualisation.

Visualisation can be an effective problem solving strategy: "Visual methods allow students to negotiate the difficulties associated with a problem when conceptual limitations do not allow a student to complete the problem quickly and analytically" (Owens & Perry, 2001, p. 3). Explicit teaching in visual strategies can be used in mathematics classrooms (Bishop, 1989; Owens & Clements, 1998). These can be especially useful where students are learning in a second language (Presmeg, 1989). However, students also need experience with manipulating three dimensional objects to improve their facility to mentally manipulate them (Diezmann & Lowrie, 2009; Lowrie, 1998; Owens & Clements, 1998). Knauff and Johnson-Laird (2002) claim that concrete visualisation may involve unnecessary detail that can in fact impede problem solving.

Individuals are sometimes classified as being visual-spatial thinkers according to the likelihood of them using visual imagery to solve mathematical problems (Booth & Thomas, 1999; Lean & Clements, 1981; Presmeg, 1986). Gender has also has a strong presence in the literature as a variable in spatial thinking (e.g., McGee, 1979). Some cultural groups have also been classified as being visual-spatial thinkers (Bishop, 1979, 1980). As we saw (§2.1.4, §3.3.4), Indigenous students as a cultural group are sometimes classified as being visual-spatial thinkers (Butterworth & Reeve, 2008; Butterworth et al., 2011; Kearins, 1976, 1981; Lewis, 1976). It is important to remember that individuals within any cultural group are likely to vary in their cognitive strengths.

3.4.2 Space in Western Thought

If spatial thinking varies with culture and language, this is an important factor to consider in making mathematics education more responsive to culture and language. But it is important to first look at the preconceptions about space which the speaker of an Indo-European language is likely to hold. These preconceptions both originate and manifest in our metaphysical traditions.

What is space? Lakoff and Núñez (2000) describe what they claim is

> how we all think about space in everyday life ... Space is absolutely continuous. Space does not consist of objects. Rather, it is the background setting that objects are located in. Space exists independently of and prior to, any objects located in space. (p. 260)

They note that the discretisation of space by Descartes changed the perception of space in modern mathematics. Descartes' coordinate system broke space into a grid of two or three dimensions. Space for Descartes (1644/2010) was material and quantifiable in terms of length, breadth and depth. The Cartesian system still is the most widely used coordinate system in our schools (e.g., NT DET, 2009d).

The space that Lakoff and Núñez (2000) describe as "how we all think about space in everyday life" (p. 20) is Euclidean and Newtonian. Just as Euclid's proofs generated a perception that mathematics is "true," the space his geometry describes has long been taken to be "real space." Newton (c. 1672/2010) rejected Descartes' notions of material space, arguing that it was infinite, motionless, eternal, unchangeable, and that it exists between bodies, that there was space with no body in it. But although he rejected Descartes' conception of space as material, his absolute, unoccupied space yielded happily to the Cartesian grid. While the analytic geometry of Descartes made space discrete, it was still absolute.

Einstein's (1917/1921) theory of general relativity and non-Euclidean geometries re-relativised space in Western thought and mathematics. However, a relativistic view of space can be regarded as either childlike and undeveloped (Piaget & Inhelder, 1948/1956; §3.4.4), or too technical for the everyday. An absolutely empty Newtonian space where distances and relationships between objects conform to Euclidean geometry persists as the everyday Western view of "real space."

3.4.3 Views of Space from non-Western Cultures

Cultures and language groups can view space quite differently: "Western conceptions of space with its ideas of objective measurement are not universal, nor are they 'natural', 'obvious', or 'intuitive'. They are shaped by the culture. They are taught, they are learnt" (Bishop, 1979, p. 144).

A study of visual illusions in 15 cultures found that culturally shaped experience including the inhabited environment affected the perception of illusions (Segall, Campbell & Herskovits, 1966). Peoples of Papua New Guinea appear to conceptualise space differently to Indo-Europeans. When Bishop (1979) investigated spatial skills of university students in Papua New Guinea, he found that some tests that involved 'pictorial' information were difficult due to cultural conventions regarding diagrams. The tests were in fact culturally biased. He found strong skills among the students in visual memory. He also noted comments from Biersack,

an anthropologist, about the conception of space of the Paiela, a group of people from the PNG highlands. For the Paiela, said Biersack (cited in Bishop), space is a quality of objects rather than the container they are in.

Pinxten et al.'s (1983) influential study of Navajo space also described a conceptual system quite unfamiliar to Western thought. Space for the Navajo as characterised by Pinxten and his colleagues is dynamic and bounded and does not accord with the Piagetian hierarchy (§3.4.4). Pinxten therefore concluded that a mathematical teaching program for Navajo children should use a Navajo conception of space rather than a Western one.

Cultural differences in spatial thinking thus extend to the conceptualisation of space itself. Culturally responsive mathematics education needs to take this into account.

3.4.4 Development of Spatial Thought in Children

Although the development of spatial thought in children has been widely investigated, this section concentrates only on two theories. The Piagetian stages of spatial development (Piaget & Inhelder, 1948/1956) have particular significance because they have been so influential in education (Bishop, 1980; Davis, 1991). The Van Hiele (1999) levels are considered because they are explicitly referred to as informing the NTCF (NT DET, 2009d). Then this section considered whether these theories are applicable in a cross-cultural context such as exists in remote Northern Territory communities.

3.4.4.1 Piaget's Stages of Spatial Development

The Child's Conception of Space (Piaget & Inhelder, 1948/1956) takes as its subject the European child. Piaget and Inhelder describe three main stages in conceptual spatial development: topological, projective and Euclidean. According to Piaget, these develop through the child's perceptual experiences. The *topological* stage involves sensitivity to proximity, separation, order, enclosure and continuity. "This primitive, topological space is purely internal to the particular figure whose intrinsic properties it expresses" (p. 153). The child's thinking about space at this stage is egocentric. In the *projective* stage, points of view begin to be taken into account: "Projective relationships presume the inter-co-ordination of objects separated in space" (p. 154). The concept of the straight line and the visual effects of perspective are grasped. In the *Euclidean* stage the conception of space becomes more abstract, a "container" for the objects within it. The child explores the "natural axes" of the horizontal and vertical and thence the use of formal coordinate systems such as grids. This is space organised by parallel and orthogonal straight lines. These stages are shown in Table 3.1.

Table 3.1. Piagetian stages of spatial development

Stage	Ages	Qualities	Descriptor
Topological	2–7 years	proximity, separation, order, enclosure continuity	egocentric
Projective	7–12 years	straight lines, perspective	points of view
Euclidean	12+ years	parallel and orthogonal axes	abstract

Note that where the term *topological* is used with respect to language throughout this thesis it refers to concepts related or similar to those in the Piagetian topological stage (§3.5.5). The mathematical field of topology also deals with related concepts. These stages accompany the child's broader development, which Piaget (1947/1950) characterised as beginning with sensori-motor and perceptual activity, passing through symbolic image to concrete operation and finally to abstract operations. For Piaget and Inhelder, development precedes learning, for example, "the child can draw long before he receives drawing lessons" (p. 446).

A large part of the data for Piaget and Inhelder's (1948/1956) study was children's drawings in response to a range of tasks. The drawing tasks require scrutiny from a cross-cultural position. Being able to draw using linear perspective is not an innate developmental stage; it is a relatively recent invention in Western art by Filippo Brunelleschi around 1425 (Battisti, 1981). Thus it is a learnt and culturally situated practice. Bishop (1979) found that adult men in PNG lacked the Western conventions for drawing three dimensional objects and thus were unable to demonstrate their spatial thinking with such tasks. It is questionable to present as universal a developmental theory based on tasks such as drawing which require culturally specific learning.

Although Piaget's concern was the development of the child's conception of space, his own conception of the nature of space would necessarily have formed a foundation to his treatment of spatial thought. Piaget's highest level of spatial thought, "Euclidean space" appears to reflect what he thinks space "really" is. From a physicist's point of view, L. Nichol (2003) finds this ironic: "the full-blown abstracting process of the adult yields a world more in line with the absolutes of Newton, while the rudimentary perceptual processes of the infant are more consistent with Einstein's relativistic discoveries" (p. 39). Crucially, the cultural backgrounds of Piaget and Inhelder will have influenced their own conception of space and thus their ideas of natural development. Piagetian theory presents development as independent of learning (Vygotsky, 1978), and thus does not include effects of language and culture.

3.4.4.2 Cross-cultural and Cross-linguistic Variation in Order of Acquisition

Studies using Piagetian theory have found differences between Indigenous Australian children and the European child of Piaget's study (e.g., Dasen, 1973; Seagrim & Lendon, 1980). The applicability of these Piagetian stages to the mathematical development of children of non-European cultures has been extensively questioned (e.g., Bain, 1992; Bishop, 1980; Dasen, 1973; Guy, 1982; K. Jones et al., 1995; Pinxten, 1991).

For example, the Navajo conception of space has a different structure and development to the Western one that has been characterised as Euclidean–Newtonian:

> the organizational structure of in Navajo spatial knowledge is not of the type that was found by Piaget in Western children. Consequently, the educational procedures that would be appropriate and satisfactory of the teaching if spatial notions in Navajo cultural settings cannot take the Western Hierarchical spatial structure for granted. (Pinxten et al., 1983, p. 161)

P. Brown and Levinson (2000) note the resemblance between the Piagetian stages and the order of acquisition of spatial language in European languages. Terms acquired early such as 'in, at, on' correspond to topological notions, terms acquired a little later such as 'in front of, in back of, to the left of, to the right of' correspond to the projective stage, and the use of geocentric terms such as north, south, east and west to the Euclidean stage. They comment:

> Because of this correspondence between acquisition order and the predicted Piagetian order, it is generally held that *the order of language acquisition is driven by conceptual development*. In other words, the presumption is that language does not facilitate or influence the course of conceptual development but depends on it. (p.173, emphasis in original)

In contrast, they refer to Tenejapan Tzeltal, a Mayan language spoken in Mexico. In this language, projective terms are not used at all, and geocentric terms are acquired at same age or possibly before the topological. In another Mayan culture, Tzotzil children follow a learning trajectory that parallels that of European children in terms of the topological coming first but "Tzotzil children begin to master the geocentric system between ages 4 and 5, [whereas] European children cannot systematically label their own right and left even at a much later age" (De León. 1994, p.880).

These examples suggest that to some extent in spatial thought and language *the order of language acquisition drives conceptual development* and that this is culturally and linguistically specific. The languages which children hear and learn as they mature in a specific culture affect the course of their conceptual development with respect to space. This has significance for mathematics curricula in cross- or inter-cultural situations, in terms of whether the mathematics curriculum follows the same or a different sequence of spatial

concept acquisition as the child. It suggests that investigating the sequence of acquisition of spatial language for Indigenous language speaking children would help determine whether the sequence of the mathematics curriculum is suitable for them.

3.4.4.3 The Van Hiele Levels

The theories of the Van Hieles are explicitly applied in the NTCF (NT DET, 2009d). Progression through the Piagetian stages is assumed to happen more or less without instruction, and to be a measure of maturity (Vygotsky, 1978). In contrast, the Van Hiele model was developed with a view to instruction (M. Crowley, 1987; Van Hiele, 1999). However, the Van Hiele levels also appear to be somewhat Eurocentric and make assumptions about a worldview shaped by an Indo-European language. The earliest level assumes a focus on visual shape. But languages vary in their focus on shape. In a comparative study of English and Yucatec, Lucy (1992b) investigated the salience of shape compared to material substance for English and Yucatec speakers. In the languages, he found that "where English lexical structure routinely draws attention to shape, Yucatec lexical structure routinely draws attention to material" (p. 89). Cognitively, he found that English speakers were more likely to use shape as a basis for categorisation, whereas Yucatec speakers were more likely to use material of composition. On the other hand, some languages, including North American languages such as Navajo, and Asian languages such as Chinese, pay more attention to shape than English, having different classifiers or counting words for differently shaped objects (Allan, 1977). Chinese classifies objects as to whether they are long, thin and flexible; long, thin and rigid; flat, thin with irregular edges; flat, thin with regular edges; round and irregular or squishy; round and bigger; round and small or cubical (Liang, 2008). The appropriate classifying term must be used with each class of objects. Because languages vary in their focus on geometric features, we cannot assume that the Van Hiele model is necessarily any more appropriate for Indigenous language speaking children than a Piagetian approach.

3.4.5 Space in the Curriculum

Education in Australia is largely a state responsibility and up until 2012 each state and territory has had its own curriculum or syllabus. A mobile population, including teachers as well as students, experience some discontinuities in the education system when moving from state to state. It's like changing railways gauges (Reid, 2005). A national curriculum is being developed with the goal of providing quality and equity in education for all Australian students (National Curriculum Board, 2011).

The *Australian Curriculum Mathematics 3.0* (ACARA, 2012a) has advertised itself as streamlining an overcrowded curriculum in order to allow teachers to prioritise their teaching (National Curriculum Board, 2009). At the time this research was conducted, the NTCF was still in use in most Northern Territory schools, including Mamaruni School, while the new curriculum was being drafted and trialled. The *Australian Curriculum Mathematics 3.0* began to be used in the Northern Territory in 2012. This section thus considers both the curriculum in use during the study and the incoming curriculum.

The influence of developmental psychology, particularly that of Piaget, on primary level mathematics curricula all over the world has been profound (Bishop, 1980). Although not today explicitly acknowledged, this influence can still be seen in Australian mathematics curricula. If we accept the above evidence (§3.4.3) that the development of spatial though and language is culturally and linguistically mediated, then we need to see whether the curriculum is making assumptions that are culturally specific. This section thus looks for evidence of a Piagetian influence on sequencing of spatial concepts in the *Location* section of the NTCF (NT DET, 2009d) and the *Australian Curriculum Mathematics 3.0* (ACARA, 2012a). *Location*, which is within *Space* in the NTCF and within *Measurement and Geometry* in the *Australian Curriculum Mathematics 3.0*, includes the locational and directional concepts and terminology that have been reported as strengths for Indigenous students (§3.3.4).

3.4.5.1 Location in the Northern Territory Curriculum Framework

The *Northern Territory Curriculum Framework* [NTCF] (NT DET, 2009d) is an outcomes based document. Rather than specify what must be taught in a particular school year, the NTCF describes Band Levels that cover approximately two years of instruction and learning. Teachers are expected to teach from the level that their students are achieving towards the next level. The correlation of NTCF Band levels to expected year level for the Early Years is shown in Table 3.2.

Table 3.2. Correlation of NTCF Band levels to Year level (after NT DET, 2009e)

Year level	Expected range of levels of achievement			
Transition	KGP 2	Comprehensive	to	Band 1
Year 1	KGP 3	Solid	to	Band 1
Year 2	KGP 3	Comprehensive	to	Band 2
Year 3	Band 1	Solid	to	Band 2

The achievement levels are called Bands and range from 1 to 4+. They are preceded by the Key Growth Points (KGPs) 1–3. As Table 3.2 shows, some students could be expected to

achieving Band 1 outcomes in the Transition year, while others might still be expected to be working within Band 1 in Year 3.

The NTCF (NT DET, 2009d) claims to have a stronger research base than the previous (NT DET, 2002) version which was based more on teacher judgement. In the Space area, the work of the Van Hieles (Fuys, Geddes & Tischler, 1984; Van Hiele, 1999) and the SOLO taxonomy (Biggs & Collis, 1982) as well as *Teaching Space and Geometry* (NSW DET 2008) and *First Steps: Space* (Willis, 2005) were used. Materials were also piloted in a remote Indigenous school (Sharon Reeves, pers. comm., October 2009).

NTCF outcomes are brief, but they are accompanied by numerous indicators which suggest how the teacher will know that the outcome is being achieved. They are also accompanied by a list of key vocabulary (this was new to the 2009 version). The *Location* outcomes from KGP2 to Band 2 are shown in Table 3.3 along with example indicators and the vocabulary.

Table 3.3. Location outcomes, indicators and vocabulary in the NTCF (NT DET, 2009d)

	Outcomes	Example indicators	Vocabulary
KGP 2	describe the position of nominated everyday objects in familiar locations	respond to simple instructions and everyday language of position and movement: forward, backward, over, under, up, down, in and out, e.g., move forward two steps describe, using everyday language, own position in immediate environment	forwards, backwards, over, under, behind, beneath, underneath, in between, middle, opposite, up, down, around, in/inside, out/outside, in front, on top, on bottom, above, high above, below, beside, next to, here, there, near, far
KGP 3	give and follow directions in familiar environments	use everyday language to describe relative position of: self to other objects, other objects to self and object in relation to other object, e.g., I am next to the chair, the book is on top of the block give and follow simple directions using everyday language of position and movement, e.g., move the book to the top of the pile	distance, close to, towards, further away, far away, nearer, nearest, on its side, row, across
Band 1	interpret and create maps, including use of grids and directional language to describe pathways	identify/mark obvious locations and landmarks on simple maps and plans drawn on grids and simple coordinate systems, e.g., Where is the shop? What is at A7? respond to and use common positional and directional language when using simple maps and plans, e.g., move left three spaces	position, co-ordinates, map, grid, centre, diagonal, path, track, birds-eye view, key, legend, left, right
Band 2	create or interpret maps and plans using grids, keys and key compass points	give or follow instructions to move involving turning through a given rotation clockwise or anticlockwise or moving a given number of steps N, S, E or W (with compass points shown)	route, North, South, East, West, boundary

Note the use of the word "everyday" at KGP 2 and KGP 3 levels. At school entry level, mathematical learning is designed to build upon students' prior out-of-school experiences and vocabulary. But the assumptions that the NTCF makes about the everyday language of students are that it is Standard Australian English, as is shown in the examples and the vocabulary.

There is no consideration in the mathematics curriculum of specific needs of ESL or Indigenous learners. The term "Indigenous" appears only twice in the entire mathematics curriculum: in a Band 1 Measurement indicator which includes Indigenous seasons in the activity of matching seasons to months of the year, and in a Band 4 Number indicator which says "demonstrate understanding of system place value by investigating and comparing other number systems, e.g., Roman, Egyptian, Babylonian, Indigenous" (NT DET, 2009c, p. 23). There is not a single acknowledgement in the NTCF that the "everyday language" of location for the thirty percent of Northern Territory students who speak an Australian language is not the vocabulary listed in the NTCF, nor an acknowledgement that the normal order of conceptual acquisition of spatial terminology might differ for these students.

Using the Piagetian stages, topological relations can be seen in KGP 2 such as 'in', 'on top' 'beneath' and 'behind' and 'in front'. KGP 3 introduces projective relations requiring descriptions of positions of self and objects in relation to other objects and in Band 1 'left' and 'right' are used along with grids and coordinates. By Band 2, Euclidean relations are being used such as the more abstract cardinal directions. The correlation of the Piagetian stages and the NTCF levels can be seen in Table 3.4.

Table 3.4. Correlation of Piagetian stages with NTCF levels and indicators.

Piagetian stage	Qualities	*NTCF*	English vocabulary
topological	scene internal	KGP2, 3	'in', 'on top' 'beneath' 'behind' 'in front'.
projective	person's point of view	Band 1	'left', 'right'
Euclidean	space as container, abstract	Band 2	'north', 'south', 'east', 'west'

This sequencing correlates to how English speakers are taught, acquire and use the language of location. However, this sequencing does not correlate to how speakers of many Australian Indigenous languages acquire and use spatial language, such as Warlpiri children for whom cardinal directions may be part of their "everyday language" by school entry age and for whom 'left' and 'right' may never be everyday language (Laughren, 1978).

3.4.5.2 Location in the Australian Curriculum

The *Australian Curriculum Mathematics 3.0* (ACARA, 2012a) is far more concise than the NTCF. Specific criticism on draft versions has included an insufficient focus on the language of mathematics (Australian Council of TESOL Associations, 2010). Outcomes are specified by school Year level. The *Location* outcome at Foundation level is simply "describe position and movement" (p.18). There are only two elaborations, with fewer examples and specific terms are given than in the NTCF. 'Left', 'right', and the compass points are not specified at any stage. By not assuming a Piagetian or European pattern of acquisition of these terms, this is potentially more inclusive of Indigenous language speaking students. One of the Foundation elaborations uses the phrase "everyday language of location and direction" (p.15), which is the level that the teacher needs to know more about the everyday language of their students if it differs from that of the teacher (Edmonds-Wathen, 2010).

Interestingly, 'clockwise' and 'anticlockwise' are specifically identified as important in the Year 1 elaborations. Understanding these requires an understanding of 'left' and 'right' (NT DET, n.d.2), which are generally not acquired until later. ACTA (2010) note that students are expected to use "everyday language" up until Year 4, and then expected to use "formal mathematical language" in Year 10 without any specification of how the bridge from everyday to formal mathematical language is to be undertaken.

The *Australian Curriculum* includes Aboriginal and Torres Strait Islander histories and cultures as a cross-curriculum priority. Surprisingly there are more links to Aboriginal and Torres Strait Islander histories and cultures in the *Number* strand than to the strands such as *Measurement and Geometry*. At Foundation level, these include elaborations such as "using Aboriginal and Torres Strait Islander methods of adding, including spatial patterns and reasoning" (ACARA, 2012a, p. 17). Year 2 mentions Indigenous seasons in a calendar outcome within *Measurement and Geometry*, and Year 3 mentions symmetry in Aboriginal Art. The only Indigenous elaboration in *Location* comes at Year 5 level: "comparing aerial views of Country, desert paintings and maps with grid references" (p. 37). The Indigenous elaborations are more aimed towards educating mainstream children about the existence of Aboriginal and Torres Strait Islander histories and cultures than towards taking account of the learning needs of Indigenous students.

3.4.5.3 Northern Territory Diagnostic Net

In 2010, the Northern Territory introduced a *Diagnostic Net* for numeracy and literacy specifying minimum achievements by year level for students to make satisfactory academic progress (NT DET, 2010b). Many of the expectations are very similar to those in the

Australian Curriculum Mathematics 3.0. However they are phrased in more prescriptive language: where the *Australian Curriculum Mathematics 3.0* gives examples using the words "such as," the *Diagnostic Net* turns those examples into things students *must* learn (Figure 3.5).

Figure 3.5. Phrasing of expectations in Diagnostic Net (NT DET, 2010b, p.47)

There is a contradiction in *Diagnostic Net* proscribing expectations for all students while support material for the Net states that "it is likely that Beginning Phase EAL/D learners ... will not demonstrate age-appropriate expectations (NT DET, 2012b). Neither the *Diagnostic Net* nor the support material explicitly refer to Indigenous students, but a guide's description of reasons that student may not meet the expectations, "For example, if a child comes to school in Year 1 and doesn't speak any English or doesn't know what written text is for, or if a child misses a lot of schooling for a variety of reasons" (Perso, 2010, p. 8), describes some of the common reasons that Indigenous students in the Northern Territory may have different learning trajectories to mainstream students. However, having acknowledged that "clearly the learning paths and rates of progression of these children will more than likely be different" (p. 8) from mainstream English speaking children, no allowance is made for this other than that "schools and parents ... provide the additional time and support needed" (p. 8). What forms this additional support might take are not described. The *Diagnostic Net* was being used in 2010 by some teachers instead of the NTCF.

3.4.6 Conclusion to Space

Understanding that our very conception of space is culturally and linguistically mediated helps explain the some of the difficulties in formulating educational responses to the Indigenous spatial strength that were discussed earlier (§3.3.4; §3.3.5). A different conception of space from that assumed in mathematics curricula could affect the learning and practicing of mathematics across its breadths, not just in areas considered spatial. A different sequence of developing spatial thinking and language from that assumed in mathematics curricula could also affect mathematics learning. The *Northern Territory Curriculum Framework* makes assumptions about the development of spatial thought that may not hold for students from non-Indo-European backgrounds. The *Australian Curriculum Mathematics 3.0* appears to be less prescriptive in its order of introduction of spatial terms in the Early Years. However, for it to be used successfully with Indigenous language speaking students requires supporting

teachers to be aware of the variation in development of spatial thought and spatial language from the normal pattern of English. Little is known about normal development of spatial language in Australian languages. Investigation into the development of spatial language in Iwaidja or other Australian languages could help the writers of curricula and support material such as the *Diagnostic Net* to design pathways for learning mathematics that have reasonable and achievable expectations of age-related outcomes which are more culturally responsive.

3.5 Spatial Frame of Reference

In order to investigate spatial language in Iwaidja without privileging one culture and language over another, a means of describing variation in spatial language is needed which enables the comparison languages on their own terms (Lucy, 1992b). This section presents the framework of *spatial frame of reference* as a way to do this. I define the three main frames described in the literature: *intrinsic* (§3.5.1), *relative* (§3.5.2) and *absolute* (§3.5.3), and other ways of describing spatial location: *deixis** (§3.5.4), topology (§3.5.5), *named places* (§3.5.6) and the alternative framework of *orientation* (§3.5.7). These categories will be used extensively throughout the thesis. I consider variation of domain of use in frame of reference preferences (§3.5.8). I then describe linguistic relativity effects observed with frame of reference (§3.5.9). The spatial frame of reference is then applied to the articulation between Piagetian stages of spatial thinking and the curriculum that was shown in Table 3.5 (§3.5.10). Finally, I review what has been documented about spatial frame of reference in Australian languages (§3.5.11).

Laughren's (1978) finding that direction formed a grammatical category in Warlpiri was one of the key pieces of research that has permeated the Indigenous mathematics education field. This finding and similar findings by Haviland (1993) about Guugu Yimithirr, a language spoken in Hopevale, Queensland also came to the attention of the Cognitive Anthropology Research Group [CARG], an interdisciplinary group based at the Max Planck Institute for Psycholinguistics in Nijmegen [MPI]. Over a period of several years, the group conducted cross-linguistic studies into relations between language and cognition, focusing on aspects of spatial language and behaviour (Pederson et al., 1998). Each member undertook field research in a community with which they had a deep and established relationship. They developed elicitation tools collaboratively, revising them in a field manual each year, and ensuring that much of their data could be reliably compared across the different languages and sites (Senft, 2007; e.g., CARG, 1992, 1993a). These tools provide a viable means to describe differences

in spatial language from a cross-cultural perspective. The actual tools will be described in detail in the next chapter (§4.3.3).

The finding that some languages include cardinal compass directions as a grammatical category but have no use of left/right as a projective concept sparked an interest in spatial frame of reference (Pederson et al., 1998). Spatial *frame of reference* is a subsection of the language of space (Figure 3.6). The spatial domain is divided into location and movement, with frame of reference classified within location. It describes where things are located with respect to each other and essentially involves *coordinate systems* which provide *angular* information about location (Levinson, 2003, p.24). This is contrasted with non-angular descriptions of *coincidence*, which include *deictic* (§3.5.4) and *topological* (§3.5.5) descriptions. Other important terminology used in the literature includes the distinction between *figure** and *ground** (Talmy, 1983). The figure is a salient object, potentially moveable, and the ground is a reference object with respect to which the figure is located. For a detailed description of these terms see Levinson (2003, Ch. 2).

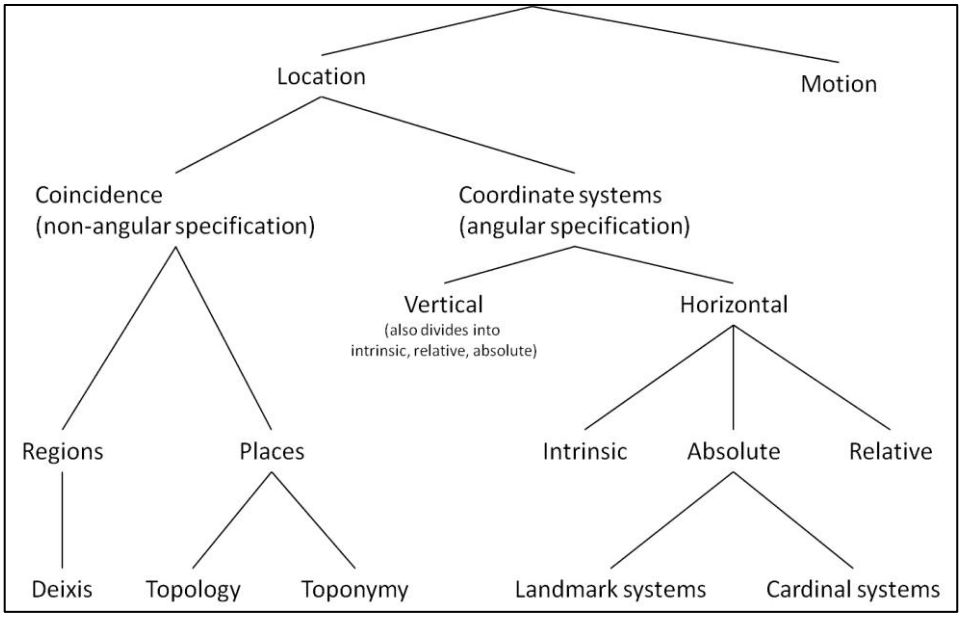


Figure 3.6. Conceptual divisions of the spatial domain (after Levinson, 2003, p.66)

In terms of frames of reference, the CARG focused on describing the variations between languages according to a typology they developed. They described three main frames of reference, *intrinsic*, *relative* and *absolute*.

3.5.1 Intrinsic

In the *intrinsic* frame of reference, the location of the figure is described with respect to a part or facet of the ground. For example, “the pen is at the handle of the cup” (Figure 3.7).

Figure 3.7. Intrinsic frame of reference: the pen is at the handle of the cup

The description is scene internal, and can be rotated with respect to the viewer and the wider world without the description being invalidated. Key terms in English are *front*, *back* and *sides*. However, if the ground object is rotated, the description is invalidated. The intrinsic frame of reference seems to be the only one that is present in all languages, is generally the first acquired (Johnson & Slobin, 1979) and can form a continuum with the topological system (Levinson, 2003; §4.3.5). Mopan, a Mayan language spoken in Belize and Guatemala, appears to only have this frame of reference (Danziger, 1996).

3.5.2 Relative

In the *relative* frame of reference, the point of view and body of the speaker are used to relate the figure to the ground. For example, "the pen is to the left of the cup" (Figure 3.8).

Figure 3.8. Relative frame of reference: the pen is to the left of the cup

Key English terms are *in front of, behind, to the left of* and *to the right of*, where these are from the speaker's perspective. In this reference frame, the ground object can be rotated and the same description holds. If the viewer or whole scene rotates, the frame of reference is invalidated. Terminology used in this frame of reference is often derived from the intrinsic

frame of reference. In “my left hand,” *left* is intrinsic, but in “the pen is to the left of the cup” it is not the cup’s left we are talking about, it is a zone that has been projected from the speaker. Another term that has been used for the relative frame of reference is ‘egocentric’ (e.g., Levinson, 1996b). This frame of reference is used extensively in European languages, but there are many languages which do not use it at all (Levinson, 2003). These languages may have words for left-hand and right-hand but their uses are restricted to people’s bodies (e.g., Wilkins, 2006).

3.5.3 Absolute

In the *absolute* frame of reference, the location of the figure is described in relation to a fixed direction or landmark. For example, “the pen is to the north of the cup” (Figure 3.9). The viewer or the ground object can rotate without disrupting the description but if the whole scene is rotated, the description must be changed. The main system in English is the cardinal directions, *North, South, East* and *West* [NSEW]. Many other languages have equivalent terms.

Other types of absolute direction systems tend have evolved in response to the environment. People who live in steep mountainous terrain or on a major river system may use a system based on water flow (Schultze-Berndt, 2006; Terrill & Burenhult, 2008), or uphill/downhill versus across (P. Brown, 2006).

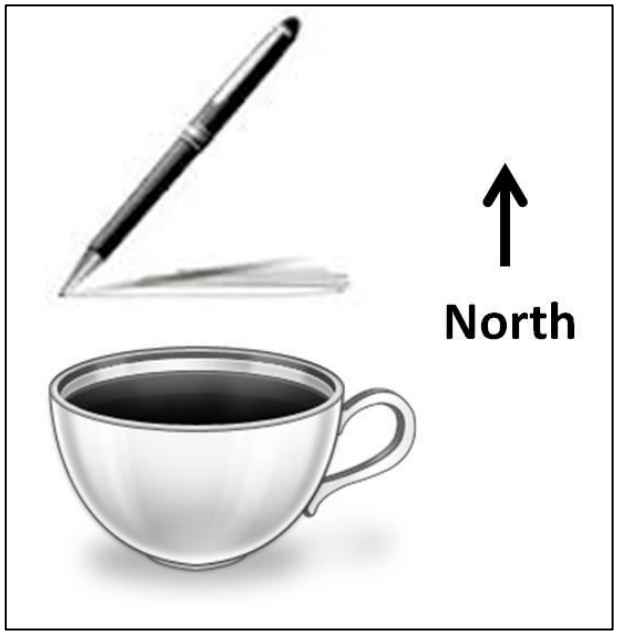


Figure 3.9. Absolute frame of reference: the pen is to the north of the cup

Island languages tend to use an inland/seaward axis. On long islands this may be coupled with an axis that represents a prevailing wind direction (Palmer 2002), or East/West (François,

2003; Levinson, 2006); on rounder islands such as atolls, the inland/seaward axis rotates, and may be coupled with an across/level type axis (Cablitz, 2002; Hyslop, 1999; Ozanne-Rivierre, 1999; Palmer, 2002). Desert people may use a cardinal NSEW system or one that closely correlates with it (Laughren, 1978; Wilkins, 2006). An East/West axis based on sunrise/sunset is common throughout the world (C. Brown, 1983). The choices of these axes are not random. Even in English, to 'orient' oneself derives from locating east; despite north taking primacy in modern maps, finding east or west by the sun is a common strategy used by English speakers. Some languages do not have a deeply lexicalised absolute system but use local landmarks as reference on an *ad hoc* basis (Senft, 2006).

Additional variation occurs in the manner of conceptualising such directions, which may be a projected line, as in English (Figure 3.10), or a quadrant, as in Guugu Yimithirr (Figure 3.11) (Haviland, 1993; Levinson, 2003).

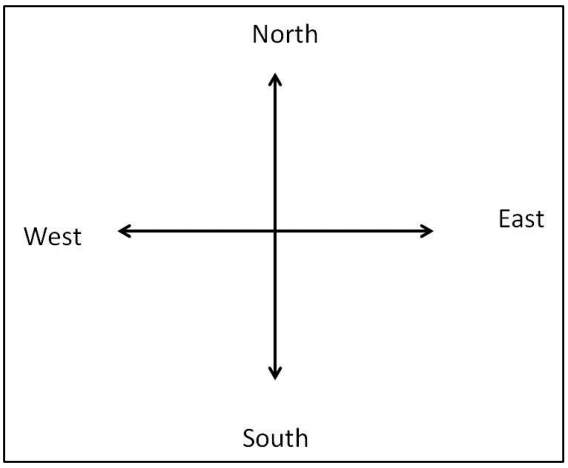


Figure 3.10. Directions as lines in English

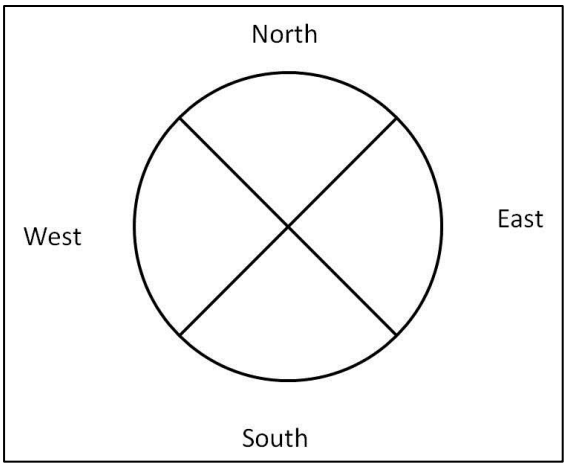


Figure 3.11. Directions as quadrants in Guugu Yimithirr

Table 3.5 shows key features of the three frames of reference.

Table 3.5. Frames of reference

Frame of reference	Qualities	Example		English vocabulary
Intrinsic	scene internal		'the pen is at the handle of the cup'	'in', 'on top' 'beneath' 'behind' 'in front'.
Relative	person's point of view		'the pen is to the left of the cup'	'left', 'right'
Absolute	fixed directions or landmarks		'the pen is to the north of the cup'	'north', 'south', 'east', 'west'

3.5.4 Deixis

Spatial *deixis* refers to information internal to the speech situation and the location of the participants (Levinson, 2008). For example, in the instruction, "come here!," 'here' refers to the location of the speaker. 'Here' and 'there' are two common deictic spatial terms in English. Some languages also have deictic terms referring to the position of the listener; for example the Portuguese *aí* means 'there where you are', compared to *la* which means 'there away from both of us'. Other languages may have a larger range of terms range of terms which differentiate degrees of 'there-ness'. For example, Quileute (from the northwest United States) has words for 'here'/'there' for: close to speaker but not addressee, close to addressee but not speaker, close to speaker and addressee, and close to neither speaker nor addressee (Levinson, 2008).

Deictic terms usually do not include angular information and thus do not in themselves constitute frame of reference, but they can be used with each frame of reference (Levinson, 2003; Palmer 2002). For example:

> Intrinsic: "The cup is in front of me."
>
> Relative: "The cup is in front of the tree" (between me and the house).
>
> Absolute: "The house is north of me."

In these sentences 'me' is the deictic term, and is implicit rather than expressed in the relative sentence.

Deixis can be combined with gesture to provide angular information. This is a common practice in Australian languages such as Garrwa (McGregor, 2006) and Gurindji Kriol (Meakins, 2011). Danziger (2003, 2010) has developed a fourth frame of reference which she

calls the *direct* frame of reference which incorporates deixis and gesture into frame of reference. This allows an utterance such as "It's over there!" coupled with a pointing gesture to be included in the frame of reference system.

3.5.5 Topology

The classification of language as *topological* is derived from the Piagetian view of topology, which was discussed earlier (§3.4.4). It refers to descriptions of proximity, order, enclosure and continuity. In English, topological information is largely expressed through prepositions such as 'at', 'in', 'on' and so on. This part of language is particularly important mathematically (Jorgenson, 2010; MacGregor, 1990). Topological language is usually acquired by children before frame of reference (Johnson & Slobin, 1979; cf., P. Brown & Levinson, 2000).

3.5.6 Named Places

Another way of specifying location is to give every place a name (also known as *toponymy*). This is a strategy for large scale space, rather than tabletop space. Some islands are reported to have extremely dense networks of named places. For example, Stokes (1982) describes an old woman naming over a hundred place names in order along a section of coast on Groote Island. In this case, coordinate systems are not needed when interlocutors know all the places being talked about.

3.5.7 Orientation

Terrill and Burenhult (2008) have used *orientation* to describe information about the facing* direction of something under description. In their analysis, all descriptions which would be classified as intrinsic are regarded as orientational. Some absolute utterances such as "the man is facing north" and relative ones such as "the man is facing left" would also be included as orientational. Standing* information such as "the man is on the north side" or "the man is on the left side" would not be. They claim that in some languages, such as Jahai (a Mon-Khmer language of mountainous Malaysia), and Lavukaleve (a Papuan language spoken in the Solomon Islands), this strategy is preferred to the use of frame of reference. For the Australian languages Jaminjung and Kriol, Hoffman (2009) claims that "the functional features of orientation are parallel to those of motion descriptions" (p.135).

3.5.8 Domains of Use

While many languages, including English and Iwaidja, have all of three frames of references, others only have two. Languages vary greatly in the contexts in which frame of reference will

be preferred. In general, they tend to use only one or two frames of reference and the domains in which they are used are also language specific (Levinson & Wilkins, 2006).

In Warlpiri, the use of cardinal directions in small scale space demonstrates a preference for the use of an absolute frame of reference. In English, the relative frame of reference is preferred for small scale space, such as locating a cup on a table, and the absolute is usually only used in large scale directions, such as the location of cities (Barton, 2009; Levinson, 2003). Small scale space can also be referred to as 'table-top space'. Although I admit that this is a culturally specific phrase, it is suitable in a study of mathematics education in Australia where much school activity occurs at tables.

The discussion of spatial frame of reference is generally restricted to location in the horizontal place since the frames of reference have a tendency to conflate in the vertical (Levinson, 2003). That is, what is 'up' for the viewer is 'up' for the viewed and is also 'up' in an absolute, gravitational sense.

3.5.9 Linguistic Frame of Reference and Cognition

The controversial aspect of the CARG's frame of reference research was the claim that frame of reference preferences in speech have an effect on cognition (e.g., Li & Gleitman, 2002). The research had been stimulated by evidence that speakers of absolute dominant languages remembered spatial information differently to speakers of relative dominant languages. Haviland (1993) recounted a man telling the same story in Guugu Yimithirr on two occasions, with gestures that demonstrate a recall of the cardinal directions associated with the story. Figure 3.12 shows the storyteller in 1980, facing west. Figure 3.13 shows him in 1982 telling the same story, facing north. In both cases he is telling how he instructed a companion to jump in the boat with him on the east side. In Figure 3.12 he is pointing back behind him, in Figure 3.13 he is pointing to his right.

Figure 3.12. Pointing east in 1980 (Haviland, 1993, p. 19)

Figure 3.13. Pointing east in 1982 (Haviland, 1993, p. 21)

This use of gesture is common practice among Guugu Yimithirr speakers. Levinson (1997) quotes a young Hopevale man as saying "You always know which way the old people been watching the TV when they tell the story" (p. 110). Levinson hypothesised that the type of memory coding required for this type of recall must be different from that used by, for example, an English speaker who was recalling the same events. CARG's linguistic research was therefore accompanied by non-linguistic research investigating use of spatial frame of reference in memory. More details of these tasks are given in Chapter 4.

Palmer (2004) claims that their perception of the environment affects how people think about the world and that this affects how they talk about it. This is an explanation for how absolute linguistic systems are created. However, although these absolute direction systems are often stimulated by the environment, they attain a conceptual significance once within the language. Inland people tend not to develop an inland/seaward axis but coastal people might carry that axis to the desert. Levinson (2003) writes of a Tzeltal woman in a city hotel in Mexico, far from the hills of home, asking her husband "Is the hot water in the uphill tap?"(p. 4) as an example of how the speaker carries the linguistic system and the associated way of thinking out of the immediate environment.

3.5.10 Development of Linguistic Frame of Reference

The order of acquisition of the frames of reference in Indo-European languages corresponds to the order of acquisition of the Piagetian stages for the European child: firstly the intrinsic, followed by the relative, with the absolute acquired last (P. Brown & Levinson, 2000; Levinson, 2003). We can now add the frames of reference to the comparison of Piagetian stages and the NTCF (Table 3.6).

Table 3.6. Frames of reference, Piagetian stages and NTCF level

Frame of reference	Piagetian stage	Qualities	NTCF level	English vocabulary
Intrinsic	topological	scene internal	KGP 2 – KGP 3	‘in’, ‘on top’ ‘beneath’ ‘behind’ ‘in front’.
Relative	projective	person’s point of view	KGP 3 – Band 1	‘left’, ‘right’
Absolute	Euclidean	space as container, abstract	Band 2	‘north’, ‘south’, ‘east’, ‘west’

We can also use the terminology of spatial frame of reference to describe some of the variation in spatial languages and in acquisition of spatial language which was previously mentioned (§3.4.3; §3.4.4). In Tenejapan Tzeltal, the relative frame of reference is not used at all, and the absolute frame of reference is acquired at same age or possibly before the intrinsic (P. Brown & Levinson, 2000). In Tzotzil, children acquire the intrinsic frame of reference first, but begin to use the absolute between ages 4–5 (De León. 1994). Warlpiri children acquire the absolute frame of reference at an early age, being receptive to it before the age of two, but Warlpiri does not use the relative frame of reference (P. Harris, 1991; Laughren, 1978). Spatial frame of reference thus provides us with a typological way to compare how different languages describe spatial locations.

3.5.11 Frame of Reference in Australian Languages

There has been extensive work by linguists on spatial frame of reference in Australian languages over the past decade. This section describes their findings.

3.5.11.1 Absolute

In this area of spatial frame of reference, linguistic attention in Australian languages has focused on absolute dominant languages. There are those in which absolute directions are grammaticalised, necessarily occurring in every utterance involving spatial location or movement (Haviland, 1998; Laughren, 1978; Levinson, 1997; Pederson et al., 1998) and those in which such language is frequent but not compulsory (Wilkins, 2006; Meakins, 2011). There are also those in which the absolute frame can be used in small scale space only when there is no availability of more preferred systems such as the use of the intrinsic frame of reference (Schultze-Berndt, 2006) or topological relations (McGregor, 2006). Absolute systems include cardinal type directions such as in Arrernte (Wilkins, 2006), Warlpiri (Laughren, 1978), Gurindji (Meakins, 2011), Guugu Yimithirr (Haviland, 1993), Kuuk Thaayorre (Gaby, 2006), and Warrwa (McGregor, 2006); and river drainage systems such as in Jaminjung (Schultze-Berndt, 2006). Some languages such as Gurindji have both (Meakins,

2011). These directions can be lexicalised as adverbs (Wilkins, 2006) or locational nouns (Haviland, 1998; Meakins, 2011; Schultze-Berndt, 2006). All of the above named languages belong to the Pama-Nyungan language family except for Jaminjung, which belongs to the Mirndi family, and Warrwa, which belongs to the Nyulnyulan family. These are the two languages which are reported to use the absolute frame in small scale space only when other resources are not available.

3.5.11.2 Relative

The dominant use of the absolute frame of reference in many Australian languages is frequently coupled with the restriction of the terms for 'right' and 'left' to body parts, as in Arrernte (Wilkins, 2006), and at times with the complete absence of these terms and of the relative frame of reference such as in Jaminjung (Schultze-Berndt, 2006). The only languages which have been reported to extend the use of these terms beyond the body into a relative frame of reference are Djamparrpuyngu, Murrinh Patha and Kala Lagaw Ya (P. Harris, 1991), which are all languages of the northern island and coastal areas. There is some doubt about this relative use of 'right' and 'left' as Harris does not provide evidence for this claim and it has not been corroborated for Djamparrpuyngu (Melanie Wilkinson, pers. comm., 12 December 2011) or Murrinh Patha (Joe Blythe, pers. comm., 14 August 2011). The relative use of 'right' and 'left' to describe projected zones rather than the intrinsic left and right side of a person would appear to be the exception rather than the norm for Australian languages.

3.5.11.3 Intrinsic

The use of the intrinsic frame of reference is widespread in Australian languages. There are varied forms of expression in this frame of reference. Body parts can be used to indicate the orientation of a person (Schultze-Berndt, 2006; Wilkins, 2006). Languages may also have terms meaning 'in front' and 'behind'; these are described as adverbs or coverbs, and sometimes extend to relative as well as intrinsic meanings (Meakins, 2011; Schultze-Berndt, 2006; Wilkins, 2006). Intrinsic locations can also be indicated by grammatical case (Schultze-Berndt, 2006). In some languages this is the preferred frame of reference (Schultze-Berndt, 2006). In the case of Warrwa, McGregor (2006) includes adverbial intrinsic terms meaning 'in front', 'behind' and 'by the side of' within the topological system rather than the frame of reference (§4.3.5).

3.5.11.4 Summary

Frame of reference research in Australia shows a dominance of the absolute and little use of the relative with some languages showing a strong use of the intrinsic. However, there is variation between languages, and in those Australian languages which do not belong to the

Pama-Nyungan family do not show the same dominance of the absolute. Spatial frame of reference can be used to analyse observations about spatial language in Indigenous groups that have been noted within the field of mathematics education. Research into spatial frame of reference for a coastal language such as Iwaidja could yield different results to frame of reference in Pama-Nyungan languages spoken in desert areas.

3.5.12 Conclusion to Spatial Frame of Reference

Spatial thinking and spatial language are acquired developmentally and the order of acquisition varies cross-culturally and cross-linguistically. The typology of frame of reference can be used to describe some of this variation. It can be used to show how Piaget's stages correlate with children's order of acquisition of spatial language in Indo-European languages, differ from with the order of acquisition in some other cultures. The order of acquisition of spatial language in Indo-European languages appears to have influenced both Piaget's stages and the sequencing of school mathematics curricula as can be seen in the *Location* area of the NTCF (Table 3.5), although the influence is not as pronounced in the *Australian Curriculum Mathematics 3.0*. The curriculum sequence may need modification for Indigenous language speaking children because it may not be consonant with their linguistic and conceptual development. However, there has been no previous research in Australia applying a frame of reference analysis to education. Identifying this gap led to the development of the two main research questions for this study.

3.6 Research Questions: Frame of Reference and Mathematics Education

The first research question was designed to gain the knowledge and understanding required for culturally responsive mathematics education. The second question was designed to respond to that understanding in a way which informs teaching and learning in the context of remote Indigenous education.

3.5.1 Research Question 1

How is frame of reference expressed in Iwaidja?

The scope of this question ranges from the vocabulary of spatial location to how it is expressed in practice in daily life. There has been no previous study of spatial language in Iwaidja. As we saw (§3.5.11), there is a documented tendency in Australian languages, particularly those from the Pama-Nyungan family, to favour the absolute frame of reference

and little evidence of use of the relative frame of reference. The Iwaidjan language family is different to other Indigenous languages in Australia (Evans, 2000). However, the differences between Iwaidja and English are greater than those between Iwaidja and other Australian languages, that is, the linguistic distance is greater. It was therefore expected that the way frame of reference is expressed and used in Iwaidja would differ significantly from English, and might resemble frame of reference use in some other Australian languages.

3.5.2 Research Question 2

How can teachers' understanding of the frame of reference in Iwaidja be used to construct and teach a more culturally responsive Early Years mathematics program?

As we also saw (§3.4.5), the current sequencing of the mathematics curriculum in the Northern Territory is based on a Western, Indo-European worldview. This curriculum correlates with the sequential findings of Piaget and Inhelder (1948/1956), whose work was all conducted with children of European backgrounds. Since curriculum writers and non-Indigenous teachers have internalised and use spatial frames of reference as they are used in English, this appears to them logical and intuitive. This logic or intuition does not necessarily hold for Indigenous language speaking students, specifically those from an Iwaidja speaking background, and the Early Years teaching sequence for these students needs to reflect this.

During the course of the project, some additional questions arose which are described in the next chapter (§4.3.7; §4.4.6).

3.7 Conclusion

Mathematical thinking is inextricably linked to the different ways that languages structure the world. Mathematics is practiced in language and some languages facilitate some types of mathematics more than others. Understanding this helps the appreciation of diverse cultural practices as ethno-numerate, rather than limiting numeracy to the narrow Mathematics of school. While spatial thought and language are cultural strengths for Indigenous students, they do not translate to success with current mainstream teaching and assessment approaches. Building successfully on a spatial strength requires deep understanding of the strength on the part of the teacher. The cross-linguistic approach in the frame of reference studies can successfully explain some of why Piaget's stages and the curriculum are not appropriate: because they correlate with the order of acquisition of spatial language in Indo-European languages, but not in Australian languages. Earlier findings about Indigenous spatial strengths in thought and languages such as Kearins (1976, 1981) and Laughren (1978) can also be

explained using the frame of reference approach. The framework can therefore be a tool for guiding linguistic and cognitive educational research with the aim of understanding more about uses of space in Indigenous language and thought. This will assist the development of a more culturally responsive mathematics approach. The following chapter will elaborate on the methodology and methods used to investigate spatial frame of reference in language and cognition.

Chapter 4
Methodology

This chapter describes the design of the project, the methodologies employed and tasks used. First it describes how the model of culturally responsive mathematics education that I used fit with the two phase study which had distinct methodologies for each phase (§4.1). It then discusses some of the important political and ethical considerations of being a Balanda researcher in an Indigenous community, including negotiating access to the research site and protecting Indigenous intellectual and cultural property rights (§4.2).

The methods that were used in Phase I and Phase II are then described in turn. Each phase was designed to address one of the two main research questions, with the first phase informing the second in terms of content and approach. The interdisciplinary nature of the project is also apparent in the research design, with Phase I utilising a theoretical approach from linguistics (§4.3) and Phase II seeking to use the data from Phase I for the purposes of mathematics education (§4.4).

4.1 Research Design

According to the model of culturally responsive mathematics education used in this thesis, a deep *understanding* of the students' culture is required as a basis upon which to form a *response*. The central hypothesis of this study was that by better understanding part of the conceptual and linguistic spatial framework of their students, teachers would be better able to construct and teach a more engaging and relevant mathematics program. While the specific focus of the mathematics program was on space and location, the benefits of this understanding could be expected to extend to other areas of the mathematics program (§3.4.1). The broader aims of culturally responsive mathematics education were addressed from a theoretical perspective of linguistic relativity (§2.2.2).

The project was designed with two phases that had different and complementary goals. The phases were designed sequentially, but conceptually Phase I was in fact embedded in Phase II (Figure 4.1).

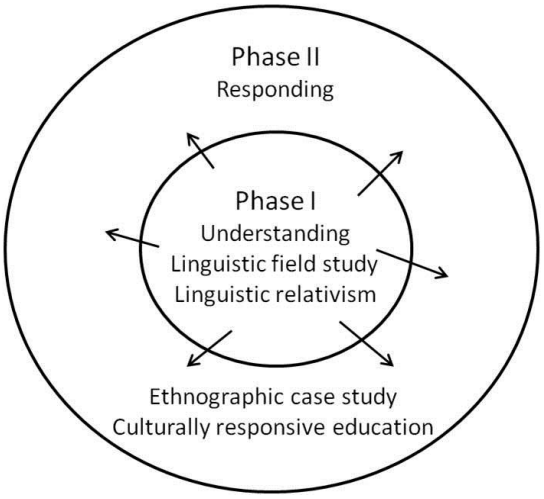


Figure 4.1. Relation of the two phases of the project

Phase I was a *linguistic field study* of spatial language in Iwaidja, focusing on spatial frame of reference. This phase addressed the goal of *understanding*. Phase II was an *ethnographic case study* of teachers' understanding of mathematics teaching at Mamaruni School. This phase was designed as the *response* to the understanding gained from the first phase (the evolution of this phase is described in §4.4.1). This sequential design could thus be described as developmental in terms of the relation between the phases (Greene et al., 1989). The methodological labels were generated by the project rather than driving and defining the project. These labels were applied to best match the research activities that were designed and undertaken to address the research questions according to my critical objectives and theoretical frameworks.

The design also informed the structure of this thesis, in which the results and discussions of the two phases are presented sequentially. Phase I results and discussion are presented in Chapters 5 and 6, with discussion integrated with the results in both the chapters. Phase II results and discussion are presented in Chapters 7 and 8 respectively.

4.2 Political and ethical considerations

Political and ethical considerations affected the design of the project. RMIT University's primary ethical consideration is: who is the research designed to benefit? Secondly: will the research design achieve this and will it do this without causing harm to anyone else?

The relationship between academic research and indigenous peoples is complex and contested. It is the prototypical nature of academic research to be *on* something rather than *with* someone. People asked me "*what* are you researching?" before they asked me "*who* are you researching *with*?"

Key considerations were to involve Arrarrkbi (Iwaidja speaking Indigenous people) as consultants, participants and collaborators, not as "research objects" (L. Smith, 1999, p. 81). This included identifying them as the sources of linguistic knowledge and authority (Pinxten et al., 1983; §4.2.4). It was also important to consider the risks of romanticising and essentialising traditional language and culture. Linking people to particular "traditional" identities and practices can be detrimental and at odds with the goal of improving life conditions (Patrick, 2007).

There were further complex issues associated with the wish to involve Arrarrkbi in Phase II, the educational side of the project. The Indigenous peoples of Australia are among the most socio-economically disadvantaged in our country. Education is one way in which oppressed and disadvantaged people may be able to create for themselves futures with choice and agency (Freire, 1968/1970). Although education can perform such an emancipatory function, it can also act as a further tool of oppression (S. Harris, 1990; Pinxten et al., 1983). It can be met with resistance (Beresford & Partington, 2003). As a Balanda teacher myself, my focus was on developing Balanda teachers' understandings of the cultural and linguistic context of their school. Balanda teachers working in schools with Indigenous students may be there with what they consider good intentions, but nevertheless be a part of this oppression (Truscott & Malcolm, 2010). These schools are essentially white institutions with decision making processes in which Arrarrkbi find it hard to participate (Christie, 1995). These factors influenced both the design and course of the project.

4.2.1 Being a Researcher–Participant

The project involved repeated reflection on my own role as researcher–participant (L. Smith, 1999). Some of the tensions associated with this role were constant throughout the project, and affected the development of the project. Through my previous experience at Minjilang and in other situations of working with Indigenous people in remote communities, I was aware of my own voice, that of a white, tertiary educated woman who, while working with and sometimes for Indigenous people, remains an outsider to their cultures and a part of the dominant Western education system.

However, I had begun the project as an insider to the Mamaruni School community through my work as a teacher there in 2008. In some ways, I found that the ethics process required by my university acted to separate my role as researcher from my previous role as a teacher. I needed to take the role of an outsider to the school in order to answer questions on my ethics application such as what I would do if a child became upset during a session. I discovered that

it would not be sufficient to say that I would address the situation of a distressed child in the same manner I would as their classroom teacher. I had to justify using photos and video to document the project when I would be working in classrooms where the children and myself were accustomed to use photos and video to document our daily activities. In fact, some of the methods I use/d as a teacher might not have been approved for use as a researcher.

However, I found the university ethics approval process valuable for two main reasons. The requirements to be explicit about my intentions at every step of the study contributed to the planning and design of the study. My own ethics documents of intent became functional reference materials. It also provided me with the opportunity to reflect upon my own intentions in the research process. Although the project was designed to benefit the community, the students and the educational process, I also admit a substantial intellectual and career benefit to myself. This is not unusual in the context of research in Indigenous communities. An Indigenous educator expressed a tendency of Balanda research thus:

> I see non-Aboriginal people coming into schools doing a quick research, taking Aboriginal ideas and knowledge making a big name for themselves and then leaving without acknowledging the input of the Aboriginal people involved. (quoted in Howard, 2001, p. 46)

I am obligated to the people of Minjilang for allowing and assisting me with this research project. It took me a long time to develop relationships within the community. This included participating in shared social experiences with Arrarrkbi such as going fishing on the weekends or after school. In doing do, I was seen as by some Arrarrkbi as different from other Balandas in the community. Arrarrkbi see Balandas as wanting to keep to themselves. Balandas see Arrarrkbi as wanting the same. I saw the development of relationships as essential to developing a "common discourse" (Haynes, 2009) in which Balanda and Arrarrkbi worldviews could coexist.

Throughout the project, I deepened my relationship with the school. Over many visits, I taught every class of the school and knew all the students individually. I participated in staff meetings, and in many planning sessions with individual teachers. As teachers left and new teachers were employed, I helped orient the new teachers to the school, community and the Northern Territory. I used my role as a teacher to gain the trust of parents and children for their participation in research activities. While this role allowed me access for research, it also impeded my development of deeper relationships with the local community since within the school I was on the Balanda side of a Balanda/Arrarrkbi divide. This divide meant that while there were opportunities for me to discuss the project with the Balanda teachers, the opportunities to do the same with the Arrarrkbi assistant teachers were more limited.

There were times when, turning down a dinner invitation from the teachers in order to go fishing with some of the mothers of my students, I felt my roles as researcher, teacher and "fringe" community member to be precariously opposed. I almost expected to be asked by someone at some point, "Whose side are you on?" There were also many moments during the study when I asked myself whether this project was really going to help anyone, or whether I was just "doing a quick research" (Howard, 2001, p. 46) to make a name for myself. On the other hand, my role as relief teacher seemed to be valued by the principal more than my role as a researcher. I felt that my research was viewed by the school as primarily a personal project, rather than as something to benefit the school.

Some of this tension involving multiple roles is perhaps unavoidable in the specific context of Minjilang Community, and in the more general contexts of both of being a Balanda researcher in an Indigenous context, and in being a university researcher in a school in which I teach/have taught. This tension is one of the factors that constrained, limited and yet also propelled and enriched the research project.

4.2.2 Permissions

There were many sources from which permission to conduct this research was obtained.

4.2.2.1 Traditional Owners

The project was first discussed with Joy Williams, Mary Yarmirr and Daisy Yarmirr, Traditional Owners of Minjilang, as well as members of the school community. A letter of support was provided by Joy Williams, who was also a member of *Iwaidja Inyman* (2010). Contact with the Traditional Owners was maintained throughout the project, particularly with Joy Williams who was closely involved as the key translator.

4.2.2.2 RMIT Human Research Ethics Committee

Ethics approval was sought and obtained from the RMIT University Human Research Ethics Committee. This included describing how the research design took account of the requirements of reciprocity, respect, equality, responsibility, survival and protection and spirit and integrity in the National Health and Medical Research Council (2003) guidelines.

It is interesting to note that all research at RMIT University that involves Indigenous participants is automatically assigned to a high risk category and that guidelines developed by a medical authority need to be followed. I believe the core risks associated with this project involved cultural and intellectual property and heritage, rather than health risks or risks to personal wellbeing. These risks are discussed below (§4.2.5).

4.2.2.3 Other Authorities

Written consent was obtained from the principal of the Top End Group School and the teaching principal at Mamaruni School. Research approval was also obtained from the Northern Territory Department of Education. A research permit from the Northern Land Council was obtained each calendar year, and carried on all trips to Croker Island.

4.2.2.4 Participant Consent

Each participant signed a consent form. Participants included community elders, caregivers, children and teachers and assistant teachers at the schools. In the case of children, a caregiver signed the form, but children were asked for their voluntary participation. Plain language statements and consent forms and were explained verbally, especially to those participants who could not read. Archiving of recordings at the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) in Canberra, as required under their funding conditions (§4.2.3) was also explained.

All participants were informed that they could withdraw from the project at any time. With one exception, all those who were approached to participate gave their consent and none of them withdrew from the project. The person who chose not to participate was a teenage girl who was no longer attending school.

Although I had rewritten consent forms in plain language according to AIATSIS guidelines, it was difficult to explain the content to some of the participants in a meaningful way. Some of the older people have lived their whole lives in small remote communities and do not really know what a university is. The forms are only the material manifestation of what is actually a personal contract of trust between myself and the participants. The participants trusted me more because of the relationships I was developing with them and their families and my ongoing role in the school, than because of a written contract that I would look after their words, their images and their cultural knowledge. Consent as a singular event rather than a process is more a feature of a contractual society. Transforming the contract from print to verbal doesn't actually change its nature as a singular. Consent as a process is more a feature of a relationship based society.

Although I tried to inform the participants' consent, it was obviously limited in those cases where participants didn't understand the academic world. I wondered at times whether I had really been able to communicate my somewhat arcane intentions to the community. Sometimes people appeared to think that I was learning Iwaidja to teach it to their children.

My general statement was that I was trying to understand things about Iwaidja in order to help the teachers teach mathematics to the children better.

I found it necessary to practice *good faith*. Above and beyond the written and verbal contracts that I entered into is an ongoing, active intention for this study to help and not to hinder. I differentiate this from just "good intentions," in that it entails a responsibility on me to constantly reflect upon and assess my own actions and their consequences for the participants.

4.2.3 Funding from AIATSIS

I applied for and received a research grant from AIATSIS to pay people for their participation in this project. Those people who had previously worked on linguistic projects were accustomed to receive payment. Payment compensates people for their time and provides recognition of their expertise (T. Crowley, 2007). All adults participating in Phase I were paid an amount depending upon the time spent on the activities at rates determined by AIATSIS.

Children were not paid. Those who participated outside school hours were given a small present such as snacks or fruit juice, which I paid for out of my own money. Those who participated during school sessions were sometimes given a small present. More often the activity was presented as a normal part of school. Most of the children were familiar with leaving the class to participate in one-on-one assessment activities with me, and they were willing to leave their regular class to participate in the research activities.

4.2.4 Identification of Participants

Conflicting with individuals' right to privacy is their right to be acknowledged for their contribution to the project. It is no longer acceptable to regard community members as being subjects (Pinxten et al., 1983). The consensual naming of consultants and attribution of the specific information they have provided values them as experts. The senior adult participants in Phase I were given the choice of whether or not their name would be included in the thesis and publications. Most chose to have their name used. Teacher and assistant teachers are not identified by name, but they were informed that the small size of the community meant that people might be able to identify them.

Children and their parents were informed that no names of children would be used. Again, they were informed that the small size of the community meant that people might be able to identify them. In particular, where a child worked with a known adult, the identity of the child can be deduced through their relationship with the adult.

Anonymity as a principle doesn't really hold in a small specific context. The situation would be similar if conducting educational research in a special school or alternative school such as a Steiner school in Darwin, because of the unique nature of the research site. Since the results from Phase I contained no statements of opinion by the participants, I felt that there was a very low risk of adverse effects from possible identification. In Phase II, because of the continued employment of the adult participants in the school system, there was a slightly higher risk associated with identification.

4.2.5 Indigenous Intellectual and Cultural Property Rights

As noted previously, Indigenous people are concerned when non-Indigenous people use research on Indigenous knowledge solely for their own benefit (§4.2.1). The very concept of *research* is part of the history of imperialism and colonialism (L. Smith, 1999).

There may be a difference in what Indigenous and non-Indigenous people regard as intellectual property. Unlike world languages such as English, Australian languages are often seen by Australian Indigenous peoples as the property of a particular group of people, and belonging to a particular piece of land (Janke, 1998). The linguistic data collected in Phase I of the project remains the intellectual property of the Iwaidja community (Copyright Advisory Group, 2008). Archiving of the data thus provides community access to the data and respects their right to control that access (AIATSIS, 2011). Because I hold the copyright on this thesis and future writings, I have granted to the contributors of Phase I an irrevocable perpetual license to reproduce the copyrighted material (Appendix A: Speaker Consent Form).

4.3 Phase I – Spatial Frame of Reference in Iwaidja

This section describes the research design of Phase I including the theoretical framework, participants, detailed descriptions of each task, data processing and analytical tools. Phase I was a *descriptive field study* of spatial language in Iwaidja, using the frame of reference typology developed by the Cognitive Anthropology Research Group [CARG] based at the Max Planck Institute for Psycholinguistics (Nijmegen) [MPI] (Levinson, 2003; Pederson et al., 1998). It addressed the first research question.

Research Question 1

How is frame of reference expressed in Iwaidja?

This phase involved eliciting and video recording speech from Iwaidja speakers using carefully designed stimuli. The stimuli (§4.3.3), were mostly taken or adapted from those

used by the CARG in their cross-linguistic investigation of spatial language (CARG, 1993a; Levinson & Wilkins, 2006). I also included a task adapted from the Human Communication Research Centre [HCRC] Map Task (Anderson et al, 1991; HCRC Map Task [online], 2010).

4.3.1 Linguistic Field Study

The phrase "field study" is a broad term used in linguistics which refers to doing research in the field where the language being studied is spoken. It can include direct elicitation with speakers as well as observation of naturally occurring speech. Working within a contemporary linguistic descriptive approach, I consulted guides to conducting linguistic field work (Bowern, 2008; T. Crowley, 2007; Ratliff & Newman, 2001; Vaux & Cooper, 1999). I also consulted guides to conducting research in educational settings (Delamont, 2002; McTaggart, 1991). I had previous experience in linguistic elicitation gained through an undergraduate Linguistic Fieldwork unit at the University of Melbourne in 1993 and through work on a language maintenance project for the Arabanna People's Committee, Marree, South Australia, in 1992–1994. However, my main guidance to the mechanics of description came from Bruce Birch of the Iwaidja Documentation Project. Bruce provided expertise on using appropriate software, transcription and translation.

More specifically, the goals of this part of the study were those of semantic typology: "to explore similarities and differences in semantic concepts" (Levinson & Wilkins, 2006, p. 53). The study was more descriptive than theoretical, in that the purpose was not to seek explanations for why linguistic features exist, but to try to describe the spatial language of Iwaidja "on its own terms" (Dryer, 2006, p. 209) while facilitating comparison with other languages. Doing this I attempted to follow a common analytical approach followed by many descriptive linguists which Dixon (2010) has called "basic linguistic theory." This is an informal theory practised by several generations of linguists.

4.3.1.1 Investigating Linguistic Relativity

The typologically descriptive approach was informed by the hypothesis of linguistic relativity. This was defined as the idea that language affects the way that people think and that people who speak different languages think differently (§2.2.2).

Lucy (1992a) developed a method to empirically investigate effects of language differences on cognition. The two key points of his method are that it is *comparative*, and that it includes *non-linguistic* tasks as well as linguistic tasks. With this method one does not study one language in isolation. One compares unlike languages, although one language can be the focus of a study and another the referent for comparison. The method uses non-linguistic tasks

to investigate whether linguistic phenomena have a non-linguistic cognitive effect. This method also focuses on *habitual thought*, rather than potential thought (Lucy, 1992a). The term *preference* has been used in this thesis in reference to habitual language practices.

Lucy's (1992a) approach informed the cross-linguistic investigations into spatial language of the CARG at the MPI and the design of the tasks that I used in this study (Levinson, 2003). Of course it is not straightforward to devise activities to elicit differences in languages that affect cognition. Differences can lie as much in patterns of language use as in vocabulary and grammar. The method thus uses techniques to elicit speech from two speakers in interaction. Because they are performing a task, the speech has a direct communicative function. It is different from naturally arising speech in a normal day-to-day situation, but it is also different from generic speech such as the formal telling of a story. This speech is not natural, but it is *naturalistic* – within the constraints of the task speakers can interact, interrupt each other, ask questions, and so on. Appropriate non-linguistic tests to investigate the cognitive effects of the target language features are then carefully devised to complement the linguistic tasks (Levinson, 2003). The CARG devised many of their activities collaboratively and over a period of years, with some tasks subject to redesign (e.g., CARG 1992, 1993a).

4.3.1.2 Child Language Acquisition

One of the goals of the project was to understand the spatial language and associated thinking that children bring with them to school. However, a large part of the research focused on adult speech. A description of adult spatial language was necessary in order to provide a basis of comparison from which developmental factors in child speech could be separated from differences between the languages of Iwaidja and English. It reflects a constructivist approach which seeks to understand not just what children know, but what they are coming to know. Children become cognitively sensitive to categorical spatial distinctions made in their language environment well before they are able to reproduce such distinctions. For example, infants in English speaking and Korean speaking environments become sensitive to spatial distinctions made in their respective languages at less than two years of age (Bowerman, 1996; Choi, McDonough, Bowerman & Mandler, 1999).

In a typical developmental approach, where the researcher is from the same culture as the children, the developed adult form of the linguistic feature being studied is already known. Although Australian language speaking children clearly develop their spatial language and thinking with experience and maturity, their paths and outcomes are unlike those of European language speaking children. For this reason, it was central to the study to investigate adult language, in order to understand where the children were heading.

4.3.2 Participants

The Iwaidja data collection involved two main groups of participants. The first group consisted of fluent adult speakers of Iwaidja. The second group consisted of children who spoke or understood Iwaidja, and their parents or caregivers. The adults in the second group were mostly younger than the adults in the first group, but there was some overlap between the two groups. All the participants live primarily at Minjilang, Croker Island.

4.3.2.1 Adults

There were two groups of adults who participated in Phase I of the project.

The first part of the project involved gathering data on spatial language in Iwaidja from fluent adult speakers. Eight individuals participated, four men and four women, who all speak Iwaidja as a first language. These are referred to throughout the thesis as *senior consultants*, *senior adults* or *senior speakers*. All of them had prior experience working on the Iwaidja Documentation Project and some of them were key members of *Iwaidja Inyman* (2010). Two of the women first worked on language documentation projects in the 1970s, when their mothers were working as consultants to the linguists Noreen Pym and Bonnie Larrimore and as such can be considered second generation language consultants.

As well as speaking Iwaidja as a first language, the members of this group spoke between them a range of other languages widely used at Minjilang such as Mawng, Kunwinjku and English. Some of them could also understand the nearly extinct Amurdak and Marrku languages. Introduction to these people was through the linguist Bruce Birch from the *Iwaidja Documentation Project*. Bruce facilitated most of the sessions working with this group, and gave instructions to participants in Iwaidja. Table 4.1 shows a list of the senior consultants. More bibliographic details of KM, CM, RG, and JW can be found on the *Iwaidja Inyman* website (2010).

Table 4.1. List of senior consultants

Name	Initials	Age in 2010	Sex
Khaki Marrala	KM	82	M
Charlie Mangulda	CM	75	M
Rae Girribuk†	RG	73	F
Anon1	A1	–	M
Joy Williams†	JW	64	F
David Galak	DG	–	M
Maggie Marburrunbi	MM	–	F
Anon2	A2	–	F

Note that Joy Williams is referred to as Joy in relation to her role as translator and JW in relation to her role as participant in the tasks.

The second group of adults who participated in Phase I were parents or grandparents of school aged children. They are referred to as *caregivers*. Most of this group were invited to participate because they were reported by the senior consultants to speak Iwaidja to their children. There were six people in this group, three men and three women. One of the men (Anon1) and one of the women (Anon2) were also senior consultants in the first group, working with other adults. Table 4.2 shows a list of the caregivers.

Table 4.2. List of caregivers

Name	Initials	Sex
Anon1	A1	M
Anon2	A2	F
James Cooper	JC	M
Freddy Gabiya†	FG	M
Anon3	A3	F

The adults in this group participated in paired linguistic activities with their children. Some of them I already knew through being fellow employees at the school or through social activities in the community such as going fishing together. I approached the caregivers directly to ask if they would participate. I was introduced to the others by the Government Business Manager, a federal government officer based in the community whose role is to coordinate government services. I visited their houses with the Government Business Manager and asked them to participate.

4.3.2.2 Children

The core group of children who were asked to participate were those who were reported by the senior consultants as having an understanding of Iwaidja, and as having parents or other caregivers such as grandparents speaking to them in Iwaidja. In one case, the parents of a child had told me that they had been actively teaching the child to speak Iwaidja. The ages of these children ranged from seven to 14 years old. These children participated in activities paired with their caregivers, or with a peer.

Some other children were chosen on an *ad hoc* basis when I had some free time at the school. These were children who had parents working at the school from whom I could get immediate consent. They were children who were regular school attenders, with a good understanding of school mathematics and of English.

Through my teaching, I knew all the school aged children in the community. I was able to approach them directly at school or at home. Those parents who I did not already know were introduced to me by the Government Business Manager. In total, 12 children participated, two girls and 10 boys. This gender imbalance in the sample is due to a gender imbalance in this age group in the small community. It appears to be normal variation (Kim Johnstone, pers. comm., 28 February 2012). The children who participated in this Phase were given generic pseudonyms, Child1 through Child12. The children's details are given in Table 4.3.

Table 4.3. List of children, Phase I

Pseudonym	Year of birth	Age at activity (year: month)	Sex
Child1	2000	10.6	M
Child2	2001	10.2	M
Child3	1999	12.2	M
Child4	1998	13:2	M
Child5	2001	10.2	M
Child6	2003	8.3	M
Child7	1999	12.2	M
Child8	1999	11.5	M
Child9	1999	11.5	F
Child10	2000	10.5	M
Child11	2002	8.9	M
Child12	1998	12.5	F

All the children were first language speakers of local Australian languages except Child7, who identifies as Iwaidja but who speaks Aboriginal English as his first language. Child7 was one of the students asked to participate on an *ad hoc* basis.

4.3.2.3 Representativeness and Limitations of Sample

The data obtained from the senior consultants reflects 'traditional' Iwaidja. Some variations in uses between speakers may be due to different levels of formal schooling and literacy. There are also variations in speech depending upon where participants grew up. As the activities relied on visual stimuli, eyesight problems including cataracts may have affected some of the speakers. This was explicitly identified as a problem during one session.

One omission is data from younger adults such as the parents of the children working together. Such data would provide more information about the rate and nature of change to Iwaidja, and perhaps demonstrate a more 'contemporary' Iwaidja. It wasn't possible to expand the project to obtain this data. In particular, most of the people in this group were

attending a ceremony in another community during the period when this data might have been collected.

4.3.3 Tasks

There were two linguistic tasks and one non-linguistic task in this phase. The linguistic tasks were designed to elicit naturalistic speech between two participants that involved use of spatial language. The Man and Tree task (§4.3.3.1) was designed to elicit use of spatial frame of reference in speech, and to demonstrate preferences in frame of reference use. The Map task (§4.3.3.2) was designed to elicit spatial terms that involved movement such as verbs. These tasks were a type of 'game' in which the participants had to solve a problem verbally, using unfamiliar visual stimulus material. The participants in each case were separated by a barrier. The barrier allowed them to see each other but not the stimuli and inhibited the use of gesture. They were free to question each other, repeat themselves and interrupt each other. Although the tasks were artificial and to some of the participants quite strange, the speech elicited was nonetheless naturalistic in terms of phrasing, speech rhythms and interaction between participants. The third task, the Animals in a Row task (§4.3.3.3) was a non-verbal task that was designed to complement the verbal tasks, providing data about spatial memory.

The Man and Tree and the Animals in a Row activities were developed by the CARG. Instructions for their implementation are given in CARG (1993a). These instructions were followed as closely as possible. The Map task was developed following the model of the Human Communication Research Centre (HCRC) Map Task (2010).

The linguistic tasks for two participants had two roles, Director and Matcher. The participants sat side by side with a barrier between them, each with a set of the cards. The barrier prevented the viewing of the other's cards and inhibited the use of gesture while permitting verbal communication. Cardboard boxes sitting on a table, chairs hung with fabric and sheets of cardboard were used as barriers. This setup is illustrated in Figure 4.2.

The participants were seated side by side in order to preserve the same absolute orientation of the two speakers, in the event that this might be a factor. The first session was conducted at Adjamarragu Outstation on Croker Island with the participants facing west during the late afternoon. They were inside a house facing out over the coast and they could see the sea and the sunset from where they were sitting. This made the absolute orientation strongly salient for the participants. All further sessions were conducted with the participants also facing west to facilitate comparison between data sets. Other sessions were conducted at Minjilang in the breezeway of the Government Business Manager's premises and in the library at Mamaruni

School. One session was conducted at the North Australia Research Unit in Darwin while the participants, JW and MM, were in Darwin for a Bible study course.

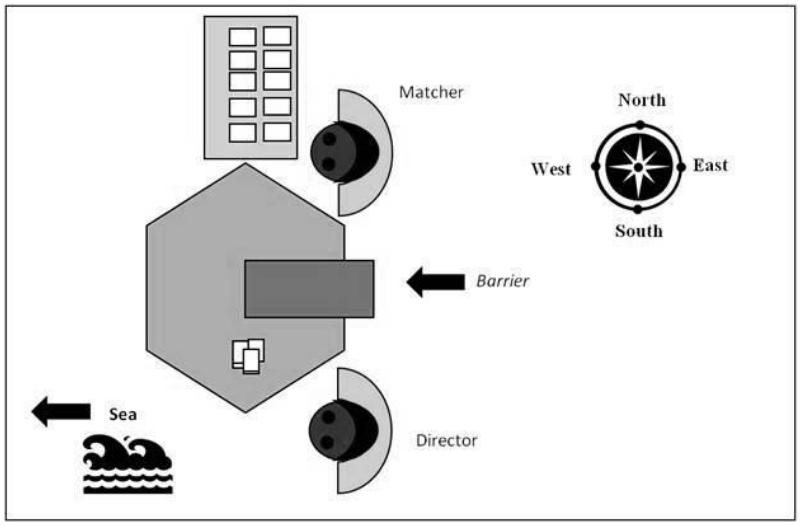


Figure 4.2. Setup of Man and Tree task

4.3.3.1 Man and Tree Task

The Man and Tree task was a picture–picture barrier matching task for two participants. It has been widely used in several variations with different language groups in different parts of the world (Hoffmann, 2009; Levinson & Wilkins, 2006; Li & Gleitman, 2002; Pederson et al., 1998; Meakins, 2011; Terrill & Burenhult, 2008) and thus presented a strong basis for cross-linguistic comparison (Senft, 2007). It provided the bulk of the data for the frame of reference analysis of Iwaidja for this study.

The stimuli for this task were two identical sets of cards which showed photos of a small toy man and tree (Figure 4.3). Each photo showed the same man and tree in a different spatial arrangement. The Director chose one card at random and described it to the Matcher. The Matcher, who had the cards laid out before them, tried to find the matching card. The Matcher was free to ask questions at any point. The game continued for as long as required to match all the cards. A card showing the images in Figure 4.3 is included in a pocket at the end of print copies of this thesis. This can be removed for ease of reference while reading Chapters 5 and 6. Otherwise, the reader is advised to print out a copy of Figure 4.3.

The cards all showed one faceted object, the man, and one non-faceted object, the tree. Generally the man will feature as the *figure*, while the tree will take the role of the *ground*, since the man is faceted (Talmy, 1983). The set of 16 cards used was developed by Ann Senghas to show all possible arrangements of the man and tree in the horizontal plane at right angles (Terrill & Burenhult, 2008). Thus the man can be situated behind, in front of or on

either side of the tree and he can be looking at the tree, facing away from it or have it at his left or right side. As all the cards can be described using more than one frame of reference; the speakers' choices indicate both language specific and individual preferences.

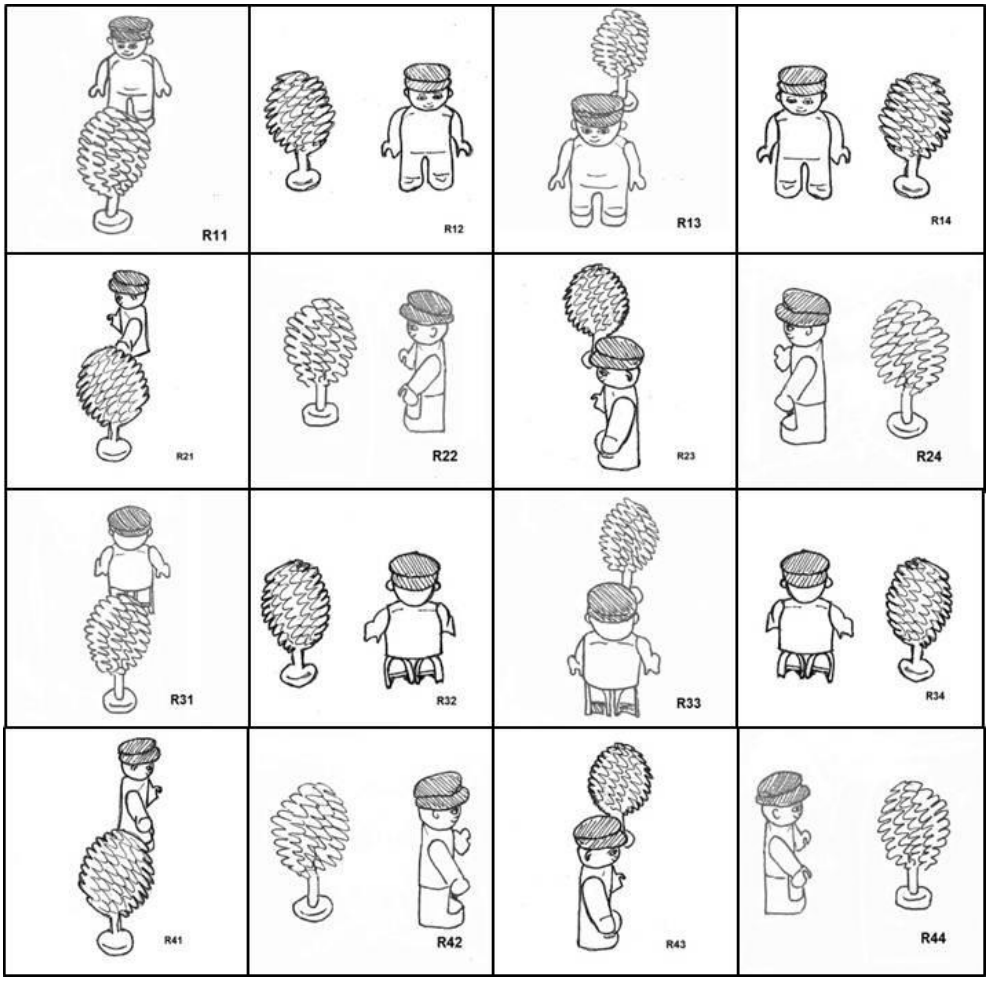


Figure 4.3. Man and Tree cards, Anne Senghas version (after Terrill & Burenhult, 2008, p. 96).

The cards are named with a two digit number, prefixed with *R*. The first digit refers to the facing direction of the man and the second digit refers to his position with respect to the tree. For example, if the first digit is *1*, the man is facing the viewer. A reference such as *R1x* thus means any card where the man is facing the camera, that is, *R11*, *R12*, *R13* or *R14*. If the second digit is *1*, the man is standing in the background and the tree is in the foreground. A reference such as *Rx1* includes *R11*, *R21*, *R31* and *R41*.

The original task was one of a group of the *Space Games* developed by the CARG which contained sets of six pictures and two distracter pictures. The pictures that are equivalent to the original set are *R12*, *R14*, *R22*, *R24*, *R32* and *R44*. The *Rx2* and *Rx4* cards, which includes the original six card set, all show the man and tree arranged on the *lateral* or *across-axis**. The *Rx1* and *Rx3* cards show the man and tree arranged on the *away-axis**. Most of the literature which refers to the Man and Tree game, including Terrill and Burenhult (2008),

refers to only the original six card set using the across-axis. In this case, the Ann Senghas set was chosen as it offered more complex data than a smaller card set. The set was reduced for use with some of the child participants. In most cases the reduced set included the original six card set, and ranged from eight to 14 cards. In one case, which was an impromptu session, only five cards were used.

With the group of eight senior adult participants, the task was performed a total of seven times. Three pairs each took a turn at the Director and Matcher role, swapping after completion. These sessions ran for between 46 and 77 minutes for the two turns. One pair, A1 and DG, took 54 minutes for the first turn, and so did not swap roles due to task fatigue. Instructions were given by Bruce Birch in Iwaidja and by myself in English. In the session conducted in Darwin, instructions were given by myself and Sabine Hoeng in English.

During the first session, the Matcher's cards were initially laid out in front on a table (Figure 4.4). The Directors tended to hold up the card that they were describing. However, the Matcher noted that the absolute description being given by the Director didn't match the cards lying down on the table. For example, the Director's description of the man as facing *wurrying manyij* 'sunset/east' which applied to any card *R3x* did not match the Matcher's view, in which the man was facing down at the floor. The cards were then rearranged to sit upright and all further sessions were conducted with the Matcher's cards pegged vertically on a frame (Figure 4.5).

Figure 4.4. First Man and Tree session: cards flat

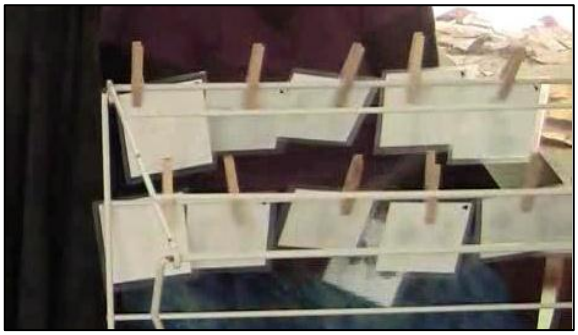


Figure 4.5. Subsequent Man and Tree session: cards vertical

A reduced set was used for the child–adult and child–child sessions which varied between six to 12 cards. This reduced the complexity of the task and time taken to complete. Sessions varied between three and 18 minutes for each turn with most sessions taking between 10 and 14 minutes. In particular cards *R21*, *R23*, *R41* and *R43*, which show the man side on to the tree, but in front or behind from the viewer's perspective and which had seemed to present the most difficulties for the senior adults, were not used. I gave instructions for the child–adult and child–child sessions in English.

In all sessions, matching became easier as the task progressed since there were less cards remaining to choose from. In some cases, the Director gave no description of the final card, since a match was obvious.

4.3.3.2 Map Task

The Map task was another barrier task for two participants and was derived from the HCRC Map Task (Anderson et al., 1991). One participant, the Director, was given a map with a route marked on it. The other participant, the Matcher, had the same or similar map but without the route. The Director described the route to the Matcher and the Matcher drew the route on their map. I designed the maps to contain items that existed on Croker Island and would be familiar to all participants and which had common names in Iwaidja. An example of a Director's map is shown in Figure 4.6. For more maps see Appendix B. An example transcript of a Map task session is given in Appendix C.

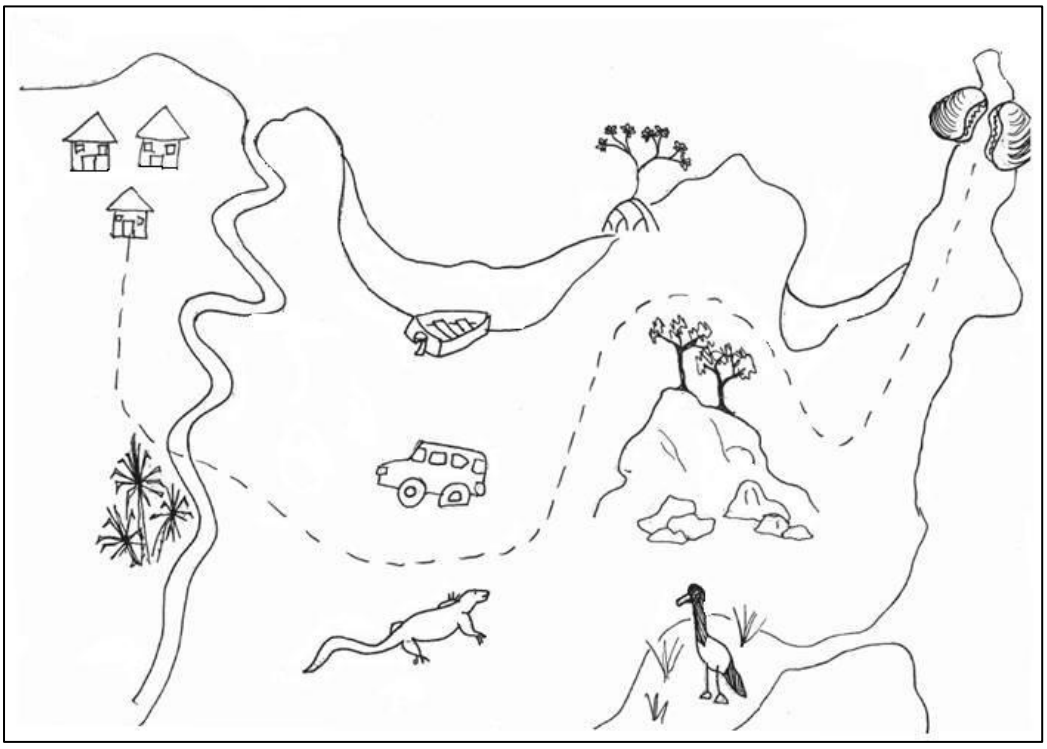


Figure 4.6. Example of a Director's map showing route

The maps differed from those used in the HCRC Map Task by having a coastline and other landscape features such as a creek and beaches. Additionally, items were chosen whose names predominately featured the 'a' vowel, so that the data could be used in future phonological work. The sounds of consonants tend to be clearer around 'a' than around 'u' or 'i'. The items on the maps were shown as drawings rather than symbols, as some of the participants would not have been familiar with map conventions.

This task was conducted six times with the senior consultants, with three pairs of participants who each had a turn at directing. As with the Man and Tree task, the sessions were videoed with an external microphone. The first pair used matching maps where the only difference was that one had a route marked and the other did not. The other two pairs were given different maps, so that some of the items on one map either did not appear on the other or were in different locations. The Director's map still had a route marked on it. The intention was that more complex language would be generated as the participants encountered the differences in their maps. Participants in the sessions where the maps differed were informed that the maps might be different. However, this was not stressed and some participants might not have fully understood this aspect of the task.

The task gave participants a choice as to whether they used spatial frame of reference or other strategies. It generated a wide range of spatial terms. There was some use of frames of reference with this task, but other forms of spatial language were more prominent. Since the task did not seem to be a strong elicitor of frames of reference usage, I decided not to repeat this activity with the children.

4.3.3.3 Animals in a Row Task

The Animals in a Row task was a non-linguistic task designed as a complement to the linguistic tasks to test the use of frames of reference in memory. It was specifically designed to distinguish relative and absolute thinking (Levinson, 2003). This activity was an individual task. The participant was shown a line of toy animals facing along a table (Figure 4.7). They were told to look at the scene and remember it. They were then taken to another table which was rotated at 180 degrees from the stimulus table, upon which were lying the same animals.

They were told to 'make it the same', to reproduce the array of animals on the second table. In order to ensure that the memory was being used, there was a delay between stimulus and solution produced either by the distance in moving to the second table or by a distracter activity. This activity was done with five of the senior consultants and with 10 children. In the case of the senior consultants, who were elderly and moved slowly, the delay was only the

walking time between stimulus and solution tables. A puzzle was used as a distracter for the children. Scoring of this task is described with the task results (§5.2.6).

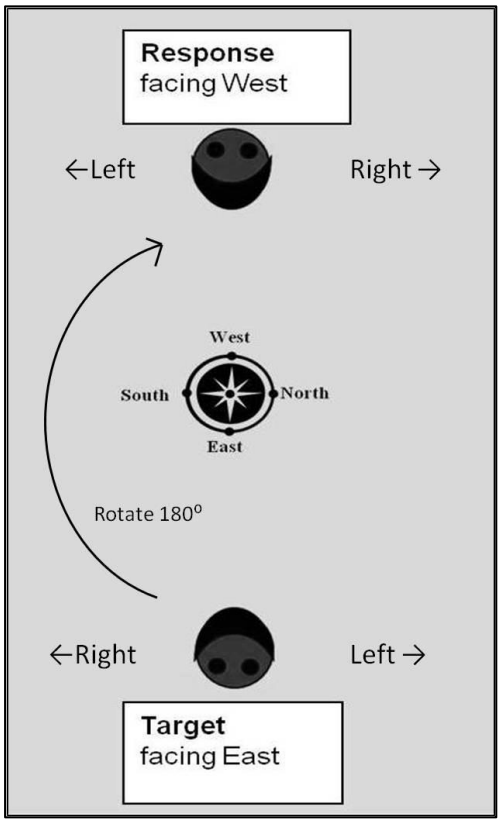


Figure 4.7. Setup of Animals in a Row task

4.3.3.4 Task Validity – Animals in a Row

There has been debate on whether the non-linguistic tasks such as Animals in a Row show the cognitive effects claimed by their designers. The reference study showed while Dutch speakers predominately used a relative solution, Guugu Yimithirr speakers of Hopevale used an absolute solution in the majority of cases (Levinson, 1997).

Individual speakers may diverge from the group norm, favouring a frame of reference not used by the rest of the group (Majid, Bowerman, Kita, Haun & Levinson, 2004). Pederson's (1993) work on several Tamil communities found a distinction between the absolute preference of the rural group and the relative preference of the urban, more educated group. Most of the groups that favour the absolute have tended to be rural and generally not literate. However, many rural groups do not use the absolute (Majid et al., 2004).

Li and Gleitman (2002) argued that the distinctions Levinson found were situational and momentarily environmental, that the absolute solutions were prompted by obvious landmark cues. They tested this by conducting the Animals in a Row activity with English speakers, using both a featureless environment and one with salient landmark cues such as toys ducks

on a toy lake. They found more absolute solutions in the English speakers exposed to the landmark cues. They argued that

> it is just as possible to interpret the correlation in reverse; namely, that culturally differing spatial reasoning strategies lead these groups to deploy different terminologies, those that are consistent with their reasoning. ... Just because linguistic and cultural practices are so often and usefully intermeshed, it is difficult to tell cause from effect. (p. 272)

Levinson, Kita, Haun, and Rasch (2002) countered that what Li and Gleitman in fact showed was that they could bias the Animals in a Row test by introducing salient landmarks and that this bias was in fact towards an intrinsic solution, where the landmark cue was incorporated into the solution.

4.3.3.5 Limitations of Tasks

Some limitations to the three tasks were observed. They were "Western" type activities that were quite foreign to the older participants. For the children, on the other hand, the tasks matched more closely their experiences of school activities.

With the Man and Tree task, the images divide the field into 90 degree axes, an assumption that is possibly culturally biased. However, since the task had already been conducted with a wide range of non-European languages, in diverse cultural settings, it had a strong potential to be used for cross-linguistic comparison. Some of the images were ambiguous for those older participants who had eyesight difficulties, with a few participants unsure which was the front and which was the back of the toy man, for example, confusing *R14* and *R34*. None of the participants appeared to have trouble interpreting the depth of the picture or that the objects were toy representation of real objects. Finally, because the sessions were all conducted with the participants facing the same direction, the comparative strength of axes could not be assessed.

The sessions were video recorded. During later sessions an external microphone was used after difficulties with audibility of the recordings, especially due to the presence of ambient noise such as an electric generator (at the outstation) and construction trucks passing (in Minjilang). There are small sections of some of the recordings that could not be transcribed because of this noise.

4.3.4 Data Processing

Each file was assigned a unique name encoding the date and session number. The original video files were in a proprietary .mov or .mp4 format. These were converted into a standard .mp4 video file and a .wav sound file. These files were then imported into ELAN (EUDICO Linguistic Annotator) and an annotation file created. ELAN is a linguistic annotation software

developed for the language analysis and used by many linguists (Hellwig, Van Uytvanck & Hulsbosch, 2010).

I began the initial transcriptions with assistance from Bruce Birch, transcribing at a phonic level with little knowledge of the Iwaidja vocabulary. These transcriptions were then checked with a native speaker. As the transcription process progressed and I acquired a working knowledge of the key vocabulary, the process became easier. I also worked closely with Joy Williams on many of the transcriptions. As well as being a Traditional Owner of several areas of Croker Island, Joy was one of the most experienced Iwaidja translators. The texts were then translated at sentence level in collaboration with Joy. While some of the translations strove for idiomatic English, I also sought to preserve the phrasing of the Iwaidja original, as discussed below (§4.3.5), and in more detail in Chapter 5.

New words that were not in the *Iwaidja Dictionary* (Birch & Evans, n.d.) were checked with Bruce and Joy and other examples of their use elicited from Joy. They were then added to the *Iwaidja Dictionary* (§5.1.6). Other Iwaidja languages resources consulted included Capell (1962), Larrimore (1972), Pym (1982, 1985) and Pym and Larrimore (1979).

4.3.4.1 Archiving

The linguistic data collected in this phase forms part of the cultural and linguistic heritage of Arrarrkbi. It is of particular importance considering the endangered status of Iwaidja today. In accordance with conditions of the AIATSIS grant, a copy of the data will be deposited in the AIATSIS archive in Canberra. Original versions of videos files and .wav sound files have also been archived with the *Documentation of Endangered Languages Programme* [DoBeS] at the Max Planck Institute, Nijmegen, the Netherlands. The access conditions are such that research participants have access to the data and the right to give or deny access to others.

4.3.5 Analytical Framework: Frame of Reference

The linguistic focus was spatial frame of reference according to the framework developed by the CARG (Levinson, 1996a; Pederson et al., 1998), using some of the same tools. It is a tripartite framework, with utterances – phrases or sentences – classified as *absolute*, *intrinsic* or *relative*, each of which is discussed below. This approach also classifies languages according to which frame of references speakers prefer in which contexts, and according to speakers' performance on the non-verbal tasks. Frame of reference is only one part of a language's repertoire of spatial talk and some languages rely on it as a strategy more than others.

I earlier described the three types of frame of reference, absolute, relative and intrinsic (§3.5) and how the order of acquisition of these frames of reference in speech for children learning Indo-European languages parallels Piaget's stages of spatial thinking (Piaget & Inhelder, 1948/1956) and the sequencing of the Northern Territory Curriculum Framework (NT DET, 2002, 2009d) (§3.5.10). I also described how the three frames of reference have been documented for Australian languages (§3.5.11). In this section, I again provide a definition of each type of frame of reference with an explanation of how decisions were made about categorising utterances in the data. I then describe some of the other parts of spatial language that were included in the analysis. These include *topology*, *deixis*, *naming* (which is also known as toponymy) and *orientation*, and will each be described below.

4.3.5.1 Absolute

In the *absolute* frame of reference, the location of the figure is described in relation to a fixed direction or landmark. Descriptions that included cardinal directions, wind directions, landscape directions (such as 'inland' and 'mainland') and place names were analysed as absolute. In most cases, the use of a specific term was considered sufficient to categorise a description as absolute.

4.3.5.2 Relative and Intrinsic

In the *relative* frame of reference, the point of view and body of the speaker are used to relate the figure to the ground. For example, "the pen is to the left of the cup." Key English terms are *in front of, behind*, *to the left of* and *to the right of*, where these are from the speaker's perspective.

In the *intrinsic* frame of reference, the location of the figure is described with respect to a part or facet of the ground. For example, "the pen is beside the cup." Key English terms are *front*, *back* and *sides*.

As with English, the intrinsic and relative frames of reference in Iwaidja share vocabulary. Context was used to determine the frame of reference being used. Some utterances have been classified as ambiguous because both these frames of reference are possible in the context. Descriptions that included the body parts or gaze of the man with respect to the tree or the speakers were analysed as intrinsic.

4.3.5.3 Deixis and Gesture

Spatial *deixis* (§3.5.4), refers to information internal to the speech situation and the location of the participants (Levinson, 2008). The activities in this study were designed to eliminate the use of gesture. However, deictic terms were used at times. Sometimes these served to clarify

the frame of reference that was being used. Some speakers used the phrases "my side" and "your side" to distinguish the left and right sides of the cards. Despite arguments for classifying these descriptions as either relative or absolute, deixis was retained as a separate analytic category (§5.2.5).

4.3.5.4 Topology

Topology (§3.5.5) describes proximity, order, enclosure and continuity. Separation can be included as the negative of continuity. In the Iwaidja data, there was a continuum between topological and intrinsic terms, which is not uncommon in other languages (Levinson, 2003). The main topological concepts identified in the data were proximity and separation.

4.3.5.5 Named Places

Consideration was given as to whether named places were used as referents (§3.5.6).

4.3.5.6 Orientation

Terrill and Burenhult (2008) have used *orientation* (§3.5.7) to describe information about facing direction. Orientation thus includes all intrinsic descriptions and some absolute and relative ones. Throughout the analysis, orientation was considered as an alternative to frame of reference.

4.3.5.7 Process of Analysis

Spatial terms from the Man and Tree task and Map task were defined with native speaker collaboration. The semantic scope of each term was analysed through a process of eliciting and testing sample scenarios for the use of each word. This included asking Joy, who was the main translator with whom I worked, for other sample sentences. Sometimes we physically modelled scenarios with people or objects to explore the boundaries of a term's applicability. For example, this might involve placing an object *warrwak* 'behind' another object and then moving it around asking "is it still *warrwak*?" Previously undefined terms were added to the Iwaidja Dictionary with contextualised examples.

The data from each Man and Tree session was grouped by the target card that was being described by the Director and put into an Excel spreadsheet. Utterances that used frame of reference were classified as absolute, relative or intrinsic. Some data did not fit neatly into these categories, such as deictic information (§5.2.5). I calculated frequencies such as the use of some terms and each category by each speaker. I also compared all the speakers' descriptions of each card. An example transcript of a Man and Tree session is given in Appendix D. A summary of the same session is given in table form in Appendix E.

I also separated *facing* and *standing* information. Facing refers to the direction that the man was facing in each card, and standing to the locations of the man and the tree. In particular I analysed the frequency and contexts of gaze or vision verbs such as 'look at' or 'stare'.

4.3.6 Sample Size and Validity

Tables and graphs were used to summarise some of the results. In some cases I performed simple statistical operations. It is essential to note that this research is based on a small sample size. Quantities are used for the purpose of comparison and clarification, and no statistical significance is being claimed.

4.3.7 Additional Research Questions Phase I

Due to the lack of children who were fluent in Iwaidja, the children performed the tasks in a basic learner's Iwaidja, in English, in Mawng (minimally) or in Kunwinjku. It was this use of different languages that stimulated the following additional research questions:

- Is frame of reference use in Iwaidja related to frame of reference use in Minjilang English, in Mawng and in Kunwinjku?
- What are the preferred strategies of children who are speaking a learner's Iwaidja, Kunwinjku and/or English? Are these preferences related to language acquisition and/or to the language background and worldview of the children?

These questions are addressed in Chapter 6.

4.4 Phase II – Mathematics Education at Mamaruni School

Phase II was an *ethnographic case study* of teachers' understandings of mathematics education at Mamaruni School, particularly in relation to space and language. As a core element, it included a mathematics teaching program in the area of location that was designed in collaboration with the Early Years Teacher in 2011 which drew on the results from Phase I (§4.4.2). It addressed the second research question.

Research Question 2

How can teachers' understanding of frame of reference in Iwaidja be used to construct and teach a more culturally responsive Early Years mathematics program?

4.4.1 Ethnographic Case Study

A defining feature of ethnographic research is sustained immersion in the research environment. This is crucial in fields such as anthropology where the aim is "thick description" (Geertz, 2000, p. 10). It has also been the traditional approach in linguistics,

especially with descriptive goals such as creating grammars and dictionaries. Limiting factors to this type of research are time and resourcing. It requires both money and a home-life from which the researcher can be absent in order to spend the necessary time in the field, particularly when the location of the field site is remote.

Repeated immersion in the school was enabled by my casual employment as a relief teacher in the school. It also contributed to my role as participant–observer. I interacted with the teachers as a professional peer, concerned with the educational engagement and performance of the students. I was able to make each visit brief, returning home to Darwin after a week or two and thus lessening that disjunction that the field researcher experiences from their domestic life. My time as a teacher in the school before beginning the project meant that I already knew what it was like to spend an extended amount of time in a remote community.

During the course of the project, 2009 to 2011 inclusive, I spent approximately 35 weeks on Croker Island. This comprised 22 visits ranging from five days to three weeks in duration. Most of these visits included a session – usually a week – relief teaching at Mamaruni School. The school paid for my flights for these visits, and I was able to stay in the community after each period of relief teaching for research activities. Research activities were also conducted in weeks in which I was teaching, either after school or within the school day.

Research activities included interviews (§4.4.3) and lessons (§4.4.4). These were enriched by the observations made during the many visits. The results, presented in Chapter 7, include narrative documentation of the observations as well as the interviews and teaching program. In doing this, my goal has been to make the ethnographic description interpretive of the discourse on mathematics education in the school (Geertz, 2000). My approach is also critical, rather than conventional, seeking to make judgements, and propose alternatives which could improve the mathematics teaching in the school (Thomas, 1993).

4.4.1.1 Evolution of the Design

This phase was originally envisioned as an *action research* project where I would work closely with the classroom teacher designing, implementing and revising a teaching programme. This is a methodology which can empower the participants by virtue of the "authentic participation of the research in the research" (L. Smith, 1999, p. 81). In this approach, myself as researcher, teachers both Indigenous and non-Indigenous and other community members would have come together to form a working party to improve teaching practice. Action research is generally conducted in a cyclical manner, where each round of action is frequently and regularly assessed, changes are made and a new or altered course of

action is implemented (McTaggart, 1991). To some extent, this is a formalisation of what teachers already do in their teaching practice of retaining and refining what appears to work and rejecting what does not. To make it action research, there is both a commitment to change by all parties and formal recording and reporting of results (McTaggart, 1991).

One of the long term goals of this project was to produce knowledge and understanding from which it would be possible to generalise, for example by following a similar procedure for another language and in another school (see Creswell, 2009, p. 193). Thus, the original plan also contained elements of A. Brown's (1992) *design experiments*, that is, classroom based research operating within the normal complexity of that environment, but which is designed to have reproducible outcomes. My intentions diverged from "pure" action research where "it is not possible, nor desirable, to aim for replication or generalisation, since the aim is to understand rather than to predict" (McNiff, Lomax & Whitehead, 1996, p. 106).

During the course of the three years from conception to implementation of the project, the Early Years teacher in the school changed three times (§4.4.2). It was thus not possible to conduct this Phase with the same teacher closely involved. The teacher interviews that had been designed as an initial interview of the participating teacher became a series of interviews of incoming teachers. I consequently shifted focus from the school based design experiment/action research to an ethnographic observation of the school environment and how the teachers understood mathematics teaching in that context. Over the course of multiple visits, frequently working as a teacher in the classrooms of the school, participating in staff meetings and planning with the teachers, I was able to add to my own experience of the context by the observation of others. At the same time, my slowly developing relationships with locals in the community, including those who work at the school, enabled me to investigate the question of Indigenous participation in the school.

4.4.2 Participants

Five teachers participated in interviews for the project. At the start of 2009, every classroom teacher and the teaching principal were new. I had been discussing the project with the previous Early Years teacher and teaching principal and had to begin again. At the end of that year, three of the teachers left and at the start of 2010, three out of four classes also received new teachers, including the Early Years class. I have given the teachers codenames. P means Principal, EYT means Early Years teacher (teaches Transition – Year 2), PYT means Primary Years teacher (teaches Year 2 – Year 5) and MYT means Middle Years teacher (teaches Year 5 – Year 9). Hence Shirley, EYT3, was the third Early Years teacher at the school in the

course of the project. The teachers who were interviewed have been given pseudonyms to assist the reader, as has Carol (P3), the principal from 2010 onwards. The teachers who participated in the interviews were Shirley (EYT3), Katie (EYT4), Leah (PYT3), Simon (PYT6) and Joanne (PYT7). Katie, the 2011 Early Years teacher, participated in the planning and implementation of the teaching program. Table 4.4 shows which teachers taught which classes at Mamaruni School from 2009 until 2012.

Table 4.4. Teachers at Mamaruni School 2009–2012

<table>
<tr><th rowspan="2">Class/ Role</th><th colspan="2">2009</th><th colspan="2">2010</th><th colspan="2">2011</th><th>2012</th></tr>
<tr><th>Sem. 1</th><th>Sem.2</th><th>Sem. 1</th><th>Sem.2</th><th>Sem. 1</th><th>Sem.2</th><th>Sem. 1</th></tr>
<tr><td>Principal</td><td>P1</td><td>P2 (was EYT1)</td><td colspan="5">P3: Carol</td></tr>
<tr><td>Early Years</td><td>EYT1
EYT2</td><td>EYT2</td><td colspan="2">EYT3: Shirley</td><td colspan="2">EYT4: Katie</td><td>EYT5</td></tr>
<tr><td>Primary Years</td><td colspan="2">PYT1</td><td colspan="2">PYT2</td><td colspan="2">PYT3: Leah</td><td>PYT4</td></tr>
<tr><td>Primary Years2</td><td colspan="2" rowspan="2"></td><td rowspan="2">PYT5</td><td>PYT6: Simon</td><td colspan="2" rowspan="2">PYT8</td><td rowspan="2"></td></tr>
<tr><td>PYT7: Joanne</td></tr>
<tr><td>Middle Years</td><td colspan="2">MYT1</td><td colspan="2">MYT2</td><td colspan="2">MYT3</td><td>MYT4</td></tr>
</table>

The students who participated in this phase comprised the Early Years class of 2011. Parental consent was obtained for their participation, including the use of video and photo documentation (Appendix A). There were 12 students attending the class on the days when data was collected. Seven of these students are referred to directly in Chapter 7. Like the teachers, the students mentioned in this phase have been given pseudonyms. Their ages at the time of observation are given in Table 4.5.

Table 4.5. List of students, Phase II

Student	Year of birth	Age at activity (year: month)	Sex
Sierra	2004	7.2	F
Zoe	2004	6.11	F
Will	2003	8.1	M
Adam	2004	6.9	M
Carter	2003	7.6	M
Brendan	2003	7.11	M
Robert	2003	7.9	M

4.4.3 Teacher Interviews

The teacher interviews were semi-structured, focusing on the teachers' perceptions, knowledges and understandings of Indigenous mathematics practices, the use of Indigenous language in mathematics programs and best practice in mathematics lessons (Appendix F: Teacher interview questions). The purpose was to elicit the teachers' attitudes and beliefs about teaching mathematics in an Indigenous context. The questions were general and designed to lead to further questions and probes in response to the teachers' answers. There were questions on space, curriculum and relevance as well as language. I also asked some of the teachers to perform the Scaffolding Numeracy in the Middle Years Card Sort (Appendix G: Siemon, 2005). This was a task designed to see how the teachers viewed mathematics and themselves as teachers of mathematics.

The interviews were conducted after school at the teachers' houses. Each interview was audio-recorded, and then transcribed and analysed. I interviewed five teachers, Shirley, the Early Years teacher in Semester 1, 2010 and four of the five teachers at the school in Semester 1, 2011.

All the teachers that I approached agreed readily to be interviewed. Joanne asked to see the questions in advance so that she could have some time to think about her answers, which I provided for her a day or so before the interview.

I also conducted a follow-up interview with Katie in the final term of 2011. This interview concentrated on reflections on the teaching program that had been implemented and on the changes and continuities in Katie's perceptions of her mathematic teaching context over the year.

4.4.4 Lesson Plans and Observations

A central consideration of the teaching program was that it was not conceived as an intervention requiring extra staff. It is no surprise that a common factor in successful interventions is extra resourcing (McRae, 2000). Resourcing is a constant issue in remote education, and class teachers cannot rely on having a specialist teacher present in order to implement the lessons or conduct one-to-one assessment (see Bobis et al, 2005; Perry & Dockett, 2004). As A. Brown (1992) says,

> intervention research designed to inform practice ... must operate always under the constraint that effective intervention should be able to migrate from our experimental classroom to average classrooms operated by and for average students and teachers, supported by realistic technological and personal support. (p. 143)

In particular, since many remote schools have a high teacher turnover, useful innovations are going to be those which are easy for teachers to understand and implement. Thus activities were designed so that they could be implemented by the classroom team without extra support, rather than, for instance, requiring the presence of myself in addition to the normal classroom staff.

In Term 2, 2011, Katie and I participated in joint planning sessions where I shared results from Phase II and we discussed ways in which she might make use of them in her mathematics program and throughout the school day. Some of these lessons, Katie taught and some of them I taught. Documentation of the teaching program included

- Notes made during planning sessions,
- Katie's mathematics unit plan made after a joint meeting,
- Observations of lessons that Katie taught and that I taught,
- Video footage taken by Katie during lessons, and
- Copies of student work during a mathematics lesson.

These were supplemented by observations made in the school during the course of the project. They included observations that were either typical of teaching practices in the school or that appeared directly relevant to the project.

4.4.5 Interview Processing and Analysis

The teacher interviews were audio recorded. The files were converted into a .wav sound file, inserted into ELAN (§4.3.4) and then transcribed and analysed. The purpose of the analysis of the interviews was to illustrate the teachers' thoughts about teaching mathematics in a remote Indigenous context. I used elements of the constant comparison method (Glaser, 1965). Some of the data categories, such as language, space, curriculum and relevance, were predetermined by the interview questions. Other categories, such as engagement and life-skills, emerged from the data as themes which various teachers raised in response to different questions. Coding was done in Word and Excel. The analysis and presentation of the interviews in Chapter 7 owes a lot to the exemplary model of Howard's (2001) thesis.

4.5 Conclusion

A mixture of methods was used throughout the project depending on the goals of the particular phase or activity. In attempting to embed a linguistic study into an education study, I encountered very different approaches to the role of methodology and method in the two disciplines. Linguistic theses sometimes only have a one or two page methodology (e.g.,

Singer, 2006). This chapter has aimed to provide the necessary description for the reader to appreciate the contexts which produced the results reported in the following chapters, as well as the analytical approach applied to the results.

All the tasks used in Phase I have been used in a wide range of settings by other researchers, facilitating comparison of Iwaidja results with data from other languages. The tasks were adapted in one way or another to the specifics of the research environment. The maps were designed to be intelligible to participants. Animals were chosen that had names in Iwaidja (mostly borrowed from English). The rich descriptions that were necessary for participants to solve the extended Man and Tree task were valued over the quicker solutions of the six card set used by most other researchers with this task, particularly since there was so little prior documentation of spatial language in Iwaidja.

The design of Phase II evolved during from action research to more of a focus on ethnographic description, reflecting the constraints and changes of the research environment. To work on a teaching program with a teacher assumes that the teacher has the willingness and capacity to collaborate in that way. However, much research in schools, remote schools particularly, is a "quick research" (Howard, 2001, p. 46). The ethnographic approach, with many visits and many conversations, some purposeful, some random, enabled a richer description of the environment than could be drawn from just a few quick visit.

Chapter 5
Spatial Language in Iwaidja

This chapter presents an analysis of spatial language in Iwaidja, focusing on spatial frames of reference, but including deixis, topological language and the language of motion. It is based on the three Phase I tasks which were conducted with the senior consultants, that is, the Man and Tree task, the Map task and the Animals in a Row task. A card showing the Man and Tree images is included in a pocket at the end of the thesis. This can be removed for ease of reference while reading Chapters 5 and 6.

Section §5.1 provides background linguistic information about Iwaidja. It is challenging to present linguistic data in a manner that is comprehensible to the non-linguist while also linguistically rigorous, running the risk of being neither comprehensible nor rigorous. Key terms are defined in the Glossary as well as throughout the text. The section on phonology (§5.1.1) is not necessary for an understanding of the chapter and can be skipped by the non-linguist. The approach to glossing (§5.1.2) shows how to read the examples. The section on verbs (§5.1.3) may also be unnecessary for the non-linguist, although an understanding of verb formation will enrich the reader's understanding of the examples. Descriptions are then given of frame of reference in Iwaidja (§5.2), topological language (§5.3) and the language of motion (§5.4). The literature is discussed throughout these sections with the contextualised examples. The chapter concludes with a discussion of orientation and dynamism in Iwaidja (§5.5).

5.1 Introduction to Iwaidja

This section presents information the phonology (sound system), verbs, spatial prepositions and demonstratives in Iwaidja. It also explains the gloss of the examples in this chapter and the following chapter. The interested reader is referred to *Kindi ngamin nuwung: what do I call you, a guide to kinship and address* (Marrala et al., 2008a) for more detailed information for the beginner learner. See also Evans (2000, 2007, 2009), and Evans and Birch (2007).

5.1.1 Phonology

Table 5.1 shows the sounds of Iwaidja.

Table 5.1. Sounds of Iwaidja (from Marrala et al., 2008a)

Characters	IPA[1]	As in Iwaidja:	Pronounce as:	As in English:
a	a	*m**a*** ‘alright’	ah	c**a**r
i	i	*k**i**nd**i*** ‘how much’	ee	w**i**n
u	u	*b**u**l**u*** ‘bee species’	oo	w**oo**l
b	p	***b**arda* ‘then’	b	**b**arn
d	t	***d**ubulu* ‘card game’	d	**d**o
j	c	*i**j**alkud* ‘really’	j	**j**am
k	k	***k**ayirr**k*** ‘now’	g or k	**g**um, brea**k**
l	l	*burru**l**i* ‘good’	l	**l**olly
m	m	***m**a**m**inga* ‘scale giant clam’	m	mum
n	n	***n**a**n**ung* ‘brother-in-law’	n	**n**oo**n**
w	w	***w**arrkbi* ‘man’	w	**w**ater
y	j	***y**arda* ‘eye’	y	**y**arn
ld	ɭʳ	***ld**a* ‘and’	ld	old
ny	ɲ	*marru**ny*** ‘kentia palm’	ny; may occur at end of word; not ‘nee’	ba**ny**an
ng	ŋ	***ng**abi* ‘I/my’	ng; may occur word initially; not like ‘finger’	si**ng**er
rr	ɾ	*ba**rr**a* ‘northwest monsoon’	the flap in the middle of ‘butter’ if you say it quickly	the flap in the middle of ‘bu**tt**er’
r	ɻ	*wa**r**a* ‘he/she/it goes’	As in US English r	ca**r**
rd	ʈ	*ma**rd**an* ‘small’	As in US English rd	ca**rd**
rl	ɭ	ka**rl**u ‘no’	As in US English rl	Ca**rl**
rld	ɭᵗ	*ma**rld**u* ‘wind’	As in US English rld	world
rn	ɳ	*ma**rn**ung* ‘sulphur crested cockatoo’	As in US English rn	da**rn**
rt	ʈ	*a**rt**ayan* ‘I see’	As in US English rt; may occur word initially	ca**rt**
h	ɰ	*ba**h**arl* ‘his/her/its head’	velar approximant; often left out in casual speech; does not occur in English	

[1]International Phonetic Alphabet

Phonologically, Iwaidja has a rich set of liquid phonemes, an unusual velar approximant *h*, and the absence of length and voicing contrasts in the stop series. Although most of the liquid phonemes of Iwaidja occur in dialects of English, in Iwaidja they often occur in syllable initial position. Iwaidja also has a set of morphophonemic alternations applying at the boundaries of bound morphemes, for example, the boundary between a prefix and a stem (Evans, 2000; Pym and Larrimore, 1979). As this alternation often applies to the initial consonant of a verb stem, for example, it can be challenging for the learner of Iwaidja to recognize stems within inflected forms, particularly if the stem is short. For example, the third person singular past form of *mi* 'say' in the is *abiny* 'he/she/it said'. The morphemes are: *a-bi-ny* (3SG-say-PST), where the /m/ has hardened to 'b'. In this chapter, verb stems will be cited in the text.

5.1.2 Approach to Glossing

The examples are glossed using four levels according to the Leipzig glossing rules (Comrie, Haspelmath, & Bickel, 2008). The top level gives the Iwaidja in sentence form. The second level gives the Iwaidja morphemes (word parts), the third level the English morphemic gloss using standard abbreviations, and the final level gives a free translation in English. Morphemes are separated by a hyphen. Where the Iwaidja or Kunwinjku word is translated by more than one English word, but these cannot be separated morphemically in the original, the English words are separated by a period. For example, the 'in' and 'front' cannot be separated in Iwaidja *urdaka* 'in front', so it is glossed 'in.front'. In all the examples in this chapter *urdaka* occurs with the third person singular prefix *w-* 'he/she/it', glossed 3SG, so the entire word *w-urdaka* is glossed '3SG-in.front'. In the free translations I have sought to preserve some elements of the original Iwaidja expression where this reflects important distinctions in the data, so for example *rukung rtamburryak* is generally glossed 'he gives it his chest' rather than 'he's facing it' so as to retain the body part in the description.

Examples are numbered (Chapter-Number). They are referenced (file name, time code for start of example in minutes and seconds, speaker, (where relevant) card number). For example (dvR_101115_02, 13:33, CM, *R12*). The parts of an example are shown in Figure 5.1.

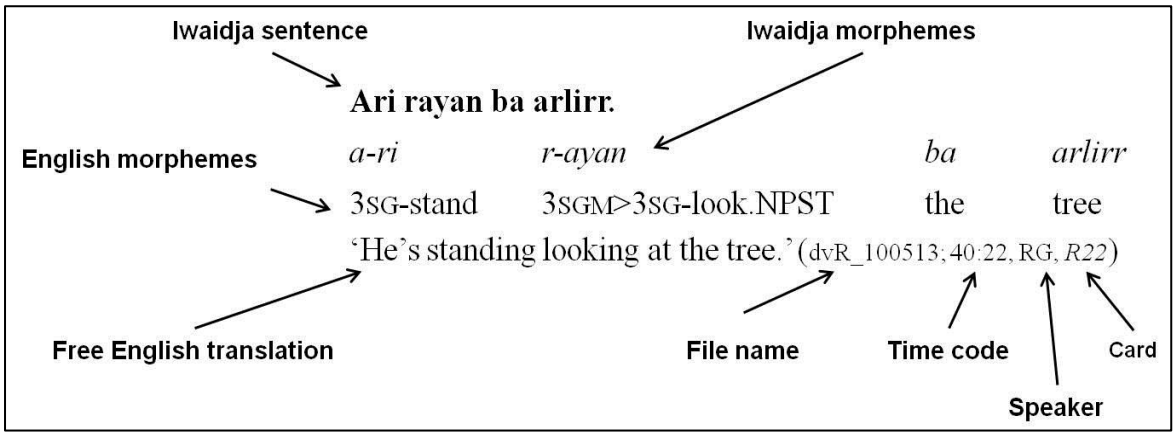


Figure 5.1. Parts of an example

The abbreviations used in the glosses are given in Table 5.2.

Table 5.2. Abbreviations used in glosses

Abbrev.	Meaning	Abbrev.	Meaning
>	(subject) acting on (object)	M	masculine
ø	empty morpheme	NEG	negative
1	first person	NOM	nominative
2	second person	NPST	non past
3	third person	NW	north west
AWAY	away	OPT	optative, expresses desire
DEM	demonstrative	P	proximal
DU	dual	PAST	past
ENG	English word	PL	plural
FE	feminine	PR	present tense
FRUSTR	frustrative	RECIP	reciprocal
FUT	future	REDUP	reduplication
IMP	imperative	REL	relative particle
INCL	inclusive	SE	south east
ITER	iterative	SG	singular
LOC	locative	TO	towards

5.1.3 Verbs

Iwaidja is a verb-rich language and many aspects of life are described as processes rather than things. Kin relations, for example, may be expressed using inflected verbs. Sentences often contain serial verb constructions, where verbs are strung together to describe sequential or simultaneous actions (Pym, 1985). Verbs also often take coverbs or adverbs. In Iwaidja, many

adjectives inflect for number, and it is not always immediately clear whether words are verbs, adjectives or adverbs.

Iwaidja is a 'head-marking' language, in which affixes provide information including subject, object, direction and tense with regard to a stem. In general, spatial verbs consist of a stem with a prefix indicating either the subject (in the case of intransitive verbs) or both subject and object (in the case of transitive verbs). Future tense and irrealis aspect is indicated via a separate prefix. In addition, there is an optional prefix indicating directionality, either away from a deictic centre (glossed AWAY) or towards it (glossed TO). Without this prefix the directionality can be considered NEUTRAL. This prefix sometimes combines with subject and object prefixes as well as the future tense prefix to form a single morpheme (Pym and Larrimore, 1979). For example, *jan-ara* glossed AWAY.1SG.FUT-go 'I will go' and *nyan-ara* glossed TO.1SG.FUT-go 'I will come'. An example of prefix which combines subject and object is *r-* is glossed 3SGM>3SG which means 'he (third person singular masculine subject) acts upon it (third person singular object)'. Past tense is indicated by suffixes.

Iwaidja has many verbs that encode manner, position and state. For example *dangkarranaka* means 'he/she lies on side, head supported by elbow' (5-1) while *ngawanardi* is 'I lie or sleep with one calf crossed across the other knee' (5-2).

(5-1)

Aju dangkarranaka wuka kujali.

aju	*d-angkarranaka*	*wuka*	*kujali*
3SG.lie	3SG-lie.on.side	LOC	fire

'He's sleeping by the fire with his head on his elbow.'

(5-2)

Ngayaldi ngawanardi.

nga-yaldi	*nga-wanardi*
1SG-lie	1SG-lie.with.crossed.leg

'I'm lying with my leg crossed over my other knee.'

Other stems in Iwaidja which do not have the typical semantic profile of verbs nevertheless inflect in a verb-like manner for person. These include many body parts (Table 5.3) and kinship relations (Table 5.4) as well as some adjectives.

Table 5.3. Examples of inflecting body parts in Iwaidja (Marrala et al., 2008b)

English	First person singular	Second person singular	Third person singular
head	*nga-waharl* 'my-head'	*ang-baharl* 'your-head	*ø-baharl* 'his/her/its-head'
arm	*nga-mawurr* 'my-arm'	*ang-mawurr* 'your-arm'	*ø-bawurr* 'his/her/its-arm'
chest	*ng-amburryak* 'my-chest'	*anng-amburryak* 'your-chest'	*rt-amburryak* 'his/her/its-chest'

Note the changes to the initial consonant in the stems, which depend on the prefix, and the empty morpheme *ø* which indicates that a historical prefix which has no vocalisation. Note also that one can still say *ngabi ngawaharl* (lit. 'my my.head'), using the personal pronoun in conjunction with the inflected body part.

Table 5.4. Examples of verbal kinships terms in Iwaidja (Evans & Birch, 2007)

English	Noun	3SG>1SG	3SG>2SG
mother	*kamu* 'mother'	*ngandu-wulang* 'she.mother.to.me'	*kundu-wulang* 'she.mother.to.you'
father	*bunyi* 'father'	*ngandu-mardyarrwun* 'he.father.to.me'	*kundu-mardyarrwun* 'he.father.to.you'

Again, note that the verbal kinship terms can take pronouns as in *ngabi nganduwulang* (lit. 'my she.mother.to.me') 'my mother'.

5.1.4 Spatial Prepositions and Demonstratives

Those prepositions and demonstratives relative to this study are presented here.

5.1.4.1 The Locative Preposition *Wuka*

Iwaidja has a general locative preposition *wuka* which is used similarly to how English uses 'in, at, on, to'. It occurs immediately before the location or direction as in *wuka makumbu* 'to the south'. The interrogative pronoun in Iwaidja is *nganduka* 'where'. *Wuka* answers a *nganduka* 'where' question. The relative pronoun *jumung* can also occur between *wuka* and the location as in *wuka jumung anganyburrurtikiny* 'to where the north is'. This construction is only used by some speakers.

5.1.4.2 Demonstratives

The main demonstratives relevant to this study are given in Table 5.5.

There is also a single article *ba* which has been glossed 'the'.

Table 5.5. Iwaidja demonstratives

Demonstrative	Meaning
riki	'this, here'
ruka	'this, these, here'; a bit further away than *riki*
baraka	'that, that one'
barakbarda	'over there; that one now; that's it'

5.1.5 Summary of Key Points for the Non-linguist

Key features of Iwaidja that are essential to understand this chapter are:

- Complex verbs that can be strung together in a serial construction. These verbs include information about subject, object and direction as well as tense as affixes (both prefixes and suffixes).
- Verbs can include a directional prefix to indicate either a TOWARDS or AWAY direction.
- A single locative preposition *wuka* which is used where English uses 'in, at, on, to'.

5.1.6 Iwaidja Dictionary

The *Iwaidja Dictionary* (Birch & Evans, n.d.) is a working document. Iwaidja words that were elicited in this project were checked against the dictionary. When words were not in the dictionary, a definition was devised through consultation with Joy Williams, and they were then added to the dictionary. Some words that were already in the dictionary had their definitions rewritten or additional senses added. These additions to the *Iwaidja Dictionary* were an important outcome of the project. An example of a previously undocumented term which was used frequently in the Man and Tree task is the verb *wakaldakan* 'be on the ... side'. The spatial terms in the *Iwaidja Dictionary* as of December 2012 are shown in Appendix H.

5.2 Frame of Reference in Iwaidja

The Man and Tree game was used to elicit uses of spatial frames of reference. It was performed with the eight senior consultants in pairs. It was performed a total of seven times, with all except one senior consultant having a turn as Director of the task.

There was a great deal of variation in how the participants approached the tasks, and how difficult they found them. Some pairs found successfully strategies quite rapidly. The data gathered from those sessions is therefore more concise than that where participants were more unsure, and talked a lot before settling on a solution. In the latter case, a single card at times

generated up to ten minutes of dialogue, at times with a great deal of repetition. Some pairs of participants thus used a smaller vocabulary than others. The terms that were produced just once or twice tended to be used by those having difficulty finding a solution. This analysis counts each term *once per speaker per card*, whether that speaker used the term once or used it multiple times. In the actual corpus, the quantities are different due to repetition of some speakers.

This section presents an overview of the key terms elicited, along with contextualised examples. Intrinsic and relative terms have not been separated into subsections, since in many cases they are the same words, with the frame of reference distinction evident from context.

Each subsection presents the more frequently used terms first, followed by terms that were used only in one or a few instances. This section thus both operates as a qualitative resource describing the variety of spatial terms which were elicited during the task, and presents some quantitative information about their uses during the task. The quantitative data cannot be taken to reflect preferences in day to day speech. Some terms which occurred only rarely in this activity may in fact be more common in daily language than other terms which occurred more frequently.

5.2.1 Standing and Facing

In the Man and Tree data, a general distinction has been made between *standing* and *facing* information. *Standing* refers to the placement of the toys, and *facing* to the orientation of the toys with respect to each other. This distinction was designed into the task and is used in other studies of spatial frame of reference (Levinson & Wilkins, 2006; c.f., Terrill & Burenhult, 2008).

5.2.1.1 Standing

A *standing* description describes where the man is in relation to the tree, that is, whether he is to the left or right side or in front or behind.

In Iwaidja the default manner of convey standing information is with constructions containing the verb stem *ldi*. The third person singular form is *ari* ‘he/she/it stands’, glossed 3SG-stand. *Ldi* can be used in conjunction with other verbs in a serial construction as in example (5-3). In these cases, it often operates in the same manner as the English copula ‘is’ to provide existential information, although in Iwaidja the speaker must choose between stems meaning ‘stand’, ‘lie’, or ‘sit’ in the absence of a stem with the more general interpretation of ‘be’. In

(5-3), *ari* only provides the information that the man is standing, not any information about where he is standing.

(5-3)

Ari rayan ba arlirr.

a-ri	*r-ayan*	*ba*	*arlirr*
3SG-stand	3SGM>3SG-look.NPST	the	tree

'He's standing looking at the tree.' (dvR_100513; 40:22, RG, *R22*)

The other most commonly occurring verb for specifying standing information is *akaldakan* 'be on the ... side'. This was used most frequently in the absolute frame of reference. An example is given in (5-4).

(5-4)

Arlirr mangunyuni ari, wakaldakan makumbu. Janad wakaldakan ruka badba barra, nimarrk.

arlirr	*mangunyuni*	*ari*	*w-akaldakan*	*makumbu*
tree	beside	3SG.stand	3SG-on.side	south

janad	*w-akaldakan*	*ruka*	*badba*	*barra*	*nimarrk*
he	3SG-on.side	this	other	NW.wind	ocean

'The tree is standing beside him, on the south side. He's on the other side, the northwest side, the ocean side.' (dvR_101115_02; 13:33, CM, *R12*).

Akaldakan was also used with deictic phrases (§5.2.5) and within the relative frame of reference (§5.2.3.4). Figure 5.2 shows uses of frames of reference of *akaldakan* 'be on the ... side' for each card. The number shown below each card name is the number of speakers to use *akaldakan* about that card. Note that the totals do not match since some speakers used more than one frame of reference describing each card.

Although *akaldakan* 'be on the ... side' was used frequently by most of the speakers, one speaker, RG, did not used this verb at all, and her partner, A2, only used it three times. It was used more often about cards where the man and tree are arranged on the across-axis and are visually separated (*Rx2* and *Rx4*) than about cards where they are arranged on the away-axis and are visually overlapping (*Rx1* and *Rx3*). However, the card for which the most speakers used it was card *R41*, where the man and tree are visually overlapping on the away-axis.

There are other, more specific verbs that are used to describe standing information which are referred to in subsections relating to their specific semantics, such as 'in front/behind' (§5.2.3.1) and beside (§5.2.3.2).

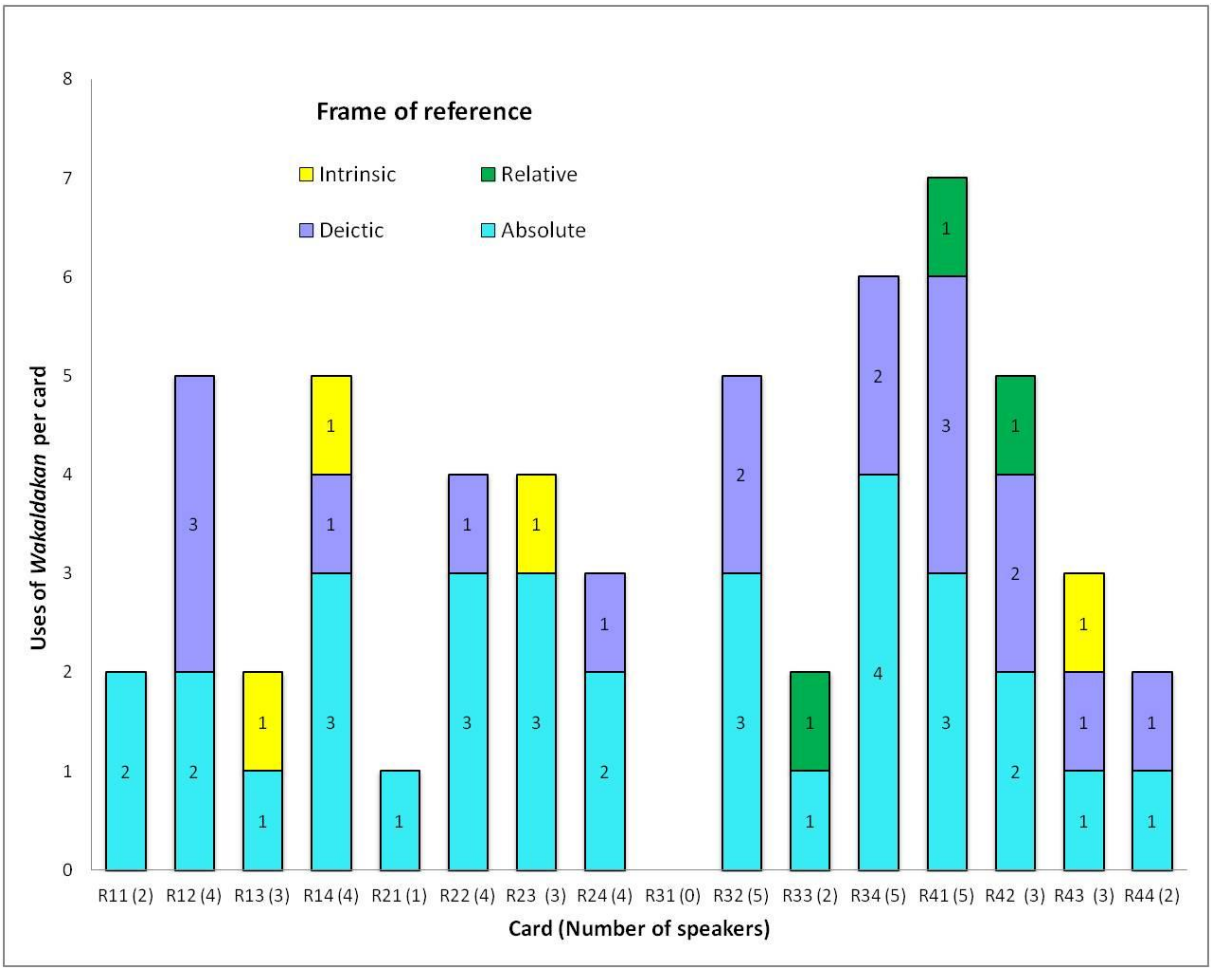


Figure 5.2. Uses of frames of reference of *akaldakan* for each card

5.2.1.2 Facing

A facing description describes the man's orientation, with respect to the tree, to an absolute description or to the viewer. This subsection concentrates on the verbs of vision, which can occur within all three frames of reference, as well as with deictic descriptions. Facing information also occurs in intrinsic descriptions using 'in front/behind' (§5.2.3.1) and body parts (§5.2.3.2).

The direction of gaze was most often used with respect to absolute direction (66 instances) and also to refer to intrinsic orientation, such as the man looking at the tree (31 instances). Much less frequently, direction of gaze was used to refer to the man's relative orientation, such as looking left or looking towards the participants (4 instances). Figure 5.3 shows a graph of the number of uses of each of the verbs of vision by frame of reference.

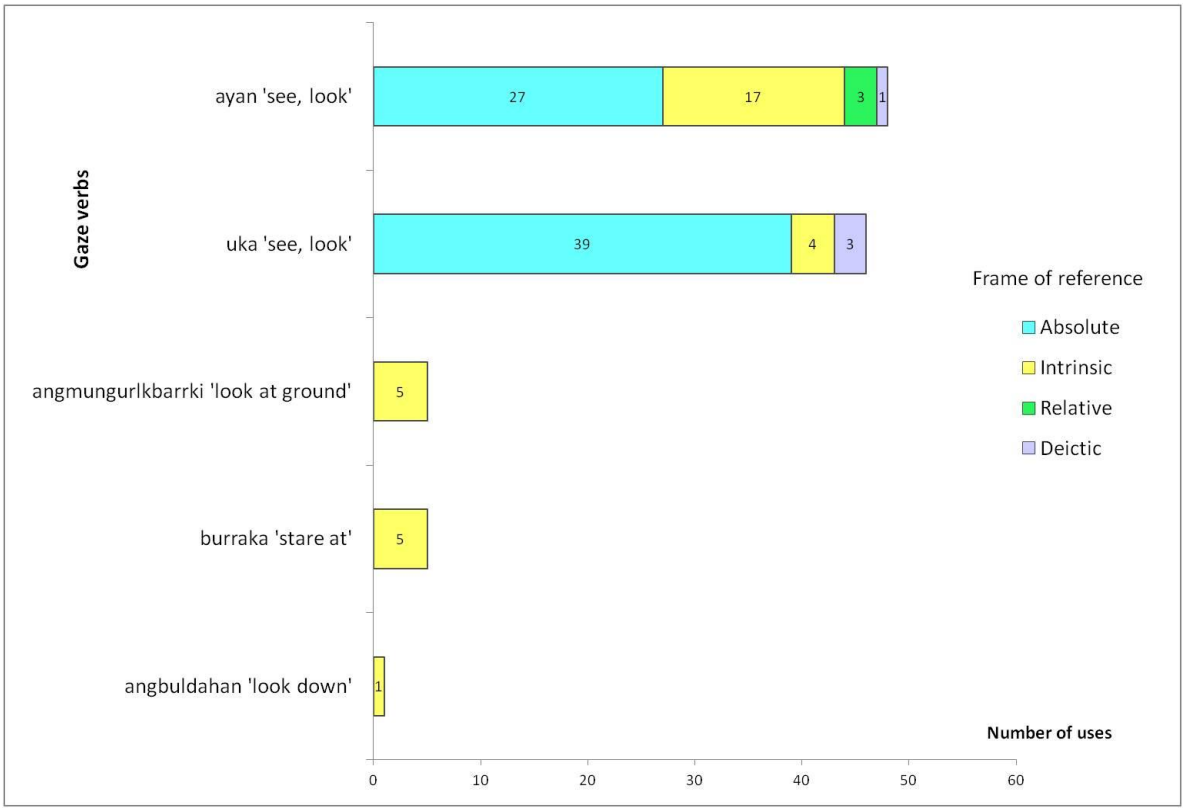


Figure 5.3. Use of gaze verbs by frame of reference

There were two main verbs of vision used, *uka* and *ayan*, which both mean 'see/look at'. *Uka* was predominantly used for absolute directions and in most of these cases it took the AWAY prefix (5-5).

(5-5)

Ba warrkbi yawukan wuka walim.

ba	*warrkbi*	*yaw-uka-n*	*wuka*	*walim*
the	man	AWAY.3SG-look-NPST	LOC	south

'The man is looking south.' (dvR_100522; 37:25, MM, *R23*)

Ayan was frequently used for intrinsic descriptions, most of which referred to the man's gaze towards the tree (5-3). When *ayan* was used for an absolute direction, it occurred with the *ang-* 'ground' prefix and usually also with the AWAY prefix, as in example (5-10) below.

The verb *burraka* 'stare at' is shown in (5-6). This is an intransitive verb and was occasionally intrinsically to refer to the man staring at the tree.

(5-6)

Ari yangbayan yawurrakan rayan jamin.

ari	*yangb-ayan*	*ya-wurraka-n*
3SG.stand	AWAY.3SG>3SG-look.NPST	AWAY.3SG>3SG-stare-NPST

r-ayan	*jamin*
3SGM>3SG-look.NPST	3SG.RECIP

'He's looking at it, staring at it (they're facing each other).' (dvR_100513; 44:41, RG, *R33*)

Interestingly, the intrinsic description in (5-6) has AWAY forms of both *ayan* and *burraka*.

There were also a few instances of *angmungurlkbarrki* 'look at ground' which was used about card *R3x*, where the back of the man was to the viewer, and one of *angbuldahan* 'look down', which was used about *R12* where the man's face is towards the viewer.

Occasionally, when these verbs of vision were used without an argument, the implication was that the viewer could see his face, and thus that the card was one of *R1x*, as in example (5-7).

(5-7)

Ba warrkbi ari wukan burnyak yarda.

ba	*warrkbi*	*ari*	*w-uka-n*	*burnyak*	*yarda*
the	man	3SG.stand	3SG-look-NPST	3SG.have	eye

'The man is looking. He has eyes.' (dvR_100522; 11:11, JW, *R12*)

In (5-7), JW's description of the man's appearance in *R12*, *burnyak yarda* 'he has eyes', indicated that the man's orientation is towards the participants. Similarly, MM used *kalkbarran* 'eyes shining' about *R13*, where the man is also looking toward the participants.

5.2.2 The Absolute Frame of Reference

Descriptions were classified as absolute on the basis that they contained an absolute term. These terms have been categorised as cardinal, corresponding more or less to the English north south, east and west (§5.2.2.1); the ocean/land axis (§5.2.2.2); wind directions (§5.2.2.3); and placenames or local landmarks (§5.2.2.4). In §5.2.2.5 general observations are made about use of these terms.

5.2.2.1 Cardinal

Cardinal terms included those derived from sun movements, and others for which the etymology is not known.

East and West

The Iwaidja words for 'east' and 'west' are lexicalised phrases meaning 'sunrise' and 'sunset'. East is *abalkbang manyij* 'sun comes out' and west is *wurrying manyij* 'sun goes into water'. On Croker Island, and on many parts of the Cobourg Peninsula, both sunrise and sunset are visible over the ocean, hence the perception that the sun emerges from the sea in the morning and then goes back into it in the evening. These directions will be glossed simply as 'east' and 'west' throughout the remainder of the thesis. 'West' sometimes occurs in the AWAY form *yawurrying manyij* 'sun goes away into the water'.

These terms were used by the most speakers, and along with *makumbu* 'south' were the most frequent terms used (§5.2.2.5). *Wurrying manyij* 'west' was used by all of the Directors, and

abalkbang manyij ‘east’ by five. They were used for both standing (5-8) and facing information (5-9).

(5-8)

Lda warrkbi jumung abalkbang manyij ari.

lda	*warrkbi*	*jumung*	*abalkbang manyij*	*ari*
and	man	REL	east	3SG.stand

‘And the man, he’s standing to the east.’ (dvR_100522; 36:11; MM; *R33*)

(5-9)

Ruka warrkbi ari yawukan wurrying manyij.

ruka	*warrkbi*	*ari*	*yaw-uka-n*	*wurrying manyij*
this	man	3SG.stand	AWAY.3SG-look-NPST	west

‘The man is standing looking west.’ (dvR_100513; 03:34, A2, *R34*)

Another word for ‘sun’, *muwarn*, was occasionally used with *abalkbang* ‘it comes out’ to also mean east. Occasionally *manyij* or *muwarn* ‘sun’ were used by themselves (5-10). In these cases, they meant ‘east’, rather than ‘west’.

(5-10)

Aldindi murrbuny yangbayan muwarn.

a-ldindi	*murrbuny*	*yangb-ayan*	*muwarn*
3DU-DU.stand	DU.together	AWAY.3SG>3SG-look.NPST	sun

‘Those two are standing together looking east.’ (dvR_100513, 30:09, RG, *R41*)

In (5-10), although the speakers were seated facing west, RG had turned her body so that she was facing north west, and had the card tilted so the man was in fact facing east. This example also includes an example of ascribed orientation (§5.5.1), with the tree assigned an orientation by virtue of its association with the man.

An alternative term for east *jirtbirdan* ‘dawn’ was used by A1 who also used the Mawng term *yanakbulman* ‘west’. There was one absolute term used by KM that appeared to encode movement toward an absolute direction, which was *ardilwarrki* ‘eastwards’. This is possibly a navigational term.

North and South

Two words for south were used in the task, *makumbu* and *walim*. *Makumbu* was used by the three male Directors, and *walim* was used by two of the female Directors. An example of *makumbu* used for a standing description of *R14* is given in (5-11).

(5-11)

Warrkbi wakaldakan makumbu.

warrkbi	*w-akaldakan*	*makumbu*
man	3SG-on.side	south

‘The man is on the south side.’ (dvR_101115_02; 01:02, CM, *R14*)

Walim is a cognate of the Kunwinjku *Walem*, a place in south Arnhem Land, which has the more general meaning of 'south'. The term most frequently used for north was *anganyburrurtikiny* (5-12).

(5-12)

Rukung kirrwarda wuka anganyburrurtikiny.

r-uku-ng	*ø-kirrwarda*	*wuka*	*anganyburrurtikiny*
3SGM>3SG.give.PST	3SG-back	LOC	north

'He gave his back to the north.' (dvR_101115_04; 00:40, KM, *R22*)

Example (5-12) describes the man's orientation to the north by use of his body parts (§5.2.3.2). One use of *awalawal* 'north' was also recorded.

5.2.2.2 Ocean/land Axis

An ocean/land axis constitutes another important axis in the Iwaidja absolute reference system. In the country inhabited by Iwaidja speakers, traditionally Cobourg Peninsula and now Croker Island, one is never far from the coast. In the Man and Tree task, *nimarrk*, 'ocean', was contrasted with *manandi* 'mainland' and with *warrin*, 'inland, bush' (5-13). *Nimarrk* also has the meaning of 'middle'.

(5-13)

Arlirr ari wakaldakan anganyburrurtikiny lda nimarrk, warrkbi ari rukung rtamburryak yabin kirrwarda warrin.

arlirr	*ari*	*w-akaldakan*	*anganyburrurtikiny*	*lda*	*nimarrk*
tree	3SG.stand	3SG-on.side	north	and	ocean

warrkbi	*ari*	*r-uku-ng*	*rt-amburryak*	*ya-bi-n*
man	3SG.stand	3SGM>3SG-give-PST	3SG-chest	AWAY-3SG.do-NPST

ø-kirrwarda	*warrin*
3SG-back	inland

'The tree is on the north, the ocean side, the man is facing (it), his back (to the) inland (direction).' (dvR_101115_05; 04:35, KM, *R44*)

In everyday Iwaidja, the seaward direction is 'down' and the inland direction is 'up', which accords with the absolute vertical relation of the shore to the interior of an island or peninsula. Iwaidja has specific movement verbs *urti* 'go up, ascend, climb' and *wulaku* **'**go down, descend'. These verbs are frequently associated with movement towards the beach or away from the beach, as in (5-14), an example from the Map Task.

(5-14)

Artirran ararlarrngbung kani jumung mudika ari artirran ararlarrngbung abulakuny awaran yabulakuny ruka ajbud.

art-irra-n	*a-rarlarrngbu-ng*	*kani*	*jumung*	*mudika*
TO.3SG-come.back-PST	TO.3SG-turn-PST	here	REL	car

ari	*art-irra-n*	*a-rarlarrngbu-ng*	*a-bulaku-ny*
3SG.stand	TO.3SG-come.back-PST	TO.3SG-turn-PST	TO.3SG-come.down-PST

aw-ara-n	*ya-bulaku-ny*	*ruka*	*ajbud*
TO.3SG-come-PST	AWAY.3SG-go.down-PST	this	beach

'He turned back where that car is, he came back, he turned, he came down, he came, he went down to the beach.' (dvR_101208_A_02, 06:40, A1)

Possibly *urti* 'go up, and *wulaku* **'**go down', could themselves be part of an absolute system of spatial reference for movement. Nash (2009, 2011) analyses the spatial prepositions *up* and *down* as comprising part of the absolute system in Norfuk, the English Creole language of Norfolk Island (§5.2.4 for more on *urti* 'go up, and *wulaku* **'**go down').

5.2.2.3 Wind Directions

Another salient environmental feature of northwest Arnhem Land is the wind direction. This is dominated by the northwest wind that brings the monsoon in the summer Wet season, and the southeast wind that heralds the cooler Dry season. The Iwaidja names for these winds *barra* 'northwest wind' and *jimurru* 'southeast wind' are loan words from the Malay language spoken by the Macassans (Evans, 1992). The historical significance of these winds is that *barra* 'northwest wind' used to bring the Macassans from the Indonesian archipelago to the Arnhem Land coast to trade and dive for trepang (sea cucumber). The Macassans would remain for several months and then return home with the *jimurru* 'southeast wind'. An example of the use of *barra* 'northwest wind' is given in (5-15).

(5-15)

Arlirr warrwak barra ari.

arlirr	*warrwak*	*barra*	*ari*
tree	behind	NW.wind	3SG.stand

'The tree is standing behind in the northwest.' (dvR_101115_04; 09:02, KM, *R23*)

At times, these wind directions were combined with the cardinal directions to give finer or more specific directions, as in example (5-16).

(5-16)

Arlirr wuka kurrkarda badba barra anganyburrurtikiny.

arlirr	*wuka*	*kurrkarda*	*badba*	*barra*	*anganyburrurtikiny*
tree	LOC	other.side	different	NW.wind	north

'The tree is on the other side, the north northwest.' (dvR_101115_03; 01:36, CM, *R24*)

The wind axis is offset from the cardinal axes. Further investigations could show how far it is offset.

5.2.2.4 Placenames

The final absolute strategy was the use of placenames (toponyms). The most frequently used of these was *Murdululi* ‘Cape Croker’. *Murdululi* is the northernmost part of Croker Island, directly north from Minjilang Community. It has an extended meaning of ‘north’, such that it was used by one speaker in Darwin to refer to the north direction, while being actually northeast from where the speaker was sitting (5-17).

(5-17)

Birta birukurnaj rayan yari, wubaka yabin, rtamburryak, ngunyun Murdululi.

birta	*birukurnaj*	*r-ayan*	*y-ari*	*wubaka*
perhaps	thing	3SGM>3SG-look-NPST	AWAY.3SG-stand	over.there

ya-bi-n	*rtamburryak*	*ngunyun*	*Murdululi*
AWAY.3SG-do	3SG.chest	in.direction.of	Cape.Croker

‘But what's he looking at, over there somewhere, facing in the direction of Cape Croker?’ (dvR_100522; 14:13, JW, *R43*)

Murdululi ‘Cape Croker’ was also used by other speakers in conjunction with *mayinmul* ‘headland’. *Mayinmul* can mean any headland but if unspecified it refers to *Murdululi* ‘Cape Croker’. When *mayinmul* ‘headland’ was used in the task, it was always in combination with *Murdululi*. Another Croker Island placenames that was used is *Ilki* ‘Palm Bay’ (a popular fishing spot).

Interestingly, the speaker in example (5-17), JW, was the least likely of the senior participants to use absolute terminology. Placenames occupy an uncertain position in relation to the absolute frame of reference (Terrill & Burenhult, 2008). Levinson (2003) categorises them as outside the system where they are used to identify location as in “X is at the place named Y” (p. 69). Kilavila (Senft, 2001) and Jahai and Lavukaleve (Terrill & Burenhult, 2008) use landmarks for facing or what Terrill and Burenhult call orientational information. However, Iwaidja uses landmarks for standing information as well as for facing (5-18).

(5-18)

Arlirr yawakaldakan makumbu ..., lda warrkbi yawakaldakan Murdululi.

arlirr	*yaw-akaldakan*	*makumbu*	*lda*	*warrkbi*	*yaw-akaldakan*
tree	AWAY.3SG-on.side	south	and	man	AWAY.3SG-on.side

Murdululi
Cape Croker

‘The tree is on the south side ..., and the man is on the Cape Croker side.’ (dvR_100512; 33:07, A1, *R22*)

While Senft (2001) regards *ad hoc* landmarks in Kilavila as part of the absolute system, Terrill and Burenhult (2008) consider their use in Jahai, including the location of nearby people, to possibly be part of the intrinsic system. Bohnemeyer and Stolz (2006) call them *pseudo-absolute* in relation to their use in Yucatec Maya. Functionally, placenames seem to operate within the absolute frame of reference in Iwaidja, or to be pseudo-absolute.

5.2.2.5 Use of Absolute Terms

Figure 5.4 shows the number of uses of each of the absolute terms in the Man and Tree task and the number of cards to which each absolute term was applied out of a total of a possible 16, as well as how many speakers used each term.

The total number of uses of each term increased with the number of cards to which each term was applied – the more frequently occurring terms were applied to a greater number of cards. This relation does not strictly correlate with the number of speakers who used each term. For example *wurrying manyij* 'west' was used by all seven speakers, but occurred less frequently than *abalkbang manyij* 'east' and *makumbu* 'south' which were used by less speakers. On the other hand, *mayinmul* 'mainland' and *warrin* 'inland' were each only used by one speaker but applied to four and five cards respectively. *Barra* 'northwest wind' also had a higher rate of use per speaker than other terms.

There was no discernible pattern about which cards were described using absolute terms more than others. *R11* had the minimum with five occurrences and *R43* had the maximum with 18. But similar cards varied in how often they had absolute terms applied to them. *R23*, the mirror image of *R43*, had just 10 occurrences. *R12* had eight and its mirror image *R14* had 14.

The men all used absolute terms more frequently than the women and applied them to more cards, as shown in Figure 5.5.

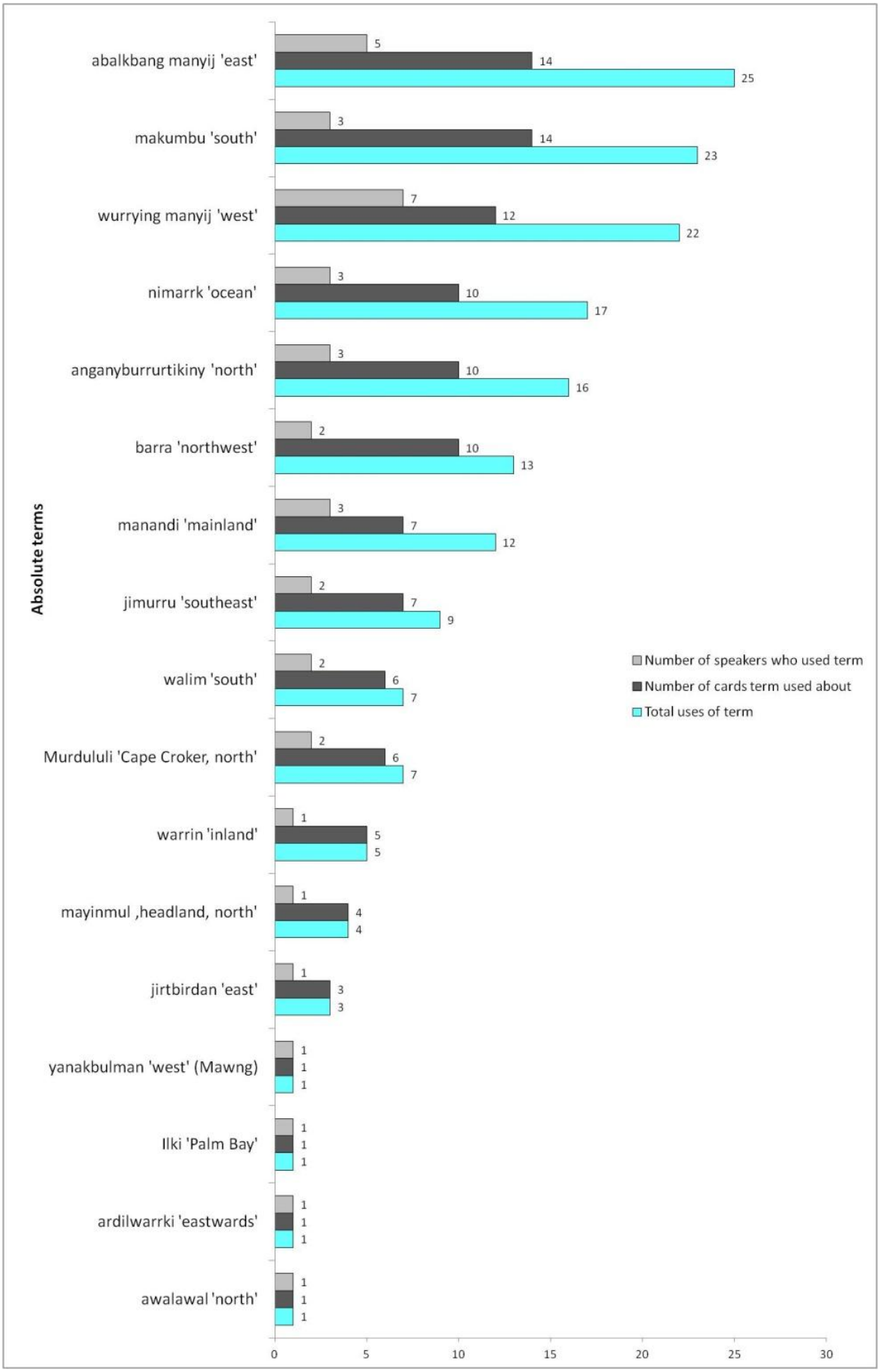


Figure 5.4. Absolute terms used in the Man and Tree task

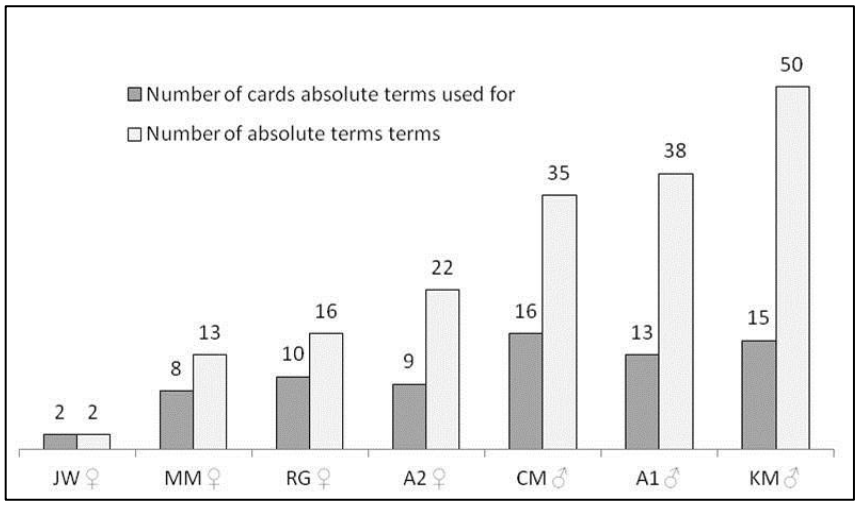


Figure 5.5. Number of absolute terms by speaker

The reasons for this gender distinction are not clear. Bohnemeyer and Stolz (2006) note a stronger control of the absolute frame of reference among men than women in their study of spatial reference in Yucatec Maya (spoken in Mexico), which they tentatively suggest might be due to traditional gender roles in Mayan society, with men travelling more than women in occupations such as hunting and collecting firewood. Iwaidja speakers belong to a society with distinct gender roles. The men spend more time fishing in boats and are likely to be the navigators. However, the women journey about the island collecting food such as yams, finding plants for dyes, fishing, gathering goose eggs and many other traditional occupations. A larger sample would be required to determine if this pattern of women using absolute terms for facing information but rarely for standing is pervasive throughout the community of speakers.

Some of the women were as likely or more likely than the men to use absolute terms in their descriptions of facing direction, using with gaze verb (verbs of vision) (Figure 5.6).

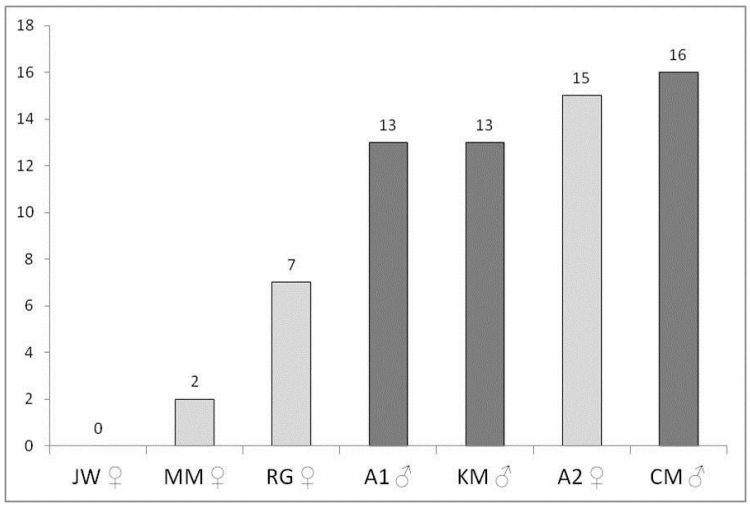


Figure 5.6. Number of gaze verb uses of absolute terms

Figure 5.7 shows the proportion of absolute uses that involve direction of gaze.

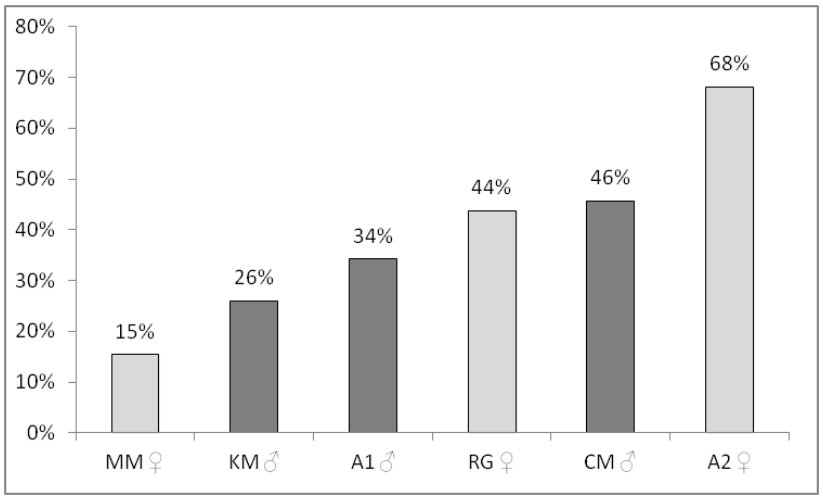


Figure 5.7. Proportion of absolute uses that involve direction of gaze

Speakers thus varies in how frequently they used absolute terms, and in whether they preferred to use them for facing or for standing description.

One pair of participants, CM and DG, used absolute terms in Map task (Table 5.6). Interestingly, the two speakers who used absolute terms the most frequently in the Man and Tree task, KM and A1, did not use them at all in the task. CM used the terms about twice as often as DG.

Table 5.6. Uses of absolute terms in the Map task

Term	Uses		
	CM	DG	Total
makumbu 'south'	17	19	36
wurrying manyij 'west'	16	1	16
abalkbang manyij 'east'	13	3	16
barra 'north west'	12	2	14
anganyburrurtikiny 'north'	10	1	11
jimurru 'south east'	4	4	8

These terms were used to describe where things on the maps were located, or where the track was located in relation to other things, rather than to describe directions of movement. The verb used most frequently with these terms was *akaldakan* 'on the ... side', as shown in (5-19).

(5-19)

Baraka wuwud wakaldakan wuka makumbu.

baraka	*wuwud*	*w-akaldakan*	*wuka*	*makumbu*
that	below	3SG-on.side	LOC	south

'It's below on the south side.' (dvR_101207_A_02, 11:08, DG)

The only times these terms were used as direction of movement was during the discussion after the activity when the participants were looking at the two maps together and clarifying their instructions. An example is given in (5-20).

(5-20)

Anganamina makumbu burdan kurrambalk.

angana-min-a	*makumbu*	*burdan*	*kurrambalk*
2SG.IMP-say-FRUSTR	south	from	house

'You should have said south from the house.' (dvR_101207_A_02, 04:07, DG)

There was some use of landscape terms to refer to map features during the Map task. The features mentioned were *mayinmul* 'headland', *nimarrk* 'ocean', *warrin* 'inland' and *manandi* 'mainland'. Although I classified these terms as absolute in §5.2.2.2 and §5.2.2.4, in the Map task they referred to features within the maps themselves, and thus were intrinsic to the map.

The predominance of the absolute frame of reference in other Australian languages such as Arrernte (Wilkins, 2006), Gurindji (Meakins, 2011), Guugu Yimithirr (Haviland, 1993), Jaminjung (Schultze-Berndt, 2006), Kuuk Thaayorre (Gaby, 2006), Warlpiri (Laughren, 1978), Warrwa (McGregor, 2006) is well known in both linguistic and educational fields. Unlike most of these, Iwaidja is not a language in which absolute terms are heard frequently in everyday speech. People are more likely to use a combination of gesture and demonstratives. However, the rich range of absolute terms elicited in the Man and Tree task demonstrated that where gesture was not possible, speakers were able to draw on the absolute frame of reference in small scale space. Most of the absolute terms used, such as sunrise and sunset over the ocean, orientation to the coast and wind direction, were perceptually salient in the local environment. Palmer (2002) contends this is a necessary condition for acquisition of many absolute linguistic systems. In Iwaidja, the absolute frame of reference is a resource that senior speakers are able to draw upon in both small scale and large scale space.

There was also a notable difference in the use of absolute frame of reference between senior adult peers and between some of those same adults and children, with the senior adults using the absolute terms less frequently with the children. This is discussed in §6.2.1.2.

5.2.3 Intrinsic and Relative Frames of Reference

As with many other languages including English, Dutch (van Staden, Bowerman & Verhelst, 2006), Tamil (Pedersen, 2006) and Tiriyó (Meira, 2006), Iwaidja uses some of the same terminology for the intrinsic and relative frames of reference. This includes words for 'left', 'right' 'in front' and 'behind'. As with some other languages in which this occurs, there is often a potential for ambiguity between the frames of reference, which is sometimes resolved by speakers being explicit about the frame of reference. For this reason, the intrinsic and relative frames of reference are discussed together in this section.

5.2.3.1 In front/behind

The analysis in this section draws on many discussions between myself and Bruch Birch, and elements of it have appeared in Birch and Edmonds-Wathen (2011) and Edmonds-Wathen (2011).

The two terms used most frequently to describe the cards in the Man and Tree task were *wurdaka* 'in front' and *warrwak* 'behind'. In an exception to the convention of using the stem of the verb in the text, the 3rd person singular form *wurdaka* 'he/she/it is in front' is used throughout the remainder of the thesis, due to the frequency of its use. As in English, these terms can have a relative meaning as well as an intrinsic. In the cases of *R11* and *R13*, both the intrinsic and the relative senses of the terms hold, reinforcing each other. Figure 5.8 shows card *R13* and an example of these terms being used with this card is given in (5-21).

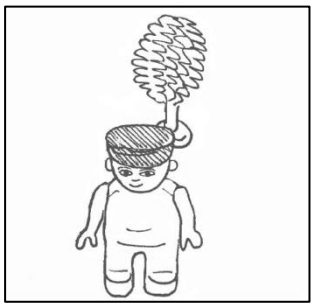


Figure 5.8. Card R13

(5-21)

Arlirr ari warrwak, warrkbi ari wurdaka.

arlirr	*ari*	*warrwak*	*warrkbi*	*ari*	*w-urdaka*
tree	3SG.stand	behind	man	3SG.stand	3SG-in.front

'The tree is standing behind, the man is standing in front.' (dvR_100512, 49:37, A1, *R13*)

Where the intrinsic and relative frames of reference reinforce each other, the actual frame of reference used by the speaker is ambiguous. In these cases the terms were extremely

frequently used; *R13* was described by all seven speakers using these two terms, and *R11* by six out of the seven.

Wurdaka ‘in front’ and *warrwak* ‘behind’ were sometimes clearly used in the relative sense in terms of proximity to the speaker. This applied to cards *R31* and *R33*. In example (5-22) the tree in card *R31* (Figure 5.9) is referred to as *wurdaka* ‘in front’ in the relative sense of being closer to the speaker, and the man is described as *warrwak* ‘behind’.

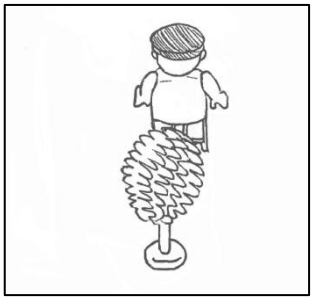


Figure 5.9. Card R31

(5-22)

Ruka arlirr wurdaka warrkbi warrwak arrumbukung bungkurryuwu.

ruka	*arlirr*	*w-urdaka*	*warrkbi*	*warrwak*	*arrumb-uku-ng*
this	tree	3SG-in.front	man	behind	3SG>1PL.give-PST

bungkurryuwu
nape.of.neck

‘In this one, the tree is in front and the man is behind, with his back to us.’ (dvR_100513, 22:27, A2, *R31*)

With card *R33*, the man could be described as being *wurdaka* ‘in front’ because he is closer to the viewer than the tree.

In the case of *R31* and *R33*, the intrinsic frame of reference is opposite to the relative frame of reference, such that for *R31* the man can be described as being in front of the tree in that he has his back to it and it is behind him (5-23).

(5-23)

Warrkbi wurdaka lda arlirr warrwak.

warrkbi	*w-urdaka*	*lda*	*arlirr*	*warrwak*
man	3SG-in.front	and	tree	behind

‘The man is in front and the tree is behind.’ (dvR_100513, 45:02, RG, *R31*)

This strongly intrinsic use of *wurdaka* ‘in front’ and *warrwak* ‘behind’ in (5-23) is in direct opposition to the relative use of (5-22).

Another unambiguously intrinsic use of the words can be seen in their use about cards such as *R22*, *R24*, *R42* and *R44*, where the man is either looking at the tree or where he has his back

to the tree, but where he is not in front or behind with respect to the speaker. It was clear in cards *R22*, *R24*, *R42* and *R44* that only intrinsic interpretations of these terms were possible. Cards *R22* and *R24* are shown in Figure 5.10 and example of these two terms being used about them are given in (5-24) and (5-25).

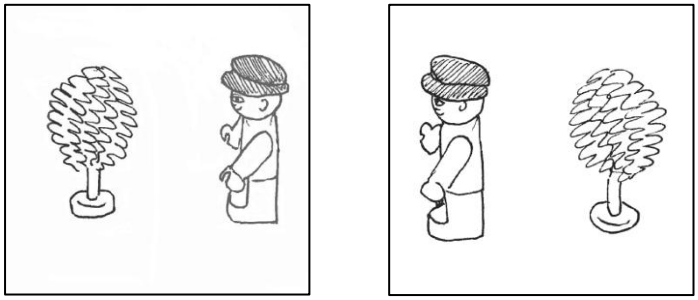


Figure 5.10. Cards R22 and R24

(5-24)

Wurdaka arlirr bingkan warrwak ba warrkbi.

w-urdaka	*arlirr*	*bingkan*	*warrwak*	*ba*	*warrkbi*
3SG-in.front	tree	3SG.come	behind	the	man

'The tree is in front, the man comes behind.' (dvR_100522, 38:38, MM, *R22*)

(5-25)

Warrkbi wurdaka, arlirr warrwak.

warrkbi	*w-urdaka*	*arlirr*	*warrwak*
man	3SG-in.front	tree	behind

'The man is in front, the tree is behind.'(dvR_100522, 17:37, JW, *R24*)

The two terms, *wurdaka* 'in front' and *warrwak* 'behind' were used about 14 of the 16 cards. The only cards about which they were not used were *R12* and *R14*, which show the man standing beside the tree looking at the viewer, hence neither the relative nor intrinsic sense of the words was a possible description. However, they were sometimes used about *R32* and *R34* which show the man and tree appear beside each other but with the man's back to the viewer, which is a use that is difficult to account for, and may be speaker error.

Figure 5.11 shows the number of occurrences of the two terms combined about each card. It was not possible to discern from the data whether the descriptions of *R11* and *R13* were relative or intrinsic. For other cards disambiguation was generally possible because of context or scope of possibility. While relative descriptions occurred more often than intrinsic for cards *R31*, *R33*, *R42* and *R43*, there were no cards in for which only relative uses were recorded.

The descriptions of *R31* and *R33* by one speaker, A1, have been classified as ambiguous since it appears that he may have been describing them as if they were in fact the cards *R11* and *R13*. He had cataracts and appeared to think that *R31* and *R33* showed front views of the man.

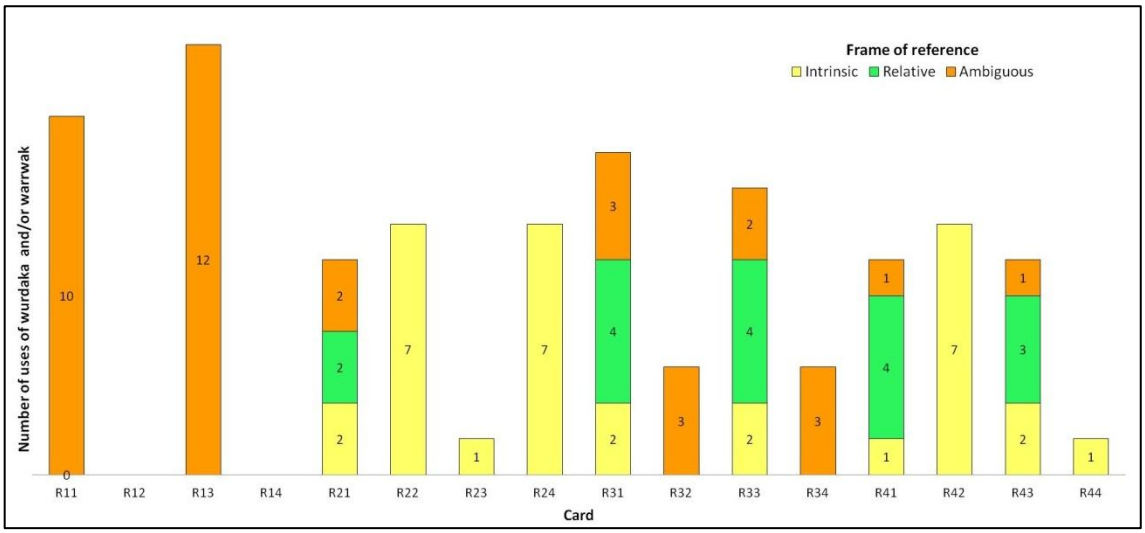


Figure 5.11. Uses of *wurdaka* and *warrwak* by card

Another example of an ambiguous description is given in (5-26) about *R21* (Figure 5.12).

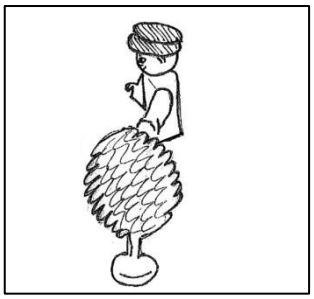


Figure 5.12. Card R21

(5-26)

Ari abingkan warrwak.

ari	*a-bingkan*	*warrwak*
3SG.stand	TO-3SG.come	behind

'He comes behind.'(dvR_101115_03, 02:41, CM, *R21*)

In (5-26), CM's use of the verb *abingkan* 'come (towards)' suggests an intrinsic interpretation of the man following the tree, rather than the speaker using his own perspective. However, this is not definite, as the motion implied by *abingkan* may be a conventional speech pattern (Talmy, 1996; §5.5.1.3).

The remainder of the responses that were classified as ambiguous were when a speaker used the same term to describe both the man and the tree (5-27).

(5-27)

Arlirr ruka yari wuka warrwak, lda warrkbi wurdaka ... Wuka yawurdaka ba arlirr.

arlirr	*ruka*	*yari*	*wuka*	*warrwak*	*lda*	*warrkbi*
tree	this	AWAY.3SG.stand	LOC	behind	and	man

w-urdaka	*wuka*	*yaw-urdaka*	*ba*	*arlirr*
3SG-in.front	LOC	AWAY.3SG-in.front	the	tree

'The tree is standing away behind and the man is in front ... the tree is away in front.' (dvR_100522, 14:64, JW, R43)

In (5-27) JW describes the tree as being both *warrwak* 'behind and as being *wurdaka* 'in front'.

The intrinsic use of 'front' and 'back' in Iwaidja needs to be differentiated from the Hausa pattern. Hausa is a Chad language spoken in Niger, Nigeria, Benin, Ghana, Cameroon, and the Sudan. The Hausa pattern is relative, but reversed from English such that the object further from the speaker is described as 'in front' and the object closer to the speaker is described as 'behind' (Hill, 1982). If the Hausa pattern applied, one would be able to say *warrkbi wurdaka, arlirr warrwak* 'the man is in front, the tree is behind' about *R11*, or *arlirr wurdaka, warrkbi warrwak* 'the tree is in front, the man is behind' about *R13*, neither of which appear to be valid Iwaidja sentences for these cards..

As well as the adverb *warrwak* 'behind', there were two specific transitive verbs *ldurlkung* 'stand behind', and *wardama*, 'go after' which were used occasionally. Examples of these are given in (5-28) and (5-29).

(5-28)

Arlirr ari wurdaka janad ari arildurlkung warrwak.

arlirr	*ari*	*w-urdaka*	*janad*	*ari*
tree	3SG.stand	3SG-in.front	he	3SG.stand

ari-ldurlkung	*warrwak*
TO.3SGM>3SG-stand.behind	behind

'The tree is standing in front, he is behind it.' (dvR_100512; 35:37, A1, *R22*)

(5-29)

Riwardama warrkbi rukung rtamburryak wuka mangku.

ri-wardama	*ba*	*warrkbi*	*r-uku-ng*
3SGM>3SG-go.after	the	man	3SGM>3SG.give.PST

rt-amburryak	*wuka*	*mangku*
3SG-chest	LOC	shade

'The man goes after it, giving his chest to the tree.' (dvR_10115_05; 04:50, CM, *R44*)

These two verbs were only used intrinsically.

5.2.3.2 Body Parts

Descriptions that utilised body parts were clearly intrinsic in the majority of cases. The most common way of using body parts was with the verb *-uku* 'give' in the form *rukung* 3SGM>3SG.give.PST 'he gave it' combined with the body part, most of which were inflected for person. Thus *rukung rtamburryak* which literally is 'he gave it his chest' means 'he is facing it'. The man's body parts were most frequently used to describe his orientation to the tree, as in (5-31).

(5-31)

Rukung rtamburryak lda jamin mana yawakaldakan baraka arlirr wuka makumbu.

r-uku-ng	*rt-amburryak*	*lda*	*jamin*	*mana*
3SGM>3SG.give.PST	3SG-chest	and	3SG.RECIP	maybe

yaw-akaldakan	*baraka*	*arlirr*	*wuka*	*makumbu*
AWAY.3SG-on.side	DEM	tree	LOC	south

'They're facing each other, maybe, and the tree's on the south side.' (dvR_100512; 33:34, DG, *R11*)

(5-31) shows the sequential or reciprocal pronoun *jamin*, which means 'he/she/it in turn'. Thus *rukung rtamburryak lda jamin*, literally 'he gave it his chest and it in turn (gave its chest to him)' means 'they are facing each other.' This pronoun is also used in *rukung kirrwarda lda jamin* 'they are back to back'. In these cases, the tree has received an ascribed orientation that is the opposite to that of the man (§5.5.1).

Other body parts used with *rukung* 'he gave it' were *bungkurryuwu* 'nape of neck', *kirrwarda* 'back', *minyminy* 'rib', *maruj* 'left (hand)', and *nurlinurli* 'right (hand)'.

These uses of *maruj* 'left (hand)', and *nurlinurli* 'right (hand)' were intrinsic; see §5.2.3.4 for relative uses of these terms.

The 'give' construction was also used in the form *arrumbukung* 3SGM>1PL.give-PST 'he gave it to us' to describe the orientation of the man to the participants, as in (5-32).

(5-32)

Ruka arlirr wurdaka warrkbi warrwak arrumbukung bungkurryuwu.

ruka	*arlirr*	*w-urdaka*	*warrkbi*	*warrwak*	*arrumb-uku-ng*
this	tree	3SG-in.front	man	behind	3SGM>1PL.give-PST

bungkurryuwu
nape.of.neck

'In this one, the tree is in front and the man is behind, with the back of his neck to us.' (dvR_100513; 22:27, A2, *R31*)

These 'to us' constructions were analysed as intrinsic, but make deictic use of the participants' location.

As well as the phrase *rukung kirrwarda lda jamin* ‘he gave his back to it (reciprocated)’, ‘back to back’ was also indicated by the specific verb *ngirrunmin*, which appears to contain the stem *irrwarda* ‘upper back’ with *unmin* ‘be the same’ in a dual form (5-33).

(5-33)

Ba aldarrunmin angirrunmin.

ba	*a-ldarrunmin*	*a-ngirrunmin*
the	3DU-level	3DU-back.to.back

They are standing level, back to back.’ (dvR_101115_05 11:35; KM, *R31*)

Again, the tree has been ascribed a ‘back’ through its association with the man, this time in the opposite to the direction of the man’s back.

The body part stem *ngunyuni* ‘waist’ appeared in various constructions to refer to intrinsically side by side arrangements. As a third person body part, it was used to locate the tree at the man’s intrinsic left (5-34).

(5-34)

Arlirr ari wuka kunyuni maruj.

arlirr	*ari*	*wuka*	*ø-kunyuni*	*maruj*
tree	3SG.stand	LOC	3SG-side.of.waist	left

‘The tree is on (his) left side.’ (dvR_101115_06; 01:16, KM, *R21*)

This stem in the coverb *mangunyuni* ‘beside’ (5-35) and in the verb *ngunyulunmin* ‘side by side’ (‘hip to hip’) (5-36) also locates the man and the tree as beside each other.

(5-35)

Ari mangunyuni jumung arlirr.

ari	*mangunyuni*	*jumung*	*arlirr*
3SG.stand	beside	REL	tree

‘He's standing beside the tree.’ (dvR_101115_01; 11:47, CM, *R34*)

(5-36)

Angunyulunmin ari wardak lda jamin.

a-ngunyulunmin	*ari*	*wardak*	*lda*	*jamin*
3DU-side.by.side	3SG.stand	far	and	3SG.RECIP

‘They're side by side, far away from each other.’ (dvR_101115_05; 10:50, KM, *R12*)

Ngunyulunmin ‘side by side’ was used intrinsically about cards such as *R23*, but *mangunyuni* ‘beside’ was only used where the relative and intrinsic frames of reference coincided. See also §5.3.1.

There were a few occasions where body parts were used to refer to absolute directions, as in example (5-37).

(5-37)

Rukung kirrwarda wuka anganymurrurtikiny.

r-uku-ng	*ø-kirrwarda*	*wuka*	*anganymurrurtikiny*
3SGM>3SG.give.PST	3SG-back	LOC	north

'He gave his back to the north.' (dvR_101115_04, 00:40, KM, *R22*)

In these cases, the descriptions were analysed as using the absolute frame of reference.

There were also a few descriptions of the appearance of the man's body which did not utilise frame of reference, but which implicitly described the man's orientation with respect to the speaker. For example, saying *burnyak yarda* 'he has eyes', as in (5-7), indicated that the man's eyes were towards the speaker. *Balu* 'face' and *bawurr* 'arm' were also used in this manner.

5.2.3.4 Left and Right

Along with a documented tendency for Australian languages to be strong in their use of the absolute frame of reference is a tendency not to use the relative frame of reference. All of the Australian languages whose absolute systems were mentioned in §5.2.2.5 also limit their use of 'left' and 'right' to body parts or the immediate vicinity of the body.

It was therefore surprising to find relative uses of *maruj* 'left' and *nurlinurli* 'right' in the Man and Tree task as intrinsic uses. These two terms were used by three of the seven Directors in the Man and Tree task. The eighth participant, DG, who acted only as a Matcher, also used these terms in questioning the Director. Two of the participants, JW and A1, used the terms only in a relative sense. The third, KM, used the terms the most often and used them intrinsically six out of eight times. Table 5.7 shows which cards were described by the three Directors using either or both of these terms.

Table 5.7. Directors' uses of *maruj* 'left' and *nurlinurli* 'right' in the Man and Tree task

	R11	R12	R13	R14	R21	R22	R23	R24	R31	R32	R33	R34	R41	R42	R43	R44
JW										Rel.					Rel.	
KM			Int.	Int.	Int.	Rel.	Int.				Rel.				Int.	Int.
A1	Rel.	Rel.											Rel.	Rel.		

As Table 5.7 shows, there was no clear pattern as to which cards were described with these terms. When used intrinsically, *maruj* 'left' and *nurlinurli* 'right' were used both in relation to the tree, and to absolute directions. The latter is shown in example (5-38).

(5-38)

Lda rtamburryak yabin, rtamburryak yabin makumbu lda maruj jimurru.

lda	*rt-amburryak*	*ya-bi-n*	*rt-amburryak*	*ya-bi-n*	*makumbu*
and	3SG-chest	AWAY.3SG-do-NPST	3SG-chest	AWAY.3SG-do	south

lda	*maruj*	*jimurru*
and	left	SE.wind

'And his chest is facing south, and his left hand, southeast.' (dvR_100115_04; 07:50, KM, *R23*)

Maruj 'left' and *nurlinurli* 'right' were also used in a relative sense to refer to the left and right side of the speaker's field of view, as in (5-39).

(5-39)

Baraka arlirr ari wakaldakan maruj.

baraka	*arlirr*	*ari*	*w-akaldakan*	*maruj*
DEM	tree	3SG.stand	3SG-on.side	left

'The tree is standing on the left side.' (dvR_100512; 00:13, A1, *R12*)

There was only one example of one of these terms being used for direction of gaze, shown in (5-40)

(5-40)

Nurlinurli wukan ba warrkbi ari.

nurlinurli	*w-uka-n*	*ba*	*warrkbi*	*ari*
right	3SG-look-NPST	the	man	3SG.stand

'The man is standing looking right.' (dvR_100522; 15:31, JW, *R43*)

The other times that they were used, these terms were only used for standing information.

Maruj 'left' and *nurlinurli* 'right' were also used by the four male participants in the Map task (Table 5.8) but not by the two female participants.

Table 5.8. Uses of *maruj* 'left' and *nurlinurli* 'right' in the Map task

Term	Uses				
	CM	DG	KM	A1	Total
Maruj 'left'	1	4	6	6	17
Nurlinurli 'right'	2	3	5		10

In the Map Task , *maruj* 'left' and *nurlinurli* 'right' were used to describe where things on the maps were located, or where the track was located in relation to other things, rather than to describe directions of movement. These terms were used relatively, to describe the sides of the map and the verb used most frequently with these terms was *akaldakan* 'on the ... side,' as in example (5-41). There were no instructions such as "now you need to turn left."

(5-41)

Like jumung yawaran kaburrwun kabirrawun jumung wakaldakan maruj ba kurrambalk bani, alan awara barakbarda.

like	*jumung*	*yaw-ara-n*	*ka-burrwun*	*ka-birrawun*
like	REL	AWAY.3SG-go-PST	2SG-know	2SG-draw

jumung	*w-akaldakan*	*maruj*	*ba*	*kurrambalk*	*bani*	*alan*
REL	3SG-on.side	left	the	house	3SG.sit	road

aw-ara	*barakbarda*
TO.3SG-come	there

'Like where it went, you know, you draw, on the left side there's a house, the road comes there.' (dvR_101208_A_03, 11:33, A1)

Some, such as Warrwa, do have a relative 'in front' and 'behind' that can be projected onto a scene, although McGregor (2006) notes that this was not shown in the Man and Tree game, since he used the original across-axis only six card set. The use of 'left' and 'right' in a relative sense in Iwaidja, projected from the speaker's body onto a scene, is thus particularly remarkable. A total of five participants in the two linguistic tasks used *maruj* 'left' and/or *nurlinurli* 'right' to refer to the side of the scene that was at their own left or right. There were also clearly relative uses of *wurdaka* 'in front' and *warrwak* 'behind' in relation to cards *R21*, *R31*, *R33*, *R41* and *R43*. As noted in §3.5.11.2, I have been unable to find evidence corroborating P. Harris's (1991) statement that Djamparrpuyngu, Murrinh Patha or Kala Lagaw Ya use a relative 'left' and 'right'. There is, however, some evidence that both Kunwinjku and Mawng have a relative use of 'left' and 'right' (§6.1). Intergenerational changes in the use of the relative and absolute frames of reference are discussed in §6.2.2.

The only woman to use the *maruj* 'left' and *nurlinurli* 'right' either intrinsically or relatively was JW. She was the speaker who was least likely to use absolute terms, but she appeared to use deictic expression where other speakers would use absolute.

It is difficult to determine whether these relative uses of *maruj* 'left' and *nurlinurli* 'right' are traditional or whether they are the result of the impact of English and schooling on Iwaidja. Some of the speakers such as JW and A1 are familiar with the use of *left* and *right* in English. However, the eldest speaker KM, who is now in his eighties, speaks little English and is less likely to have absorbed such influences. Other possible contributing factors include historical contact with other languages such as Indo-Malay. On the other hand, it is notable that Australian contact languages such as Kriol and Gurindji Kriol (Meakins, 2011) have not adopted the relative use of *left* and *right* despite having English-based lexicons. A final tentative possibility is the use of *left* and *right* in seafaring and navigation.

5.2.4 Verticality

Although the Man and Tree task and the Map task were designed to elicit descriptions of location in the horizontal plane, some descriptions made distinctions of verticality. Some participants used vertical descriptions of cards *Rx1* and *Rx3*, that is, cards where if viewed as a planar image, the man or the tree is *yurrngud* ‘above’ or *wuwud* ‘below’. Example (5-42) shows the use of these two terms.

(5-42)

Warrkbi ari yurrngud arlirr ari wuwud.

warrkbi	*ari*	*yurrngud*	*arlirr*	*ari*	*wuwud*
man	3SG.stand	above	tree	3SG.stand	below

‘The man is standing on top, the tree is standing below.’ (dvR_100522; 24:42, JW, *R21*)

Participants using this strategy were able to utilise the two dimensional nature of the picture in addition to describing the cards as representing a three dimensional scene. It was not that these participants were unable to perceive the depth of field of the image. In example (5-43) CM describes the man as appearing to stand on top of the tree in card *R21*.

(5-43)

Riki kirrimul ringardalkbung ba arlirr kirrimul.

riki	*kirrimul*	*ri-ngardalkbung*	*ba*	*arlirr*	*kirrimul*
this	like	3SGM>3SG-stand.on.top.of	the	tree	like

‘This one, it’s like he’s standing on top of the tree.’ (dvR_101115_03; 02:38, CM, *R21*)

In (5-43), CM uses the word *kirrimul* ‘like’ to indicate that it *appears* to be the case, although he knows it is not really the case, the man is not really standing on top of the tree. Similarly, for *R31*, CM says man is *yurrngud* ‘on top’, interpreting the image as two dimensional, but also agrees with KM that the man is *yangbayan barra* ‘looking north west’, recognising the depth of field depicted in the card (5-44).

(5-44)

Yurrngud wara kanayanjing yurrngud baki ... warrkbi yawurdaka yangbayan barra

yurrngud	*w-ara*	*kan-ayan-jing*	*yurrngud*	*baki*
on.top	3SG-go	2SG.IMP-look-OPT	on.top	over.there

warrkbi	*yaw-urdaka*	*yangb-ayan*	*barra*
man	AWAY.3SG-in.front	AWAY.3SG>3SG-look.NPST	NW.wind

‘He’s goes on top, look for the one on top over there ... he’s in front looking north west.’ (dvR_101115_01, 10:54, CM, *R31*).

See also (5-89) below.

There were a few uses of *yurrngud* ‘above’ or *wuwud* ‘below’ on the Map task to describe the path on the map, as in (5-45).

(5-45)

Awaran ari jumung wuwud mutika ari.

aw-ara-n	*ari*	*jumung*	*wuwud*	*mutika*	*ari*
TO.3SG-go-PST	3SG.stand	REL	below	car	3SG.stand

'He came below where the car is.' (dvR_101207_A_02, 07:32, DG)

More frequently used vertical terms in the Map task were the verbs *urti* 'go up, and *wulaku* **'**go down'. As mentioned in §5.2.2.2, normally in Iwaidja the seaward direction is 'down' and the inland direction is 'up'. An example was given in (5-14). However, in this task, participants also used the top and bottom of the map as directions. Thus in (5-46), DG talks about the track going 'up' in a direction towards the coast, because it is going 'up' the map, and in (5-47), MM uses *wulaku* 'go down' for a movement away from the coast, as the track is going 'down' the map.

(5-46)

Yartirran yawurtin ngalaj ari balarra ba narrhardi ari bani wakaldakan wuka.

yart-irra-n			*yaw-urti-n*		*ngalaj*	*ari*
AWAY.3SG-go.back-PST			AWAY.3SG-go.up-PST		LOC	3SG.stand
ø-balarra	*ba*	*narrhardi*	*ari*	*bani*		
3SG-middle	the	magpie.goose	3SG.stand	3SG.sit		
w-akaldakan	*wuka*					
3SG.on.side	LOC					

'He went up in the middle where the magpie goose is sitting on the side.' (dvR_101207_A_02, 08:46, DG)

(5-47)

Janawulakun jumung mudika ari janara angmanarrajbang wuka jumung ingbal.

jana-wulaku-n		*jumung*	*mudika*	*ari*
AWAY.1SG.IMP-go.down-NPST		REL	car	3SG.stand
jan-ara	*angmana-rrajbang*	*wuka*	*jumung*	*ingbal*
AWAY.1SG.FUT-go	TO.1SG.FUT-walk	LOC	REL	reef

'I'll go down where the truck is and then I'll walk to the reef.' (dvR_101206_A_01, 05:48, MM)

There has been little attention paid in the literature to the vertical dimension in studies of frame of reference. It has been deemed less interesting cross-linguistically, since the force of gravity means that in most normal situations vertical frames of reference converge (Levinson, 2003). Exceptions might be if someone was standing on their head, or in zero gravity. There are two points to be made about verticality in Iwaidja spatial language. The first, which has already been made in §5.2.2.2, is that 'up' and 'down' may form part of the absolute frame of reference in Iwaidja with relation to the coast/land axis. The second is the ease with which the speakers switched between the vertical dimension intrinsic to the cards or maps as two dimensional images, and the use of the intrinsic (5-46) or absolute (5-47).

5.2.5 Deixis

Spatial deixis refers to the use of the location of the speech participants in speech, such as the English word 'here', which refers to the speakers' own location. The Iwaidja equivalent *kani* 'here' was seen in example (5-14) above. In the Man and Tree task it was used to refer to the foreground of the picture, to the gaze forwards out of the picture, as well as to the left or right side of the picture on which the speaker was sitting. It was also used by some speakers to refer to the card they were holding, as opposed to the card their partner was offering as a solution.

Although deictic references can be used with all three frames of reference (Levinson, 2003; Palmer, 2002), there were some uses of deixis in the Man and Tree task which were challenging to classify within the frame of reference typology. For example, with the two participants for each task seated side by side, some speakers used their location with respect to each other to specify the sides of the card, as in (5-48).

(5-48)

Ba arlirr wakaldakan jumung nuyi angbani. Warrkbi wakaldakan kani ngabi ngawani.

ba	*arlirr*	*w-akaldakan*	*jumung*	*nuyi*	*ang-bani*
the	tree	3SG-on.side	REL	you	2SG-sit

warrkbi	*w-akaldakan*	*kani*	*ngabi*	*nga-wani*
tree	3SG-on.side	here	I	1SG-sit

'The tree is on the side where you are sitting. The man is here on the side where I am sitting.' (dvR_100522; 08:51, JW, *R32*)

Deictic information was sometimes combined and contrasted with absolute information as in (5-49).

(5-49)

Warrkbi ari wuka walim, ba arlirr ari kani wuka ngabi ngawani.

warrkbi	*ari*	*wuka*	*walim*	*ba*	*arlirr*
man	3SG.stand	where	south	the	tree

ari	*kani*	*wuka*	*ngabi*	*nga-wani*
3SG.stand	here	LOC	I	1SG-sit

'The man is standing the south, the tree is standing here where I'm sitting.' (dvR_100522; 41:37, MM, *R14*)

Deictic descriptions also occurred coupled with relative descriptions as in (5-50) which describes *R42*.

(5-50)

Barda rtamburryak wuka jumung nuyi yukbani, ba warrkbi. ... Arlirr ba rukung kirrwarda ari wakaldakan maruj.

barda	*rt-amburryak*	*wuka*	*jumung nuyi*	*yuk-bani*	
really	3SG-chest	LOC	REL you	TO.2SG-sit	
ba	*warrkbi*	*arlirr*	*ba*	*r-uku-ng*	*ø-kirrwarda*
the	man	tree	the	3SGM>3SG.give.PST	3SG-back
ari	*w-akaldakan*	*maruj*			
3SG.stand	3SG-on.side	left			

'The man's chest is really towards where you are sitting ... He's got his back to the tree (which is) on the left side.' (dvR_100512, 03:00, A1, *R42*)

In (5-50), *jumung nuyi yukbani* 'where you are sitting' refers to the side that the Matcher is sitting on, the right side, not the man's chest actually being directed towards the Matcher (Figure 5.13).

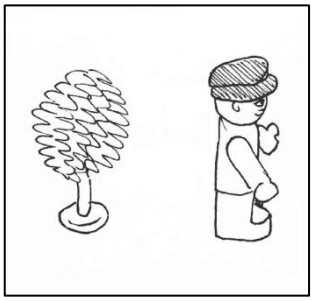


Figure 5.13. Card R42

Wilkins (2006) notes a similar strategy in Arrernte of using the deictic phrases 'your side'/'my side' but does not characterise it according to frame of reference. For Yucatec Maya, Bohnemeyer and Stolz (2006) call this strategy a relative one because it depends on a projection from the speech participants' locations. Meakins (2011) seems to imply that descriptions using deixis and gesture are relative. Another possible interpretation is to view such deictic descriptions as an *ad hoc* extreme of the absolute continuum, where the participants' locations become local landmarks for the purposes of the task. As mentioned in §5.2.2.4, *ad hoc* landmarks are variously regarded in the literature as part of the absolute system (Senft, 2001) and as part of the intrinsic system (Terrill & Burenhult, 2008), while Bohnemeyer and Stolz (2006) call them pseudo-absolute.

In (5-50) the deictic description is intrinsic, relating to the orientation of the man's body. However, in (5-48) there is no clear semantic or grammatical basis to attribute the deictic description to the absolute, relative or intrinsic frame of reference. Danziger (2010) has elaborated a fourth frame of reference called the *direct* frame of reference. The direct frame of reference is egocentric like the relative frame of reference, in that the anchor is a speech-situation participant, but it is binary, like the intrinsic frame of reference. This frame of

reference includes references of deixis and gesture, and could conceivably include utterances such as (5-48). Danziger distinguishes the direct frame of reference from the other frames of reference by a rotation test, to see whether a description still holds under rotation of a) the speech participant, b) the figure or c) the figure-ground array (Table 5.9).

Table 5.9. Rotation Sensitivities: Four Frames (Danziger, 2010, Table 4, p. 176)

Description for diagnosis	A. Description still felicitous under rotation of speech participant?	B. Description still felicitous under rotation of Ground?	C. Description still felicitous under rotation of Figure-Ground array?	Frame of Reference diagnosis
1. milk east of kettle	Yes	Yes	No	Absolute
2. milk to right of kettle	No	Yes	No	Relative
3. milk at spout of kettle	Yes	No	Yes	Object-Centred (Intrinsic)
4. milk in front of me.	No	No	Yes	Direct

However, Danziger's example of the direct frame of reference, 'the milk is in front of me' is a simple binary relation. The Man and Tree task has a speaker-interlocutor pair. It's not clear how the rotation test would hold with this situation.

Another way to address the question of how the deictic descriptions fit into the frame of reference analysis is to consider patterns such as preference for facing or orientational descriptions. We saw in §5.2.3.4 that relative left and right were only used once in the Man and Tree task for a facing description (5-40), out of a total of 14 uses. The proportion of absolute used that were facing descriptions varied by speaker and gender, as was shown in Figure 5.7. With deictic descriptions, about a quarter of the descriptions were facing descriptions. The distribution of deictic descriptions resembles the distribution of absolute descriptions more than the distribution of relative descriptions in terms of distribution of facing and standing descriptions. However, this is not sufficient to classify the deictic descriptions as pseudo-absolute. I have retained the category *deictic* despite the possibilities of classifying deictic expressions as *direct* or *pseudo-absolute*. Further investigations might be able to establish whether and how some deictic expressions should be included within frame of reference.

5.2.6 Frame of Reference in Memory – the Animals in a Row Task

The Animals in a Row task was conducted five of the senior participants at the Government Business Manager's quarters at Minjilang. Because of the small sample, and the absence of

other non-linguistic tasks to investigate cognitive effects of frame of reference preferences, it would be unwise to draw strong conclusions from the results. Nevertheless, some interesting outcomes were observed, not all of which were in the original task design.

The activity was conducted with the tables set up at opposite ends of a long breezeway (Figure 5.14). There was no formal distracter activity. However, the time taken for the mostly elderly participants to walk from one table to the other was considered a distraction.

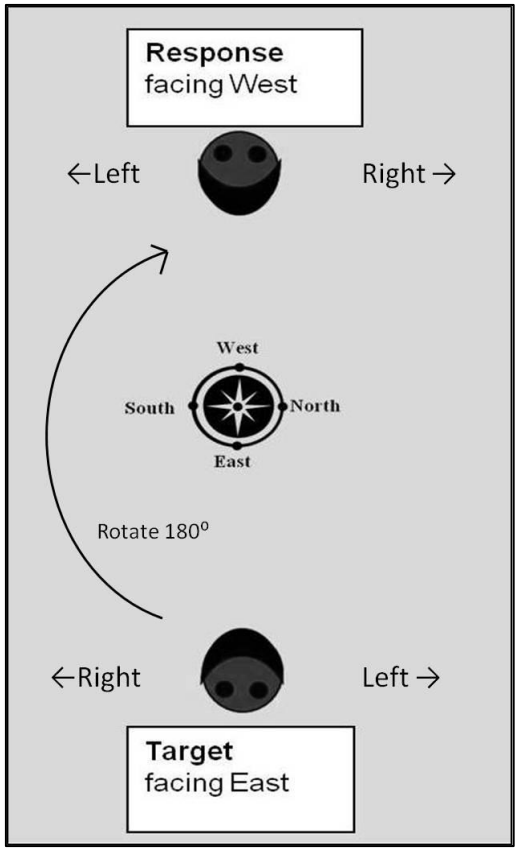
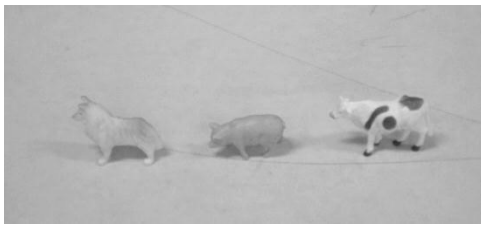
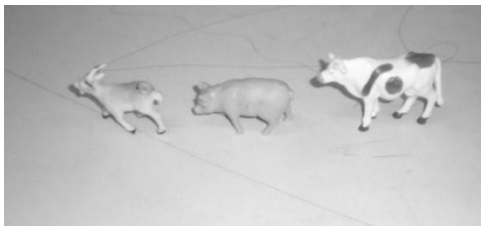


Figure 5.14. Setup of Animals in a Row task

Table 5.10 shows an example of each type of solution. In the examples shown, the stimulus animals are shown facing south to the viewer's right. In the first example, a relative solution is made by retaining the orientation of the animals to the viewer's right, which means that in the solution they now face north. In the second example, an absolute solution is made by making the animals still face south, which means they now face to the viewer's right. The intrinsic solution in the third example is made by retaining the internal arrangement of the animals, but the solution now faces neither to the right nor to the south.

Table 5.10. Example of Animals in a Row solutions

	Target on Table 1 (0°) N ← Facing East	Solution on Table 2 (180°) Facing West →N
relative		
absolute		
intrinsic		

The task was conducted five times with each participant. I recorded whether the frame of reference of the solution was intrinsic (I), absolute (A), or relative (R). I also recorded the absolute direction of the solution: north (N), south (S), east (E), or west (W). The results are summarised in Table 5.11.

Table 5.11. Adult Animals in a Row results

Participant	Frame of reference				Facing direction			
	Pattern	Total			Pattern	Total		
		Absolute	Relative	Intrinsic		South	North	West
A1	IARAR	2	2	1	ESSSS	4		1
CM	ARAAA	4	1		NNNSN	1	4	
DG	ARARA	3	2		SSSSS	5		
A2	RARAR	3	2		SSSSS	5		
MM	RRARA	2	3		NSSSS	4	1	
Totals:	-	15	12	1	-	19	5	1

Table 5.11 shows the pattern of the results. For example, CM's solutions were absolute, relative, absolute, absolute and absolute in that order, giving a total of 4 absolute and 1 relative solutions. The absolute facing directions of his solutions were north, north, north,

south, north. The pattern of the solutions showed a preference to continue to use a particular facing direction for subsequent solutions, once a direction had been chosen. Three of the participants placed all their solutions facing the same absolute direction, regardless of the direction of stimulus, and the other two placed four out of five solutions facing the same absolute direction. Slightly over three quarters of the solutions faced south, where just under half of the stimuli had faced south, and just over half had faced north. This suggests a preference for intrinsic solutions, despite being designed to differentiate between absolute and relative preferences.

There were slightly more absolute solutions than relative solutions, but not strongly so. The patterns show alternation between absolute and relative solutions. Since each participant performed an odd number of trials, this tendency to continue with the same facing direction means that the frame of reference of each participant's first solution tended to be their most frequently used solution. Two of the men and one of the women chose an absolute solution for their first solution and one of the women chose a relative solution for her first solution. One participant, A1, began his solutions in an intrinsic manner, facing each of the animals in a direction away from himself. He was then asked to do his remaining trials across the table; intervening to ask this was a deviation from the task design. A1 then stood himself at the side of the table for the rest of the solutions and continued to place the animals in a direction away from himself.

Further non-linguistic cognitive investigations into the intrinsic frame of reference are warranted. An appropriate starting point might be activities developed for this purpose by Danziger and Gaskins (CARG, 1993b).

5.3 Topological language

The investigations in this project did not specifically target expression of topological concepts. Where topological expression did occur, separating them from intrinsic ones was not always straightforward. Just as the relative frame of reference emerges out of the intrinsic, the intrinsic emerges out of topological descriptions (Levinson, 2003). Nevertheless, topological language is a core part of mathematical language which varies greatly from language to language. The general locative prepositions such as *wuka* are a central part of the topological language of Iwaidja. In static descriptions, *wuka* expresses basic proximity. This section briefly discusses the other topological descriptions that were elicited in the Man and Tree task and the Map task.

The use of the term topological for spatial language derives from Piaget & Inhelder (1948/1956). The core concepts of topological description are *proximity, separation, order, enclosure* and *continuity*. Of these, descriptions of enclosure and continuity were not elicited in these tasks. The order expressed by terms such as *wurdaka* 'in front' and *warrwak* 'behind' was generally intrinsic (and relative) rather than topological, projecting from the toys, such that *warrwak* 'behind' referred to a zone behind the toy rather than the actual back of the toy (Figure 5.11; §5.2.3.1). Similarly the body part descriptions such as *rukung kirrwarda* 'he gave it his back' also refer to a projected zone from the man's body.

The additional topological concepts used in the tasks were proximity and separation. The main distinction was between the adverbs *wardak* 'far away/apart' and *wanji/wanjikap* 'close, near', which is seen in (5-51).

(5-51)

Ari wardak lda jamin karlu wanjikap.

ari	*wardak*	*lda*	*jamin*	*karlu*	*wanjikap*
3SG.stand	far	and	3SG.RECIP	NEG	near

'They are standing far apart, not close.' (dvR_101115_03; 01:50, CM, *R24*)

There was also one use of *wardakbudarr* 'quite far away' (5-52).

(5-52)

Laik, wardakbudarr ari jamin, bad yawukan wuka, wuka Murdululi.

laik	*wardakbudarr*	*ari*	*jamin*	*bad*
like	quite.far	3SG.stand	3SG.RECIP	but

yaw-uka-n	*wuka*	*wuka*	*Murdululi*
AWAY.3SG-look-NPST	LOC	LOC	Cape.Croker

'He's quite a long way away, looking to over there, to Cape Croker.' (dvR_100512; 05:47, A1, *R42*)

Wajuk 'alone' was also used to indicate the separation between the toys (5-53).

(5-53)

Ba karlu aldarrunmin, janad ari wajuk lda jamin?

ba	*karlu*	*a-ldarrunmin*	*janad*	*ari*
the	NEG	3DU-side.by.side	he	3SG.stand

wajuk	*lda*	*jamin*
alone	and	3SG.RECIP

'They are not side by side, they are standing separately?' (dvR_100512; 41:28, DG, *R11*)

Proximity was also described using the phrase *aldindi murrbuny* 'two standing together' (5-54).

(5-54)

Aldindi murrbuny yangbayan muwarn.

a-ldindi	*murrbuny*	*yangb-ayan*	*muwarn*
3DU-DU.stand	DU.together	AWAY.3SG>3SG-look.NPST	sun

'Those two are standing together looking east.' (dvR_100513, 30:09, RG, *R41*)

The descriptions in (5-51), (5-52), (5-53), and (5-54) do not specify an angular direction between the toys, they simply indicate whether the toys are together or apart. In these examples, those that are described as *aldindi murrbuny* 'standing together' are visually overlapping, while those that are *wardak* 'apart' are visually separated on the cards. This distinction of distance in this task is applied to the two-dimensional appearance of the image, since in the three dimensional scene represented in the pictures, the man and tree are always the same distance apart.

5.3.1 Alignment

Alignment has been included in the topological language section since concepts such as 'level' do not specify angular direction. All of the cards in the Man and Tree show the man and the tree lined up either on the across-axis or the away-axis. There were many descriptions that referred to this alignment of the two toys in more or less straight lines.

Ngunyulunmin 'side by side', which was seen in (5-36), contains the root *unmin* 'be the same', as well as the body part stem *ngunyuni* 'side of waist, hip'. This root *unmin* 'be the same' appeared in other verbs to describe alignment. It appears in (5-55) and (5-56) where *anmikbin* 'same, level' is used to describe an intrinsic side by side configuration.

(5-55)

Anmikbin ba arlirr lda yawukan nimarrk ba warrkbi.

anmikbin	*ba*	*arlirr*	*lda*	*yaw-uka-n*	*nimarrk*
3DU.level	the	tree	and	AWAY.3SG-look-NPST	ocean

ba	*warrkbi*
the	man

'The man is standing level with the tree and he's looking out to sea' (dvR_1001115_03; 03:45, CM, *R43*)

(5-56)

Ari manjad rtuwa anmikbin ba arlirr.

ari	*manjad*	*rtuwa*	*anmikbin*	*ba*	*arlirr*
3SG.stand	straight	just	3DU.level	the	tree

'He's standing straight, level with the tree.' (dvR_100513, 04:24, A2, *R32*)

The sense of *anmikbin* 'same, level' in these examples can be contrasted with the intrinsic use of *wurdaka* 'in front' and *warrwak* 'behind', and applies to cards where the figures are not *wurdaka* 'in front' and *warrwak* 'behind'.

Another verb which also has the root *unmin* 'be the same' and was used to describe side by side configurations was *ldarrunmin* 'side by side, level' (5-57).

(5-57)

Aldindi aldarrunmin.

a-ldindi	*a-ldarrunmin*
3DU-DU.stand	DU-side.by.side

The two of them are standing side by side (dvR_100513; 46:08, A2, *R32*)

In (5-57) *ldarrunmin* occurs with *aldindi*, which is an irregular dual form of *ldi* 'stand'. However, in (5-33) it was used with *ngirrunmin* 'back to back' about *R31*.

The adverb *manjad* 'straight' can also mean 'correct', but in (5-56) was used to refer to the man's position. The verb *nguranganin* means 'be straight' or 'go straight' (§5.4.1). It can be used transitively to describe straightening a spear. This term was used by A2 to refer to the man's facing direction with respect to the participants for cards *R12* and *R14*, as in (5-58).

(5-58)

Warrkbi kuranganin arrungbayan.

warrkbi	*ø-kuranganin*	*arrungb-ayan*
man	3SG-straight	3SG>1PL-look.NPST

The man is facing straight at us.' (dvR_100513; 17:24, A2, *R14*)

Another speaker, A1, used the same term to describe cards *R11*, *R31* and *R42* (5-59). In these cards the toys are in a *majada* 'single file; queue' (5-60).

(5-59)

Kuranganin ba warrkbi kuranganin ba arlirr kuranganin.

ø-kuranganin	*ba*	*warrkbi*	*ø-kuranganin*	*ba*	*arlirr*	*ø-kuranganin*
3SG-straight	the	man	3SG-straight	the	tree	3SG-straight

'In a straight line, the man is straight and the tree is straight too.' (dvR_100512; 46:03, A1, *R11*)

(5-60)

Ijbuldi majada janad wurdaka arlirr ari yawurdaka.

ijbu-ldi	*majada*	*janad*	*w-urdaka*	*arlirr*	*ari*
3PL.stand	single.file	it	3SG-in.front	tree	3SG.stand

yaw-urdaka
AWAY.3SG-in.front

'They are standing in a single file. It's in front, the tree is in front.' (dvR_100512; 41:33, A1, *R11*)

Nguranganin 'straight' was also used transitively by CM to describe the man's orientation to the participants (5-61).

(5-61)

Kani arrumunguranganiny.

kani	*arrumu-ngurangani-ny*
here	3SG>1PL-straight-PST

'He's facing straight at us.' (dvR_101115_03; 00:43, CM, *R12*)

Kuranganin 'straight' can be applied to cards where the man and tree are in an intrinsic 'in front' and 'behind' arrangement and to where the man is facing the speaker.

Also derived from *unmin* 'be the same' is *ngarrunmin* 'be the same height', which has only dual forms (5-62).

(5-62)

Riki ari angarrunmin ba arlirr kartbalkbang ba wurdaka.

riki	*ari*	*a-ngarrunmin*	*ba*	*arlirr*	*ø-kartbalkbang*
this	3SG.stand	3DU-Same.height	the	tree	3SG-sticking.out

ba	*w-urdaka*
the	3SG-in.front

'This one, they're the same height but the tree is the tall one.' (dvR_101115_03; 04:48, CM, *R23*)

In (5-62) *wurdaka* 'in front' has the sense of height. CM uses *angarrunmin* 'be the same height' to refer to the intrinsic height of the man and tree, their "real" heights. The apparent height, viewing the card, is described with *kartbalkbang ba wurdaka* 'sticking out on top'. *Kartbalkbang*, from *balkbang* 'come out' seems to mean that part of the tree is sticking out. See §5.2.4 for other ways in which speakers referred to the apparent height of the images on the cards.

5.3.2 Angles

The verb *minyu* means 'across' but also 'be at a (right) angle to' or 'be perpendicular to'. It occurred in both relative and intrinsic senses. In (5-63) it is followed with the verb *ngurrkalkung* 'be side on', used relatively by the speaker, referring to the fact that the man is standing at a right angle to the viewer.

(5-63)

Binyu ari ringurrkalkung.

ø-binyu	*ari*	*ri-ngurrkalkung*
3SG-across	3SG.stand	3SGM>3SG-side.on

'He's standing across. He's side on.' (dvR_100522; 22:32, JW, *R24*)

In some of the cards where the objects are shown on the away-axis, they are slightly offset. These cards show either the tree in the foreground (*Rx1*) or the man in the foreground (*Rx3*), and in all of them except for *R23* the foreground object is set slightly to the left of the card. Presumably this was not intended to be a significant feature of these cards which were rather

intended to explore the away-axis (Terrill & Burenhult, 2008). Two examples, cards *R33* and *R21* are shown in Figure 5.15.

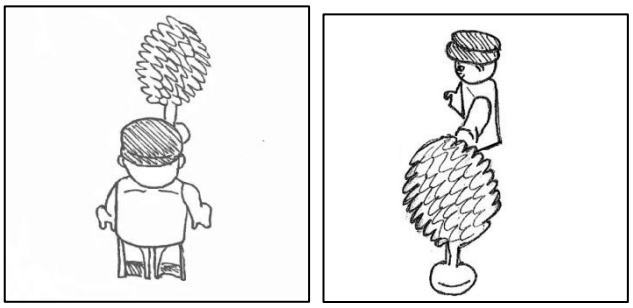


Figure 5.15. Offset man and tree in cards R33 and R21

Some of the speakers demonstrated sensitivity to the small amount of laterality in these cards. *Minyu* 'be at a (right) angle to' was qualified with *awukawuk* 'in the vicinity of' to form a phrase meaning 'be at an angle to'. It was used about some of these offset cards such as *R33* (5-64).

(5-64)

Rtamburryak yabin wuka jumung abalkbang manyij, bad binyu awukawuk.

rt-amburryak	*ya-bi-n*	*wuka*	*jumung*	*abalkbang manyij*
3SG-chest	AWAY-3SG.do-NPST	LOC	REL	east

bad	*ø-binyu*	*awukawuk*
but	3SG-across	in.vicinity

'He's facing towards the east, but at an angle.' (dvR_100512; 21:02, A1, *R33*)

Binyu awukawuk 'be at an angle to' is a verb-adverb construction that describes how something is positioned with respect to something else, rather than naming the shaped space between them. *Minyu* 'at an angle' was also used with *anmikbin* in its sense of 'same' to create the sense of 'same angle', as in (5-65).

(5-65)

Arlirr barda binyu anmikbin ijbunmin badbawarda baraka warrkbi.

arlirr	*barda*	*ø-binyu*	*anmikbin*	*ijb-unmin*
tree	really	3SG-across	DU.same	3PL-same

badbawarda	*baraka*	*warrkbi*
another.one	over.there	man

'The tree is at the same angle, the same as the man.' (dvR_100512; 21:37, A1, *R33*)

Minyu also occurred in the form *aminyujung*, meaning 'be turned away' or 'be at different angles' (5-66).

(5-66)

Karlu ijalkud rayan abalkbang manyij laik binyu awukawuk lda arlirr lda warrkbi aminyujung.

karlu	*ijalkud*	*r-ayan*	*abalkbang manyij*	*laik*
NEG	really	3SGM>3SG-LOOK.NPST	east	like

ø-binyu	*awukawuk*	*lda*	*arlirr*	*lda*	*warrkbi*
3SG-across	in.vicinity	and	tree	and	man

a-minyujung
TO.3SG-turn.away

'Not really looking east, at an angle, the tree and the man are at different angles.' (dvR_100512; 21:23, A1, *R33*)

Another term that was used once for 'offset' was *warnaju* (5-67).

(5-67)

Abalkbang manyij ba karlu warnaju?

abalkbang manyij	*ba*	*karlu*	*warnaju*
east	the	NEG	offset

'It's in the east, but is it offset?' (dvR_100512, 31:53, DG, *R21*)

A more general meaning of *warnaju* is 'crooked'. In *R13*, another card where the toys were visually overlapping but offset, one speaker used the term *kurrkamaj* 'half, one side' (5-68).

(5-68)

Arlirr ari wuka barra wakaldakan kurrkamaj ma.

arlirr	*ari*	*wuka*	*barra*	*w-akaldakan*
tree	3SG.stand	LOC	NW.wind	3SG-on.side

kurrkamaj	*ma*
half	EMPH

'The tree is standing to the northwest, halfway.' (dvR_100115_04; 10:15, KM, *R13*)

Kurrkamaj 'half, one side' is used to describe for instance half of a goose or fish cut for eating. In (5-68) it indicates that the tree is offset to one side of the man's body.

Iwaidja can qualify an angle as being somewhat greater or less than a right angle. *Minyu* 'be across' means to be *perpendicularly* across, and can be modified with *awukawuk* 'in the vicinity of'. Swetz (2009) claims that an appreciation of perpendicularity is common to "traditional people". His examples include the appreciation that a support pole for a structure must be perpendicular to the ground (in some methods of construction), and that an arrow must be perpendicular to the string of a bow. This is a large claim however, which needs to be corroborated with empirical evidence. In Iwaidja, *minyu* refers to the manner in which something crosses something else. In English, *angle* also exists as a verb, but in the nominalising world of mathematics education the focus is usually on the angle as a noun, a measurement of the space between two lines, or how one has rotated from the other. In a discussion of how a Navajo geometry might be developed, Pinxten et al. (1987) describe

Dingler's (1933) reinterpretation of geometry as based in action: "a line is not in the first place a connection between two points ... Rather, line can be first and foremost seen as the result of movement" (p. 90). Where a line itself is conceived as a movement, it makes sense to consider the meeting of lines as active.

5.4 Motion

The Map task was designed to elicit route descriptions, and to investigate whether spatial frames of reference were used in such descriptions. The language of motion in Iwaidja *per se* was not a topic of investigation. Some use of frames of reference were recorded for the Map task, but the predominate approach of the six participants was to use specific verbs of motion. Most of these verbs can be NEUTRAL or occur in the AWAY or TOWARDS forms. The participants talked about the route in a variety of ways, describing a first person journey: 'I'm going ...', instructing the Matcher: 'you have to go ...', describing the path in an impersonal way: 'it goes ...', or talking as though an anonymous protagonist had taken a journey: 'he went ...'. The extract from A1's route description in (5-69) illustrates many typical characteristics of Iwaidja motion description.

(5-69)

Artirran ararlarrngbung abulakuny awaran. Yabulakuny wardad ba ajbud. Yartirran yarnukbun jumung murrhala ari. Yartirran yarnukbun wuka jumung narrhardi bani. Yartirran barakbarda yariman ba alan ba yawaran, barakbarda jumung birtbani, arrarnarn lda arrayi.

art-irra-n			*a-rarlarrngbu-ng*			*a-bulaku-ny*			
TO.3SG-come.back-PST			TO.3SGM>3SG-turn-PST			TO.3SG-come.down-PST			
aw-ara-n		*ya-bulaku-ny*			*wardad*		*ba*	*ajbud*	
TO.3SG-come-PST		AWAY.3SG-come.down-PST			one		the	beach	
yart-irra-n			*y-arnukbun*			*jumung*			
AWAY.3SG-come.back-PST			AWAY.3SG-turn.off			REL			
murrhala	*ari*		*yart-irra-n*			*y-arnukbun*			
pandanus	3SG.stand		AWAY.3SG-come.back-PST			AWAY.3SG-turn.off			
wuka	*jumung*	*narrhardi*		*bani*		*yart-irra-n*			
LOC	REL	goose		3SG.sit		AWAY.3SG-come.back-PST			
barakbarda	*yari-ma-n*				*ba*	*alan*	*ba*		
that.one	AWAY.3SGM>3SG-take-PST				the	track	the		
yaw-ara-n		*barakbarda*	*jumung*		*birt-bani*		*arrarnarn*		
AWAY.3SG-come-PST		that.one	REL		3PL-sit		milky.oyster		
lda	*arrayi*								
and	black.lip.oyster								

'He came back, he turned, he came down, he came. He went down to one beach. He turned back to where the pandanus tree is. He turned back to where the goose was sitting. He went back there and he took that road, he went along where that thing is, milky oysters and black lip oysters.' (dvR_101208A_02, 06:41, A1)

As mentioned in §5.1.3, motion verbs in Iwaidja take a three-way directional contrast between NEUTRAL, TOWARDS and AWAY forms. These directions are with respect to the deictic location, which may or may not be the speaker's location.

Iwaidja has a basic movement verb *ara* which means 'go' or 'come' depending on the context, or as indicated with the TOWARDS and AWAY prefixes. In (5-69) this is seen in the past third person singular forms *awaran* 'he came' and *yawaran* 'he went'. We also see the verb *irra* which means 'go back' or 'come back' depending on the direction, in the forms *artirran* 'he came back' and *yartirran* 'he went back'. *Irra* thus refers to a change of direction.

We can also see the serial verb construction which is frequent in Iwaidja. The first sentence consists only of four verbs, all taking the TOWARDS prefix: *Artirran ararlarrngbung abulakuny awaran* ''He came back, he turned, he came down, he came.' A colloquial English translation might be something along the lines of 'he came straight back down'.

Serial verb constructions such as these challenge Talmy's (1985) widely used distinction between *verb-framed** and *satellite-framed** languages. This distinction is between languages that package the path of motion on the verb, with manner as additional, as in Spanish, and those that package manner on the verb, with path as a 'satellite', as in English. The challenge to Talmy's distinction has already been noted regarding serial verb construction in Ewe, spoken in Ghana (Ameka & Essegby, 2006) and Kilavila, spoken in Papua New Guinea (Senft, 2006). In the serial verb construction both motion and manner occur in verbs used sequentially.

The example (5-69) also contains both TOWARDS and AWAY forms of *wulaku* 'go down', in *abulakuny* 'he came down' and *yabulakuny* 'he went down'. The vertical dimension in Iwaidja has been discussed in §5.2.4.

Although Iwaidja packages a great deal of specific motion information onto the verb, source and goal can both be indicated with prepositions. (5-69) contains several instances of the relative pronoun *jumung* 'to it' in goal phrases such as *jumung murrhala ari* 'to where the pandanus is.' *Jumung* 'to it' is optionally strung together with the versatile locative *wuka* 'to/where'.

The goal of the path in the Map task was widely indicated using the locative preposition *wuka* 'to', which was also widely used in the Man and Tree task to indicate static location 'at'. The

source or origin of the path was indicated using the inflecting preposition *burdan* ‘from’, as shown in (5-70).

(5-70)

Burdan kurrambalk ba yurrngud awaran rimarraywung ngarrkarrk kurrambalk

b-urdan	*kurrambalk*	*ba*	*yurrngud*	*aw-ara-n*
3SG-from	house	the	on.top	TO.3SG-come-PST

ri-marraywung	*ngarrkarrk*	*kurrambalk*
3SGM>3SG.pass	two	house

‘From the top house it came past the two houses.’ (dvR_101207_A_01, 11:09, DG)

Burdan ‘from’ can also optionally be used with the locative preposition *wuka*, as in *burdan wuka kurrambalk* ‘from where the house is’.

The remainder of this section describes features of motion in Iwaidja that have implications for the expression of mathematical concepts.

5.4.1 Change of Direction

Change of direction in Iwaidja is generally indicated by changing between TOWARD and AWAY forms, and by the use of verbs such as *irra* ‘go/come back’ or ‘reverse direction’. In (5-69), *irra* was strung together with *arnukbun* ‘turn’. In (5-71), *arnukbun* ‘turn’ occurs in its own phrase, contrasting with the preceding *angmananguranganin* ‘you come/go straight’.

(5-71)

Angmananguranganin rtuwa iyi kabanarnukbun mudika muli.

angmana-nguranganin	*rtuwa*	*iyi*	*kaban-arnukbun*
2SG>3SG.FUT.straight.NPST	just	yes	2SG>3.FUT-come.around

mudika	*muli*
car	buttocks

‘You go straight down here and then you go around the back of the car.’ (dvR_101208_A_02, 29.96, KM)

Rarlarrngbu ‘turn’, which was used in (5-69), is derived from *arlarrngbu* ‘straighten’ that is used, for instance, about straightening a spear, a process which is done by turning. Another more specific verb that was used was *ngarnangkan*, which means ‘turn off (from the main route onto another road’ (5-72).

(5-72)

Anngalidba awaran wuka kabala ari barda akarnangkan ngalaj mudika ari kurrkarda.

anng-alidba	*aw-ara-n*	*wuka*	*kabala*	*ari*	*barda*
2SG-listen	TO.3SG-come.PST	LOC	boat	3SG.stand	then

a-karnangkan	*ngalaj*	*mudika*	*ari*	*kurrkarda*
TO.3SG-turn.off	LOC	car	3SG.stand	other.side

Listen, he came to where the boat is then he turned off where the car is on the other side. (dvR_101207_A_01, 06:06, DG)

Because changes of direction are marked on the verb, in these cases is not necessary to specify the goal of motion.

5.4.2 Passing

As mentioned in §5.1.3, Iwaidja encodes specific spatial information into distinct, although related verbs. The range of verbs elicited to refer to passing objects on the map is a good example of this. The most general of these is *marraywung* 'pass'. It is a transitive verb, requiring the specification of *what* is passed, but does not provide any more detailed information about how the object is passed. An example is given in (5-73).

(5-73)

Ngarrkarrk arlirr aldindi mardan kirrimul. Rimarraywung yawarang mangawala ajbud jumung kabala ari.

ngarrkarrk	*arlirr*	*a-ldindi*	*mardan*	*kirrimul*		
two	trees	3DU-DU.stand	small	like		
ri-marraywung		*yaw-ara-ng*	*mangawala*	*ajbud*	*jumung*	
3SGM>3SG.pass		AWAY.3SG-go-NPST	fast	beach	REL	
kabala	*ari*					
boat	3SG.stand					

'There are two trees there, small ones. It goes past them and runs along the beach where boat is.' (dvR_101207_A_01, 08:55, CM)

There are also verbs derived from *marraywung* for passing in front, behind or to the side of objects. Their use depends upon those objects having an intrinsic front, back or side. The verbs are *marlmarraywung* 'pass behind' (5-74), *wudbarraywung* 'pass in front' (5-75), and *ngunyunmarraywung* 'pass beside' (5-76).

(5-74)

Artirran ararnukbung rimarlmarraywung wuka jumung mudika wulurr.

art-irra-n	*ar-arnukbu-ng*	*ri-marlmarraywung*
TO.3SG-come.back-PST	TO.3SG-turn.off-PST	3SGM>3SG-pass.behind

wuka	*jumung*	*mudika*	*wulurr*
LOC	REL	car	back

'It came back, turned off and passed behind the back of the car.' (dvR_101207_A_01, 07:33, CM)

(5-75)

Kirrimul warrkarrk aju riwudbarraywung.

kirrimul	*warrkarrk*	*aju*	*ri-wudbarraywung*
like	goanna	3SG.lie	3SGM>3SG-pass.in.front

'It passes in front of where the goanna is.' (dvR_101207_A_01, 07:30, CM)

(5-76)

Angmanamin start barakbarda jumung banbani. Abanildurldalkung rtadbihi. Kabanangunyunmarraywun baraka dinghy.

angmana-min	*start*	*barakbarda*	*jumung*	*ban-bani*
2SG.FUT-go.NPST	start	there	REL	3PL.sit

abani-ldurldalku-ng	*rtadbihi*	*kabana-ngunyunmarraywu-n*
TO.3SG.FUT-cross-NPST	creek	2SG>3.FUT-pass.beside-NPST

baraka	*dinghy*
DEM	dinghy

'You start there where [the houses] are. It will cross the creek. Then you will pass beside the dinghy.' (dvR_101208_A_01, 07:29, KM)

Ngunyunmarraywung 'pass beside' contains the body part stem *ngunyuni* 'waist' which was earlier seen in *mangunyuni* 'beside' and *angunyulunmin* 'side by side' (§5.2.3.2). The derivational origins of *marlmarraywung* 'pass behind' and *wudbarraywung* 'pass in front' are not so transparent. These verbs were predominately used in the third person about the track. A second verb *ldakijba* 'pass' was used less frequently and only the first or second person, such as in the instruction *ubaldakijba* 'you go past it'.

5.4.3 Movement Around

Another set of verbs which are potentially of mathematical interest are those which were used in the Map task for 'go around' or 'circle'. There were four of these, all clearly related, with the simplest *alnga* appearing as a stem in the other three. Examples are given from the Map task of *alnga* (5-77), *ngardalnga* (5-78), *ldakburdalnga* (5-79), and *marralngan* (5-80).

(5-77)

RG: Abanalnga kabala nga?

MM: Kabanalnga ba kabala yukbanirra yukbanawulakun.

aban-alnga	*kabala*	*nga*
TO.1SG>3.FUT-go.around	boat	eh

kaban-alnga	*ba*	*kabala*	*yukban-irra*
2SG>3.FUT-go.around	the	boat	TO.2SG.FUT-come.back

yukbana-wulaku-n
TO.2SG.FUT-come.down-NPST

RG: 'I go around the boat, don't I?'

MM: 'You go around the boat and then you come back down.' (dvR_101206_A_01, 10:20, RG & MM)

(5-78)

Kabanayan mana ajbud aju. Kabanangardalnga barakbarda yukbanawulakun.

kaban-ayan	*mana*	*ajbud*	*aju*	*kabana-ngardalnga*
2SG>3.FUT-see-NPST	maybe	sand	3sg.lie	2SG>3.FUT-go.around

barakbarda	*yukbani-wulaku-n*
there	TO.2SG.FUT-come.down-NPST

'You see the sand there. Go around that and come down.' (dvR_101206_A_01, 12:04, MM)

(5-79)

Barakbarda rtuwa rildakburdalngan. Awaran mangawala j... ari abalkbang manyij wakaldakan. Anbirrk mardan yawaran rildakburdalngan wuka.

barakbarda	*rtuwa*	*ri-ldakburdalnga-n*	*aw-ara-n*	
there	just	3SGM>3SG-go.around-PST	TO.3SG-go-PST	
mangawala	*ari*	*abalkbang manyij*	*w-akaldakan*	*anbirrk*
fast	3SG.stand	east	3SG-on.side	hill
mardan	*yaw-ara-n*	*ri-ldakburdalnga-n*		*wuka*
little	AWAY.3SG-go-PST	3SGM>3SG-go.around-PST		LOC

'It just went around that [pandanus]. It came straight to where .., it's on the east side. It went around the little hill there.' (dvR_101207_A_02, 04:15, DG)

(5-80)

Nganamarralngaka.

ngana-marralnga-ka
1SG.FUT-circle-ITER

'I'll circle (it).' (dvR_101206_A_01, 09:58, RG)

Alnga and *marralngan* have been glossed as 'go around (in a circle)' while *ngardalnga* and *ldakburdalnga* have been glossed as 'go around'. However, it is not clear what the scope of each term is. From the uses in the Map task and discussion with Joy, the semantic difference between the terms does not seem to be one of scale (large circles versus small circles) nor one of completion. *Alnga*, *ngardalnga* and *ldakburdalnga* are all transitive, requiring an object to be circled, whereas *marralngan* has intransitive morphology. In (5-80), RG uses the iterative form, after which she drew a circle right around the boat (Appendix B, Figure A.4).

As well as using verbs to describe geometric concepts, objects may be also described in Iwaidja using adjectives that refer to their shapes. There are several Iwaidja words for 'round' given as adjectives in Pym (1982) such as *barlalbanbal* and *kalkbirradbij*. The latter appears to be *kalkbirdadbij*, which is a noun meaning small damper donuts used in ceremony or similar small bread rolls. *Kalkirrirr* 'money' and *kalkbirr* '(generic) shell' also contain *kalk-* which is a form of *-ngalk* 'head' (Teo, 2007) and may have acquired the meaning 'round thing'.

In her survey of spatial terminology, P. Harris (1991) gives examples of how an unnamed Iwaidja woman described to Noreen Pym four two-dimensional plane shapes with adjectives. A square was described as 'flat, smooth', a circle as 'round', a rectangle as 'long' and a triangle as 'having sides'. Harris provides only the English translations, not the Iwaidja words. Since I was unable to find her survey data, it is not clear what the Iwaidja words were.

Geometric concepts in Iwaidja are more likely to be expressed through verbs, as actions, rather than as named shapes or objects. During discussion and analysis of these terms, Joy

Williams said that there was no noun for a circle in Iwaidja. Mathematical consequences of this are considered in §5.5.2.

5.4.4 Sequencing

Wurdaka ‘in front’ and *warrwak* ‘behind’ were used extensively in the Man and Tree game to describe the intrinsic (as well as relative) position of the two standing objects (§5.2.3.1). In the Map task they were used in the senses of ‘first’ and ‘last’. In (5-81), *wurdaka* ‘first’ was used to describe the origin of the road. The verb *ang..ldakbanakbi* ‘last’ was also used.

(5-81)

Wurdaka abalkbang burdan ngarrkarrk lda wardad kurrambalk, wardad bani angbuldakbanakbi.

w-urdaka	*a-balkba-ng*	*burdan*	*ngarrkarrk*	*lda*
3SG-first	TO.3SG-come.out-PST	from	two	and

wardad	*kurrambalk*	*wardad*	*bani*	*angbu-ldakbanakbi*
one	house	one	3SG.sit	3>3-last

‘It starts from where those three houses are, (from the) one that's sitting last.’ (dvR_101207_A_01, 07:57, CM)

While *warrwak* ‘behind, last’ is an adverb and does not inflect, *ang..ldakbanakbi* ‘last’ is a transitive verb such that the subject ‘lasts’ or ‘comes last to’ the object. How this might relate to concepts of ordinality in Iwaidja is discussed in §6.4.3.

5.4.5 Crossing, Sides and Middle

The creek divided the maps, presenting an obstacle that needed to be crossed. The term used for this was *ldurldalkun* ‘cross, go across’ (5-82).

(5-82)

Mudakari lda anbirrk lda birr yangkabaldurldalkung

mudakari	*lda*	*anbirrk*	*lda*	*birr*	*yangkaba-ldurldalku-ng*
car=3SG.stand	and	hill	and	then	AWAY.2SG.IMP-go.across-PST

‘The truck and the hill (are there) and then you go across.’ (dvR_101206_A_02, 07:26, MM)

In (5-82) *mudika ari* ‘the car stands’ has contracted to *mudakari,* (shown using the = sign).

Ldurldalkun contains the root *ldalku* ‘cut’, which itself also means ‘cross’, as in (5-83).

(5-83)

Yaralkung ba rtadbihi yawurtin kurrkarda jumung bani anbirrk.

ya-ralku-ng	*ba*	*rtadbihi*	*yaw-urti-n*
AWAY.3SG-cross-PST	the	creek	AWAY.3SG-go.up-PST

kurrkarda	*jumung*	*bani*	*anbirrk*
other.side	REL	sit	hill

‘It went across the creek, on the other side it went up to the hill.’ (dvR_101207_A_01, 03:13, CM)

In (5-83) the noun *kurrkarda* ‘other side’ was used to refer to the part of the map across the creek. It was also used to describe the items on each side of the track, which the track passed between, as in (5-84).

(5-84)

Yirrarn ari kurrkarda lda narrhardi kurrkarda lda balarra ba mudika alan.

yirrarn	*ari*	*kurrkarda*	*lda*	*narrhardi*	*kurrkarda*
mangrove	3SG.stand	one.side	and	goose	one.side

lda	*ø-balarra*	*ba*	*mudika*	*alan*
and	3SG.middle	the	car	track

‘The mangrove stands on one side and the goose on the (other) side and in the middle is the car track.’ (dvR_101207_A_01, 04:41, CM)

The example (5-84) also contains the verb *balarra* ‘go/be in the middle’ or ‘go between’. This is another example of a concept which in English would be expressed with a prepositional phrase, but which in Iwaidja more commonly is expressed with a verb. A more literal translation of *balarra ba mudika alan* would be ‘the car track middles’.

Iwaidja has a noun meaning ‘middle’, *nimarrk*. It can be used to refer to the middle part of a boat, for example, and has a second meaning of ‘ocean’ or deep water’, which was seen in §5.2.2.2. In the Map task, it was used only once, in a reduplicated form, to mean ‘right in the middle’, in conjunction with the verb *balarra* ‘go between’ (5-85).

(5-85)

Balarra rtuwa nimarrkanimarrk balarran ba mudika alan.

ø-balarra	*rtuwa*	*nimarrkanimarrk*	*ø-balarra-n*
3SG-go.between	just	middle.REDUP	3SG-go.between-PST

ba	*mudika*	*alan*
the	car	track

‘In between, the car track went right in the middle.’ (dvR_101207_A_01, 12:54, CM)

This use of *nimarrkanimarrk* to mean ‘right in the middle’ occurred only once in the task, and then for emphasis. In the talk about crossing or being in the middle in Iwaidja there is again more focus on expression though verbs.

5.4.6 Uses of Frame of Reference in Motion

Although the Map task did not contain symmetric route choices which would have necessitated frame of reference usage, there was opportunity for speakers to use it as a strategy if they chose. Little evidence of this was found. One pair of male speakers used some absolute terms some of the time (§5.2.2.5) and all the male speakers occasionally used the terms *maruj* ‘left’ and *nurlinurli* ‘right’ relatively (§5.2.3.4).

As well as the use of specific verbs that encode locational information, such as the verbs for passing (§5.4.2), the track's intrinsic location in relation to objects on the map was sometimes indicated by using part names.

Body parts were used to refer to both animate and inanimate items of the maps. The body parts used were *muli* 'buttocks, bottom, backside', *wuwij* 'tail', *kirrwarda* 'back', *jinmul* 'nose' and *baharl* 'head'. Table 5.12 shows which terms were used for which object. An example is given in (5-86).

Table 5.12. Body parts used in Map task

Body part	Used about
muli 'buttocks, backside'	*warrkarrk* 'goanna', *mudika* 'car', *kabala* 'boat'
wuwij 'tail'	*warrkarrk* 'goanna', *narrhardi* 'magpie goose'
kirrwarda 'back'	*warrkarrk* 'goanna'
jinmul 'nose'	*warrkarrk* 'goanna', *kabala* 'boat'
baharl 'head'	*narrhardi* 'magpie goose'

(5-86)

Yangmanirra yangmanurtin... warrkarrk jumung warrkarrk wuwij kirrwarda barakbarda jumung jinmul wiyu yukbanirra wubanarnukbun yukbanawulakun.

yangman-irra *yangman-urti-n* *warrkarrk*
AWAY.2SG.FUT-go.back AWAY.2SG.FUT-go.up-NPST goanna

jumung *warrkarrk* *wuwij* *ø-kirrwarda* *barakbarda* *jumung*
REL goanna tail 3SG-back that.one REL

jinmul *wiyu* *yuk-ban-irra* *wu-ban-arnukbun*
nose self TO.2SG-FUT-go.back TO.2SG>3SG-FUT-turn

yuk-bana-wulaku-n
TO.2SG-FUT-go.down-NPST

'Then you got to go up to the goanna, to where the goanna's tail and back are, that one, to where his nose is, (then) you can turn and come down again.' (dvR_101208_A_03, 08:17, A1)

There was also some use of object specific part names, such as *angbaharl* 'head of creek (source)' as in (5-87).

(5-87)

Barakbarda jumung murrhala aldindi yangkabaldurldalkun ba rtadbihi jumung angbaharl.

barakbarda *jumung* *murrhala* *a-ldindi* *yangka-ba-ldurldalkun*
over.there REL pandanus 3DU-DU.stand AWAY.2SG>3SG-FUT-cross

ba *rtadbihi* *jumung* *angbaharl*
the creek REL headwater

'That's where the pandanus is, that's where you have to go across at the top of the creek.' (dvR_101207_A_03, 05:52, A1)

In Iwaidja the ‘head’ of the creek is its source, and where it exits into the sea is its ‘anus’. This is opposite form English, where the ‘mouth’ of a creek is where it exits into the sea.

5.4.7 Summary of Motion in Iwaidja

In any language, you would expect the language of motion to involve the use of verbs. However, in ‘verb-framed’ languages, according to Talmy’s (1985) classification, manner of motion is expressed outside the verb, for example as an adverb. In ‘satellite-framed’ languages the path is expressed outside the verb, for example with a prepositional phrase, as in English. The serial verb construction of Iwaidja frequently combine both manner and path in a series of verbs, as was seen in (5-69) and in the examples in §5.4.3.

The extensive lexicon of verbs in Iwaidja provides the speaker with the resources for precise specification of location during movement without necessarily using frame of reference. “Concepts” which in English are packaged into nouns (‘circle’) or prepositions (‘up’) occur in Iwaidja in precise expressions through specific and numerous verbs. This is further discussed in §5.5.2.

5.5 Orientation and Dynamism in Iwaidja

This section discusses two features of spatial language in Iwaidja of particular interest. The first is a consideration of the role of orientation in Iwaidja (§5.5.1). The second is the role of dynamism (§5.5.2).

5.5.1 Path Orientation

The Man and Tree task results have been described as comprising standing (locational) and facing (orientational) information. Facing information included direction of gaze, orientation of body parts and the intrinsic use of terms such as *wurdaka* ‘in front’ and *warrwak* ‘behind’. In the majority of cases, Directors provided both facing and standing information, but there were cards for which predominantly facing information was provided. For example (5-88) shows the use of a gaze verb with an absolute direction and *wurdaka* ‘in front’ and *warrwak* ‘behind’.

(5-88)

Ruka warrkbi yawukan manandi ... Arlirr ari warrwak lda warrkbi wurdaka.

ruka	*warrkbi*	*yaw-uka-n*	*manandi*	*arlirr*
this	man	AWAY.3SG-look-NPST	mainland	tree

ari	*warrwak*	*lda*	*warrkbi*	*w-urdaka*
3SG.stand	behind	and	man	3SG.in.front

'This one, the man is looking towards the mainland. The tree stands behind and he is in front.' (dvR_100513, 25:23, A2, *R24*)

Although in this example the verb *ari* 'it stands' is used with *warrwak*, the semantics of *wurdaka* 'in front' and *warrwak* 'behind' in the intrinsic frame of reference are such that the tree only stands behind by virtue of the man's orientation: it is behind because the man has his back to it.

Terrill and Burenhult (2008) propose a distinction between *locational* and *orientational* information. Orientational descriptions include all intrinsic information about the man's orientation with respect to the tree but also gaze information such as 'the man is facing north' or the 'the man is facing left'. Locational information includes both absolute descriptions such as 'the man is standing to the north' and relative as in 'the man is standing to the left', but never intrinsic descriptions. They argue that descriptions utilising only orientational information are the preferred strategies of speakers of languages such as Jahai (spoken in mountainous hill terrain in Malaysia) and Lavukaleve (spoken in the Solomon Islands):

> Location does not even seem to be the primary purpose of descriptions: what Jahai and Lavukaleve speakers do is produce orienting descriptions which have the eventual (and emergent) property of locating. (p. 126)

Although the preference for orientation-only descriptions in Iwaidja is not as pronounced as in languages such as Jahai and Lavukaleve, orientational information received a great deal of attention from Iwaidja speakers. All the senior adult speakers had some cards for which they gave only orientational information, as in (5-88). This was particularly the case for some of the women. RG gave very little standing information during her session as Director, giving mostly orientational information. When A2 used absolute terms, she predominantly used them for orientation rather than location.

While relative descriptions can be orientational as in 'the man is facing left', expressions such as these are noticeably rare in Iwaidja. Where *maruj* 'left' and *nurlinurli* 'right' are used relatively in Iwaidja, they refer to locational information with very few exceptions. Absolute descriptions on the other hand, at least for the senior male participants, can be locational or orientational in Iwaidja.

Hoffmann (2009) describes the functional features of orientation in Jaminjung and Kriol as more closely paralleling motion description than static location description. With Iwaidja, the motion descriptions elicited in the Map Task were highly oriented since they were describing a path. In Iwaidja, motion is commonly oriented with the use of the TOWARDS and AWAY directional prefixes, for which the referent can be the speaker or the subject of motion. These directional prefixes were also used both for orientational (5-89) and locational (5-90) descriptions in the Man and Tree task.

(5-89)

Yawukan yawurrying manyij

yaw-uka-n	*ya-wurrying manyij*
AWAY.3SG-look-NPST	AWAY.west

'He's looking over west.' (dvR_100513, 48:13, RG, *R34*)

(5-90)

Rukung kirrwarda baraka arlirr barakbarda yawakaldakan walim

r-uku-ng	*ø-kirrwarda*	*baraka*	*arlirr*	*barakbarda*
3SGM>3SG.give.PST	3SG-back	dem	tree	there

yaw-akaldakan	*walim*
AWAY.3SG-on.side	south

'He's got his back to that tree which is on the south side.' (dvR_100512, 03:21, A1, *R42*)

Probably the strongest feature in Iwaidja that suggests a focus on orientation is the prevalent intrinsic use of *wurdaka* 'in front' and *warrwak* 'behind' including in strongly intrinsic contexts which contradict the relative interpretation of these terms. There is a pervading sense through the descriptions of the static scenes that the man is going somewhere, and perhaps that the tree is going there with him (§5.5.1.1; §5.5.1.3).

Levinson (2003) made a primary division of the spatial domain between stasis and kinesis, with frames of reference classified under stasis. This division between stasis and kinesis might not be a useful starting point where the cultural and linguistic focus of a people is more dynamic than the Western view. The Navajo philosophy of space and existence is described as being fundamentally dynamic (Pinxten et al., 1983; Barton, 2009). Even a large rock on the ground is seen as being somehow moving. One of the ways that this dynamism is expressed in language is through the use of verbs in contexts in which other, more statically inclined languages and cultures use nouns. This is discussed in more detail in §5.5.2.

5.5.1.1 Ascribed Orientation

One of the most notable features of the intrinsic frame of reference in Iwaidja is the strongly intrinsic use of *wurdaka* 'in front' and *warrwak* 'behind'. In descriptions such as (5-10) and

(5-31) the unfeatured tree receives a 'front' and 'back' through its association with the man. I have called this ***ascribed orientation***.

Wurdaka 'in front' and *warrwak* 'behind' are used symmetrically about the man and the tree. They are used just as frequently about *R22*, where the tree is in front (i.e. the man is facing the tree), as about *R24*, where the man is in front (i.e. the man has his back to the tree). In Iwaidja, the ascribed orientation of the tree is usually in the same direction as the man, as though they are travelling in the same direction. It can sometimes be the opposite of the man's, such as when they are described as *rukung rtamburryak lda jamin* 'facing each other,' as in (5-31). This "ascribed intrinsic reference" is also possible in Tamil (Pederson, 2006, p. 428). An Australian language that is also reported to have strongly intrinsic terms for 'in front' and 'behind' is Jaminjung. Relative uses of these terms in Jaminjung are possible but rare and occur mainly with unfeatured ground objects or ones which block the view of the figure. Schultze-Berndt (2006) also gives an example of *birang* 'behind' being used intrinsically about figures where a toy fence was between the speaker and a toy man, who was facing away from the speaker (5-91).

(5-91)

Mangurn tharda gayu barrigi birang gayu.

mangurn	*tharda*	*ga-yu*	*barrigi*
whitefellow	face.away	3SG-be.PRS	fence
birang	*ga-yu*		
behind	3SG-be.PRS		

'A whitefellow is standing with the back to us, a fence is behind (him).' (p. 109)

In this situation, the fence was 'in front' of the man from the perspective of the speaker. It is not clear from this example whether the unfeatured fence could receive an ascribed 'front' and 'back' in Jaminjung.

5.5.1.2 The Photo Finish

Further evidence for the ascribing of 'front' and 'back' to the unfeatured object in Iwaidja came from situations where the speakers demonstrated sensitivity to the small amount of laterality in cards *R21*, *R23*, *R41* and *R43*. In these cards, the figures were intrinsically side by side, but slightly offset, such that if the figures were both moving in the direction that the man is facing (§5.5.2), they appear to be in what Bruce Birch has termed a *photo finish*. R43 and R43 are shown in Figure 5.16.

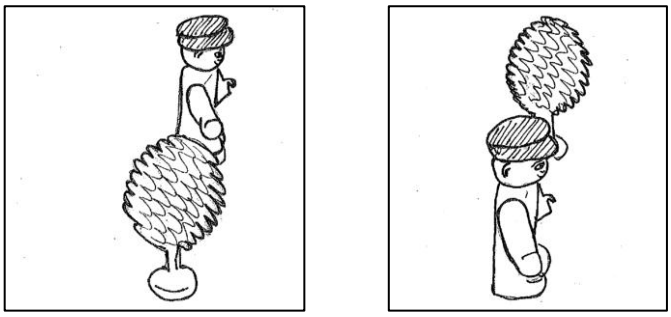


Figure 5.16. Cards *R41* and *R43*

This sensitivity to small or fine differences in position was evident in some of the speakers' uses of *wurdaka* 'in front' and *warrwak* 'behind'. For example, KM describes the tree in *R41* as *warrwak* 'behind' (5-92).

(5-92)

Kirrimul ringardakidban ba warrkbi ba arlirr warrwak.

kirrimul	*ri-ngardakidban*	*ba*	*warrkbi*
like	3SGM>3SG-go.over	the	man

ba	*arlirr*	*warrwak*
the	tree	behind

'Like, the man goes over the tree, and the tree is behind.' (dvR_101115_05, 09:43, KM, *R41*)

These uses of the terms can be qualified with *mardan* 'a little bit'. Thus A1 describes *R43* saying that the man is little bit behind the tree, and the tree is a little bit in front (5-93).

(5-93)

Aldarrunmin laik warrkbi warrwak mardan lda janad arlirr wurdaka mardan.

aldarrunmin	*laik*	*warrkbi*	*warrwak*	*mardan*
DU.stand.same	like	man	behind	little.bit

lda	*janad*	*arlirr*	*w-urdaka*	*mardan*
and	it	tree	3SG-in.front	little.bit

'He's standing beside it (level). Like, the man is a little bit behind and the tree is a little bit in front.' dvR_100512 25:58, A1, *R43*)

Describing the same card, RG refers to the man being in front, but *binyu awukawuk* 'at an angle' (5-94).

(5-94)

Warrkbi wurdaka laik binyu awukawuk.

warrkbi	*w-urdaka*	*laik*	*b-inyu*	*awukawuk*
man	3SG-in.front	like	3SG-across	in.vicinity.of

'The man is in front, like at an angle.' (dvR_100513, 30:42, RG, *R43*)

These uses demonstrate that *wurdaka* 'in front' and *warrwak* 'behind' refer to quite a wide zone that projects along the lateral axis of the man (or other faceted object) as shown in Figure 5.17, rather than just a line immediately in front of or behind the man.

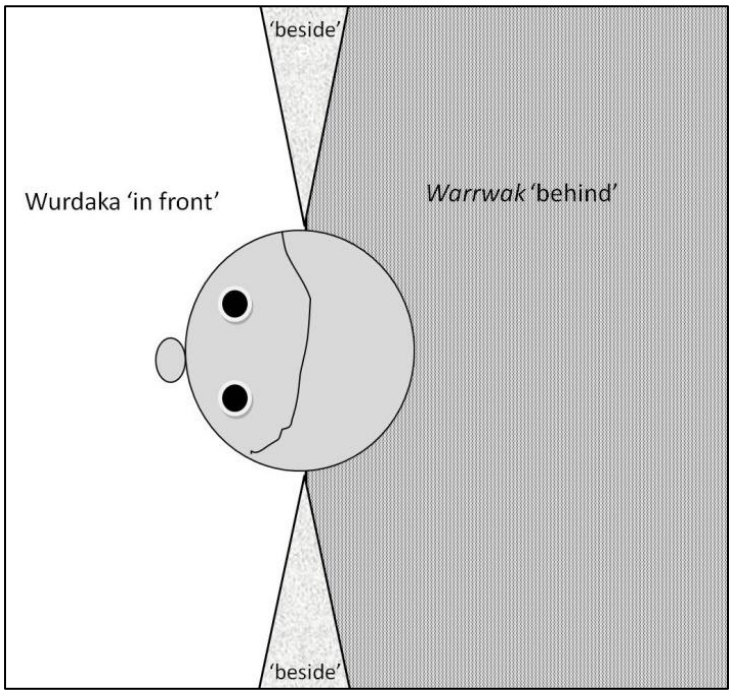


Figure 5.17. Zones of *wurdaka* 'in front' and *warrwak* 'behind'

There are various ways to describe 'beside' in Iwaidja, such as *anmikbin* (5-55) and *mangunyuni* (5-35). The zone of 'beside' appears to be quite narrow compared to those of *wurdaka* 'in front' and *warrwak* 'behind'.

The use of these fine distinctions on occasion led to confusion between the participants. A1 describes *R22* saying that the tree is in front and the man is on the north side (5-95).

(5-95)

Arlirr ari wurdaka lda warrkbi warrwak, wakaldakan yawukan mayinmul.
Wakaldakan Murdululi warrkbi lda arlirr yawakaldakan ruka makumbu.

arlirr	*ari*	*w-urdaka*	*lda*	*warrkbi*	*warrwak*
tree	3SG.stand	3SG-in.front	and	man	behind

w-akaldakan	*yaw-uka-n*	*mayinmul*	*w-akaldakan*
3SG-on.side	AWAY.3SG-look-NPST	headland	3SG-on.side

Murdululi	*warrkbi*	*lda*	*arlirr*	*yaw-akaldakan*	*ruka*
Cape.Croker	man	and	tree	3SG-on.side	this

makumbu
south

'The tree is in front and the man is behind, on the headland (north) side. He's on the Cape Croker side, the man, and the tree is on the south side.' (dvR_100512; 32:40, A1, *R22*)

In response, the Matcher, DG, repeatedly picked up *R11*, asking if it was the correct match. As can be seen in Figure 5.18 both *R22* and *R11* are in fact a match for A1's description, if significance is given to the man standing slightly to the north in *R11*.

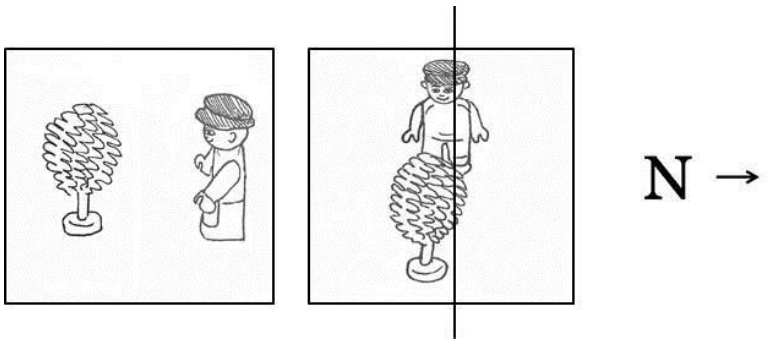


Figure 5.18. Cards R22 and R11 (line added)

These types of description and at times the resultant confusion between the participants suggested that they were not abstracting the axes of the photos. Since most of the other published material on this task does not use the cards where the figures are arranged on the away-axis, it is not possible to say if this common cross-culturally with these types of images. The photo finish descriptions confirm the tendency in Iwaidja to ascribe orientation to an unfaceted object.

5.5.1.3 Ascribed Motion

Iwaidja is not unusual in having *fictive motion* (Talmy, 1996). This is common in English as in many other languages, for example we say that a road "goes" somewhere, when the road itself does not move and it is us who move along it. I have interpreted uses of *bingkan warrwak* 'he/she/it comes behind' as fictive motion, as in (5-96).

(5-96)

Wurdaka arlirr bingkan warrwak ba warrkbi.

w-urdaka	*arlirr*	*bingkan*	*warrwak*	*ba*	*warrkbi*
3SG-in.front	tree	3SG.come	behind	the	man

'The tree is in front, the man comes behind.' (dvR_100522, 38:38, MM, *R22*)

Fictive motion was also seen in (5-24), (5-26) and (5-29). However, there were a few cases of explicitly ***ascribed motion***. For instance, A2 described the man in *R44* as *ralimang arlirr* 'he's going towards the tree' (5-97).

(5-97)

Yartirra ralimang arlirr.

yart-irra	*r-alima-ng*	*arlirr*
AWAY.3SG-come.back-NPST	3SGM>3SG.approach-NPST	tree

'He's going back towards the tree.' (dvR_100513, 20:20, A2, *R44*)

The sense on (5-97) is powerfully of motion, beyond a fictive convention. The man is described as being in motion towards the tree. It may be that the focus on orientation in Iwaidja leads Iwaidja speakers to have to a greater perception of the possibility of motion.

5.5.2 Dynamism

In Iwaidja, many mathematically related ideas are expressed through the use of verbs. Verbs are used to describe geometric concepts or processes such as circling (§5.4.3). *Binyu awukawuk* ‘be at an angle to’ a verb-adverb construction that describes how something is positioned with respect to something else, rather than naming the shaped space between them (§5.3.2). Lines are also expressed as verbs (§5.3.1). Nouns such as *nimarrk* ‘middle’ and *kurrkarda* ‘(other) side’ are less frequently used than the verbs *balarra* ‘middle’ and *wakaldakan* ‘on the ... side’ (§5.4.5).

Mathematical language tends to nominalise processes (Halliday, 1978, 2004; Schleppegrell, 2007). For example, we talk of understanding “addition” whereas the verb “to add” seems not to include all that we mean by “addition.” In fact, the idea of understanding and *abstracting* a concept appears to involve the conceptual development of an abstract noun from a process. An abstract concept is implicitly taken to be a noun. Verbs themselves are seen as too real or concrete to express abstraction. Barton (2009) notes that the English language copes particularly well with the nominalisation processes of mathematics compared with some other languages. This process of nominalisation in mathematics learning can be a challenge even for children who speak English as a first language (Schleppegrell, 2007).

It is worth questioning whether these “extremes of nominalization” (Halliday, 2004, p. 224) are educationally necessary. In particular, where children speak languages which are more verb-focused, the nominalising process may be an impediment to learning. Some North American languages such as Navajo and Mi’kmaq are also heavily verb-focused.

As previously mentioned, the dynamic verbal shapes of the Navajo inspired the creation of Action Geometry, where shapes are defined by the speed and rate of turn of a trajectory (Barton, 2009; §3.2.5). Similarly in Iwaidja the attributes of action are favoured over the naming of shape. The prevalence of verbs in any other Australian languages does not seem to have been commented on in the literature of mathematics education. Lunney Borden (2011) described this approach as using a *verb based discourse pattern*, suggesting it was suitable for Mi’kmaw children in Canada who also have a linguistic focus on verbs rather than nouns. Interestingly, Lunney Borden talks about “verbification,” herself nominalising the concept. This approach can be taken in English where there is no formal instruction in Iwaidja or other local languages and the class teachers are all English speakers from outside the community.

5.6 Conclusion

The investigations into spatial language with the senior Iwaidja consultants produced a rich body of data. In the Man and Tree task, the consultants used all three frames of reference as well as various other strategies such as deixis and topological descriptions. There were marked differences between the strategies of individual participants as well as differences by gender. It is difficult to speculate on reasons for the differences between men's and women's speech and not many potential reasons are given in the literature. The Map task also produced a variety of path descriptions from the participants.

Notable features of spatial language in Iwaidja include the strong use of the intrinsic frame of reference, particularly with terms such as *wurdaka* 'in front' and *warrwak* 'behind', but also with body part descriptions and the focus on orientation. The relative as well as intrinsic use of *maruj* 'left' and *nurlinurli* 'right' are very unusual in Australian languages. Not so surprisingly, the absolute terminology used is mostly derived from environmentally salient manifestations. A grammatical feature of note was the serial verb construction, which allows path and manner to be included in a series of independently conjugated verbs. The directional contrast on many verbs enriches their semantic scope. In Chapter 6, this description of Iwaidja is used as a type of benchmark against which to compare child language.

Chapter 6
Children's Language and Change

When I began working with the children on linguistic tasks, one of the first discoveries was that none of the children who participated in this study were fluent in Iwaidja. The main languages that the children of Minjilang are learning are Mawng, Kunwinjku and English. The processes of language shift from Iwaidja to the other languages are intertwined with the developmental processes of acquisition of spatial language and with changes that are occurring within the languages.

The adult data from Chapter 5 therefore could not be used as a benchmark in a straightforward manner. The critical question that arose in response to this was whether the adult data could be used as a benchmark at all. This chapter addresses this issue, exploring what is known about the language shifts and changes that are occurring at Minjilang, and what could be gleaned about spatial language in Mawng and Kunwinjku (§6.1). Observed similarities between spatial language in Iwaidja, Mawng and Kunwinjku provide the rationale for extrapolation of the conclusions drawn in Chapter 5 to Minjilang children who are speaking Mawng, Kunwinjku and English.

This chapter then presents and discusses the outcomes of the Man and Tree task and the Animals in a Row task that involved children. This includes the results of caregivers directing children (§6.2) and children directing caregivers and other children (§6.3). These are discussed in comparison to the adult to adult results that were presented in Chapter 5. The uses of spatial frames of reference by the caregivers provide evidence of which elements are being transmitted to the children and which are changing.

The final section (§6.4) returns to the educational implications of how Iwaidja conceptualises and organises space, drawing on the caregiver and child data from this chapter as well as the senior adult data from Chapter 5.

6.1 Language Change and Shift

Although it was known at the outset of the project that not many children at Minjilang speak Iwaidja, the study revealed that none of them are fluent. Language shift at Minjilang appears to be occurring from Iwaidja to Kunwinjku, Mawng and English. When the children were

paired with each other it was obvious that their lack of fluency in Iwaidja limited them in the activity. This was a critical finding in the project.

Although these children were generally able to understand the directions in Iwaidja, they were mostly reluctant or unable to speak it. The child who was most comfortable speaking Iwaidja, Child1, was a child whose parents were making a deliberate effort to teach him the language. Unlike the other children, who were selected because the senior consultants told me they were the children who knew the best Iwaidja, Child1's mother approached me directly and told me that her husband had been teaching their son to speak Iwaidja. One caregiver, A3, supplemented her instructions to her sons with Kunwinjku, saying to me, "The most they listen that Kunwinjku. Sometimes they don't understand (Iwaidja)." Some of the children were reluctant to take the Director role with their parents and others gave directions in Kunwinjku.

Since it appeared that the children were not in fact acquiring Iwaidja fluently or as a first language, this prompted additional research questions.

They were:

- Is frame of reference use in Iwaidja related to frame of reference use in Minjilang English, in Mawng and in Kunwinjku?
- What are the preferred strategies of children who are speaking a learner's Iwaidja, Kunwinjku and/or English? Are these preferences related to language acquisition and/or to the language background and worldview of the children?

These questions are addressed throughout the chapter. I investigated what was known about spatial language in Mawng and Kunwinjku, the two most common languages spoken by the children and whether there are similarities with Iwaidja (§6.1.1). I also investigated some of the children performing the task in English, so see what if any influences on the way they approached the task came from their language background (§6.3.4).

Iwaidja has been a strong language in the region over the past couple of hundred years. It is one that has survived while other languages of the region such as Marrku, Ilgar and Amurdak have faded away. But now some of the strongest Iwaidja speakers are not teaching Iwaidja to their children and grandchildren. At Minjilang, the senior adults were quite adamant that children are not learning Iwaidja, or not learning it properly:

> *School kid ngarri kani* (our school kids here) Minjilang, they don't learn properly Iwaidja no. Kunwinjku alright, Mawng people alright, they talking. But this country, nothing, they don't learn nothing, now Iwaidja can't understand. They can understand, listen but

> they can't talk. When we talk with them they gotta talk like, talk *balanda* way. (dvR_101207_A_03, 10:20, CM)

While there are some children who now are learning Aboriginal English as a first language, most of the shift is occurring to the other Australian languages of the community, Mawng and Kunwinjku. Children of mixed Iwaidja–Mawng marriages at Minjilang are growing up speaking Mawng, whether it is their mother or their father who speaks Iwaidja. Similarly, children of mixed Iwaidja–Kunwinjku marriages at Minjilang are growing up speaking Kunwinjku. Both Kunwinjku and Mawng have strong speaker bases at communities which are on land traditionally associated with the languages, Kunwinjku at Gunbalanya/Oenpelli, and Mawng at Warruwi. Factors which Singer (2006) attributed as contributing to the strength of Mawng include Mawng people using it as a language of business throughout the community at Warruwi and the history of a bilingual program in English and Mawng at Warruwi School. Minjilang does not have this history of using Iwaidja for business or for school.

I previously raised *perceived difficulty* of a language as a possible factor in a language's demise (§2.4.2). A closely related factor is whether the language is perceived as being *learnable* by outsiders, and in the case of shift, by children. I say *perceived* difficulty because it seems to become a factor only once a language is under threat (McConvell, 1991). Language features that are considered difficult in one context may not be seen as difficult in another. For example, in his discussion of language shift in the village of Gapun, PNG from Taiap towards Tok Pisin, Kulick (1992) talked about the perception of Taiap as a difficult language. Some of the reasons it was seen as difficult were complex morphology and a two gender system. Iwaidja has a complex morphology, it is true, with features such as inflecting body parts (§5.1.3). However, Mawng has all the morphological complexity of Iwaidja as well as a five gender nominal system (Singer, 2006). Iwaidja has lost gender from its grammar and so is simpler in that regard. Iwaidja is not necessarily any more difficult to learn than Mawng, but today some people perceive it as more difficult. Kunwinjku is widely regarded as simpler than Iwaidja and Mawng.

Perceived difficulty starts to be a reason why people are not teaching a language and why children are not learning it. Kulick (1992) found that the perceived difficulty of Taiap had been internalised by caregivers of children, so that they addressed their children in Tok Pisin *when they particularly wanted the children to pay attention to what they were saying*. That is, the children got the message that Tok Pisin was the important language to learn. A similar pattern emerged from southern Ecuador where Quichua parents, believing that Spanish was

easier for their children to learn, tended to speak to the children in Spanish (King, 2000). At Minjilang, adults sometimes address children in Iwaidja, but children are not expected to reply in Iwaidja. The senior adults reported that younger adults in the community were simplifying Iwaidja, or not speaking "proper" Iwaidja.

Another factor that may be influencing the language shift is socio-political. In a study of multilingualism at Maningrida, one of the larger Arnhem Land communities, Elwell (1982) discussed perceived difficulty of languages as overlaying and reinforcing the patterns of social dominance:

> To the extent that a general 'tribal personality' can be identified, it seems that the more aggressive, aloof, and dominating tribes (as described by informants) are less willing to learn a second language. On the other hand, the more easy going, relaxed and less dominant groups are willing to learn more second languages, thereby accommodating the more aggressive tribes. To some extent, the perceived difficulty of the languages overlays this pattern and reinforces it. (p. 97–8)

She noted Kunwinjku as a lingua franca for the area, and that Kunwinjku people were less likely to learn other languages than people from other language groups. Kunwinjku had a high rate of being learnt by people from other groups. The Mawng were perceived as more accommodating than the Kunwinjku, but the Mawng have political and social strength in the region.

Although Iwaidja speakers are the traditional owners of Croker Island, they are no longer in the majority in the community. They are not manifesting the political and social strength of the Mawng of Warruwi, nor the linguistic dominance of the Kunwinjku. Nevertheless, in this region of Australia, people tend to keep learning languages through their teens (Elwell, 1982). There is no doubt that Iwaidja is in a precarious situation. However, some of the children who today understand Iwaidja may yet decide to speak it as adults, particularly if it is their father's language. In the meantime, the very existence of a study such as this one, and the activities of the *Iwaidja Documentation Project* help to provide Iwaidja with a status that may also contribute to its survival. Senior Iwaidja speakers have expressed a desire for an Iwaidja language programme in the school which could also contribute to the survival of Iwaidja through increasing its status in the community.

6.1.1 Spatial Language in Mawng and Kunwinjku

It was apparent quite early in the project that it would be more thorough to investigate spatial frame of reference in Mawng and Kunwinjku as well as Iwaidja. Unfortunately, it was not feasible within the scope of the project to conduct a parallel set of investigations in Mawng and Kunwinjku, neither of which I speak or understand.

The key question was would it be possible to generalise from the findings in relation to Iwaidja to the other languages spoken at Minjilang? That is, would recommendations for children from Iwaidja speaking families made on the basis of adult spatial language in Iwaidja be valid for children from Mawng speaking families? A hypothesis that they would be valid was predicated on the concept of *language distance* or *areal affinity* (§2.3.2). This was tested by investigating what could be found in the literature and from colleagues about what was already known about spatial frames of reference in Mawng and Kunwinjku.

6.1.1.1 Mawng

Iwaidja and Mawng are the only two languages in the Iwaidjan language family that are still spoken. Mawng has been proposed by Evans (2000) to be related to Iwaidja as shown in Figure 6.1.

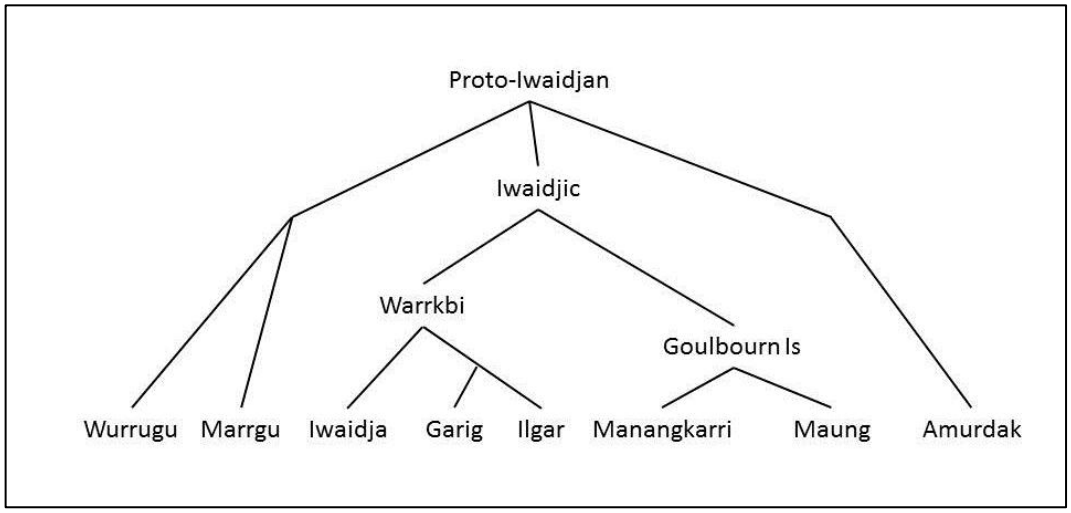


Figure 6.1. Iwaidjan language family (Evans, 2000, p. 94)

However, although Iwaidja and Mawng have been considered sister languages, Mailhammer (2012) says there is currently no evidence for the Iwadjic grouping. There are significant grammatical differences between Iwaidja and Mawng. One of these is the five gender system of Mawng, which has disappeared from Iwaidja (Singer, 2006). Similarities include head-marking and complex verb morphology, with both subject and object occurring as prefixes (Evans, 2000). More details on verb morphology in Iwaidja were given earlier (§5.1.3).

Mawng has a locative preposition *tuka* which shows a similar range of applications as Iwaidja *wuka*. Mawng also uses an away–towards distinction (TOWARDS indicated with a suffix and AWAY with a post-particle rather than by prefixes as in Iwaidja). It is clear that absolute terms in Mawng are not frequent as in strongly absolute languages such as Guugu Yimithirr or Warlpiri; for example Singer's (2006) thesis does not include them in any of her examples. Terms for 'east' and 'west' in Mawng are formed in a similar manner to Iwaidja, being

kinymalkpa muwarn 'it.comes.out sun' and *kinyuryi muwarn* 'it.goes.in.water sun' respectively (Teo, 2007).

The most relevant information on Mawng spatial language came from unpublished data from an 'object localisation experiment' conducted with Mawng speakers on South Goulbourn Island and recorded by Ruth Singer (2010). The task stimuli are a series of pictures of animals in different locations (see Skopeteas, et al., 2006). The results showed participants using absolute terms such as *kinymalkpa muwarn* 'east' (6-1), *wungijalk* 'north', *kinyuryi muwarn* 'west', *matanti* 'south (mainland)' (6-2), and *Weyirra* 'North Goulbourn Island'. The direction of gaze of the animals in the pictures was frequently referred to. The participants also used *injalku* 'left' and *wurulwurul* 'right' to describe the animals' locations (6-3), but not their direction of gaze. These Mawng examples (6-1), (6-2) and (6-3) are from Singer (2010).

(6-1)

Ja lion kilangaliø tuka kinymalkpa muwarn akut.

ja	*lion*	*k-ilangalin*	*tuka*	*kinymalkpa muwarn*	*akut*
M	ENG	PR-3M-stand-NPST	LOC	east	still

'The lion is on the east side.' (p.1)

(6-2)

Juka jita pulikang kinyuken mantanti warak.

juka	*jita*	*pulikang*	*k-iny-uke-n*	*mantanti*	*warak*
DEM.P.FE	FE	cow	PR-3F-look-NPST	mainland	away

'The cow is looking towards the mainland.' (p.1)

(6-3)

Gorilla, wurulwurul kiwaniø la pig inyjaku kilangaliø.

gorilla	*wurulwurul*	*k-i-wani-n*	*la*	*pig*	*inyjaku*
ENG	right.side	PR-3M-be-NPST	and	ENG	left-handed.person

k- i-langali-n
PR-3MA-be-NPST

'The gorilla is on the right and the pig is on the left.' (p.4)

Mawng shows similarity with Iwaidja in how speakers approach such a task. Absolute terms in Singer (2010) include sun derived and abstract directions as well as local landscape directions. There is also the relative use of 'left' and 'right', unusual in Australian languages. Other similarities with Iwaidja are the use of reciprocal constructions such as *kinnyayan la yamin* 'looking at each other', the use of *yurrng* 'on top' and *wumarrk* 'below' and of *uraka* 'first'. There is no use of *warrwak* 'later, last'; *kayirrk* 'then' is sequenced with *uraka*. All of these Mawng words are cognates (have a common historical origin) of the equivalent Iwaidja terms except *wumarrk*. There is little evidence of fictive motion.

This data suggested similar constructions and uses of spatial language in Mawng to Iwaidja. Although the collected data for this study had little Mawng content, the examples above

suggest that Mawng speakers performing the task would be likely to have similar strategies to Iwaidja speakers. This is of relevance to the children of Iwaidja-Mawng marriages who are growing up speaking Mawng and the potential application of the findings presented here.

6.1.1.2 Kunwinjku

Kunwinjku is another language widely spoken on Croker Island. It appears to be a language gaining strength and speakers. It is one of a chain closely related, mutually intelligible dialects and is also known as Bininj Kun-Wok or Mayali. It is only distantly related to the Iwaidjan languages. In Kunwinjku, the cardinal directions are also used frequently, certainly more frequently than in English (Murray Garde, pers. comm., 11 March 2011). For example, a story in the *Bininj Gun-Wok* grammar (Evans, 2003) describes the hunting of freshwater crocodile. It describes hunters hidden in the water in a waterhole and other people hitting the water to stir up the crocodiles. When they see a crocodile, the people call out to the hunters (6-4).

(6-4)

"Gumeke! Walem!" gareh "Gakbi!" o "Goyek! Ngale gareh garri!"

" 'Over there! To the south!' or maybe 'North!' or 'East! Maybe to the west!' " (p. 676)

The available information about Kunwinjku was not as clear as that which was available for Mawng, but it did suggest that the use of absolute directions might be possible in a comparatively small scale space. The Kunwinjku data collected during the study was contributed by three children either directing or asking questions as Matchers, and the parent of two of them who combined Kunwinjku with her Iwaidja directions (§6.3.3). It was expected that Kunwinjku speakers would have some similar strategies in the tasks to those of Iwaidja speakers. The observed similarities in the project between Kunwinjku and Iwaidja are summarised in §6.3.3.7.

6.2 Caregiver to Child Spatial Language: Iwaidja

Although no parents at Minjilang today address their children exclusively in Iwaidja, there are many families where Iwaidja is spoken daily. The children have a higher receptive knowledge of Iwaidja than productive, that is, they understand Iwaidja better than they can speak it. The children who were paired with the adults were able to understand the adults' directions in Iwaidja, even though some of them responded or asked questions in Kunwinjku. There were noticeable differences in the use of frames of reference between caregiver and child to those between senior peers which were described in Chapter 5. There were also similarities, particularly in the use of the intrinsic frame of reference, discussed below, which appear to be influencing the children's use of frame of reference in English.

6.2.1 Iwaidja Caregiver to Child

There were five adult and child pairs with the caregiver directing in Iwaidja. There were four parents JC, A1, FG and A3, and one grandparent, A2. One parent, A3, directed her two sons together, the two boys sitting together as Matchers. Of the adults, A1 and A3 generally address their children in Kunwinjku, JC and FG in Mawng, and A2 appears to address her grandson largely in English. One of the parents, JC, who generally talks with his son in Mawng, has made a deliberate effort to teach his son to speak Iwaidja. The relationships between the caregivers and children are shown in Table 6.1.

Table 6.1. Relationship between caregiver and child

Caregiver	Child	Language of usual address
JC	Child1	Mawng
FG	Child2	Mawng
A1	Child3	Kunwinjku
A2	Child6	English?
A3	Child4 & Child5	Kunwinjku

6.2.1.1 Standing and Facing

The caregivers' strategies with standing information were similar to the senior adults. All of the caregivers used *ari* 'he/she/it stands'. This was used existentially as in *ari rayan* 'he's standing looking at it' and to provide actually standing information, as in *ari mangunyuni* 'he's standing beside it'. *Akaldakan* 'be on the ... side' was used by three of the caregivers. All of these three used it to describe relative standing information as in *wakaldakan maruj* 'it's/he's on the left side'. It was also used by the one caregiver who gave an absolute standing description (§6.2.1.2).

All of the adults made frequent reference to the direction of gaze of the man. They all used both *uka* and *ayan* to orient the man by his gaze, except for FG who did not use *ayan*. These verbs were used with absolute, intrinsic and deictic objects, but not with relative objects.

Using *uka*, the man was described as looking (absolutely) *abalkbang manyij* 'east' and *wurrying manyij* 'west', (intrinsically) *arlirr* '(at the) tree', and (deictically) *kani* 'here' and *jumung yukbani nuyi* 'to where you are sitting'.

One caregiver, A3, used the directional prefix rather than an object to differentiate directions of gaze. She used *awukan* 'he looks towards' to describe the man's gaze in *R13* and *R14*, where he is looking towards the viewer. In these cases it was used in the phrase *awukan kani*

'he's looking (to) here'. She used *yawukan* 'he's looking away' to describe his gaze when he was looking sideways on the across axis, for cards *R22*, *R24* and *R42*. Note that in card *R22*, the man is looking at the tree. However, *yawukan* is likely used deictically, to indicate that he is not looking towards the viewer. She used the neutral form *wukan* to describe *R33* where the man is looking at the tree, but away from the viewer. In this case it was used in conjunction with the phrase *ari rayan* 'he's looking at it'.

The other main gaze verb, *ayan*, was used intrinsically with *arlirr* '(at the) tree'; deictically in *karlu rayan* 'not looking (at us)' and *arrumbayan ngarrurri* 'looking at us'; and in *yangbayan wuka* 'looking somewhere (away)'. *Rayan* was not used with an absolute object. *Riwurrakan arlirr* 'he's staring at the tree' was also used by JC and FG, which was clearly intrinsic.

6.2.1.2 Absolute

There was noticeably little use of absolute terminology by the caregivers. Only two parents used the absolute frame of reference at all. One parent, JC, used absolute directions to describe direction of gaze for several cards. The directions he used were *wukan abalkbang manyij/wurrying manyij* 'looking east/west'. Another parent, A1, used *wakaldakan wurrying manyij* 'on the west side' to describe standing information about one card. This appears to indicate that the caregivers do not expect the children to understand absolute directions (§6.2.2).

6.2.1.3 In front/Behind

Wurdaka 'in front' and *warrwak* 'behind' were used by all the adults except one. The scope of use of these terms was the same as in the adult to adult sessions. They were used intrinsically by JC, A2 and FG and relatively by A1. They were used ambiguously about *R11* or *R13* by A1, A2 and FG. Only A3 did not use these terms.

Example (6-5) shows these terms used ambiguously.

(6-5)

Arlirr ari wurdaka kani, awurdaka, janad ari warrwak.

arlirr	*ari*	*w-urdaka*	*kani*	*aw-urdaka*	*janad*
tree	3SG.stand	3SG-in.front	here	TO.3SG-in.front	he

ari	*warrwak*
3SG.stand	behind

'The tree is here in front, to the front, he is standing behind.' (dvR_110522, 07:04, A1, *R11*)

Since the intrinsic and relative frames of reference reinforce each other in *R11*, the actual frame of reference used by A1 in (6-5) is ambiguous.

Example (6-6) shows the intrinsic sense only describing card *R24*.

(6-6)

Warrkbi wurdaka, arlirr warrwak.

warrkbi	*w-urdaka*	*arlirr*	*warrwak*
man	3SG-in.front	tree	behind

'The man is in front, the tree is behind.' (dvR_101206_D, 01:44, A2, *R24*)

There were no examples of the caregivers describing cards *R22* or *R44*, where the tree is 'in front' of the man, with these terms. It is not clear whether there is a greater likelihood of perceiving the man to be 'in front' as in *R24* and *R42* than of perceiving him to be 'behind' as in *R22* and *R44*. There is potentially some asymmetry in these terms depending upon whether they apply to the faceted figure (the man) or the unfaceted ground (the tree). However, the small sample size means this is inconclusive speculation.

The relative sense only, of proximity to the speaker, can be seen in (6-7) describing card *R31*.

(6-7)

That arlirr ari wurdaka and janad ari warrwak.

that	*arlirr*	*ari*	*w-urdaka*	*and*	*janad*	*ari*	*warrwak*
that	tree	3SG.stand	3SG-in.front	and	he	3SG.stand	behind

'The tree is in front and he is standing behind.' (dvR_110522_A, 04:13, A1, *R31*)

For the same card, an intrinsic use of these words is also possible, with the opposite meaning, as in (6-8).

(6-8)

Warrkbi artbung ari wurdaka, arlirr bingkan warrwak.

warrkbi	*artbung*	*ari*	*w-urdaka*	*arlirr*
man	again	3SG.stand	3SG-in.front	tree

bingkan	*warrwak*
3SG.come	behind

'The man is in front again, the tree comes behind.' (dvR_110531_01, 10:45, FG, *R31*)

Caregivers expected the children to understand both the relative and intrinsic senses of *wurdaka* 'in front' and *warrwak* 'behind'.

Finally, one noun was used to describe the front of the scene. The noun *angbardi* means the front part of a canoe or boat, or the harpoon man who stands in the front of the boat. It can also mean a champion hunter. In (6-9) it is used to refer to the man as the lead figure in card *R13*.

(6-9)

Ba arlirr warrwak and warrkbi ari angbardi.

ba	*arlirr*	*warrwak*	*and*	*warrkbi*	*ari*	*angbardi*
the	tree	behind	and	man	3SG.stand	harpoon.man

'The tree is behind and the man is standing in front.' (dvR_100531_01; 01:50, FG, *R13*)

This term *angbardi* was not used by any of the senior adults.

6.2.1.4 Body parts

All of the caregivers used body parts with the verb *uku* 'give' to refer to the intrinsic orientation of the man. The man was oriented to the tree and deictically to the speakers. *Rukung kirrwarda* 'he gave it his back' was used by all of the caregivers except A2. *Rukung rtamburryak* 'he gave it his chest' was used only by JC. *Arrumbukung kirrwarda* 'he gave us his back' was used by A3 and *arrumbukung bungkurryuwu* 'he gave us the nape of his neck' was used by A2.

The intrinsic orientation of the man was also implied in several descriptions by FG that used the verb *mi* 'do'. In (6-10) such a description is coupled with a more explicit body part description.

(6-10)

Kabin wuka yabin and rukung kirrwarda ba arlirr kabarrun.

ka-bi-n	*wuka*	*ya-bi-n*	*and*	*r-uku-ng*	*ø-kirrwarda*
3SG-do- NPST	LOC	AWAY.3SG-do- NPST	and	3SGM>3SG.give.PST	3SG-back

ba	*arlirr*	*ka-barrun*
the	tree	2SG>3SG.know

'He's facing (got his body turned) that way (there) and his back to the tree, you know'. (dvR_100531_01; 04:53, FG, *R24*)

The caregivers all expected the children to be comfortable with body part descriptions in Iwaidja, except A3, who for card *R13* coupled the Iwaidja *rukung kirrwarda* 'he gave it his back' with the corresponding Kunwinjku description *gunbotme biwong nawu* 'he gave it his back'.

6.2.1.5 Beside

Some of the caregivers described the man and tree as being beside each other or as standing together. There were a few ways in which the man and tree were described as being beside each other. *Mangunyuni* 'be beside' was used by FG, a coverb which was seen in the senior adult examples (5-35). A3 used the body part inflected for the third person *kunyuni* 'his/her/its waist' (6-11).

(6-11)

Ari kunyuni jumung arlirr.

ari	*ø-kunyuni*	*jumung*	*arlirr*
stand	3SG-waist	REL	tree

'He's standing beside the tree' (dvR_110521_01 05:39, A3, *R12*)

During a translation session, Joy said that this use of *kunyuni* was wrong, and that A3 should have used *mangunyuni*. This may be an example of the changes occurring in Iwaidja amongst younger adult speakers which are reported by older speakers, which include simplification of body part inflections. These terms were only used where the relative and intrinsic frames of reference coincided.

The phrases *aldindi murrbuny* 'two standing together' (about *R12*) and *aldindi anmikbin* 'two standing level' (about *R14*) were also used by A2 and JC.

These 'beside', 'level' and 'together' descriptions were used only about cards *R12*, *R14* and *R32*, where the man and tree are beside each other both intrinsically and relatively. This contrasts with the senior adult data where *kunyuni* 'his/her/its waist' was used to describe the intrinsically side by side arrangement of the tree in *R21* (5-34) and *aldindi murrbuny* 'two standing together' was used for cards where the figures were visually overlapping such as card *R41* (5-54). *Aldindi anmikbin* 'two standing level' was also used by the senior adults about *R34* (5-55) as well as *R32* (5-56). This different distribution of caregiver uses of these descriptions suggests a stronger relative interpretation of the terms than in the senior adult data.

6.2.1.6 Left and Right

Three of the five caregivers used the terms *maruj* 'left' and *nurlinurli* 'right'. A1 used them relatively for standing information with the verb *akaldakan* 'on the ... side'. He used them for seven of the 11 cards that he described, all of the cards in which the man and tree are arranged on the across axis (cards *Rx2* and *Rx4*). The two other parents used the terms intrinsically in relation the man's left and right side. In (6-12), the body part *mawurr* 'arm' makes explicit that JC is asking about the man's (intrinsic) left and right.

(6-12)

Ngunyun bawurrwurr ... nurlinurli or maruj?

ngunyun	*ø-bawurr-wurr*	*nurlinurli*	*or*	*maruj*
LOC	3SG.arm-PL	right	or	left

'(It's) near (which of) his arms ... right or left?' (dvR_110222_04; 09:54, JC)

One description by FG was ambiguous as to frame of reference, as shown in (6-13).

(6-13)

Ba arlirr ari kani nurlinurli

ba	*arlirr*	*ari*	*kani*	*nurlinurli*
the	tree	3SG.stand	here	right

'The tree stands here on the right.' (dvR_100531_01; 11:05, FG, *R34*)

In card *R34*, the tree is both relatively on the right hand side of the card, and at the man's intrinsic right side, hence in (6-13) it is not clear which frame of reference FG is using. FG was himself sitting on the right hand side, which appears to be the reference for the deictic term *kani* 'here'.

A fourth caregiver, A2, used the English words *left* and *right* about one card, shown in (6-14).

(6-14)

Warrkbi on the left and arlirr on the right.

warrkbi	*on*	*the*	*left*	*and*	*arlirr*	*on*	*the*	*right*
man	on	the	left	and	tree	on	the	right

'Man on the left and tree on the right.' (dvR_101206_D, 00:44, A2, *R42*).

The sentence in (6-14) is really an English sentence with the Iwaidja nouns *warrkbi* 'man' and *arlirr* 'tree' inserted. The man is actually on the right in *R42* and the tree is on the left, so A2 used the terms erroneously. Nevertheless, she was attempting a relative description, since the man has his back to the tree and an intrinsic use of these terms would not apply. A2 did not use *left* and *right* in Iwaidja or English with her senior peer. See also §6.2.2.

6.2.1.7 Deixis

All of the caregivers used *kani* 'here' to refer either to the orientation or the standing location of the man. It was used to describe both the standing location of the man as in *kani abin* 'standing here' and the direction of his gaze as in *awukan kani* 'looking here'. JC, A2 and A3 used it for direction of gaze, and A1 and FG for standing location. As mentioned above, the orientation of the man described by body parts included deictic referents such as *arrumbayan ngarrurri* 'he's looking at us' (§6.2.1.4). These deictic body part descriptions were used by A3 and A2. There was only one instance of using a deictic division of the field of the card, which is shown in (6-15).

(6-15)

Yawukan wuka jumung yukbani nuyi.

yaw-uka-n	*wuka*	*jumung*	*yuk-bani*	*nuyi*	
AWAY.3SG-look-NPST	LOC	REL	TO.2SG-sit		you

'He's facing to where you are sitting.'(dvR_110522_A, 09:49, A1, *R24*)

This description of the facing direction of the man is similar to A1's description to his peer of *R42* using the same phrase *wuka jumung nuyi yukbani* 'to where you are sitting' which was given in (5-50).

6.2.1.8 Alignment

The alignment of the man and the tree on the across-axis and on the away-axis was noted by some of the caregivers. The straightness of the arrangement of the man and tree in cards *R11* and R13 was described by A1 using *nguranganin* 'be straight/be in a straight line'. In these cards, the man and tree are both relatively and intrinsically lined up together on the away-axis. A1 also described the man in *R34* as *ari akuranganin* 'he's standing straight', where he is beside the tree and looking towards the viewer (6-16).

(6-16)

Ari akuranganin kani awakaldakan.

ari	*a-kuranganin*	*kani*	*a-wakaldakan*
3SG.stand	TO.3SG-straight	here	TO.3SG-on.side

'He's standing straight on this side.' (dvR_110522_A, 08:22, A1, *R34*)

As noted above (§6.2.1.5), *aldindi anmikbin* 'two standing level' was used by A2 and JC to describe *R14*, where the man and tree are beside each other on the across-axis.

A1 was the only caregiver to use *minyu* 'perpendicularly across', which he used both about *R44*, where the man is side on to the viewer, and about *R34* to describe the man being side on to the tree, as shown in (6-17).

(6-17)

Karlu rayan, ari binyu jamin lda jamin ari

karlu	*r-ayan*	*ari*	*binyu*	*jamin*	*lda*
NEG	3SGM>3SG.look.NPST	3SG.stand	across	RECIP	and

jamin	*ari*
RECIP	3SG.stand

'He's not looking at it, they're standing beside each other.' (dvR_110522_A, 08:16, A1, *R34*)

As Matcher, JC used *kalidban* 'be on the side' to query the man's orientation relative to the speaker, shown in (6-18).

(6-18)

Kalidban? Ari rayan arlirr?

ø-kalidban	*ari*	*r-ayan*	*arlirr*
3SG-be.on.side	3SG.stand	3SGM>3SG.look.NPST	tree

'He's side on? Looking at the tree?' (dvR_100222_03; 03:24, JC, *R22*)

The verb *kalidban* 'be on side' could be used for example to refer to a pot turned over on its side; in (6-18) it was used to describe the man's orientation with respect to the speaker.

6.2.1.9 Ascribed Motion

As mentioned previously (§5.5.1), Iwaidja not only attributes fictive motion, but more strongly what I have termed ***ascribed motion***. The caregiver with whom this was evident was

FG. He attributed what is possibly a conventionalised fictive motion to the tree with the phrase *arlirr bingkan warrwak* 'the tree comes behind'. He also explicitly ascribed motion to the man, saying that he was walking past the tree, as shown in (6-19).

(6-19)

Kabanayan biru barangayirrak angkumarrajbang rildakijba ba arlirr.

kaban-ayan	*biru*	*barangayirrak*	*angku-marrajba-ng*
2SG>3.FUT-see.NPST	what	whatsitsname	3SG>3-walk-NPST
ri-ldakijba	*ba*	*arlirr*	
3SGM>3SG-pass	the	tree	

'Can you see that one, he is walking, passing that tree.' (dvR_100531_01; 06:58, FG, *R21*)

FG uses two motion verbs, *marrajbang* 'walk' and *ldakijba* 'pass' to the man. More than a convention, this is a description of the man in motion.

6.2.2 Intergenerational Differences

The most notable difference between senior adult to adult and caregiver adult to child speech in the Man and Tree task was the rarity of absolute descriptions among the latter group. There was also an increase in some adult to child participant of use of relative left and right. Nevertheless, most of the strategies and many of the terms used by the adult to adult group were used by the caregivers directing children. Most of the child participants appeared to understand the Iwaidja instructions.

There were two adults who participated in the Man and Tree task with another adult, and then with a child or grandchild. There were noticeable differences in the approach of both these adults in the two situations. The most striking difference was that both the adults frequently used absolute terms when talking with a peer, and hardly used them at all when talking with a child. They also showed an increased use of relative terms when directing a child.

A2's strategy with both peer and child was predominantly orientation. Directing a senior peer, A2 only used explicit standing information with three cards out of 16. Her directions involved the man's gaze and his orientation as well as *wurdaka* 'in front'/*warrwak* 'behind' information. A2 had a low rate of differentiation on the across-axis, and a high rate of mirror image confusion (§6.4.3). The key differences when A2 was directing her grandson were the complete absence of absolute terms, which she had used frequently for facing information with her peer, and the introduction of the English relative *right* and *left*. There was also a decrease in the use of body part terms like *arrumbukung bungkurryuwu* 'he gave us the back of his neck'. As previously mentioned (§6.2.1.6), in *R42*, the man is actually on the right, and the tree is on the left, opposite to how A2 described the card, suggesting a lack of familiarity

or confidence with the terms, but a belief that this is what her grandson would understand. The results also suggest that she did not think he would be confident with the absolute landscape terms. This is summarised in Table 6.2.

Table 6.2. A2 directing peer and child

A2	Number of cards		Example or comment
	To peer	To child	
Total cards described	16	6	
Standing information – absolute	3	–	*wakaldakan manandi* 'on the mainland side'
Standing information – topological	–	1	*aldindi murrbuny* 'those two are standing together'
Standing information – relative?	–	1	*warrkbi* ('man') on the left, *arlirr* ('tree') on the right
Gaze – absolute	8	–	
Gaze – towards tree	4	1	
Gaze – unspecified	–	1	Implied away
Gaze – toward viewer	–	2	
Orientation – towards viewer	6	1	*arrumbukung bungkurryuwu* 'he gave us the back of his neck'
wurdaka 'in front'; *warrwak* 'behind'	8 – 3 relative – 2 intrinsic – 3 ambiguous	4 – 2 intrinsic – 2 ambiguous	

A1's strategy with both his peer and his son differed noticeably from that of A2 in his greater use of standing information, and less facing information. With his peer, A1 used absolute terms frequently for both facing and standing information. He also used body parts and used *wurdaka* 'in front' and *warrwak* 'behind' both intrinsically and ambiguously. A1 had impaired vision due to cataracts, and had difficulty distinguishing between the front and back of the man. This was apparent in his description of *R33*, which he thought was like *R13*, and for this reason such descriptions have been analysed as ambiguous. This might be a partial explanation for him providing less facing information than some other participants, and more focus on standing position, which would have been easier for him to discern. With his son, A1

described 11 cards. He used gaze verbs for six cards, the Iwaidja *ayan* and *uka*, the Kunwinjku *ngunkuknan* and *kamwonan*, and the English *looking*. His use of *maruj* 'left' and *nurlinurli* 'right' appears to have been prompted by his son, who asked about the second card *Nawu bale kureh right or left?* 'Which way [is he looking] right or left?' This is summarised in Table 6.3.

Table 6.3. A1 directing peer and child

A1	Number of cards		Example or comment
	To peer	To child	
Total cards described	13	11	
Standing information – absolute	11	1	*wakaldakan makumbu* 'he's standing on the south side'
Standing information– relative?	4	7	*maruj* 'left', *nurlinurli* 'right'
Gaze – absolute	10	–	*yangbayan abalkbang manyij* 'he's looking east'
Gaze – intrinsic?	–	6	Iwaidja *ayan* and *uka*, Kunwinjku *ngunkuknan* and *kamwonan*, English *looking*
Orientation – body parts	9	2	
wurdaka 'in front' *warrwak* 'behind'	8 – 4 intrinsic – 4 ambiguous	4 – 4 ambiguous	

Again, the key differences with A1's strategy when directing his son compared to his peer was an almost complete absence of absolute terms, an increase in his use of relative *maruj* 'left' and *nurlinurli* 'right', and a decrease in the use of body part terms. As with A2, this suggests that A1 thought his son would be more likely to understand relative than absolute descriptions. A1's son was one of the older children in the sample (12.2 years old). A1 is more accustomed to speak to his son in Kunwinjku than Iwaidja and the son asked questions in Kunwinjku. However, although A1 answered in a mixture of Iwaidja, Kunwinjku and English, he did not introduce absolute terms in Kunwinjku.

The only comparable study of language shift in spatial frame of reference is Meakins' (2011) study of language shift from Gurindji to Gurindji Kriol. She found that Gurindji speakers, who are now mostly quite old, use an absolute system comprising both cardinal and river-

drainage terms. Gurindji Kriol speakers, who are younger adults, use a greatly reduced set of cardinal terms and prefer the use of gesture and deixis in small scale space. However, when the use of gesture is prevented, such as in the Man and Tree barrier task, they use cardinal terms with ease. Meakins suggests that the use of deictics and gesture are relative. However, their use is considered in the literature either to be outside the frame of reference system (Levinson, 2003) or part of what Danziger (2010) labels the *direct* frame of reference. The use of deictics and gesture is generally *not* considered to be use of the relative frame of reference (Levinson, 2003). Deictics and gesture may in fact be commensurate with the continued use of the absolute frame of reference, when frame of reference is used. Meakins and Jones (2011) state of Gurindji Kriol speakers that "descriptions of country both visible and distant are always accompanied by gesture which relies on absolute points in space" (p. 37). Despite widespread exposure to English, Gurindji Kriol speakers have not adopted its relative left/right system.

Intergenerationally, there appears to be an increase in the use of the relative frame of reference in Iwaidja and decrease in the use of the absolute. With the Man and Tree task, Directors are motivated to speak in a manner which they believe the Matcher will comprehend. The data shows that senior Iwaidja speakers think that the children will not understand absolute landscape and sunset/sunrise directions, but that they will understand relative left and right. The influence of English and of school are the most likely causal factors in this change.

The other possibility is that the senior speakers do not think that the children will yet have developed the absolute frame of reference. If this is the case, it indicates that the absolute frame of reference is not particularly strong in the context of the Man and Tree game. In languages where the use of the absolute frame of reference is extensive and compulsory, it is acquired much younger than the two children discussed in this section, who were eight and 12 years old. Tzotzil children learn to use the absolute frame of reference around four or five years old (De León, 1994) and Warlpiri children can understand it before they are two years old (Laughren, 1978). It is likely that the observed differences in caregiver speech with their children to their peers reflect changes happening to Iwaidja rather than only developmental factors relating to child maturity. With Iwaidja itself in a precarious state, there is a possibility that the rich vocabulary of absolute terms could be under threat.

6.3 Child Spatial Language

The results for the Man and Tree activity performed by children either with other children or with adults demonstrated that none of the children were fluent in Iwaidja. Those children who participated in the Man and Tree game with parents, or in one case with a grandparent, were successful Matchers with the directions given in Iwaidja. One parent gave some duplicate instructions in Kunwinjku. Some of the children were then able to perform as Director in Iwaidja, whereas others switched to Kunwinjku or were unwilling to direct their parents. The one pair of children who attempted the activity in Iwaidja produced a very small range of descriptions and mixed Mawng with their attempts to speak Iwaidja. Other children chose to perform the activity in English or Kunwinjku.

This section presents the range of terminologies and approaches used in these sessions using the same categories as in §6.2. Examples are given only if the use of the term varied from examples already given in §6.2 or in Chapter 5. There is no quantitative analysis for the following section. There were too many variables to compare sessions. Some sessions used a smaller or larger set of cards than others, and the introduction of the Kunwinjku and English languages further complicates the data. Nevertheless, trends are noted in the results, such as where all participants in a group used a particular term or strategy, or where a use was unique in the data.

6.3.1 Iwaidja Child to Parent

There were only two children who gave directions to their parents in Iwaidja, both boys. Child1's parents had approached me to tell me that they had been teaching him Iwaidja. Child2 was coached by his mother during the session where his father was Director. Both these boys generally speak Mawng with their families.

6.3.1.1 Standing and Facing

The boys provided little standing information in their descriptions, providing mostly facing information. Child1 used *ari* 'he/it stands' in an existential sense in the phrase *ari rayan* 'he stands looking'. He also used it for card *R42* to say *arlirr ari warrwak* 'the tree stands behind'. Child2 used *ari* only in the phrase *ari mangunyuni* 'he stands beside', about *R12* and *R14* (§6.3.1.5).

Facing information was predominantly intrinsic. Both the boys used *ayan* intrinsically, saying *rayan arlirr* 'he's looking at the tree'. Child1 also used it to describe the man looking east and west, as shown in (6-20).

(6-20)

Ari rayan wurrying manyij.

ari	*r-ayan*	*wurrying manyij*
3SG.stand	3SGM>3SG.look.NPST	west

'He's looking west' (dvR_110222_04, 01:45, Child1, *R34*)

This not grammatically correct as the form used for an absolute direction should be *angbayan* or *yangbayan.* Neither of these children used*wuka.* Child2 also used the intrinsic *riwurrakan arlirr* 'he's staring at the tree' about *R11, R22* and (surprisingly) *R12.*

6.3.1.2 Absolute

Child1, the son of JC, mirrored his father's descriptions of the man as 'looking east/west'. However, as seen in (6-20) he used *rayan* 'he looks at it' rather than the more grammatically correct *yawukan* 'he's looking over to ...' which his father had used. Neither of the boys used absolute descriptions for standing information.

6.3.1.3 In front/Behind

Child1 used *warrwak* 'behind' intrinsically to refer to the tree in *R42*. Child2 used *wurdaka* 'in front' intrinsically to refer to the tree in *R22*. He was coached in this use by his mother. Neither of the boys used the terms relatively.

6.3.1.4 Body Parts

Both the boys used *rukung kirrwarda* 'he gave it his back.' Both the boys used this phrase about three of the four possible cards to which it applies.

6.3.1.5 Beside

Child2 used *ari mangunyuni* 'he's standing on the side' about *R12* and *R14*.

6.3.1.6 Left and Right

Child1 used *maruj* 'left' and *nurlinurli* 'right' about *R32,* but not with confidence. To the question *Arlirr ngunyun nurlinurli or maruj?* 'Is the tree near (his) right or left?' Child1 answered *nurlinurli* 'right' which is not correct either in the intrinsic or relative frame of reference. After difficulties in finding the matching card, his father then asked *Ngunyun bawurrurlwu, nurlinurli or maruj?* 'It's near which arm, left or right?' to which Child1 replied *maruj* 'left', and a match was made. This use of *maruj* 'left' was intrinsic. Child2 did not use these terms.

6.3.1.7 Deixis

Child1 began his description of *R12* with *kani wurrying* 'here (west)'. Because this was the last card, his father was easily able to find it. Child1's use of *wurrying*'(west)' was erroneous.

Kani 'here' in this case could refer to the direction of the man's gaze, towards the speaker. Child2 did not use these terms.

6.3.1.8 Summary

Neither of the boys were confident in their use of Iwaidja and both made errors. However, their uses showed some patterns similar to adult use. Both the boys gave orientational information more frequently than standing. This was direction of gaze or body with respect to the tree, the intrinsic use of *wurdaka* 'in front' or *warrwak* 'behind', and in the case of Child1, the use of absolute directions with gaze. Each of the boys only used explicit standing information about two of the cards. Standing information was intrinsic in Child1's use of *maruj* 'left' and *nurlinurli* 'right' to refer to the man's left or right in *R14* and *R32,* and in Child2's use of *mangunyuni* 'on the side' about *R12* and *R14*. Neither of the boys used relative descriptions.

6.3.2 Mawng

Mawng was used by the two children who attempted to perform the task in Iwaidja. Both these children usually speak Mawng with their families. Their Iwaidja was not sufficient for the task and they mixed Mawng into their descriptions.

6.3.2.1 Facing

Both these children used only direction of gaze to describe the cards and a process of trial and error to find the matching card. They did not provide any standing information. For example, Child1 gave the identical description for *R11, R22, R33* and *R44,* shown in (6-21).

(6-21)

Rukan tuka warlk.

rukan	***tuka***	***warlk***
"look"	to (Mawng)	tree (Mawng)

'He's looking at the tree.' (dvR_110418_A, Child11)

They used the gaze verbs *uka* and *ayan* with *ajbud* 'beach', *kani* 'here', *camera, nuyi* 'you', *ngabi* 'me', *kunak* 'ground' and *gaba* 'somewhere' (Mawng). These terms are all the same in Mawng and Iwaidja. *Camera* refers to the video camera which I was operating during the session. The only clearly Iwaidja object of gaze was used by Child12, who said *rayan arlirr* 'he's looking at the tree'.

The session with these two children was the first one that I conducted with two children. They had been reported to understand some Iwaidja but it became clear that they were not able to speak it. Their strategy in this situation of limited linguistic resources for the task was to concentrate on facing information, and not to attempt to provide standing information.

6.3.3 Kunwinjku

The Kunwinjku data was child directed. It was used by some of the children to ask questions (as Matcher) or to provide descriptions (as Director). Although some of the parents used Kunwinjku at times, they did so in response to questions by their child partners, or to repeat information that they had stated in Iwaidja.

The Kunwinjku data was translated by Keira Gameraidj (KM). I have provided word by word gloss of the Kunwinjku rather than a morphemic one, since I am not familiar with word construction in Kunwinjku.

6.3.3.1 Standing and Facing

The word generally used for standing was *kadi* 'he/she/it.stands'. It was used both for locational information, to describe where the man or tree were standing, as in the examples given in §6.3.3.2 and in existential descriptions, as in the example in §6.6.3.3.

Where the man was looking was one of the most frequent descriptors. He was variously described as looking at the tree, looking *gonda* 'here' – towards the speakers – or looking 'there' or 'somewhere', which could either mean he was looking away from the tree or from the speakers. An example of a child asking about the man's facing direction is given in (6-22) and an intrinsic facing description is given in (6-23).

(6-22)

Bale kabolknan, gonda or kureh, kureh nguta or kureh kabolknan?

bale	*kabolknan*	*gonda*	*or*	*kureh*
which.way	3SG.look	here	or	that.way

kureh	*nguta*	*or*	*kureh*	*kabolknan*
that.way	you	or	that.way	3SG.look

'Which way is he facing, here or there? Is he looking towards you, or where?' (dvR_110522_A; 05:31, Child3, *R44*)

(6-23)

Kanan nawu gundalk.

kanan	*nawu*	*gundalk*
3SG.look	DEM	tree

'He's looking at the tree.' (dvR_110521_02; 04:04, Child4, *R22*)

The phrase in (6-23) is very similar to the frequently used Iwaidja *rayan ba arlirr* 'he's looking at the tree'. There were various Kunwinjku verbs for looking used, but these are not presented in detail here, due to insufficient data to describe their different meanings and scopes of use.

6.3.3.2 In front/Behind

The English *front* and *back* were used by one of the children, Child5, incorporated into Kunwinjku sentences. They were used both intrinsically and ambiguously, but there were no unambiguously relative uses. (6-24) is an example of an ambiguous use of frame of reference, where the intrinsic and relative frames of reference coincide.

(6-24)

Nungka back and kanan that gundalk kadi front.

nungka	*back*	*and*	*kanan*	*that*	*gundalk*
him	back	and	3SG.look	that	tree

kadi	*front*
3SG.stand	front

'Him in the back and looking, the tree standing in the front.' (dvR_110521_02, 06:24, Child5, *R11*)

Both (6-25) and (6-26) use the intrinsic frame of reference in situations which contradict the relative frame of reference, where the man and tree are arranged one the away-axis.

(6-25)

Bininj kadi back and gundalk kadi front.

bininj	*kadi*	*back*	*and*	*gundalk*	*kadi*	*front*
man	3SG.stand	back	and	tree	3SG.stand	front

'The man is standing in the back and the tree is standing in the front.' (dvR_110521_02; 10:32, Child5, *R33*)

(6-26)

Bininj kadi front and that gundalk kadi back.

bininj	*kadi*	*front*	*and*	*that*	*gundalk*	*kadi*	*back*
man	3SG.stand	front	and	that	tree	3SG.stand	back

'The man is standing in the front and the tree is standing in the back.' (dvR_110521_02, 09:44, Child5, *R31*)

Child5 also used *front* and *back* about cards where the man and tree were arranged on the across-axis such as *R22* and *R44*. He thus used them intrinsically in all the contexts in which Iwaidja speakers use *wurdaka* 'in front' and *warrwak* 'behind' except for the unambiguously relative context, which would be the opposite of (6-25) and (6-26).

6.3.3.3 Body Parts

The phrase *biwong gunbokme* 'he gave it his back' was used by Child4. It is the equivalent to the Iwaidja phrase *rukung kirrwarda* in construction and meaning. An example is given in (6-27).

(6-27)

Kore kadi biwong gunbokme kawohrnan.

kore	*kadi*	*biwong*	*gunbokme*	*kawohrnan*
there	3SG.stand	3SG>3SG.gave	back	3SG.look

'He's standing there with his back to the tree, looking (away).'(dvR_110521_02; 01:28, Child4, *R42*)

Child4 used the phrase about *R42* (man and tree on across-axis) and about *R31* (man and tree on away-axis).

6.3.3.4 Beside

The English *side* was used by the children in ways that appear predominantly relative. In (6-28), it is not clear whether *side* was used intrinsically or relatively.

(6-28)

Kadi side gonda kawohrnan.

kadi	*side*	*gonda*	*kawohrnan*
3SG.stand	side	here	3SG.look

'He's standing on the side looking here.' (dvR_110521_02, 12:41, Child4, *R14*)

In (6-29), *side* refers to the relative side of the card.

(6-29)

And nane kadi side that gundalk kabinan, that bloke kadi that middle.

and	*nane*	*kadi*	*side*	*that*	*gundalk*	*kabinan*
and	this.one	3SG.stand	side	that	tree	3SG.look

that	*bloke*	*kadi*	*that*	*middle*
that	bloke	3SG.stand	that	middle

And this one the tree is standing on the side, that bloke is looking at it standing in the middle.' (dvR_110521_02, 06:51, Child5, *R22*)

The English *middle* was also used in (6-29) in a manner that was not entirely clear.

6.3.3.5 Left and Right

Child3, who used Kunwinjku questioning his parent, mixed the *left* and *right* into the Kunwinjku, as shown in (6-30).

(6-30)

Nawu bale kureh right or left?

nawu	*bale*	*kureh*	*right*	*or*	*left*
DEM	which.way	that way	right	or	left

'Is he on the right or the left?' (dvR_110522_A; 02:33, Child3, *R33*)

That question prompted his parent to provide standing information in Iwaidja using *nurlinurli* 'right' and *maruj* 'left' about a number of cards. The use of *left* and *right* for standing but not for facing descriptions is consistent with the Iwaidja data.

KM told me that in Kunwinjku *injalku* 'left' could be used in a relative sense as in (6-31), about *R12* (Figure 6.2) as well as intrinsically as in (6-32), about *R14* (Figure 6.3). She did not know the term for 'right'.

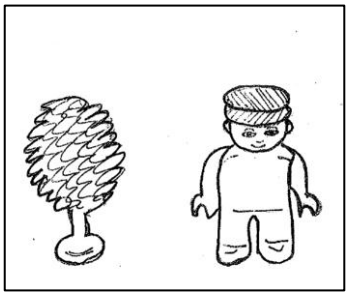


Figure 6.2. Card R12

(6-31)

Gundalk kadi injalku.

gundalk	*kadi*	*injalku*
tree	3SG.stand	left

'The tree is standing on the left.' (KM, 25/04/11)

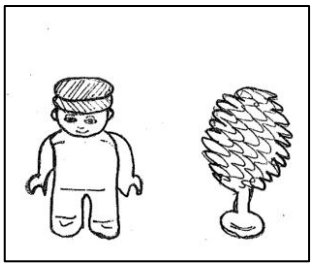


Figure 6.3. Card R14

(6-32)

Biwong injalku

biwong	*injalku*
3SG>3SG.PAST-gave	left

'It's on his left.' (KM, 25/04/11)

Although KM said that a relative use of *injalku* 'left' was permissible, there is an asymmetry with her not knowing the term for 'right'. From the Iwaidja and Kunwinjku data it appears that the left hand is more frequently referred to than the right. This is likely because a general right-hand dominance is taken for granted, whereas the use of the left hand is marked because it is less frequent. Some people on Croker Island who are left handed are called *Maruj* or *Injalku* 'Lefty' as a nickname.

6.3.3.6 Ascribed Orientation

There was an example of ascribed orientation where Child4 described the tree in *R13* as 'looking back', as shown in (6-33).

(6-33)

Gundalk kabinan back way

gundalk	*kabinan*	*back*	*way*
tree	3SG-look	back	way

'The tree looking back.' (dvR_110521_02, 04:14, Child4, *R13*)

The tree's ascribed orientation in (6-33) is the opposite of the man's orientation.

6.3.3.7 Summary

The Kunwinjku examples of spatial language, although only a small part of the data collected, show some of the same characteristics as Iwaidja. Similarities observed between Kunwinjku and Iwaidja included attention to the direction of gaze of the man and the use of body parts with a "give" construction, for example *biwong gunbokme* 'he gave his back to it'. Two of the children used English *left* and *right* in their Kunwinjku sentences for standing information, not for facing. These children's use of English *front* and *back* also paralleled the strongly intrinsic uses of the corresponding *wurdaka* 'in front' and *warrwak* 'behind' in Iwaidja, rather than their use in Standard Australian English. In one case the tree was explicitly ascribed an orientation. There was no use of absolute terms in the Kunwinjku data.

6.3.4 English

Some of the children chose to perform the Man and Tree task in English with each other, since they were not confident in Iwaidja. There were also two sessions where the children were asked to perform the task in English.

6.3.4.1 Standing and Facing

The children performing the Man and Tree task in English gave standing descriptions using both the relative and the intrinsic frames of reference. Some of them used the verb *standing*. Others used the simple verb *is* with a locational term, as in *the man is back*. Some children left out the verb completely, as in *a person on your left*.

The children used two verbs for direction of gaze: *looking* and *facing*. The man was variously described by the children as looking or facing at the speakers, at the tree, front or back, the camera, the ground and at the researcher who was standing in front of the speakers behind the video camera. These objects of vision thus included intrinsic, deictic and local *ad hoc* landmarks. An example of the last is shown in (6-34) where Child6 refers to the table at which he was seated during the activity.

(6-34)

He's looking behind, he's looking at the table.

(dvR_110530_02; 06:48, Child6, *R34*)

See §6.3.4.2 for more on the use of local landmarks.

A sideways orientation of the man was sometimes described deictically as him looking towards the Matcher, as in (6-35).

(6-35)

A person like on the right looking at you, like if I'm holding it.

(dvR_110418_B_01; 08:37, Child7, *R22*)

See §6.3.4.7 for more on the use of deictic descriptions. See §6.3.4.6 for the infrequent use of the relative frame of reference for facing descriptions.

6.3.4.2 Absolute

Only one child, Child2, used English cardinal directions, and only about one card as is shown in (6-36).

(6-36)

The bloke standing west, standing up, the tree standing south.

(dvR_110530_01; 11:21, Child2, *R23*)

He did not appear to be sure which direction was which, as he also used 'east' for the man's position.

However, there was some use of *ad hoc* landmarks for facing direction, as was shown in (6-34). Child3 compared the man's direction of gaze with that of the researcher standing in front of the participants, as in (6-37).

(6-37)

He's facing towards me like, like Cris is doing, she's looking at me.

(dvR_110418_B_01, 04:13, Child3, *R12*)

I was standing facing the children, on the other side of the cards and video camera to them. Child3 also described the cards where the man was looking away from himself and his partner as *facing towards Cris*. This applied to *R31*, *R32* and *R34*. As was discussed (§5.2.5), it is arguable whether these descriptions are at the end of the absolute spectrum, or whether they are deictic descriptions not using frame of reference. See also §6.3.4.7.

6.3.4.3 In front/Behind

In front and *behind* were used by the children, as were *forward* and *back*. They were used both relatively and intrinsically. The scope of the intrinsic uses paralleled those described for the Iwaidja of the senior consultants (§5.2.3.1) and the caregivers (§6.2.1.3). Examples (6-38)

and (6-39) show two descriptions of card *R11*, where the intrinsic and the relative frames of reference coincide.

(6-38)

The man is back and the tree is front.

(dvR_110530_02, 09:24, Child6, *R11*)

(6-39)

A person behind a tree facing towards me.

(dvR_110418_B_01, 2:31, Child3, *R11*)

In example (6-38), Child6 used *back* and *front* without prepositions. This use is fairly typical of Aboriginal English. In example (6-39) Child3 used *behind* in a more Standard Australian English sentence.

Some of the children also used *back* and *front* in ways that were unambiguously relative, particularly with *R31*, as in example (6-40).

(6-40)

The tree is front, the man is back facing at the camera.

(dvR_110530_02, 12:07, Child2, *R31*)

Other children used the terms about the same card in ways that were unambiguously intrinsic, as in example (6-41).

(6-41)

He's in front of the tree.

(dvR_110418_B_01, 07:17, Child3, *R31*)

Child3 was partnered with Child7, the only child who did not speak one of the local indigenous Australian languages. When it was Child7's turn to direct the task and he was describing *R31* to Child3, there was some debate between the two about *front* and *behind*, as shown in (6-42).

(6-42)

Child7: **Now the person, is this on the front or behind? Behind. A person behind the tree looking to the white thing.**

Child3 : **I kn.., it's in front but I know what you mean.**

(dvR_110418_B_01; 10:35, Child7 & Child3, *R31*)

In (6-42) both children try to decide between the intrinsic and relative frames of reference, Child3, with the Australian Indigenous language background, chooses the intrinsic, and Child7 chooses the relative.

In (6-43), Child8 appears to be using *behind* relatively about *R31*.

(6-43)

The man is behind the tree but he's facing front.

(dvR_110418_C_01; 07:29, Child8, *R31*)

However, there are two reasons to analyse this as intrinsic. The first is that Child8 also says *he's facing front*, where *front* is an intrinsic direction ascribed to the man since he has the tree at his back. The second is that he also uses the phrase *the man behind the tree* about *R13*, *R24*, and *R42* where the tree is behind the man, intrinsically, as in (6-44).

(6-44)

The man behind the tree and he's looking forward.

(dvR_110418_C_01; 03:45, Child8, *R24*)

In *R24* and *R42* the man and tree stand on the across-axis of the card, and from the viewer's relative perspective are beside each other. This suggests that Child8 means something along the lines of 'the man has the tree behind him.'

Child2 uses *last* to describe 'behind' in the ambiguous situation of *R11* (6-45).

(6-45)

The tree facing me and the thing is last.

(dvR_110530_02, 09:54, Child2, *R11*)

Thing in (6-45) refers to the man, which is not unusual in Aboriginal English.

6.3.4.4 Body Parts

There were no references to body parts as such, only to his *whole body* by Child8, shown in (6-46).

(6-46)

His whole body's facing on the tree.

(dvR_110418_C_01, 08:20, Child8, *R11*)

6.3.4.5 Beside

Three of the children described the man as being beside the tree. Child3 used the phrase *beside the tree* about cards *R24*, *R32*, *R34* and Child8 said *next to the tree* about cards *R12*, *R14* and *R32*. Child7 said the man was *on the side of the tree* for *R22* and *R24*. These descriptions are all ambiguous with intrinsic and relative frames of reference coinciding, except those for *R22* and *R24*, which are clearly relative. There were no child descriptions of the man being beside or next to the tree from a purely intrinsic perspective.

6.3.4.6 Left and Right

Left and *right* were used by all of the speakers using English. They were used to give standing information, rather than facing, as in (6-47).

(6-47)

The man's on the left, the tree's on the right.

(dvR_110418_C_01; 04:20, Child8, *R24*)

The only exceptions were two occasions where Child6 described the man's facing direction in terms of *left* or *right*, shown in (6-48) and (6-49).

(6-48)

The tree is looking at the man and the man looking right.

(dvR_110530_01, 04:23, Child6, *R24*)

There is an is an erroneous use of right in (6-48), as in *R24* the man is looking left. (6-49) is a negative example of *left* and *right* being used for facing direction, coupled with a standing use *he's right*.

(6-49)

But he's looking straight, not looking left or right, but he's right he's standing up and he's looking straight.

(dvR_110530_01, 06:26, Child6, *R32*)

Left and *right* were used by the children about all the cards where the man and the tree are on the across-axis (Cards *Rx2* and *Rx4*). This included the cards where the man is facing towards or away from the tree (*R22*, *R24*, *R42*, *R44*) and thus is not intrinsically beside the tree, as well as those where he is intrinsically beside the tree (*R12*, *R14*, *R32*, *R34*). The children's uses of *left* and *right* were clearly relative.

6.3.4.7 Deixis

Four of the children described the man as looking towards themselves, saying *facing me* or looking *towards us*. These descriptions were applied to *R11*, *R12*, *R13* and *R14*. Two of them also described the man in cards *R22* and *R24* as *facing towards you*. An example was given in (6-35). For these two cards the man is facing to the viewer's left, where the Matcher was sitting. There were a variety of descriptions using deixis of card *R33*. In (6-50) Child7 described the man as *in front of us* referring to the fact that the man is standing in the foreground of the pictures, closer to the viewer than the tree.

(6-50)

The person in front of us looking at the tree.

(dvR_110418_B_01; 10:01, Child7, *R33*)

In (6-51), Child2 refers to the man's proximity to the viewer by saying *he's right here*.

(6-51)

Like me and this table, lineding up ... bloke lineding up with the tree and he's right here.

(dvR_110530_02, 01:38 Child2, *R33*)

In (6-51) Child2 also used a simile regarding his position and that of the man. Child3 used the same strategy of describing the man's location and orientation using a simile that referred to the location and orientation of people and objects in the room (6-52).

(6-52)

A man facing towards the tree, like he's facing out like I am, like there's a tree in front of me.

(dvR_110418_B_01; 10:01, Child3, *R33*)

This was similar to Child3's strategy of using the researcher's position as a simile for the man's orientation which was shown in (6-37).

Most of the uses of deixis were for facing information rather than for standing descriptions. Further to the discussion of how deictic descriptions in Iwaidja might be classified within frame of reference (§5.2.5), their use for facing information suggests they could form part of the absolute continuum (§5.2.2.5).

6.3.4.8 Alignment

Other than the relative beside arrangements described earlier (§6.3.4.5), the only references to the alignment of the man and tree were Child2 in (6-51) and Child3 in (6-52).

6.3.4.9 Ascribed Orientation

The tree was described as facing a direction or looking at something by some of the speakers. Examples are given in (6-53) and (6-54).

(6-53)

The tree is looking at the man and the man looking at the tree.

(dvR_110530_02; 09:28, Child6, *R11*)

(6-54)

The man is facing forward and the tree facing on him.

(dvR_110418_C_01; 09:37, Child8, *R13*)

In general the ascribed orientation of the tree was the direction that the man was facing, although in some cases where the man was looking at the tree, as in (6-54) they were described as looking at each other. While a phrase such as *the tree facing* (6-54) could be taken to be fictive convenience in English, a phrase such as *the tree is looking at the man* (6-53) is explicit in ascribing orientation to the tree.

6.3.4.10 Ascribed Motion

There was one instance of the man being ascribed motion (6-55).

(6-55)

'That man is ?? running for the camera.'

(dvR_110530_02; 03:06, Child2, *R12*)

There was an unintelligible word in the middle of this utterance.

6.3.4.11 Multipurpose *Where* in Minjilang English

In Minjilang English, *where* is used as a general locative preposition as well as an interrogative preposition. It can mean 'at', 'on' 'in' or 'to' depending on the context. The answer to a "where" question will contain "where" as in, for example:

Q: Where are you going?

A: Where shop ('to the shop').

Q: Where are the keys?

A: Where bag ('in the bag').

This is similar to the uses of *wuka* is in Iwaidja, or the comparable *tuka* in Mawng. In Kriol and some other dialects of Aboriginal English the locative *la* is used. Reciprocal evidence for this is that during translation sessions, while giving a literal translation Joy would frequently translate *wuka* as 'where'. For example, for *arlirr yangbayan wuka makumbu* she might say "the tree is looking where south." An example from the Man and Tree task is given in (6-56).

(6-56)

A man looking where me.

(dvR_110530_02, 08:05, Child6, *R13*)

I observed an example of this use being taught to a child. One afternoon at the beach, a young girl, aged around four and a half years, was running around with a small sucker fish which had been attached to a shark which had just been caught. She was amusing everyone by insisting that it was a baby shark, cradling it, and trying to put it on other people. The child went up behind a woman who was sitting on the beach and put it on the back of the woman's neck. Their dialogue is shown in (6-57).

(6-57)

Child: I'll put the shark on you neck.

Adult: I'll put it where you neck.

Child: Don't put it where my neck.

The child initially used the Standard English preposition *on*. The adult responded using *where* as the locative preposition. The child then adopted the use that had been modelled for her.

Another explanation for the origin of this type of construction is the lack of the copula verb 'is' in Aboriginal English (Butcher, 2008). The Standard English sentence "I'll put it where your neck is" with the use of 'you' as the possessive pronoun, and the dropping of the copula

becomes "I'll put it where you neck" in Minjilang English. However, there is a strong possibility that it is the influence of Iwaidja and Mawng on Minjilang English that gives *where* its semantic and syntactic scope.

6.3.4.12 Summary

The children's uses of frames of reference and other spatial language strategies in English presented some interesting similarities and differences from the adult Iwaidja. There was a frequent use of relative *left* and *right* by all the children compared to the Iwaidja data, but like the Iwaidja data they were used predominantly for standing rather than facing descriptions. With the near complete absence of absolute terms, facing descriptions tended to be intrinsic (e.g., *looking at the tree*) and deictic (e.g., *looking at me*). The uses of in *front/front* and *behind/back* for both facing and standing descriptions were similar in scope and context to the Iwaidja data. Although there were some unambiguously relative uses of the terms, there were also strongly intrinsic uses that contradicted the relative frame of reference. There was no use of body part descriptions. There was, however, explicit orientation ascribed to the tree by some of the children.

6.3.5 Animals in a Row

The Animals in a Row activity was conducted with seven children in the library at Mamaruni School and one child at the General Business Manager's quarters. Each child did the activity five times, except Child6 at the General Business Manager's, who wanted to stop after three turns. The children in the library performed a picture puzzle as a distracter activity in between stimulus and solution (Figure 6.4).

Figure 6.4. Distracter activity for Animals in a Row

The children produced a higher number of relative solutions than absolute solutions. One child produced purely intrinsic solutions. Only Child9, the only girl in the sample, produced a

relative solution each turn. One child, Child5, did not produce a solution to one of his five turns, saying he had forgotten. This is shown by an X in the pattern column.

The Animals in a Row task shows a greater use of relative thinking in the child population, much as the linguistic data shows a greater use of relative frame of reference in speech. This appears to be related to schooling, with increased schooling leading to more relative thinking. Child2, who produced all intrinsic solutions, and Child10, who was the only child to produce two absolute solutions in a row, are both low school attenders. Those children who are regular school attenders, Child1, Child7, Child8 and Child9, all produced three or more relative solutions.

Table 6.4 shows a summary of the children's solutions (§5.2.6 describes how to interpret the table) . No statistical significance is claimed for the results of this very small sample.

Table 6.4. Child Animals in a Row results

Child	Frame of reference				Facing direction			
	Pattern	Total			Pattern	Total		
		Absolute	Relative	Intrinsic		South	North	West
Child1	RRARA	2	3	–	NNNNN	–	5	–
Child2	I I I I I			5	WWWWW	–	–	5
Child5	RRAXA	1	3	–	SSSXS	4	–	–
Child6	RAR	1	2	–	SSS	3	–	–
Child7	RRRAR	1	4	–	SSSSN	4	1	–
Child8	RARAR	2	3	–	NNNSS	2	3	–
Child9	RRRRR		5	–	NSNSN	2	3	–
Child10	AARAR	3	2	–	NSSSS	4	1	–
Totals:	–	10	22	5	–	19	13	5

As with the adults (§5.2.6), the pattern of the children's solutions showed a preference to continue to use a particular facing direction for subsequent solutions, once a direction had been chosen. Four of the children placed all their solutions facing the same absolute direction, regardless of the direction of stimulus, and three others changed the facing direction only once. Only Child9 alternated the directions of her solutions each time. As with the adults more of the solutions faced south than north, whereas the stimuli has been evenly distributed between north and south. This shows a preference for intrinsic solutions over either absolute

or relative preferences, which further non-linguistic cognitive investigations into the intrinsic frame of reference could explore.

6.4 Discussion of Child Spatial Language

Striking similarities were seen between the children's use of spatial language in Iwaidja, Kunwinjku and English. These included paying more attention to facing or orientational information than to standing information. Those children who tried to work in Iwaidja with each other, with very limited resources, used only direction of gaze to describe the cards, which they linked to both picture-internal ('he's looking at the tree') and picture-external ('he's looking at the beach') cues. As mentioned in Chapter 5, Terrill and Burenhult's (2008) definition of orientation includes all intrinsic directions. The intrinsic frame of reference tends to be the first acquired by children learning their first language (Levinson, 2003; Piaget & Inhelder, 1948/1956) and is possibly the first acquired by children learning additional languages.

The children in this study produced orientational descriptions that were intrinsic but also that used absolute or *ad hoc* landmark (pseudo-absolute) references. They only used absolute or pseudo-absolute phrases for orientation, not for standing descriptions. Orientational information was also given through the use of terms meaning 'in front' and 'behind' as well as describing where the man was looking. The terms for 'in front' and 'behind' were used relatively in Iwaidja, Kunwinjku and English, as well as being used intrinsically on both the across-axis and the away-axis. The children speaking Iwaidja only used them intrinsically about cards on the across-axis.

When the children used English, and English words in Kunwinjku sentences, their uses of *in front* and *behind* paralleled the uses of their parents and grandparents directing them in Iwaidja. It is likely that the scope of similar words in Kunwinjku resembles Iwaidja rather than English, although this has not yet been investigated. The children appear to be learning meanings for English words that have mathematical meanings such as *(in)front* and *behind*/ *back* by transferring the meanings from Iwaidja and Kunwinjku.

The privileging of the intrinsic frame of reference may reflect a cultural value. The transfer of spatial frame of reference uses into another language has recently been reported as occurring from Aymara, spoken in the Andes into the local Aymara influenced Spanish dialect of Castellano Andino (Núñez & Cornejo, 2012). Aymara uses the absolute frame of reference but within this has a distinct use of intrinsic terms for *nayra* 'front' and *qhipa* 'back' to denote

east and west respectively. In Castellano Andino, speakers of Aymara use *adelante* 'ahead' and *atrás* 'behind' for east and west respectively. In this Chilean community, education is in Spanish and children are no longer acquiring Aymara. Núñez and Cornejo do not report whether this unusual use of frame of reference in Castellano Andino also occurs with younger people who do not speak Aymara. However, they provide an ethnographic explanation for the linguistic phenomenon in terms of an eastwards orientation in Aymara culture, evidenced in layouts of houses and communities. Another correlation between use of spatial language and social relationships was made by Danziger (1996) regarding the use of the intrinsic frame of reference and kinships relations in Mopan Maya: "The Mopan talk about, and act upon, spatial and 'kinship' relations in a similar manner" (p. 78). Similarly, the privileging of the intrinsic frame of reference in speakers of Iwaidja, Kunwinjku and Aboriginal English from Minjilang may reflect a cultural value or worldview. This would need to be investigated using multimodal ethnographic methods, such as used by Núñez and Cornejo or by Danziger.

The educational consequences of the transfer of Indigenous semantic scope of these spatial terms to the children's use of English is that teachers who speak only English are unlikely to be aware of how the children's uses of these words differ from the Standard Australian English. The teachers who are thinking of the Standard Australian English meanings of *in front* and *behind/back* are likely to perceive some of the children's uses of these words as incorrect. The children are using the terms with a semantic consistency that owes more to Iwaidja and other local languages than to Standard Australian English, as was shown in §6.3.4.3.

Thus it is likely to be difficult for the children in school to understand why some of their uses of these words are considered wrong by their teachers and why others are accepted. In many cases how they use and respond to *in front* and *behind* will concord with the understanding of the teacher. But in other cases they will not. Because the differences in context are so subtle, the teachers' criticism has the potential to seem random to the student (see Moses & Wigglesworth, 2008). The students' understanding can also seem random or unconsolidated to the teacher, although they are in fact demonstrating a conceptual consistency based on the local languages. See also §8.2.3.

Phrases referring to the figures being *beside* each other appeared to be only used relatively. They occurred most often when the relative and intrinsic frames of reference coincided (*R12*, *R14*, *R32* and *R34*) but occasionally only relatively (e.g., *R24*). The "photo finish" cards (§5.5.1.2) where the man and tree are intrinsically but not relatively beside each other (*R21*, *R23*, *R41* and *R43*) were not used with the children. These cards were omitted because they

had seemed the most difficult for the adults to successfully describe. Thus it is not possible to assess whether the children would have privileged the intrinsic or the relative frame of reference in these cards.

As with the adult Iwaidja speakers, *left* and *right* were used by the children for standing descriptions and rarely for facing descriptions. These terms were noticeably more frequent in the English data than in the other languages, and were used primarily relatively in English. In Iwaidja they were used intrinsically. There was no use of body part descriptions in English, but they were used in Iwaidja and Kunwinjku.

The children demonstrated minimal use of the absolute frame of reference. Before the session with Child3, while I was explaining the task to him, he offered *looking south* as a description for the man in *R23*. In a discussion about this after the task, Child3 said he did not know the word for 'south' in Kunwinjku. Interestingly, Child3's partner, Child7, said that *south* was towards the bottom of the card "not like real life." Discussion revealed that Child7 (who speaks only English) had absorbed the convention that north is at the top of a map, so that for him if you were talking about cardinal directions with a printed picture, north was also at the top. As with the adults, it may be that Child3 was aware that his partner Child7 was unlikely to understand if he used absolute directions, and so chose to use other strategies. This awareness may have been on an unconscious level.

However, in English there was a significant use of deixis and *ad hoc* local landmarks, particularly for facing descriptions. It is possible that these strategies are used where senior adult Iwaidja speakers would use the absolute frame of reference. This is a further possible argument for placing the use of both deixis and *ad hoc* landmarks in the spectrum of the absolute frame of reference, or to consider them pseudo-absolute.

Changes in the use of spatial frames of reference from the benchmark of the senior adult Iwaidja were apparent in the use of relative *left* and *right*, probably from the influence of English and of schooling (in English). However, the influence of Iwaidja or "close" languages such as Mawng and Kunwinjku on the children's English was apparent in features such as the scope of use of *in front* and *behind*, and the lack of use of relative *left* and *right* for facing descriptions.

Because Gurindji Kriol speakers use deixis and gesture where Gurindji speakers use the absolute frame of reference, Meakins and Jones (2011) predicted the Animals in a Row task would show an increase in relative solutions for Gurindji Kriol speakers compared to Gurindji speakers. The increase was far less than expected and they found that the younger age group

(children) had a higher rate of absolute solutions than the young adults. The study found an increase in relative solutions related to years of Western schooling, which Meakins and Jones claimed to be literacy effect rather than an English effect, related to the perception of left–right differentiation (Danziger & Pederson, 1998).

The Minjilang findings presented here suggest an increase in use of the relative frame of reference amongst the children in both speech and action. This could be an effect of English or an effect of literacy, although it must be remembered that it is English language literacy and English language education in which the children are participating. It is difficult to separate a "literacy effect" from a "literacy in English effect" (cf., Zebian, 2005). However, the finding of a relative left and right in Iwaidja, Mawng and Kunwinjku is very unusual in Australian languages and warrants further research. Because of the multilingual environment of Minjilang, this would need to investigate spatial language and cognition in Mawng and Kunwinjku as well as elaborate the Iwaidja data.

6.4.1 Similarities in Spatial Language between Iwaidja, Mawng and Kunwinjku

Key similarities in spatial language which were found for Iwaidja, Mawng and Kunwinjku are:

- the relative use of *left* and *right* for location but not for direction,
- attention to direction and orientation over location,
- a semantic interrelation between cardinality and orientation/direction manifesting as the lexical conflation of *first* and *in front,* and of *later, last* with *behind, in back of,*
- the possible use of the absolute frame of reference in small scale space, and
- the use of body parts for intrinsic relations.

The first three of the above points have been observed in children's use of English. There is no evidence of the last two being transferred to English.

6.4.2 Mirror Image Perception and Left–Right Differentiation

During the Man and Tree task several adult participants including caregivers demonstrated difficulty in perceiving the difference between cards that were mirror images of each other. For example, some participants considered *R23* and *R43* to be the same card, or *R24* and *R42*. At times, this occurred even when a Director had given a description that included absolute directions that the Matcher's card did not match. When it was pointed out to her that the cards

were different, A2 described the relationship between *R23* and *R43* as *rukung rtamburryak lda jamin* 'giving their chests to each other (facing each other)' (Figure 6.5).

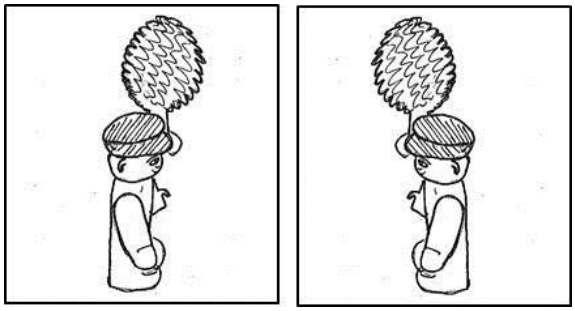


Figure 6.5. Mirror images facing each other: *rukung rtamburryak lda jamin* (*R23* & *R43*)

FG, one of the caregivers, had a great deal of difficulty perceiving mirror image differences when the two cards were held side by side. When this occurred with *R24* and *R42*, I held the two cards one above the other to facilitate his perception (Figure 6.6).

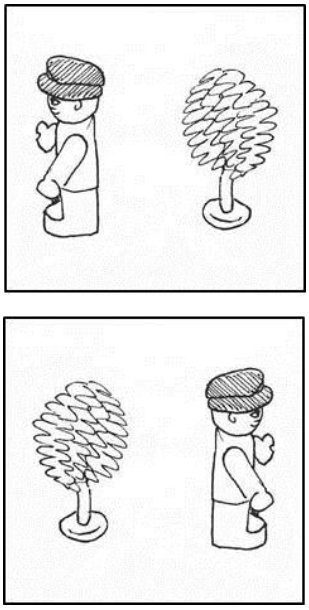


Figure 6.6. Mirror images above each other (*R24* & *R42*)

Later, when his son handed him *R34*, the mirror image of *R32*, FG examined the two cards side by side for 16 seconds in silence before concluding *kirrimul* 'similar'. FG used predominantly intrinsic descriptions. When I did the same for A3, holding one card above the other, she described it as *kurrkarda ari* 'it's standing on the other side.'

I did not observe the same difficulty in perceiving mirror images among the children, who all have recent exposure to schooling. However, I noticed that Child2 at age 11 still reversed letters when writing and sometimes wrote from right to left in mirror-fashion. Child2 was an infrequent school attender who spent much of his time out and about the island with his ranger father.

This perception of mirror images as being the same images has been noted in speakers of Warrwa (McGregor, 2006) and the central American languages Mopan (Danziger & Pederson, 1998) and Tzeltal (P. Brown, 2006). The perception of the difference between mirror images does not appear to be innate, but is affected by linguistic and cultural processes such as the acquisition of literacy (Danziger & Pederson, 1998; Kolinsky et al., 2011). The acquisition of literacy in the Roman and Japanese scripts requires making the distinction between letters or characters that are mirror images of each other, such as 'p' and 'q' or 入 'enter' and 人 'person'. The Tamil script, on the other hand, does not include mirror images. In a study of discrimination between two dimensional line figures in ten different language groups, literate groups using the Roman and Japanese scripts made the mirror image distinction more than the illiterate groups. However, both literate and non-literate Tamils showed a high rate of acceptance of mirror images as identical (Danziger & Pederson, 1998). Thus it appears not to be the acquisition of literacy *per se* that enables this discrimination, but specific perceptual practices of certain writing systems. It appears that other cultural practices can also develop mirror image perception: Verhaeghe & Kolinsky (1991, cited in Danziger & Pederson, 1998) reported that illiterate Portuguese lace makers had higher rates of mirror image perception than illiterate Portuguese who did not make lace. Nevertheless, literacy appears to be the most significant factor in the acquisition of mirror image perception (Kolinsky et al., 2011).

Speakers of Mopan, a Yucatec Mayan language spoken in Belize and Guatemala, habitually do not discriminate right from left, but neither do they use absolute spatial references (Danziger, 2011). They instead use only the intrinsic frame of reference. Danziger (2011) found that both literate and illiterate Mopan speakers tended to perceive not only two dimensional but also three dimensional "mirror image" objects as the same object. McGregor (2006) notes that for the Warrwa speakers distinguishing between mirror images was "of little interest to them" (p. 152), that they did not seem to regard the difference as significant. This is my own interpretation where Iwaidja speakers did not make this distinction. Although they were able to perceive the difference when it was pointed out to them, it was with a measure of reluctance or disinterest. The difference was not important to them.

In mathematics, mirror images are considered to be *incongruent counterparts* or *enantiomorphs* which differ by being left-handed or right-handed. *Handedness* as an inherent quality of space was proposed by Kant (1768/1991) as part of his argument for the absolute nature of space. The mathematical development of non-Euclidean spaces, such as those of a Möbius strip or Klein bottle, has provided scope for counter argument (Van Cleve &

Frederick, 1991 provides excellent coverage of this debate). Handed images are generally congruent in a higher dimension: for example, two dimensional objects which are incongruent in two dimensional spaces can be congruent in three dimensional spaces (Nerlich, 2009). School mathematics and the English language both come from a tradition of left–right differentiation or handedness. Perception of this difference is far from innate, and it not regarded by people from some cultures and languages such as Mopan and Iwaidja as particularly important. Teachers need to be aware that perception of handedness is not only developmental – something that children can acquire with maturity – but is a culturally specific value which may need extra attention in a cross-cultural educational environment.

Perceptual salience is a significant feature of linguistic relativity. Some of the studies that seek to disprove linguistic relativity focus on showing that people can *perceive* phenomena which they are not accustomed to talk about (e.g., Butterworth et al., 2008). We need to remember Lucy's (1992a) important point that linguistic relativity is about *habitual* thought, not *potential* thought. The Iwaidja participants were capable of perceiving that mirror images were different, but placed little value on this distinction. On the other hand, senior participants were sensitive to the slight offset of the man and tree in *Rx1* and *Rx3* cards (§5.3.1). I myself was not aware of how they were offset until analysing the data. I could easily perceive it, but had not, due to my own habits of aligning objects in perpendicular axes.

Obviously, teachers are going to want to teach left–right differentiation in mathematics. Many children only learn left and right through remembering with which hand they write. Although it takes most Indo-European children up to age 11 to control the left–right distinction (Piaget & Inhelder, 1948/1956) there is a difference between the situation where a distinction of handedness is reinforced in home life, and where it is used only in school. Teachers of students who do not make a strong left–right distinction in their home culture and language should remember that left and right are largely conventions rather than innate universal qualities.

A possible approach would be to derive left and right from absolute directions. East appears to be the most salient direction for Iwaidja speakers. It was the most frequent absolute term used in the tasks, and it was the default direction when just *manyij* 'sun' was used. In languages as diverse as Welsh, Yareba (Papua New Guinea) and Dyola (Senegal) there is an association of 'north' with 'right' and 'south' with 'left' due to a sun-focused eastwards orientation (C. Brown, 1983). Therefore 'east' could be used to teach the convention of left and right. For children on Croker Island who know where the sun comes up, 'left' could be the side towards *Murdululi* 'Cape Croker' at the north of the island when facing east, and

'right' could be the side facing south to *Injirnaj* 'Point David'. As a mediated strategy for remembering left and right, this could be drawn on in other locations by visualising oneself facing east, or physically facing east, the direction of which an Iwaidja speaker is likely to be most aware, and then using this association of 'left' with 'north' and 'right' with 'south'. It is worth noting again that some of the Iwaidja speakers showed more awareness of a relative left–right distinction than is generally found in those other Australian languages that have thus far been documented.

Kolinsky et al. (2011) report that mirror image sensitivity is acquired quite early in the acquisition of literacy: "a relatively small practice in reading and writing letters and words is enough to found enantiomorphy, and that this holds true even if literacy learning takes place in adulthood" (p. 234). They note that writing letters by hand may help this process, as compared to typing letters, since the physical process to form a lower case 'p'– a straight line and then a circle – is different from the process to form a 'q' – a circle and then a straight line.

While research to date has focused on mirror image perception as a literacy effect, further investigations of implications for mathematics education might be beneficial. One of the challenges of mathematics education in remote communities is how to continue students' mathematics learning when they have not reached the same level of literacy that their English speaking mainstream peers generally have reached. Thus geometric activities that rely on mirror image discrimination may be proposed by teachers before students have learned the reading and writing required to acquire this discrimination. While the NTCF (NT DET, 2009d) mentions symmetry at all Band levels for KGP2 to Band 4, it only mention of mirror images in relation to a line of symmetry. In this case it might be beneficial to include specific teaching activities focused towards the perception of mirror images, not just with letter discrimination activities. Children may benefit from early exposure to separate images or objects which are *incongruent counterparts* – mirror images of each other – in order to practice this type of discrimination.

6.4.3 Ordinality

Path orientation (§5.5.1) and a dynamic, verb-based worldview (§5.5.2) affect how ordinality is perceived. Objects or people in a line, in an order, do not just occupy their places, they follow each other. In English, a number that comes 'after' is 'higher' or 'greater', and a number that comes 'before' is 'lower' or 'smaller'. In Warlpiri, the concepts are also linked to height and size but in the inverse relation. For example, the taller tree sprouted first and its smaller companions later, it is taller and older, it came 'before'; the 'bigger' brother came

'first' and his 'smaller' brother came 'after' him, although the 'bigger' brother's age in years is 'greater'. Thus in Warlpiri larger numbers a 'larger' number can be seen to come 'before' the 'smaller' number (Mary Laughren, pers. comm., 11 March 2011). To some extent, this inverts the relationship between ordinality and cardinality. This may have an effect on learning the concepts of 'before' and 'after' in relation to the number line.

In Iwaidja, similar to Warlpiri, the concepts of 'first', 'in front', 'go before' are combined in one word, *wurdaka*, while 'behind', 'later' and 'after' are combined in *warrwak*. Iwaidja also has a greater emphasis on orientation and implied or actual direction than location in spatial descriptions compared to English. From this perspective, points on a line always have direction and any given number is facing away from its origin, travelling towards infinity. Larger number are thus before it, in front of it, while small numbers have been left behind, they are coming after it. The line is not going from left to right, or right to left, it is going forward. Note that this is not necessarily how the people of Minjilang actually perceive a number line, it is my extrapolation of the data, my thought game (Barton, 2009). For the difficulties reported by teachers at Mamaruni School in teaching these concepts see §7.2.2.3 and §7.2.3.2.

Ordinality may also be seen as a transitive relation. I have heard *second* being used by students getting into a line in class at Mamaruni School as a transitive verb, as in "You second her and I'll second you," where *second* means 'follow' or 'come immediately after, come next'. Rather than naming a place, it describes a relation between two bodies. The transitive verb *ang..ldakbanakbi* 'last' (§5.4.4) was initially translated by Joy as 'second' or 'third', according to the context of it referring to the last of two or three objects. Some of the difficulty in eliciting a more accurate translation of this term may have been due to the transitivity of it, the fact that it says that the subject 'lasts' or 'comes last to' the object.

Although cardinality and ordinality are often perceived to be in a one-to-one relationship to each other, Seife (2000) points out that the invention of zero meant that zero now came 'first', and 'one' became the 'second' number. Descriptions of traditional uses of numbers and counting by Indigenous Australians seem to refer to cardinal uses rather than ordinal ones (e.g., J. Harris, 1982, 1987). Teachers need to be aware that using number lines and talking about which numbers come 'before' or 'after' depend upon ordinality. Different spatial concepts, as evinced through language, seem more likely to affect variations in the perception of ordinality than of cardinality. This is a point of which teachers might need to be made aware.

6.4.4 Vectors

The mathematical implications of a focus on orientation rather than location lead to a consideration of (Euclidean) vectors. Note again that this is my own thought game, not a comment of how Iwaidja speakers and their families actually conceptualise the world (Barton, 2009). In mathematical terms, one might say that in Iwaidja there appears to be no such thing as a scalar, directionless point, a location which a faceted figure such as a man can occupy without orientation. There is always direction even when there is no explicit movement. Even the apparently facetless tree acquires direction, an ascribed orientation (§5.2.3.2; §5.5.1; §6.3.3.6; §6.3.4.9). In two dimensions, vectors are defined as having the two components of direction and magnitude. In standard vector mathematics, the zero vector has no magnitude and its direction is taken to be any or every direction. Is it possible to elaborate a vector mathematics in which points have direction? Mathematicians might like to consider that possibility. Vectors are an advanced topic in school mathematics, not formally introduced until the later years of high school. However, it is possible that for children with a highly developed orientational sense, vectors could be productively introduced at a much earlier age.

The Davydov approach of Dougherty (2010) has shown that young children can use algebraic representation well in advance of learning formal algebra, and proposes that this can advantage future numeric learning. Similarly, there might be ways to utilise the oriented view of Minjilang children to strengthen their spatial thinking and language. In everyday terms, this might be as simple as foregrounding attention to orientation as much as to location. Activities where children respond to location directions or describe locations could be carried out with faceted objects such as toy people or cars. The teacher could include language such as talking about which way the object is facing. In graphical representations of spatial scenes, children could include arrows which show which way the represented object is facing. As with the verb-focused discourse (§3.2.5; §5.5.2), this might be another way of making mathematical discourse more responsive to the children's world view.

6.5 Conclusion

Sadly, this study demonstrated that no children at Minjilang are currently fluent in Iwaidja, although some are able to understand Iwaidja instructions and are learning to speak it. The study showed similarities in the spatial language of Iwaidja and the English that the children of Iwaidja speaking families speak. The analysis of spatial language in Iwaidja described in this chapter and Chapter 5 indicated linguistic features that teachers could take account of in mathematics lessons.

Possible responses to this analysis which would bridge to the school curriculum include being aware of the significance of orientation in spatial description and location. The significance of orientation was demonstrated by the prevalent use of the intrinsic frame of reference and features such as ascribed motion. Teachers at Mamaruni School could also make use of the absolute frame of reference by referring to local landmarks and sunrise/sunset directions. These directions could also be used to teach about *left* and *right* rather than using a body centred definition: on Croker Island, if you are looking towards the sunrise, then left is towards Cape Croker and right is towards the barge landing. Being aware of the dominance of verbs rather than nouns in Iwaidja speech is also advised. Chapter 7 will turn to the context of mathematics teaching at Mamaruni School, Minjilang, describing Phase II of the study which was designed to take account of the findings described in this chapter.

Chapter 7
Mathematics at Mamaruni School

This chapter presents the findings of Phase II, an ethnographic case study of language and mathematics education at Mamaruni School. The initial goal of Phase II was the planning and implementation of a mathematics unit in response to the understandings developed in Phase I. The ethnographic narrative that follows and the discussion in the next chapter describe the extent to which this was achieved and outlines some factors which impeded the process. My approach in this and the following chapter is both interpretive (Geertz, 2000) and critical (Thomas, 1993).

This chapter tells part of the story of the teachers who taught mathematics at Mamaruni School from 2009 to 2011. It includes data from interviews with five of the teachers from 2010 and 2011. It also presents data related to planning Early Years mathematics lessons on space and location.

The first section provides background information about Mamaruni School, describing the school ecology (§7.1.1), the relationship between the school and the community (§7.1.2) and how mathematics is taught (§7.1.3) and assessed (§7.1.4) in the school. The next section gives profiles of the interviewed teachers (§7.2.1) and results from the interviews (§7.2.2). The chapter describes briefly the role of local Indigenous assistant teachers in the school (§7.3) and then reports on the design and implementation of the teaching plan that was developed in response to Phase 1 of the project (§7.4).

7.1 Mamaruni School

Mamaruni School is a part of the Top End Group School [TEGS]. There are five group schools in the Northern Territory, each made up of about a dozen very small schools of between one and seven teachers, and a central administration which includes a Principal and Assistant Principal. Each small school has a teaching principal, who assumes most of the day-to-day responsibilities of the school, and who also has a part time teaching load. Mamaruni School has five teachers, including the teaching principal, and four classes. It has students from Transition to Year 9, with each class covering several year levels. Each class also has a local Indigenous assistant teacher for all or part of the day.

7.1.1 School Ecology

The school is a mixture of old and new buildings. In 2005, Cyclone Ingrid destroyed the main school building, and a new building was constructed in 2005–6, with classes taking place in demountable temporary buildings during construction. One of the demountables has been retained as the Middle Years classroom. The older, brick Early Childhood classroom survived the cyclone.

Classes are all multi-age and multi-Year level. The school caters for students up to Year 9. After Year 9, academically engaged students go to boarding school in Darwin, while disengaged students or those who are unable to live in a boarding school environment end their schooling.

The school also has a preschool. In 2010, there were few preschool students and they were frequently incorporated into the Early Years class, creating a class that ranges from ages three to seven years. In 2011, the preschool usually had around five students and was taught by an assistant teacher.

The student population is subject to flux. The majority of students attend Mamaruni School with only brief and exceptional absences from the community. Some students visit from other communities in the region, and some students move between places of residence during the course of a year, such as moving between their mother's country and their father's country. In almost every visit I made to the school, usually only a few weeks apart, I would see a few new students or a family who I had not seen for many months. Most of the students who appear at the school have an ongoing connection to the community. While the current classroom teacher may not know them, the other assistant teachers and students do, and they might already have a file in the front office.

Changes in day-to-day attendance affect the teaching program. Average attendance in 2010 was over 80 percent (ACARA, 2012b), a huge increase from under 60 percent in 2008 and 2009. Some of this was an actual increase and some was due to changes in enrolment procedures. There are individual students with 98 percent attendance and others who attend just 15 percent of the time. There is a seasonal pattern, with higher attendance in the first semester, when it is raining than in the second, when it is nicer to be outside. Major ceremonies generally occur in the second half of the year. Funerals can occur at any time and can keep a child out of school for several weeks. The addition of a fourth class in 2010 had a positive effect on attendance as well as teaching, through reducing overcrowding and conflict in the classroom.

There are more boys at the school than girls: in 2010 there were 38 boys out of 66 students. In 2008 it was 45 out of 70 students. This is likely the result of normal variation in a small population (Kim Johnstone, pers. comm., 28 February 2012). The high ratio of boys has noticeable impact on the school dynamic. The older groups at the school include fewer girls while the younger cohort of students has a more even distribution.

The school has many visitors. In 2011, some of these came to assist the teachers with their learning, such as the Literacy and Numeracy coach, and the *Accelerated Literacy* coordinator. There were also visits regarding health issues such as hearing or epilepsy (two students in the school had epilepsy) or arts or sports programs. At some times, there were more visitors in the school than classroom teachers, and most of these visits required meetings during or after school. As an estimate from my observations, there were visitors in the school eight weeks out of 10, with approximately three visitors per week. This impacted upon the time that teachers had for preparation, and for building relationships in the local community.

7.1.2 School–Community Relationship

Mamaruni School has does not have an easy or close relationship with Minjilang Community. The physical location of the school illustrates the separation. It is located on a hillside more or less above the shop, away from where local people live. Although there is a school entrance near the shop, this is kept locked, and people have to walk up around the school and in past the front office. There is little use of the school's resources by the community or of the community resources by the school.

Other than minimal and necessary interactions, the school and community have little to do with each other. Parents sometimes accompany younger children in the Early Years class who are adjusting to school and reluctant to leave their families. Occasionally when a student is presenting behavioural difficulties in the other classes, a parent will also spend time in the class to monitor or check their behaviour. From time to time the school organises an event to which families are invited such as a sports carnival, science afternoon or Christmas concert and awards night. Other than the Christmas concert and awards night, these events are irregular because they depend upon the enthusiasm of the current cohort of teachers to organise. A school council that includes parents was established in 2010.

In 2010 and 2011, the school attempted a "Culture" program on Friday afternoons, with the goal of engaging in locally relevant cultural activities. The school invited community members to participate in this program as volunteers, but this invitation was not taken up. Since many of these cultural activities are gender specific, boys and girls were separated into

two groups. The female assistant teachers and tutors assisted with the girls' program, for example demonstrating pandanus weaving. The boys' program was more problematic, at times with only the sole male teacher in the school responsible for nearly two thirds of the school. They ended up watching videos. The Culture program was not continued in 2012.

The community makes few demands of the school. The presence of teachers and/or students is requested at an occasional community meeting. During funerals, the school bell is not rung, and the school is generally closed for the final day or half day of a funeral. Other nearby communities such as Warruwi on Goulbourn Island are perceived to have much more positive school–community relations. The weak relationship between school and community means that the local staff are unwilling to be spokespeople for the school in the community or for the community in the school.

7.1.3 Mathematics Programs

Mathematics instruction is a priority at Mamaruni School. In most classes, mathematics is taught in the 90 minute block between recess and lunch Monday to Thursday. While following the Northern Territory Curriculum Framework (NT DET, 2009d), individual teachers have a fair degree of autonomy in deciding the content and structure of their mathematics program. Number generally receives more attention than other curriculum areas.

Where possible, teachers use a mix of whole class and rotating small group work. Groups are usually dependent upon assistant teachers and other adults being present as it is difficult to get groups to work without adult facilitation. Rotations often include a session on the computers for this reason, since sometimes students will stay at a computer without adult assistance. Groups are generally arranged according to students' levels of mathematics achievement, but membership can also depend upon age/Year level, attendance and group dynamic. Some teachers assign a lower achieving group to the assistant teacher while they themselves work with the top group. An observed outcome of this is that some lower achieving students receive less mathematics instruction from their trained teacher and more from the lesser trained assistant teacher from year to year.

The school is well resourced materially. It has plentiful physical resources: measuring devices of all kinds; large moveable number boards; base 10 Multi-base Arithmetic Blocks; two and three dimensional shapes of varied substances; play money; and fraction kits, to name but a few. It has a range of teacher and student books from various states. Although the school does not buy class sets of student workbooks, teachers have access to unlimited photocopying and

printing, so they can use as many worksheets from books or the internet as they wish. There is rarely competition between teachers for these resources.

All the teachers receive some training in the number aspects of *Count Me In Too* (NSW DET, 2001). There has been little other professional development in mathematics until the latter part of 2011 when a literacy and numeracy coach began making regular visits to the school.

Teachers seek to find a compromise between teaching "age-appropriate" mathematics content and targeting their teaching towards the level at which their students are working. As students progress through the school, the gap between those performing at the lower and higher ends of the academic spectrum widens. Teachers understandably feel that they need to progress their students, and may teach techniques to deal with more advanced topics for which their students have consolidated prerequisite techniques. As an example, I have seen some students in Year 8 who still require concrete materials for simple operations involving numbers under ten. They might be taught how to do more elaborate operations such as division with multi-digit dividends by making pencil marks on a piece of paper, eliminating the need to know basic number facts. It is questionable whether they will be able to make constructive use of the unwieldy algorithms they are taught. On the other hand, I saw many attempts by teachers to make mathematics relevant and interesting for their students.

7.1.4 Mathematics Assessment

Mathematics assessment at Mamaruni School includes diagnostic and in-class summative assessment, as well as national assessment. Diagnostic assessment includes the Schedule of Early Number Assessment (SENA) from *Count Me In Too* (NSW DET, 2001) which is completed for each student each year. In the Early Years, a baseline test is also administered which includes shape recognition and understanding of English spatial prepositions such as *beside* and *under*. Both these tests require one-on-one application so they are usually administered in the teacher's release time. Teachers receive two and a half hours non-classroom release time per week. Summative assessment of units of work in different mathematics areas includes class tests and individual work samples.

Student achievement against NTCF Band levels is entered into a centralised online database known as the Curriculum eTool (or CeTool) each semester. This automatically generates an A to E grade for each student based on national and Territory expectations. While most students who regularly attend Mamaruni School show significant progress in their achievement of NTCF outcomes each semester, almost all Mamaruni School students receive a D (below

expected level for their year) or E (well below the expected level for their year) grade (§8.3.2).

Students in Years 3, 5 and 7 participate in the NAPLAN tests. The school encourages teachers to familiarise students with the format of the NAPLAN tests and to do practice questions. A majority of students at all year levels performed below the national minimum standard in numeracy in 2009 and 2010 (ACARA, 2012b). However, the results show students at Mamaruni School make a significant improvement between tests (§8.3.2).

7.2 Teachers

Mamaruni School has a high turnover of teachers, who are non-local and non-Indigenous. Table 7.1 (which was shown earlier in Table 4.4) shows which teachers taught which classes at Mamaruni School from 2009 until 2012. The teachers who participated in the interviews were Shirley, Katie, Leah, Simon and Joanne. The Early Years teacher in 2011, Katie, participated in the planning and implementation of the teaching program of this project.

Table 7.1. Teachers at Mamaruni School 2009–2012

<table>
<tr><td rowspan="2">Class/ Role</td><td colspan="2">2009</td><td colspan="2">2010</td><td colspan="2">2011</td><td>2012</td></tr>
<tr><td>Sem. 1</td><td>Sem.2</td><td>Sem. 1</td><td>Sem.2</td><td>Sem. 1</td><td>Sem.2</td><td>Sem. 1</td></tr>
<tr><td>Principal</td><td>P1</td><td>P2 (was EYT1)</td><td colspan="5">P3: Carol</td></tr>
<tr><td>Early Years</td><td>EYT1
EYT2</td><td>EYT2</td><td colspan="2">EYT3: Shirley</td><td colspan="2">EYT4: Katie</td><td>EYT5</td></tr>
<tr><td>Primary Years</td><td colspan="2">PYT1</td><td colspan="2">PYT2</td><td colspan="2">PYT3: Leah</td><td>PYT4</td></tr>
<tr><td>Primary Years2</td><td colspan="2"></td><td>PYT5</td><td>PYT6: Simon
PYT7: Joanne</td><td colspan="2">PYT8</td><td></td></tr>
<tr><td>Middle Years</td><td colspan="2">MYT1</td><td colspan="2">MYT2</td><td colspan="2">MYT3</td><td>MYT4</td></tr>
</table>

7.2.1 Teacher Profiles

I began this project in 2009 with the support of the then principal and friendly negotiations with the Early Years teaching couple, that is, two married teachers who were sharing a single teacher position. However, they, along with the other Balanda teachers all left the school by the end of 2009.

In 2010 a new teaching principal and three new teachers commenced. A fourth teacher commenced in Term 2 with the creation of a fourth class. The fourth teacher left after a term and a teaching couple, Joanne and Simon, took the position, making five teachers for four classes.

At the start of 2010, I began discussions about the project with the new Early Years teacher, Shirley. Shirley had close to 20 years of teaching experience at preschool and Early Years levels. Many years earlier, she and her husband had taught in various remote Northern Territory schools, including another community in West Arnhem Land. They had moved back south to raise their children. In 2010 their youngest child finished school and they returned to the Top End. They were quickly comfortable in the community where some people remembered them from their previous time in West Arnhem. When there was a ceremony in the latter part of the year, Shirley was the only teacher permitted to drive to the ceremony camp, which she did each morning to pick up students for school.

Shirley enjoyed teaching her class and dedicated a lot of time to planning and preparation. Throughout the year, she had consistently high attendance. Over the year, we spoke many times about the mathematics and language program. Shirley was enthusiastic to participate. Unfortunately, her husband suffered several acute illnesses and injuries during the year, and the long distance from the hospital meant delays in receiving appropriate care. Interstate trips were necessary for surgery that was unavailable in Darwin. For health reasons, Shirley and her husband decided to leave the island at the end of 2010. One other teacher also left at this time to go to a different Arnhem Land school.

In 2011, the principal Carol began her second year, Joanne and Simon their second semester and three new teachers commenced. Katie, the new Early Years teacher, and Leah, who taught the Years 4–6 class, were friends and shared a house. They were both in their mid-twenties with a few years of teaching experience each, and had been teaching in an upper socio-economic area of a state capital city. They had no previous experience of an Indigenous community and they knew little about Indigenous culture or language. They had attended a week's orientation in Darwin, and they kept in contact with some of the other teachers they had met there. They visited the shop and council office each day and attended church on Sundays, making their presence known in the community in a gentle, low key way. They kept in close touch with their families and friends interstate, using Skype and Australia Post. They both had a steep learning curve that year.

Katie had a challenging timetable. The first session, from the start of school until recess, was called Investigations, and drew on the *Walker Learning Approach* (Early Life Foundation, 2012). Katie did not receive any training in this until sometime in the middle of the year. The session between recess and lunch was devoted to the *National Accelerated Literacy Program* (NALP, 2009–2012). Katie and the other new teachers spent a week in Darwin being trained in the *Accelerated Literacy* program early in Term 1. Thus the only time in which Katie could timetable mathematics lessons was after lunch – a difficult timeslot for her young students.

The Early Years class had many diagnostic assessment requirements. As well as the baseline tests and SENA tests, there was the Indigenous Language Speaking Students [ILSS] program, designed to support such students in the first year of compulsory schooling with their oral English development. It required that she do two speech transcripts a year each of a high, medium and low student, which she would send to the ILSS coordinator.

Leah had somewhat fewer assessment demands, some very able students and the most experienced assistant teacher in the school. She was very interested to learn about local culture and ways in which she could be responsive to it in her teaching program. However, she had a boyfriend and found the separation from him difficult. He found a job for 2012 where he would work week-on, week-off and be able to spend the alternate weeks with her. With a return flight from Darwin to Croker Island costing over five hundred dollars, Leah looked for a new teaching position on the mainland, where her boyfriend would be able to visit by car. Leah and Katie wanted to stay together, appreciating the value of a close friend in a small community. They found two positions for 2012 at another small TEGS school which was a few hours' drive from Darwin.

Joanne and Simon left the school and island at the end of Semester 1 in 2011. Since they had started at the beginning of Semester 2 in 2011, they had not received any orientation from the Northern Territory Department of Education. Simon had come into conflict with a parent of one of his students, and was increasingly negative about the community's attitudes towards the school. Joanne was struggling with the behaviour of their students. They both felt that they were not receiving enough support from the school and principal.

The Middle Years teacher also left at the end of the 2011. For her, the plan had always been a year's teaching adventure in the Top End. 2012 began with the principal Carol entering her third year, PYT4 her second semester, and yet again three new teachers.

This high teacher turnover, while not unusual in remote communities, makes it hard to provide quality education. Communities and education authorities obviously would prefer teachers to stay longer. Starting in 2009, the Northern Territory Government began offering a bonus to teachers who complete a year in a remote school. There is also a study leave incentive where four years of full time teaching in a very remote school entitles a teacher to six months study leave on full pay or a year on half pay.

I know firsthand the realities of living and teaching in the small community of Minjilang. I began teaching at Mamaruni School in the second term of 2008 after a teacher left after only one term's employment. I completed the year but did not want to stay for a second year because I missed my friends, my exercise groups and my culture. Remoteness played a major role in all of the teachers' decisions to leave the school after a year or so, whether it be for medical, financial, family, social, cultural or professional reasons. This was also my own personal experience.

7.2.2 Interviews

Five teachers participated in a one-on-one semi-structured interview which ranged from 22 to 42 minutes long. The interviews were intended to elicit the teachers' attitudes and beliefs about mathematics teaching in an Indigenous context.

I had a list of questions (Appendix F: Teacher interview questions), but varied the order in which I asked them. In some cases, I omitted some of the questions, or asked additional questions which arose during the interview. Katie also participated in a second interview of 35 minutes. Teacher comments have been edited for clarity, removing repeated words or phrases such as "you know". Any words inserted for clarity have been shown in brackets. In addition to the quotes, teacher responses are also both paraphrased and interpreted in the text. The teachers interviewed were the Early Years teacher in 2010, Shirley, and four of the teachers from the first semester of 2011 (all except the Middle Years teacher).

7.2.2.1 What is Mathematics?

The teachers had diverse views about the nature of mathematics. The Scaffolding Numeracy Card Sort (Appendix G: Siemon, 2005) was designed to see how teachers view mathematics and themselves as teachers of mathematics. Joanne chose the instrumentalist view, seeing mathematics as "rules, facts and strategies that are useful in solving every-day problems." Shirley chose the Platonist view of maths as "a universal body of knowledge which is discovered over time."

> Shirley: No matter what culture you are, or where you live, or where you are in the whole world, or in a small community like this, that knowledge is a discovery and it's a discovery over time. It's a slow process and it's not something that just comes. And I believe you have to be ready to accept that knowledge and to understand that knowledge.

Although Simon also chose the Platonist card, his explanation was more that of a problem solver, that "maths develops and changes in response to human needs and cultures."

> Simon: You can't deny that it's developed over time and across different cultures, you've got lots of cultures that have made their different contributions ... and you can't really deny that there are rules and facts. Now the facts ... as part of being developed over time, are up for change ... I guess it's once that's sort of been decided that's a shared thing, other people benefit from that as a society and it's developed as part of the society and that's part of that kind of body of knowledge. You don't know if it's universal or not but it's discovered over time discovered over time, added to.

Simon saw mathematics as a way of understanding the world. He was the only teacher who spoke about his enjoyment of mathematics, saying that he liked mathematics and enjoyed teaching it.

All of the teachers saw mathematics as a life skill which their students would need in the future.

> Shirley: It's a survival skill as well, no matter where a child goes, if they learn mathematics and they have an understanding of mathematics then they can be understood in any society. If they don't have the language and the understanding of mathematics their life will be a lot harder because they have to move from the society they are in now into maybe the city, university, and to get a job, or even in their own society they need to have mathematical skills to do any sort of job at all.

Joanne and Leah talked about using mathematics in practical situations such as building and reading street directories. Leah and Katie talked about needing mathematical skills such as counting and number recognition to use money. They saw these skills as contributing to personal empowerment and fairness. Simon also viewed mathematics as a useful tool, but he commented that people have different mathematical needs in their lives.

When teachers talked about student strengths, they had had more to do with student knowledge of facts than of mathematical processes. Joanne and Simon mentioned rote counting (recitation of number names) as a student strength, and Leah mentioned rote knowledge of basic number facts to ten. Shirley said that her students were good at adding small numbers up to five. Katie also mentioned her students' oral memory. The teachers contrasted the oral memory strength of their students with the students' weakness in reading

and writing numerals. Katie also said her students were "strong in shape," which meant recognising and naming shapes and their attributes.

Leah, Katie and Joanne all said number was the first thing that they thought of in relation to mathematics, although they recognised that mathematics was more than number. Although Shirley described mathematics as a "language", most of her examples throughout the interview also related to numbers and counting. Simon also recognised that the role of number in mathematics was very prominent, with which he was not necessarily in agreement.

> Simon: Things across the North, in fact across Australia, have a very much number type of focus and I think most Boards are really unashamedly almost saying you really got to focus in on the literacy and *numeracy* [emphasis in original] side of it. A lot of other areas get pushed, like data, get sometimes pushed to the edge with the focus on number.

When I asked how they saw space and location in mathematics, Joanne and Simon focused on uses that students might have for spatial skills in the future. Shirley claimed that space was an important part of mathematics but did not offer any examples. Katie saw teaching about space as something that could be integrated with other learning areas in her Early Years classroom.

> Katie: If you've got an integrated unit it just naturally ties in more than sometimes number does ... Because we've been doing *Rosie's Walk* we've been doing obstacle courses and talking about positional language and location and shapes at the same time, so I find it comes up more naturally than, it does get taught but maybe not as explicitly as numeration because it's just more in daily living, daily life, everyday conversation.

On the other hand, Leah saw space as more difficult to integrate into her teaching program, and admitted that she saw it as less important than other areas.

> Leah: I think that the reason that I wouldn't think it was the most important is because I don't see it as requiring as much number as the others. When I'm teaching number, it's easier for me to link in measurement, and easier for me to link in teaching other mathematical concepts [which] require the use of number. With location I don't think I do that as much, and with space I don't tend to do that as much, it's a lot more language and visuals. I guess it is a good link with English, looking at prepositions, as well.

Simon implied that he wasn't sure about the role of space and location in the curriculum:

> Simon: They're in the syllabus, so they're in there for a reason; the relevance I also guess it depends on where the kids are in the end going to take it and what they're going to do with it.

In her second interview in November 2011, Katie said her ideas about the nature of mathematics had changed through the year, partly through participation in the project.

> Katie: I remember at the beginning of the year when you asked me "what is maths?" and I'm like "addition? subtraction?" At this Early Years it just really is the basic

> stuff, but it is so much more than that and you know, I never used dominoes in the classroom, and subitising, or any of this stuff before, so I've learnt a lot this year. And a lot through you, so thank you. That maths is a lot more than playing games or doing rote counting or all that sort of stuff that you're just kind of given are a given with teaching.

7.2.2.2 Teaching Mathematics

Three of the four teachers who did the Scaffolding Numeracy Card Sort (Appendix G) about the way they teach mathematics described themselves as an explainer, focusing on teaching concepts.

> Shirley: As an early childhood teacher, I'd have to develop an understanding of concepts. Because if the children don't understand in the first place, they can't develop the skills to problem solve and they can't master those skills.

Two of the teachers said they would like to focus on problem solving, but found it difficult. Leah, who said that she focused on teaching skills, said that at Mamaruni School it was easier to teach skills rather than problem solving. Simon spoke about children's backgrounds being a factor in using a problem solving approach, with it being easier with "upper class or middle class kids who come to school with this language and with maybe more numerate backgrounds." Shirley, Simon and Leah their students were unwilling to take risks or become involved in problem solving and discussion. They all said that their students were more focused on getting the right answer rather than solving the problem and were happy to have the teacher supply them with the answer. A. Jones (1989) found that class and cultural background affected student expectations of classroom practice. Students then affect the teaching program by cooperating with practices that they value and expect. Thus the teaching of concepts or skills may be expected by the students of Mamaruni School whereas they may not value problem solving in mathematics in the same way.

Just as most of the teachers saw mathematics as primarily about number, all of the teachers except for Simon indicated that they directed the focus of their teaching towards number.

All of the teachers found language to be an important issue in teaching mathematics to Indigenous students. Joanne described it as a "language barrier." Both Joanne and Simon saw part of the issue being lack of a shared language between themselves and their students, with students not understanding all that the teacher said.

> Simon: You gotta have a shared understanding of the language which you use to teach in order to teach, to communicate the new mathematical language and the concepts. And out here obviously a lot of that shared understanding of the base language is not there which then makes the mathematical side, an extra, another leap forward, whereas in another school the maths language is really where most of the learning time is spent.

Joanne: I think that's perhaps where we lose them, when we do talk too much.

Katie said that her students found some of the mathematical language difficult. Her strategies for dealing with this included being explicit and using visual prompts while still phrasing things in everyday English. Joanne also said she used visual aids as well as concrete materials, because of the difficulty for her students in learning in a second language.

Shirley and Leah both thought the lack of shared language between teacher and students made learning mathematics for their students more difficult. Leah thought that trying to learn the multiple ways that English can express mathematics was a challenge that was unfair to her students. For Shirley, her appreciation of the difficulty stemmed from her own early learning experiences in different countries where she didn't speak the local languages.

> Shirley: If I wanted to go to school and I wanted to learn, I had to learn that language to have, to gain an understanding of what I was being taught. And it was very, very difficult ... That's why quite often when I'm teaching, and I look at their little faces and I think, "Hey, hold on. Take a step back. Because what they're doing, they're not actually understanding what you're talking about." And I find out their understanding by asking questions which when I was young, I wish some people had asked me, "are you understanding what I'm saying?"

Students' lack of proficiency in Standard Australian English was seen as an impediment to them demonstrating their mathematical abilities.

> Leah: I haven't been able to really see what they're capable of yet, because we're still working on the language and I find that a lot of the activities that we do to see how well they actually know it rely on the language.

The teachers saw "concepts" as an important part of what they were teaching in mathematics.

> Katie: We have been working on positional language because we are doing *Rosie's Walk*. And they grasp the concepts but they find the language difficult.

> Leah: I think for them to understand what the word means they need to actually practice the concept, so whether they know the concept in their own language or not they're not going to be able to attach, that English word is not going to sink in unless they have something to attach it to, so I think it's a bonus if they understand it in their own language because then it might help to give them those neuro-pathways or whatever it is to actually be able to connect the word that I'm trying to teach them to what they already know.

The relationship between concepts and language is explored in §8.2.3.

Students' lack of proficiency in English meant that reflective discussions at the end of a lesson were often curtailed.

> Leah: I thought the most rich part of the lesson would then be coming back together and discussing it. And one person shared, no one listened and we couldn't continue so then we went outside.

Students' literacy was also an issue in these teachers' classrooms, particularly students' ability to read and write numerals, and link them to the number name. Shirley and Katie talked about numeral "recognition" whereas Simon talked about "reading" numerals. Three teachers mentioned that their students found it difficult to learn to write numerals and number names. Leah talked about literacy being a factor in using mathematics programs on the computers, with programs with spoken instructions being more accessible for the students.

7.2.2.3 Spatial Language

Most of the teachers were not very aware of differences in the ways that different cultures and language groups have in talking and thinking about space. Both Joanne and Simon admitted this directly. Katie said she had never thought about it. She spoke about Indigenous perspectives in art, such as the local x-ray style line art, and what she thought that might mean.

> Katie: Rather than the surface object, they're looking more internally and the base of the object, that's a very different way of looking at things ...
>
> Cris: What sort of implications do you think this could have for teaching maths?
>
> Katie: Well it would mean that their strengths are in different areas, for every culture, so these kids might not be particularly good at writing a number but they might be better at drawing the amount of objects for the number or, they might be good at drawing shapes to represent everyday living or that sort of thing while I'd probably more actually ... I think a big thing would be drawing for them and while sometimes it's more number sentences for another culture.

Leah mentioned people's orientation as important in positional language.

> Leah: The common one that I heard when I came up here was, it's always wherever the person is facing is forward, how people talk about their location from that, but other than that, I haven't heard of any others that I need to be aware of. Well, I wasn't. During training, that was the only one that they sort of said, "oh and just remember, it might be a little bit different when someone is talking about it."

She then talked about the impact of this in the mathematics classroom.

> Leah: And I noticed it with number, trying to teach 'before', the number that comes 'before' and the number that comes 'after', they always have trouble with that, no matter how many times we look at a number line and say "what number is before?" and "what number is after?" I just find they still always just say one or the other and they don't seem to know which one I'm asking of them.

Joanne and Shirley also talked about teaching 'before' and 'after' in mathematics lessons in relation to numbers. Shirley found it difficult.

> Shirley: This is the language thing again, is numbers, we were playing a game on the board, and they had to listen to the word 'before' and 'after' so we were doing the number before five, the number after six, for instance and because of that language, again, the barrier, language in maths, the number before five, the

> number after five, that just fell down in a big hole, just because language was being used with the number, and it took, it would have been six weeks, before that actual connection was made with the word with the number, the number *before*, the number *after*, so, and that was a disaster when I did it because [laughs] the children just played around and were talking to each other, totally bored because they had no idea what I was talking about.

I asked Shirley about how she had then gone on to teach these concepts. She said she tried to ground the concepts in the students' lives such as "Before it got dark, what did you do?", "Before you came to school, what did you do?", and "What did we do after we did the cooking?" She got the students to draw lots of pictures. When I asked how she made the links between that and the number line, she said, "I don't think they really got that bit. I don't think they really clicked onto that concept."

Katie also spoke about her students' understanding of the positional language she was focusing on in class:

> Katie: So if you say "behind the bin" you'll still find, you know some kids may be in front of the bin or you know, '"put a line underneath this word," I have to usually show them where underneath is, so there's a lot to still work on with the language aspect.

Throughout the year Katie's main focus in her language teaching was on speaking in complete sentences. In the area of spatial language, this involved modelling and expecting spatial prepositional phrases. In November, she said that her students had improved throughout the year.

> Katie: I'd still say maybe 'in front' can be something they might struggle with. 'Behind' they generally grasp by now because I've kind of done enough activities around the classroom or wherever. You know, I get them to go behind something. 'In front', for some reason, I think, maybe because it's two words ...
>
> Cris: What about 'before' and 'after' in terms of number?
>
> Katie: They do struggle with it. And usually need a visual, whether it's a one hundreds chart, or a number line or whatever in front, and they still, they still struggle with the language aspect of it. I've noticed (the assistant teacher) will start yelling "No! After! You know, next one!" or, you know, or just rephrasing it like that or ... so. Before and after, you can tell when you are doing number that it is something that they do struggle with.

Katie had not given much attention to the teaching of 'left' and 'right'.

> Katie: I haven't handled it a lot this year. Just because it's not something that really it's in the curriculum quite yet and I wanted to get a few other things up and going before left and right. So it hasn't been a major focus. I have mentioned it, and I have done the whole one hand that looks like an L. Even when I was little, that confused me, "now which one looks like an L?" If they don't know their letters yet, which a lot of them didn't, then they just go ...

Cris: What about the ‘clockwise’ and ‘anticlockwise’ that has scraped into the curriculum at that very early level?

Katie: When we’ll go around in a circle we’ll always go in a clockwise direction. I don’t say the word clockwise though, I just go “let’s go the way that we go round.” And then sometimes I might go “this is the way we go round a clock”, or whatever. So I guess I’m incidentally doing it, I’m not using specific terminology ... everything we do that’s like our rotations always goes that way.

I had suggested to her in August trying to use absolute references as a tool to remember left and right, for example “Look at sunrise and your right hand is the one towards Cape Croker,” but it appears she did not take up the suggestion.

Leah said that her students were good at using local landmarks and cardinal compass point for direction when outside, and also at visual measurement.

Leah: Direction I find they’re good with. We’ve been trying to do the cardinal compass points and when we actually put it into action outside and describe it using, “Ok, well, where’s the water, where’s the land, where’s Point David, where’s this?” and using the cardinal compass points they’re fine. So I think that’s a strength for them, but when they’re outside and actually seeing and pointing and showing me.

She also mentioned that she had to be careful that when they expressed something differently to the way she would express it, that she didn’t automatically think they were mistaken.

Leah: When they talk about a crocodile they’ve seen, and catching a fish or something and they talk about the width of it rather than the length, so I think they’ve got that understanding but it’s just making sure that I don’t then have the misconception that they’re getting it wrong.

Both Leah and Katie talked about the labelling aspect of teaching about shape.

Katie: I think probably the most difficult thing is when you’ve got the labelling aspect of what’s a cylinder and what’s a cone and the oral bit is where they probably find it a bit difficult. But in terms of knowing faces and corners and all those sorts of things, I found they were very, very good at that.

Leah: 2D and 3D shapes I found they described differently. They were strong with knowing the difference between 2-dimensional and 3-dimensional shapes but then it was once again the language that you needed to describe the attributes of those shapes that was their falling point, and that was the part that you needed to be able to extend them, but they actually in their own way could describe them, it just wasn’t using the correct language.

7.2.2.4 Relevance and Engagement

The teachers were concerned both whether the mathematics they were teaching was relevant to their students, and how to make it engaging. The main issues were making connections between mathematics and the students’ lives, and whether the curriculum was suitable for their students.

Making connections with the student's present and future lives was mentioned in terms of engagement and relevance. Teachers saw connecting lessons with the students' present lives as a way to make mathematics meaningful.

> Katie: Today we started using money for the first time. The kids are really excited. So just some plastic money and daily activities where you're trying to bring it into real life situations for them. If you place it out of context I just feel like it's kind of meaningless. Play situations where you can set up a shop just like they have here.

Shirley talked about needing to appreciate the Indigenous students' context in terms of environment and family. Joanne also felt she needed to relate her teaching to the students' world, but was not confident that she understood it.

Both Leah and Shirley felt that the students didn't see mathematics as relevant to their lives.

> Leah: It'd be good if there was some (professional development training so that) outside school they could see the reason that they would need to learn maths. I feel like I'm fighting a bit of a losing battle out here with trying to teach maths, whereas I don't get that as much teaching them English. I think that because they know that they are going to need English if they are going into Darwin to be able to communicate to people to do things but they don't really seem to want to learn maths.

Shirley related this to mathematics not being a part of the students' society. The teachers seemed to have difficulty seeing how to connect mathematics to their students' lives. Simon recognised that the primary mathematics curriculum needs to be broad in scope and that not everything in it can be relevant to everyone. Nevertheless, he mentioned the relevance of the curriculum as a major issue in teaching mathematics to Indigenous students

Teachers' views of suitability of the curriculum were related to the level at which they were expected to teach. Four of the teachers said that they did not find the NTCF (NT DET, 2009d) suitable for their students. In particular, they said that their students were working at a lower level than the usual age level specified in the curriculum. There were also concerns about the amount of material they were expected to cover in the curriculum. Shirley had begun the year teaching at a certain level, but then gone back a level in the NTCF.

> Shirley: I started at Level 3 because that was the recommended level ... and that was really hard for the children, so I've taken it back, but I must admit from when I started Term One and I took it all back, I'm now finding we're catching up. Quickly. But at first the children had no idea what I was trying to teach them.

Leah said that when she tried to teach lessons that were too advanced or too abstract, it was "disastrous".

> Leah: I just find that I need to pitch it a lot lower than where they should be working at with the NTCF and a lot of it is language based which then means I need to teach them the language which means they're behind, I feel like I need to teach them so many things to keep up with the NTCF but there is not enough time.

Shirley and Joanne said that the NTCF itself was suitable for their students once they pitched their teaching at a lower level. Simon was the only teacher to comment on the suitability of the curriculum content itself. He said that he wasn't sure about the relevance due to his lack of familiarity with what his students would need in their lives. He also commented on the multiple curriculum and assessment documents that were in use in the Northern Territory.

> Simon: It's hard to work out almost what is directed and what is you know a choice ... so what you have to do, and what you're encouraged to do, and what's offered to do that's right, and what you have to do at a system level and then within the regional level and the school level.

Katie was the only teacher of the five who said that she found the mathematics curriculum suitable, "even bordering on easy in some regards." However, Katie was using the *Diagnostic Net* (NT DET, 2010b), which specifies minimum achievements for children to progress, and she was not familiar with the NTCF at all.

Leah, who was using the Remote School Curriculum and Assessment Materials (RSCAM, 2010) to structure her program wasn't sure about the approach which involved covering something for a term and then leaving it.

> Leah: I kind of think that you kind of need to do a little bit of everything every day so that they're not losing it ... but I don't want to mess up that scope and sequence.

The two teachers who commented on the Australian Curriculum both thought that it was a good thing, especially from the point of view of being teachers who had moved interstate. However, while supporting a national curriculum, Shirley also spoke about the need for an Indigenous curriculum with Indigenous consultation.

> Shirley: But Aboriginal children are not learners in the same way European children are because English is their second language and it is a language, especially here, [other place she has taught], all those children's second language was English and all of them struggle ... they still have every right to speak their language and therefore that should be respected, therefore there should be another curriculum, a different curriculum for Aboriginal. I think really when a curriculum's written, it should be written with a lot of Aboriginal people's input. And I'm not talking about Aboriginal people's input that have been brought up in the European environment. I really think they need to get some of these people, TAs [Assistant Teachers] who actually live on communities, and get their input.

Two of the teachers mentioned NAPLAN. Leah was concerned that the terminology she was teaching her students might be different from that used in the tests, and that she didn't want

her students disadvantaged because of that. Simon felt that the tests were not relevant and took up teaching time that could be better used differently.

7.2.2.5 Teacher Preparedness and Training

The teachers varied in how prepared they felt to teach mathematics in the remote Indigenous context. Both the teachers who were taking the Early Years class felt confident. Shirley credited her many years of experience in teaching Early Years, some in remote settings, and having done extensive workshops in mathematics for early childhood. Katie related her confidence to the level of mathematics that she was teaching, seeing it as "just setting up those basic foundations generally."

Both Joanne and Leah said they felt unprepared. Leah said her difficulties were selecting the appropriate level of teaching, and engaging the students in learning. Joanne related her difficulties to the language situation. Simon was confident about the mathematics content, but said the language situation in the classroom presented challenges.

The teachers had all received some in-school training at Mamaruni School in the *Count Me in Too* (NSW DET, 2001) program. Both Katie and Simon noted it was very number focused. The training had focused on games and activities using the interactive whiteboard. Shirley saw the fun aspect of these games as positive for the children's learning since they weren't viewing them as work. Rather than a program or approach, both Katie and Leah saw *Count Me in Too* as set of expendable activities which would be used up rapidly.

> Katie: It was good as a base of activities that we could use but after a while they will run out.

None of the teachers had received any training in specifically focused on teaching mathematics to Indigenous students. All of them were open to it. Both Simon and Joanne thought more training for mathematics in an ESL situation would benefit them. Katie commented that there was generally more training for literacy than for mathematics. Leah wanted something specific to Indigenous students that would hold their attention, as well as assistance in identifying reasons for unsuccessful lessons.

During the course of 2011, Katie, Leah, Joanne and Simon all undertook a Teaching English to Speakers of Other Languages [TESOL] course at Charles Darwin University, attending intensives in the term breaks. By November, Katie had completed the TESOL course and also attended an English as a Second Language for Indigenous Language Speaking Students (ESL for ILSS) conference. She found both of these experiences useful and was a lot more confident in her skills to teach in the ESL learning environment.

> Katie: Having done the TESOL course has been really, really valuable. The first intensive was a bit dry and they did do stuff on grammar ... they couldn't really apply it to the languages here, because every indigenous culture has its own similarities and differences with their languages which is quite difficult really, when you come to the challenge of teaching Indigenous kids ... so I'd say I probably learnt more off you than I did of them through that time, but the next one was really good and having an ILSS program as well has probably really helped me look specifically at their language.

Katie had not been confident with the ILSS program at the start of the year, and requested more training. She had found that some of the guidance she received prior to going to the ILSS conference what different from what was recommended at the conference.

> Katie: I guess it's taken a year, and also different PD (professional development) opportunities and hearing from different people and kind of learning that even the people who are in a job maybe need to, you know, you can't always take what's given to you as the best example.

In summary, most of the teachers were underprepared, aware of it, and keen to receive more targeted training for their teaching context.

7.2.2.6 The Mathematics Lesson: Successful and Unsuccessful Strategies

Some of the teachers said that sometimes they did not know what had contributed to the success of failure of a lesson.

> Leah: I don't know if it was the kids that were there on the day or if something had happened at home, or if it was too hard for them because it was too much language or if they were tired or what. I often find I don't know a lot of the time why things don't work.

> Katie: I never know if it's a teaching thing or if it's a language thing, or if it's just a combination of everything.

Simon talked about teacher reflection as an important part of the process of identifying what worked, as well as talking with colleagues. He also talked about repeating activities with another group of students as enabling improvement.

All the teachers mentioned concrete materials or hands on activities as contributing to the success of lessons in terms of students' engagement and learning. Katie mentioned that her lessons were more successful using resources that the students were already familiar with such as cards or sticks rather than novel equipment. All the classrooms have interactive whiteboards, which several teachers said they used in their lessons. Joanne's examples of both a successful and an unsuccessful lesson included her use of the interactive whiteboard.

All of the teachers used small groups in their lessons some of the time. Group work was mentioned by three of the teachers as contributing to successful lessons. All of the classes in the school cover at least three year levels in age, and more than that in curriculum level.

Students vary in their attendance and engagement. Designing activities which are possible for the lower achieving students to attempt and which extend the more advanced students is a challenge. Simon gave the example of a Tangram style activity where the students had to produce pictures out of the Tangram pieces. As well as being in small groups, he attributed part of the success to the students being able to participate at variety of levels. Katie talked about small groups enabling more targeted teaching and focused attention. However, this depended on having enough adults in the class to supervise each group.

Making the transition from teacher modelled and directed work to independent work was sometimes more difficult for students than the teachers expected. Both Katie and Leah gave examples of unsuccessful lessons involving students constructing tables individually where students had previously done the activities as a whole class, but were unable to do then do them independently. This could be because students were unwilling to risk making mistakes.

Choice of lesson content, and its relevance, was mentioned by Simon as contributing to the failure of a lesson he taught on using a protractor to measure angles. Although he felt like he should be covering everything in the curriculum, he questioned "the concept and relevance of concept and how much background understanding of the concept the kids had."

7.3 Assistant Teachers

In general, each class at Mamaruni School has an Indigenous assistant teacher in addition to the classroom teacher. At times there are also other adults in the classroom employed as tutors or inclusion support assistants for students with special needs. In practice, sometimes an assistant teacher's time is split between two classes and there are some who are employed part-time. There are three assistant teachers who have been working continuously at the school for more than four years. These women all have children in the school, most of whom participated in the project. Their children all attend school regularly and are among the higher achievers academically in the school.

The role of the assistant teacher is a complex one. They provide cultural and linguistic support, sometimes translating the teacher's instructions for students who don't understand English very well. When classes are divided into groups, they sit with a group, but when the teacher leads a whole class session, the assistant teacher often has little to do. Teachers often have little experience of working in this type of team.

At Mamaruni School, the only time available for the teacher and assistant teacher to plan together is immediately before or after the day's classes. In practice, both teacher and

assistant teacher often spend the time immediately after school cleaning, and the teacher plans after the assistant teacher has left for the day.

All three of the long term assistant teachers have undertaken certificate studies with Batchelor Institute of Indigenous Tertiary Education [BIITE]. None of them are in a leadership role in the community. Some of the elders who used to work in the school, and who have more local authority, complain that the current assistant teachers do not teach the children enough local language and culture. But the assistant teachers do not feel they have the authority to do this, even where they have the knowledge.

It proved difficult to interview the assistant teachers. The assistant teacher in the Early Years class was reluctant to be interviewed individually. I thought she might agree to a joint interview with the other assistant teachers. However, over the course of several visits where this interview was one of my main goals, two of the three assistant teachers were absent each time, for varied reasons. Although their voices would have been a valuable addition to this thesis, the omission reflects their lack of say in the mathematics (and other) programs of the school as it stands.

7.4 Lesson Plans and Observations

In the examples in this section, students are have been given pseudonyms. Their ages at the time of observation are given in Table 7.2.

Table 7.2. List of students in Phase II

Student	Year of birth	Age (year: month)	Sex
Sierra	2004	7.2	F
Zoe	2004	6.11	F
Will	2003	8.1	M
Adam	2004	6.9	M
Carter	2003	7.6	M
Brendan	2003	7.11	M
Robert	2003	7.9	M

Shirley's choice to leave the school at the end of 2010 was a serious setback to the school-based aspect of this project. She had been enthusiastic and open to the idea, although we had not discussed any specifics of how the teaching program might be designed and implemented.

When Katie arrived at the beginning of 2011, I spoke with her during my first visit of the year in February. She was cautiously receptive to my initial approaches regarding participating in the project, but it appeared she considered it just one of many demands on her time. She said she was willing to meet with me and discuss lessons, but she already had her year's mathematics program planned in outline and that she could teach about space in mathematics in Term 3.

In Term 1, Katie was already addressing positional language through her Accelerated Literacy test, *Rosie's Walk* (Hutchins, 1968). *Rosie's Walk* is a single sentence book in which Rosie the hen is chased by a fox who has a series of misadventures to which Rosie is apparently oblivious. Unfortunately, I was not part of Katie's planning for this book, nor did I see her lessons for it, as it would have been very suitable to link with the project. It is a popular Early Childhood text which illustrations of a series of locational prepositions phrases. The text reads:

> Rosie the hen went for a walk, across the yard, around the pond, over the haystack, past the mill, through the fence, under the beehives, and got back in time for dinner.

In Term 2, Katie's class text was *Handa's Surprise* (Browne, 1994) which tells the story of a girl called Handa taking a present of fruit to her friend Akeyo in a neighbouring village. As with Rosie in *Rosie's Walk*, Handa is shown walking from left to right in all these encounters, reinforcing reading conventions for beginning readers. Early in the term, Katie and I discussed ways in which she might incorporate teaching and talking about space with this text. The story shows Handa unwittingly encountering a sequence of animals. In each meeting, the animal approaches the girl from behind and steals a piece of fruit from the basket she is carrying on her head. In the next picture the animal is seen turned around the opposite way, travelling away from the girl. We talked about this turning, and making double-sided animal cut-outs so that the animals could be shown moving in both directions. This idea was influenced by the TOWARD and AWAY distinction in Iwaidja movement verbs, as well as by the focus on the intrinsic frame of reference (§5.1.3; §5.2.3; §5.4). We talked about prepositions to describe the location of the animals, such as *up/in* the tree, *on* the ground, *in* the grass, animals *behind* Handa and Akeyo coming *towards* Handa.

We also talked about the ordinal numbering of the animals both as a teaching point and as a source of potential confusion. All the animals are shown in the end-piece in sequence, and we discussed how it looks like the goat is 'first' but was actually the last one that Handa meets. This was something that I noticed because of the emphasis on the facing direction or the path

orientation in Iwaidja. The ‘first’ of a left–right sequence was in conflict with the ‘first’ in the oriented sequence (§6.4.3).

Another point I mentioned was Iwaidja’s dual verb forms, that is, words that describe two people or objects together, for example *aldindi* ‘two (animate) standing together’ (e.g. 5-50, 5-57) and *arindi* ‘two (inanimate) standing together’. Katie thought she might ask the students about this when Handa and Akeyo are seen standing together at the end of the story. I did not see these lessons being taught.

Katie and I also discussed incorporating spatial language into her mathematics lessons. I was not able to have further meetings with Katie towards the end of Term 2, as during my visits she was either unwell or busy with report writing.

Early in Term 3, I gave a brief talk at the weekly staff meeting about the general findings of spatial language in Iwaidja. This had taken some months to organise, as most weeks there was another visitor or urgent matter to attend to in staff meetings. In response, the principal Carol noted that the Western/relative manner of speaking about location was egocentric. I discussed using local landmarks such as Cape Croker and the barge landing, as well as sunset and sunrise in activities involving directions. Leah picked up on this and incorporated it into it in her mathematics lessons during the next month.

> Leah: Direction I find they’re good with. We’ve been trying to do the cardinal compass points and when we actually put it into action outside and describe it using, “Ok, well, where’s the water, where’s the land, where’s Point David, where’s this?” and using the cardinal compass points they’re fine. So I think that’s a strength for them, but when they’re outside and actually seeing and pointing and showing me.

During the same visit, Katie and I talked about how Iwaidja did not have names for the two dimensional shapes, but that there were verbs such as *marralngan* ‘go around in a circle’ (§5.4.3). I suggested talking about the actions that a shape can do: that a circle can roll, a square can sit, that is, using a verb based discourse pattern (§5.5.2).

Katie and I also discussed an assignment she was doing for the TESOL course. She was required to analyse a transcript of student speech for grammar aspects to teach, and we were looking for spatial language. An example of the transcript is shown in (7-1).

(7-1)

Katie: Where do you live?

Sierra: Where office but office you go down and this way.

Katie and I had previously discussed the use of ‘where’ in Minjilang English shown by Sierra in (7-1) as a general locative preposition, possibly filling the same linguistic slot as Iwaidja

wuka (§6.3.4.11). In Katie's notes from the planning session we did together, she wrote "lack of preposition in language – like use *where* constantly." This suggests a deficit interpretation with the goal of Standard Australian English proficiency.

I taught one of Katie's maths lessons involving an obstacle course. We designed the course so that all the instructions had near equivalents in Iwaidja. The students had to perform the actions and then recount them, with teacher modelling. They returned to the classroom then drew a map of the obstacle course.

7.4.1 Investigation Sessions

Three weeks later, I visited in order to observe Katie implement some of the lessons we had discussed. I realised that there had been a gap in communication between us. She had already taught those lessons and told me she was focusing on weight that week in maths. I observed a lesson involving collecting and weighting tamarind pods (§7.4.2).

The main element of Katie's approach to teaching about space and spatial language which I was able to observe was a focus on modelling and eliciting sentences with phrases containing spatial prepositions. She did this throughout Investigations sessions, where she moved around the classroom filming and questioning students; during the lesson that involved collecting and weighing the tamarind pods; and in sessions at the end of the mathematics lesson where she used flash cards with spatial words written on them.

In the two examples below, a group of students and I were seated at the play dough table. The teacher initiated conversational dialogues which she filmed, saying, "Tell me what you're doing. One at a time. Sierra, in English, nice sentences."

Sierra had been making a sausage with the play dough and then she began to make an egg (Example 7-2; Figure 7.1).

(7-2)

Katie:	Where are you putting the egg?
Sierra:	Um, here.
Katie:	Can you say it in English?
Sierra:	I'm putting it in the sausage. I mean in the house in the sausage.
Katie:	You're making a house with the sausage.
Sierra:	And I'm putting this egg.
Katie:	Where are you putting it? You're putting it in –
Sierra:	– the – house
Katie:	Oh, good.

Figure 7.1. Making an egg

Although Sierra is already speaking English, saying "here", Katie's request "in English" means to complete sentences. Sierra says "in the house in the sausage", since the play dough is in transition from being a sausage to being a house, which Katie validates. Sierra uses the phrase "in the" three times in this utterance, but it is not validated by Katie, who re-prompts with stress on "in". The dashes represent pauses between words that are emphasised in a disjointed manner. Sierra completes the sentence in this manner and Katie praises her.

Katie then talks with Zoe (7-3) who has been listening to the above dialogue and who is also making egg-like shapes (Figure 7.2).

(7-3)

Zoe: I'm making, um, roun' ting, and I'm putting this ting where basket. And I'm gonna get another one.
Katie: And you're gonna roll it.
Zoe: And I'm gonna roll it.
Katie: And you're gonna put it ins...
Zoe: And I'm gonna put it in – the – basket
Katie: And you're going to put it *inside* the basket. Can you say that?
Zoe: I gonna put a inside wh the basket
Katie: How many are you putting in there?
Zoe: Um, five.

Figure 7.2. Putting eggs in the basket

Zoe initially uses the Minjilang English phrase “where basket”, but when prompted for a correction uses the staccato “in – the – basket”, as had just been modelled in the previous dialogue. Katie corrects her to use *inside*, despite “in the basket” being an appropriate English phrase in the context.

Examples (7-2) and (7-3) show teacher directed dialogue that is characterised by explicit modelling and instruction. Students are praised for completing the teacher’s sentence and following her instructions. In both examples, students spontaneously use the phrase “in the ...”. Sierra was not praised until she completed the teacher’s sentence. Zoe was not praised despite having listened to the teacher’s model and replicating it correctly.

Example (7-4) shows a dialogue that took place between two students in the block corner and demonstrates a natural use of “in” and “inside” by the students. Will is attempting to crawl inside a toy house the two boys have made (Figure 7.3). Will has the camera on a low block within the play house so he can film himself entering the space. He is concerned that it is too small and that he might knock it down. Adam reassures him.

(7-4)

Will:	I was doing some house.
Adam:	You going in?
Will:	Yep. Mm, too little.
Adam:	Yeah, go in.
Will:	Ah, e’ll break.
Adam:	Nothing ... (No, it won’t)
Will:	*Ma*, *nuyi* be go in? (Alright, did you go in?)
Adam:	*Yuway*. (Yes)
Will:	Too big, ah, too little.
Adam:	*Ma*, put your leg inside. (Alright, put your leg inside.)

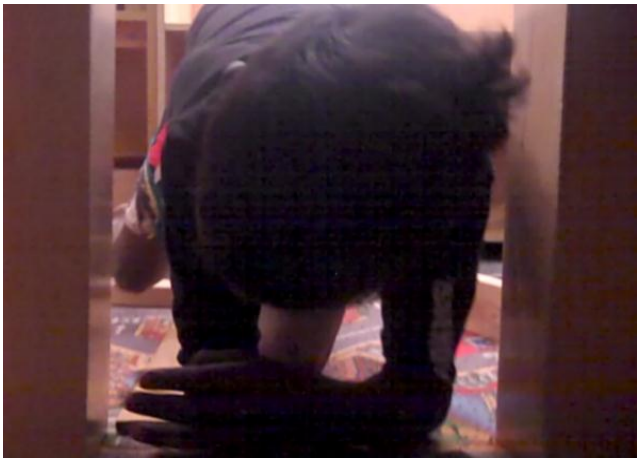


Figure 7.3. Inside the block house

This dialogue also shows some common features of Aboriginal English such as *be go* for the past tense of go, and the use of *nothing* as a broader negative. It also includes *nuyi* 'you' from Iwaidja/Mawng.

The children demonstrate an acute consciousness of the size of the play space they have created. Will is hesitant to enter the space, assessing it as "too little" and fearful he will cause the structure to fall. The other child, Adam, assures him that it is ok. Will checks this by asking "*Nuyi* be go in?" (Did you go in?). When Adam replies affirmatively, Will enter cautiously. As can be seen in Figure 7.3, he keeps his arms aligned with the walls of the space. A final example (7-5) during this Investigations session was noted when a student was pouring water from one container to another beside the water tub.

(7-5)

Katie:	Carter, make sure when you pour, you do it *over* the tub.
Brendan:	Carter, inside where *wubaj* (water).

In this example, Carter did not seem to understand Katie's instruction. Another student, Brendan, translated the teacher's words into Minjilang English using the general locative preposition *where* coupled with *inside*. It's not clear whether Brendan's instruction means "make sure the water that falls goes *inside* the tub" or whether *inside* refers to the space *over* the tub.

7.4.2 The Tamarind Lesson

The dialogue shown in example (7-6) took place during a lesson on weight. Katie took the students outside to collect tamarind pods from a tree in the school yard. The students like to eat these fruit, which they collect by knocking them off the tree with thrown sticks (Figure 7.4). Katie incorporated discussion about location as she talked with students about the activity.

(7-6)

Katie:	What are you guys trying to do? You're trying to get the tamarind down.
Robert:	See that?
Katie:	Yes I can see it. Where is it Robert?
Robert:	Up here, up here. There look.
Katie:	Can you tell me where it is?
Robert:	Ah, there look in the tree [pointing with a stick]
Katie:	Where in the tree? Robert, where in the tree?
Robert:	Inside the tree.
Katie:	Inside the tree. Is it up high or down low?
Robert:	A little bit low.
Katie:	A little bit low, in the tree, inside the tree.

Figure 7.4. Knocking down tamarind pods

In (7-6), Katie affirms the student's non-standard phrasing, such as "inside the tree," rather than modelling a particular phrase that she wanted as in (7-3).

After collecting the tamarind pods, and some rocks, the students went back inside. Katie counted and weighted them with the students sitting around in a circle. Towards the end of the session, Katie got the location flashcards and held them up asking questions such as "What was on *top* of the tree?" (Figure 7.5)

Figure 7.5. Location flashcards

As Figure 7.5 suggests, few of the students were engaged with this final part of the lesson. As can be seen from the above examples, Katie's spatial focus was largely on topological terms (§3.4.4; §3.5.5).

7.5 Conclusion

Because I worked alongside the teachers, because I knew their students as individuals and as classes, because I shared their frustrations and isolations, we were able to achieve a rapport during interviews that would not be possible for a stranger making a "quick research" (Howard, 2001). My extended presence in the school also enabled rich observations,

interactions and interpretations. When the school based phase of the project had to be adapted to circumstance I was able to understand why those changes needed to be made.

The aim of this chapter has been to recount how the Early Years teacher Katie and myself tried to implement a more culturally responsive mathematics program, and also to elucidate some of the factors that inhibit Mamaruni School becoming more culturally responsive. There are two main factors involved. The first is the teachers' understanding, which relates to their level of preparation, experience in the context and knowledge about the culture and languages of their students. The second is the environmental and systemic constraints that act against the teachers' desires or attempts to be more culturally responsive.

Both the teachers and I considered that the fact that the language of instruction and assessment was not the first language of the students was a major factor affecting the teaching and learning of mathematics. They were aware that the school system's expectation that students learn in an additional language was a difficulty for students that those taught in a first language do not have. The teachers were very aware that discussing mathematical concepts and processes was difficult, and sometimes impossible, because they and the students were not equally fluent in a shared language. Examples were seen of assistant teacher and other students trying to translate for the teacher when students didn't understand instructions (§7.2.2.3; example 7-5). These examples are from Standard Australian English into Aboriginal English, but translation also occurs into the other languages of the community.

Katie was interested in the project in terms of how it could assist her to teach to the curriculum, or rather the *Diagnostic Net* (NT DET, 2010b). Despite mentioning the importance of teaching concepts, the goal of teaching Standard Australian English appeared to be more important for her than mathematical conceptual development. When these goals conflicted, she chose to focus on the English teaching rather than the mathematics. This was probably both because of the emphasis placed on teaching Standard Australian English from the school and because she had not previously thought deeply about the development of mathematical concepts. However, as she admitted in her second interview, her views of the nature and purposes of mathematics broadened over the course of the year. She, along with the other teachers, tried to sequence their mathematics teaching to build on the prior knowledge and interests of the students, and was more able to do this as she learnt more about her students.

Other linguistic issues included differences in semantic structure between the Standard Australian English of the school and teachers and the languages of the students. Getting the

teachers to understand some of these differences, which was my aim, was not always easy. In 2011, the teachers all undertook TESOL training throughout the year, but at the start of the year they had no previous TESOL training. Through this training they were gradually able to gain a better understanding of linguistic issues that affected their teaching.

Teacher turnover is a serious impediment to developing a culturally responsive program. By the start of 2012, all the Balanda teachers interviewed for this project had left to go to other schools and there was a new cohort of teachers at Mamaruni School with the same lack of experience and preparation. This is an ongoing problem in remote communities, particularly very small, very remote communities like Minjilang. Reasons included social isolation and lack of health care, among others. The lack of school–community partnership also affects this, with teachers not feeling acceptance or welcome in the community.

Various other issues are evident from the teacher interviews which have an impact on mathematics teaching. The management of lessons and classroom behaviour is a significant factor which overrides the benefit of generous resourcing. Students generally need a facilitator for group work, not just in mathematics. This could be related to how students conceive the purpose of school and their role at school. Similarly, although the teachers appeared to prioritise facts rather than processes, the students also play a role in determining what the teacher is able to focus on.

Becoming numerate is all about learning to connect mathematics with real life. Daily we move in space, manipulate things in space and communicate with others about this. However, the teachers seemed to think that locational skills were not as important for students' future lives as number skills. This may a message they receive about what is important in mathematics. The teachers had difficulty seeing the relevance of some of the mathematics curriculum for the students. To some extent, this means they had difficulty seeing how they could transform teaching mathematics to teaching numeracy.

The teachers at Mamaruni School were all attempting to teach the mathematics curriculum to their Indigenous language speaking students to the best of their ability but they felt that the curriculum could be made more suitable for their students. As Shirley powerfully put it,

> Shirley: They still have every right to speak their language and therefore that should be respected, therefore there should be another curriculum, a different curriculum for Aboriginal. I think really when a curriculum's written, it should be written with a lot of Aboriginal people's input. And I'm not talking about Aboriginal people's input that have been brought up in the European environment. I really think they need to get some of these people, TAs (Assistant Teachers) who actually live on communities, and get their input.

Chapter 8
Implementing Culturally Responsive Education

The second phase of this project addressed Research Question 2:

How can teachers' understanding of frame of reference in Iwaidja be used to construct and teach a more culturally responsive Early Years mathematics program?

This question broadened during the project to include an investigation of factors at Mamaruni School affecting teachers' ability to teach in a culturally responsive manner. This chapter returns to the model of culturally responsive mathematics that was described in Chapter 2, in which the components of culturally responsive education were described as *empathising*, *understanding* and *responding*. As I stated in §2.1, the description *culturally responsive* broadly reflects my approach and concords with how some other researchers have used the phrase, but I do not apply any predefined theory of culturally responsive education. This chapter draws on the ethnographic data obtained though my repeated immersion in the environment of Mamaruni School and examines it in the light of the research literature.

Briefly mentioned in Chapter 2, this chapter first examines some of the complexities of *empathising* in a cross-cultural educational context (§8.1). This project focused on language as the core means of reaching the foundational understanding required to be culturally responsive, because of the relationship between language and mathematical cognition. In the next section, examining *understanding*, I interpret the multiple roles of language in mathematics education at Mamaruni School (§8.2). The study showed that the teachers were aware of language as a major issue in their mathematics lessons. The fact that teachers and students did not share a first language affected how language was used to access and communicate mathematical concepts and processes and also how assessments were made. Finally, I consider ways in which the school system could *respond* more appropriately to the needs of Indigenous language speaking students in their mathematics and numeracy learning (§8.3). I argue that current curriculum and benchmark expectations impede teachers' capacity

to be culturally responsive and discuss how these systemic requirements could be reconfigured more appropriately for remote Indigenous contexts.

8.1 Empathising

Empathising was mentioned in Chapter 2 as a necessary ingredient in good teaching in general. The study revealed some of the difficulties involved in trying to empathise with a different culture that holds different values to one's own (§8.1.1). Different goals and different values on the part of school and community members at times come into conflict. Meaning well on the part of the teachers and school does not always translate into doing well. In this section I also look possible relationships between social values and spatial language and whether interpretations of Indigenous cultural values lead teachers to valid assumptions about cultural learning styles (§8.1.2).

8.1.1 Valuing Difference

Mamaruni School and its teachers have goals that are not necessarily shared by all the community. The compulsory education of Indigenous students in an essentially non-Indigenous institution by non-Indigenous teachers is a situation requiring the deepest cross-cultural sensitivity. In practice, there is an assumption on the part of the school system that this education is required, necessary and good, rather than it being at the request of the Indigenous community. While many Indigenous people are very keen for their children to participate and achieve in school, others may not value school education in the same way, sometimes because of their own negative experiences of school (Collins, 1999; Watson et al., 2006). Brandl (1981) makes an interesting point asking whether many non-Indigenous Australians would be willing for their children to be educated by Indigenous people. She points out that Indigenous Australians have no choice about having their children educated by people from another culture with different values. This may change in the future with more Indigenous people becoming qualified teachers, but, as previously mentioned, less Indigenous teachers have been trained in the Northern Territory in recent years than 20 years ago (§2.3.6). Most Northern Territory schools, including Mamaruni School, continue to operate according to Western norms and values rather than Indigenous ones.

Despite talk in the school about respecting Indigenous culture, Mamaruni School promotes Western values to the students. For example, traditional Indigenous values such as personal autonomy (Christie, 1995; Malcolm et al., 2003) are often at odds with school practices which privilege adherence to teachers' authority and timetabling. School start time is an example.

Mamaruni School starts at 8:10 am each day, with breakfast before that at 7:45 am. However, lessons in class do not begin until 9am, with the first 50 minutes given to a whole school assembly and sport session. One of main the reasons for this is that students are often still arriving at school during this period. Teachers defer formal academic lessons until the majority of students have arrived for the day. They talk about how late the children in the community go to bed for the night. During the project, I frequently heard teachers wonder to each other why families didn't insist their children go to bed earlier. I rarely observed an understanding of the personal autonomy that Indigenous parents grant their children, which means that the parents do not believe it is their role to determine a bedtime for their children, nor to wake children up in the morning to go to school. While the morning sport program is a measure of responsiveness to the timetable of the community, this was still within the predetermined timetable of the school day. Teachers did not talk about changing the actual hours of the school day to a later start time, which would have been a culturally responsive action if it had been implemented. Christie (1995) identifies the Balanda/Western school "semi-religious preoccupations with planning and preparation, timetabling and the regulation of planned activities" (p. 32) as a factor that obstructs and undermines Indigenous participation in schooling. Truscott and Malcolm (2010) point out that in Indigenous education

> though intentions are good, control is exerted on groups such as students, schools and language speaker communities through financial reward and incentive, psychological punitiveness, ideological rhetoric and often passive acceptance. (p. 15)

Some of the underlying values of local Indigenous culture are unknown by the Balanda teachers, and very different from their own values. Thus it is difficult for the teachers to practice cultural empathy, as opposed to the sympathy that they might feel for an individual child in difficult circumstances. Empathy needs to be founded on a qualitative understanding of differences and variances, which takes time and care to develop. With greater understanding of the values of the local culture, the teachers would be more able to respond rather than react to the differences. However, where Indigenous values come into conflict with Balanda values such as, in this example, child autonomy conflicting with punctuality, it is particularly difficult for the Balanda teacher to accept the differences.

8.1.2 Different Values

This thesis has been concerned with the relationship between language and cognition as vital to mathematics education, and has taken linguistic relativity as a central philosophical and methodological premise (§2.2.2). It has also considered the impact of the natural environment

on the types of absolute reference used (§3.5.3). This section considers the possibility of a relationship between social values and spatial reference.

When I presented some of my findings about spatial frame of reference to the teachers at Mamaruni School, the principal, Carol, responded in socio-psychological terms. She identified the relative frame of reference frequently used in English as *egocentric* (§7.4). This term has been used in the literature for the relative frame of reference (e.g., Miller & Johnson-Laird, 1976; Pederson, 1993), since it is dependent on the position of the speaker within the speech situation. When the principal used it, however, it also appeared to refer to personality values associated with egocentrism or individualism, such as selfishness, and the contrasting values associated with collectivism such as generosity and cooperation (McInerney, 2012). It would be a massive oversimplification to suggest that societies that prefer the relative frame of reference promote egocentric personalities, or similarly, that a preference for the absolute might promote a detached and objective personality, and a preference for the intrinsic lead to highly developed empathy.

However, there are a few studies that claim a relationship between social structures, people's use of social and physical space, and linguistic representations of space. For example, a study of Tongan language and society found the preference for a radial system of representing space in language and cognition could also be found in cultural practices such as social relationships (Bennardo, 2009). Aymara speakers of the Andes encode 'east' with the 'front' and 'west' with the 'back', both in their speech and in the layouts of traditional houses (Núñez & Cornejo, 2012). Danziger (1996) found that the Mopan "talk about, and act upon, spatial and 'kinship' relations in a similar way" (p. 78), noting a similarity between Mopan kinship and the use of the intrinsic frame of reference. Danziger claims that within the Mopan community language and social relations mutually influence and reinforce each other:

> Linguistic structure here becomes more than merely a 'reflection' of social practice. It also functions in everyday life constantly to re-create the very constellation of social forms which gave it meaning in the first place. (p. 79)

Social relations in Arnhem Land societies are determined by kinship. People are born into a *skin* group determined by their mother's skin. The skin group determines many of the social obligations and relations that the person will engage with throughout their life. The related kinship systems of the Yolngu of East Arnhem Land have been analysed as recursive and identified as ethnomathematical (Cooke, 1990; Watson-Verran, 1992). These kinship systems could be viewed as absolute systems in which the individual is located with respect to a pre-

existing matrix, as compared to an egocentric or relative kinship system in which relations are constituted projecting from the individual. Watson-Verran (1992) expresses it thus:

> Constituting the world as a named matrix (with many levels of names) Yolngu languages predicate through pointing to change relations in the matrix. In contrast English predicates by pointing to the movement of a foreground body against an undifferentiated background. (p. 31)

However, in West Arnhem Land, individuals' relations with other individuals may take precedence over the systemic relations of the skin groups. Relationships may change through adoption. A death may lift a person into a different generational role, for example, an aunt may become a sister. A woman's relations with her husband's family will not necessarily be defined through him as "in-laws" but instead she will have her own relationship with each of them (Ruth Singer, pers. comm., 6 May 2012). Each member of the society has their own network of relations with all the others. This could be seen as more about intrinsic relations, rather than relativistic projected relations, or fixed absolute relations.

Socio-cultural effects on cognition are assumed in culturally responsive education approaches that focus on culturally responsive learning styles (e.g., S. Harris, 1987; R. Nichol & Robinson, 2000; Yunkaporta, 2009). Carol's comment about Western egocentrism invoked widely held ideas of Western society as individualistic and Indigenous society as cooperative. A recent large-scale quantitative psychometric study that investigated goals and learning processes among Northern Territory students in different settings expected collectivist values such as social concern and affiliation for very remote Indigenous students (McInerney, 2012). The study in fact found high levels of both collectivist *and* individualist goals for very remote Indigenous students compared to urban Indigenous, remote Indigenous and non-Indigenous students. The researcher was surprised at how competitive and power-oriented the very remote students were. Difficulties with group work in mathematics classes may be due to factors such as family dynamics (Jorgensen, 2011). However, many individualist characteristics are valued in Indigenous society in Northwest Arnhem Land, and these might interfere with the use of group work. In my experience, the students at Mamaruni School are very competitive and I often found turning an activity into a competitive game was the only way I could engage students in the activity. Further ethnographic investigation into social practices coupled with linguistic research in manners such as described by Bennardo (2009) and Danziger (1996) could potentially enrich ideas of culturally preferred learning styles.

8.2 Understanding

In this section the theme of *understanding* is explored with respect to language in mathematics education at Mamaruni School. Language is the primary means through which teachers and students can understand each other and understand mathematics. This section considers the role of language in the cognitive load (Sweller, 1994) of mathematics teaching practices at Mamaruni School. It also looks at how language is understood by teachers in relation to the teaching of mathematical concepts. It examines how conceptual confusion between teachers and students can arise in this multilingual situation.

8.2.1 Language in the Classroom

The teachers who I interviewed saw the language situation in the mathematics classroom as a difficulty both for themselves and, more so, for their students (§7.2.2.2). The teachers spoke Standard Australian English, which the students were expected to be learning. In the Early Years class in particular, some students began school with little English. The teachers were aware that some or much of their talk was not understood by the students. They were often not aware of exactly how much their students did or did not understand, and to what extent this contributed to the success of a particular lesson (§7.2.2.6). In such a language situation, there is a substantial amount of bewilderment and guesswork on the part of both students and teachers.

The teachers were aware that being taught mathematics in English was difficult for their students, and that this consequently increased the extraneous cognitive load for the students. Teachers tried to address this by using visual aids and explicitly teaching mathematical vocabulary. They were very conscious of explicitly teaching the (English) language of mathematics (§7.2.2.2).

Teaching mathematics in English to students who have other home languages means that teachers are simultaneously teaching Standard Australian English and mathematics. One of the dangers of these situations is that “mathematics students learn very little mathematics because the teachers are focusing more on developing their fluency in the language of learning and teaching (e.g., English)” (Barwell, Barton, & Setati, 2007, p. 119). As we saw in Chapter 7 in examples (7-2) and (7-3), Katie was highly conscious that she was teaching Standard Australian English to ESL learners. Student efforts to speak Standard Australian English were praised, but the focus on this caused the teacher to overlook instances where students displayed the desired conceptual understanding. Katie noted that the assistant teacher in her class would sometimes rephrase the teacher’s language in Aboriginal English. Example

(7-5) showed a student doing the same for another student. This may be a productive strategy, given Brenner's (1998) findings that Hawaiian Creole English students performed better when Hawaiian Creole English was used (§2.1.4).

The acquisition of the written forms of mathematics was also a concern for the teachers. They

recognised their students as proficient learners of some oral mathematical language (§7.2.2.2), but found their students had difficulty with the written forms. In the Early Years, up to and including Year 3, the literary focus in mathematics was on reading and writing numbers. Here the urgency of the curriculum imperative came into conflict with the teachers' understanding of the cognitive load that their students experienced. Rather than being given time to consolidate their oral learning (B. Graham, 1984), students with minimal or emergent literacy were often directed to read and write their mathematics. These lessons sometimes unwittingly contained a considerable amount of extraneous cognitive load (Sweller, 1994). For students with beginning literacy, the cognitive focus might be on the motor control to hold the pencil and form the letters, at the expense of linking the form of the numeral to a number name also not yet remembered. Low literacy impacted upon the types of mathematics lessons that were possible throughout the years of school.

The students' relatively low level of English also presented a challenge to the teachers in terms of assessment because the students did not always have adequate command of English to express their mathematical experiences and thoughts (§7.2.2.2). Both lessons and assessments that involve students talking about mathematical processes and concepts are difficult in a language-learning environment. The diagnostic assessment component of the *Count Me In Too* program (NSW DET, 2001) includes asking students about how they solved a problem. In my own experience, having carried out these assessments with many of the children at Mamaruni School across all year levels, these types of student explanation are difficult to elicit. Similarly, these teachers often could not make discussion the focus of their mathematics lessons. As Leah said about the planned discussion at the end of a lesson, "one person shared, no one listened and we couldn't continue so then we went outside."

Leah's statement, "no one listened," needs to be understood in the context that these children are trying to talk about mathematical ideas or processes in a language in which they are still developing proficiency. When the attempt to understand and produce the mathematical talk in English is coupled with new mathematical ideas, the cognitive load can be too much for effective learning. The result is that the students disengage from the lesson and engage in

other behaviours such as such as talking to each other about other things, moving around, or going to sleep.

In contrast to a focus on teaching mathematical language, Braid and Sullivan (2012) describe mathematics lessons trialled in a remote school in the Kimberley, Western Australia, which are predominantly non-verbal, using only an "economy of words." These lessons take account of Indigenous learning styles being described as based on observation rather than verbal instruction (S. Harris, 1987; R. Nichol & Robinson, 2000; Yunkaporta, 2009). One of the purposes of the lessons is to avoid the cognitive overload that can come from students being submerged in a "sea of blah" when they are not fluent in the language that the teacher is using. Another feature of this approach is that during these lessons the learning of English is de-emphasised and the focus is solely on the mathematics.

The difficulty of teaching lessons at Mamaruni School that involved reflective or expressive talk was a factor that led to the focus on the teaching of skills and concepts. Despite some of the teachers believing that teaching problem solving was important, none of the teachers focused on it, finding it too difficult in the context of the student group (§7.2.2.2). This may be because these Indigenous students place less educational value on discussion or the processes of problem solving than the Balanda teachers (S. Harris, 1987; Yunkaporta, 2009). It is likely also due to the fact that language required to discuss the processes of mathematical problem solving is more complex than that required to teach discrete skills or define a mathematical terms.

8.2.2 Use of First Language in the Classroom

There is no official use of Iwaidja, Mawng or Kunwinjku at Mamaruni School. Some of the assistant teachers use local languages to explain lessons and activities to the students in the class. This varies from individual to individual depending on their own language repertoire. The principal uses a few words from local languages when she talks to the students at school assembly. She uses words like *kuburruburr* 'early morning, next morning' to remind the students to come to school on time. Local languages are thus used for understanding as well as for trying to establish a rapport between principal and students.

However, at various times some of the teachers observed at Mamaruni School banned the use of "Language" in class. "Language" is sometimes used generically to refer to any Indigenous Australian language, as in "talking in Language." The reason given for this ban was that students used local languages to tease each other and to swear. The argument that banning "Language" prevents teasing was coupled with the argument that students come to school to

learn English. Some of the assistant teachers also used this second argument. While the teachers did not defend their banning of local languages in class in terms of the *Compulsory Teaching in English for the first four hours of each school day policy* (NT Government, 2009), it could reflect the same attitude as that policy, that school success should be measured in English (cf. Commonwealth of Australia, 2000).

Students also exercise power in the classroom through the use of their home language. If students use language that the teachers do not understand, the teachers are not able to gauge fully to what extent the students are on task. Students are able to have private conversations to which the teacher does not have access. In this type of classroom environment teachers can feel they need to control students' talk, hence the ban (Jorgensen, 2011).

Such banning, however, contributes to the devaluation of these languages by the school. Local languages are not seen as an important part of children's learning in the school. This inhibits students from access to the language in which that they are cognitively and socially comfortable and confident. Often, it is only in the casual conversations with each other that Indigenous ESL students are able to use language in a normally complex and sophisticated way (Moses & Wigglesworth, 2008). Not only is the social function of home language use reduced for the students but the cognitive benefits of using home language to discuss their learning with each other is also denied to them.

The dialogue between children that they filmed themselves in the house made of blocks which was shown in example (7-4) shows casual yet thoughtful use of language to discuss the interior capacity of the house. It contrasts with the stilted speech that the students produce in the teacher directed dialogues such as (7-2) and (7-3). Without the pressure to speak Standard Australian English, the students speak an Aboriginal English that is effective for their needs.

In some mathematics lessons, teachers might need to regard Standard Australian English proficiency as a lower priority than the mathematics, in order to engage with their students' thinking processes as expressed in their home language or Aboriginal English, or in fact sometimes without focusing on language at all, as with the approach described by Braid and Sullivan (2012).

8.2.3 Conceptualising

All of the teachers talked about mathematical concepts. This section discusses what the teachers might mean by 'concept' and how this fits into the multilingual mathematics learning environment.

Most of the teachers appeared to view concepts as discrete entities. Concepts were not viewed as identical with the word that named them, hence Katie's statement that her students could "grasp the concepts but they find the language difficult" (§7.2.2.2). A concept can be viewed as the 'signified' to which a word refers (Bell & Woo, 1998; cf. de Saussure, 1983). In this view, while words are not the concepts themselves, they each point to a concept, hence the expression "concept words" (Kimberley Education District, 2000). In mathematics, concepts tend to be abstract. The goal of grasping the abstract concept in mathematics has its basis in the Aristotelian idea of the *essence* (Lakoff & Núñez, 2000). In this view, concepts can be attributed with an independence from language and culture, and so run the risk of being considered *real*. This is a questionable view considering the interdependence of mathematical concepts, language and culture.

Despite recognising that words and concepts are not identical, teaching concepts at Mamaruni School was sometimes reduced to teaching vocabulary. It seemed easier for the teachers to understand what I could tell them about the vocabulary of Iwaidja than about the speech practices and the way concepts were used. In her notes from our joint planning session, Katie wrote "lack of preposition in language." This was her interpretation of what I had said about the multi-purpose *where* in Minjilang English. In the observed lessons, Katie appeared to focus on this as a *lack*, with her goal being to teach the Standard Australian English use of spatial prepositions (§7.4.1). In doing so, at times she did not recognise student responses as appropriate. Katie's focus in particular was on the teaching of the words laid out in the Northern Territory's *Diagnostic Net* (NT DET, 2010b), so she was interested in whether Iwaidja and the other local language had equivalent terms or not. However, she had more difficulty in taking up other suggestions we had discussed that had more to do with incorporating grammatical and conceptual practices of Iwaidja into her discourse patterns, such as the use of dual forms, or the emphasis on *AWAY* and *TOWARD* forms. It takes time for teachers to learn about grammar and inter-linguistic conceptual variation.

The analysis of the spatial language of the students from the Man and Tree game in Chapter 6 showed how some of the children's uses of spatial terms paralleled similar terms in Iwaidja rather than Standard Australian English (§6.3.4). I raised the possibility that teachers could perceive some of the children's use of these words as "wrong," but that how the teachers made these judgements might not be understood by the students (§6.4).

In their interviews, several of the teachers mentioned difficulties associated with spatial terms such as 'in front', 'behind', 'before' and 'after', that potentially were related to frame of reference uses (§7.2.2.3). When Katie said, "if you say 'behind the bin' you'll still find, you

know, some kids may be in front of the bin" she was expecting a situation like Figure 8.1, where the person is behind the bin relatively as well as intrinsically. It is possible the students are producing a situation like in Figure 8.2, where the person is 'behind' the bin intrinsically speaking, but not relatively.

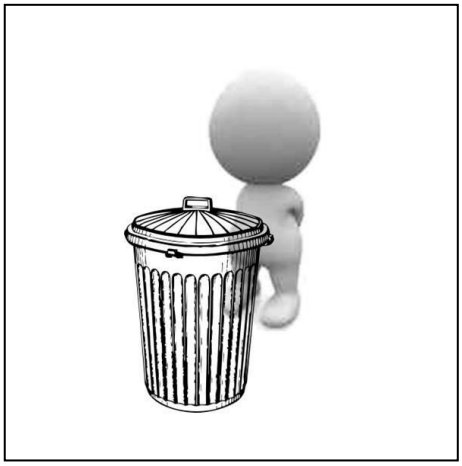


Figure 8.1. 'Behind' the bin, both relative and intrinsic frames of reference

Figure 8.2. 'Behind' the bin, intrinsic frame of reference, 'in front' of the bin, relative frame of reference

This demonstrates what can happen when children already have a pre-existing word-concept network, but the scope and domain of this network is different from that of English. Note that this is a possible interpretation of the event related by Katie, but further investigation would be required to determine if this was what was actually occurring.

A different understanding of 'before' and 'after' from the Standard Australian English concepts was noted by B. Graham (1988) as quite widespread:

> When exploring the difficulties that many Aboriginal children experienced when working on number lines, it was found in one language that a word was being used for 'after' (e.g. What comes after 3?) that was related to the speaker's point of view. Thus, the word could be translated back into English as 'before', 'after', 'previously', 'following', etc., depending on the context. This confusion has been found to be quite widespread, but

> interestingly, it is only through extensive use of two languages in education that many of these confusions have been revealed. (p. 129)

Applying a frame of reference analysis to the use of these terms permits a systematic explanation of the contexts of use.

It is common in mathematics to attempt to teach a concept through providing a definition (Bell & Woo, 1998). This is unlikely to be effective, as Vygotsky (1963/1986) warns.

> Direct teaching of concepts is impossible and fruitless. A teacher who tries to do this usually accomplishes nothing but empty verbalism, a parrotlike repetition of words by the child, simulating a knowledge of the corresponding concepts but actually covering up a vacuum. (p. 83)

One of the teachers, Leah talked about the need to *practice* concepts, seeing concepts as connections between lived experiences and words (§7.2.2.2). A concept is developed through the practice of conceptualising, rather than through connecting it to a word through definitions and examples. This has something in common with Lakoff's (1987) idea of *conceptual embodiment*, particularly that conceptual development arises through "the experience of functioning in a physical and social environment" (p. 12). It is also related to Vygotsky's (1963/1986) view that

> concept formation is a creative, not a mechanical, passive process ... a concept emerges and takes shape in the course of a complex operation aimed at the solution of some problem. (p. 54)

In this multilingual situation, it is important to return to the subtle differences in concepts that can exist between languages. Leah said about teaching concepts that "it's a bonus if they understand it in their own language," since if children already have a word with its associated networks of meaning, they can attach the English word into the pre-existing word-concept network.

It is important that teachers not view mathematical concepts as having an essential reality, but instead realise that very similar, related concepts are shaped by cultural, experiential and linguistic factors. Concepts which teachers think are abstract may have powerful contextual constraints. Kazima (2007) describes a similar situation in Malawi, where Chichewa speaking students learning in English have an understanding of probability words that is founded on probability concepts in Chichewa. As she says, "even though students might use the same words as the teacher, the meanings for students might be very different from that of the teacher" (p. 188). Teachers need to be careful to find out whether the children do actually have the same concept as the teacher.

These types of conceptual confusions are not limited to multilingual situations. Comrie (2003), a typological linguist, wrote an "auto-ethnographic" account of his experiences with 'left' and 'right' after moving from the United Kingdom to the United States. He found that he was confusing directions to turn while driving. In the United States, driving on the right hand side of the road, he turned right in response to directions to turn left. He concluded that he had internalised the specific understanding such that " 'left' when driving was the direction in which it is easier to turn" (p. 54). A study of concepts of Turkish topologists (mathematicians) found that they each had very different notions of the core concept 'open' (Barton et al., 2005). Thus conceptual confusions can arise for in many circumstances.

Kazima (2007) suggests that in the case of young children, conceptual confusion may also be developmental. I could not analyse the language use of the children of Mamaruni School in developmental terms, since the children were using different languages to their elders (§6.1). Two complex factors affecting the children's spatial language are their home language environment and the fact that they are children who have not yet learnt adult spatial language. The study was not able to fully describe and separate these factors. However, the parallel structures between the conceptual understandings that the children express in English and those which I have described for Iwaidja offer a powerful argument that the structures of the home or background languages influence the children's conceptual development.

The observed variations in conceptual development between speakers of different languages may be examples of linguistic relativity. This study did not provide systematic evidence for the validity of the linguistic relativity theory. However, it is my contention that the conceptual frameworks of the children are the result not just of their cultural viewpoint, but of the influence of grammatical structures in their home languages. Lucy's (1992a) identification of *habitual thought*, as opposed to potential thought, as the key domain affected by linguistic relativity has enormous repercussions for mathematics education in a multilingual environment. Teachers need to understand that Indigenous language speaking students think differently from first language speakers of Standard Australian English in ways that originate in the structures of their home languages. In teaching mathematics, they need to take account of their students' habitual thought even as they work with their students' potential thought to develop their specialised thought.

In Chapter 5, I mentioned the possibility of abstracting mathematical processes without necessarily nominalising them (§5.5.2). This came from considering of the verb-focused discourse practices of Iwaidja and in other languages such as Navajo (Pinxten et al., 1983) and Mi'kmaq (Lunney Borden, 2011). In English, mathematics concepts are generally nouns.

Mi'kmaw children have more events, processes and actions on which to draw compared to nominal "things" than English speaking children (Battiste & Henderson, 2000; Lunney Borden, 2011). When we think about conceptualising mathematics through practice rather than grasping an essence, we come closer to the *relational concepts* of languages such as Mi'kmaq and Iwaidja.

There seems to have been little examination in the literature of how developing concepts in Indo-European languages is associated with nominalisation. Concept maps are an example of an educational tool to develop and explore relations between concepts which were developed in English (Novak, 1990; Novak, & Cañas, 2008). Concept maps are used in a way that reflects the basic subject-verb-object pattern of English sentences, showing nouns or nominalised processes as the concepts and verbs as the links between them (Kilic, 2010). Speakers of Turkish, a case-marking language with sentence-final verbs, report difficulties using and making concepts maps as a result of Turkish's grammatical structure. Kilic's recommendations to address this with Turkish speaking students include talking about the conceptual relations and writing paragraphs below the maps. This example demonstrated that even the concept of a 'concept' is linguistically mediated.

The nominalising processes of mathematics, particularly in English, can easily lead to the perception that concepts are discrete. The idea of "grasping" a concept evokes this "thingness" of concepts. However, meaning is made in networks of relationships, which A. Collins and Quillian (1969) termed *associative networks*. Concepts do not stand on their own. As Leah said, concepts need to be practiced: this is concept as process.

It is important to note again that all of the teachers in the study except one were in their first year of teaching in this multilingual context and that none of them had received training in Teaching English to Speakers of Other Languages [TESOL] before commencing at Mamaruni School. It is difficult for teachers to become aware of cross-linguistic variation in concepts and grammar without linguistic training. In her first interview, Katie had said she'd not previously considered cultural differences in talking and thinking about space (§7.2.2.3). By the end of the year, she was appreciative of the learning she had done through the TESOL course, and through participation in the project (§7.2.2.5).

While teachers should not focus solely or primarily on the acquisition of mathematics vocabulary in Standard Australian English, neither should they avoid teaching the mathematics register. As Morgan (2007) points out

> Simplification or avoidance of specialised language may be seen as a positive strategy to enable learners to access mathematical ideas but, without it, they are denied access to the forms of mathematical knowledge that are most highly valued (p. 241).

Nevertheless, teachers of Indigenous language speaking students might try to create bridges to the formal or standard language by using both discourse patterns (Lunney Borden, 2011) and dialectal variations (Brenner, 1998) of mathematical talk that are more familiar to the students.

8.3 Responding

The teachers indicated that our discussions had helped them and given them ideas to implement in their mathematics teaching programs. However, these changes were always in deference to the overriding imperatives at the school and system levels shaped by formal assessment requirements. This section critiques some of these system requirements in terms of the unreasonable and counterproductive strain that they place on the teachers. It argues that these systemic demands, along with the teachers' relative lack of experience, are among the impediments to implementing culturally *responsive* teaching programs.

8.3.1 Curriculum

Teachers at Mamaruni School have to negotiate a veritable maze of curriculum and assessment documents and requirements. Simon commented that he was not sure which documents and resources he was supposed to be using (§7.2.2.4). Katie was not even aware of the NTCF (§7.2.2.4). For the duration of this study, Australia was in a period of transition from state and territory curricula to a national curriculum. There were also other frameworks and documents which teachers were expected to use. Figure 8.3 shows the first page of the *Assessment of Student Competencies Alignment document* (NT DET, 2011a), which introduces these varied frameworks and curriculum documents.

Figure 8.3. Front page of *Assessment of Student Competencies Alignment document* showing documents to be aligned (NT DET, 2011a, p. 1)

Although the NTCF was being used in Northern Territory schools including Mamaruni School in 2011, it was with the knowledge that it was the last year that it would be used. In 2012, the *Australian Curriculum Mathematics 3.0* (ACARA, 2012a) began to be used in the Northern Territory. Teachers also needed to use the *Early Years Learning Framework* (Commonwealth of Australia, 2009), the *Diagnostic Net* (NT DET, 2010b), and the *Assessment of Student Competencies* (NT DET, n.d.1).

The *Assessment of Student Competencies Alignment document* matches outcomes and expectations of these different documents across the learning areas. Table 8.1 shows how the outcomes or expectations for Space are aligned for Transition level in the different documents. The very need for a document to align the different frameworks and curricula demonstrates that working this out is not always straightforward.

Table 8.1. Transition outcomes for Space (from NT DET, 2011a, p. 13)

Frameworks				
Assessment of Student Competencies Is the child able to:	Northern Territory Curriculum Framework	Australian Curriculum Foundation	Early Years Learning Framework	Diagnostic Net T–9 By the end of Transition
10.1 Recognise and identify a triangle, circle and square (provide an assortment of shapes) Show me a triangle What's the name of this shape?	*S KGP2.1 2D shapes* *Knowledge and Skills* Identify simple 2D shapes in the environment: circle, square, triangle and rectangle	*Shape* Sort, describe and name familiar two-dimensional shapes and three-dimensional objects in the environment	*OUTCOME 5:* Children are effective communicators Children interact verbally and non-verbally with others for range of purposes	*Shapes and Measurement* Use words such as longer, longest, heavier, heaviest, shorter, shortest , holds more, holds less, to compare objects they can see, hold or touch
10.2 Say positional words *over/under, on/off, up/down* and use them in action demonstrating a direction e.g., *Jump on the mat*	*S KGP2.4 Location* *Knowledge and Skills* Respond to simple instructions and everyday language of position & movement: forward, backward, over, under, up, down, in and out, e.g., move forward two steps	*Location and Transformation* Describe position and movement	*OUTCOME 4:* Children are confident and involved learners	*Location and Maps – Transition* Know and use the language of their position and movement (next to, behind, below, underneath, forwards, backwards, towards) and of familiar objects

Teachers starting at Mamaruni School have many things to learn just to manage the day to day teaching context. In general, they are underprepared for what they first encounter (§7.2.2.5). They tend to be new to the Northern Territory and to Indigenous education. Few commence at the school with any training in ESL methodology; neither do they have experience of working in a team with an Indigenous assistant teacher. This lack of teacher

preparation is common in remote schools and has been reasonably well-documented (e.g., Cooper et al., 2004; Cooper, Baturo & Warren, 2005; Jorgenson, 2011; Moses & Wigglesworth, 2008). However, there is little in the research literature on the effect of the multiplicity and confusion of curriculum and assessment requirements on teacher performance in these contexts. Rather than holding teachers accountable for their own lack of experience, the school system should do more to prepare and support these teachers while they gain experience.

8.3.2 Urgency and Failure

There is a sense of urgency that pervades the field of Indigenous education, which this section examines in terms of the concept of *age-appropriate* education. The goal to close the gap between educational outcomes for Indigenous students and non-Indigenous students is a misinterpretation of equity which aims for the same outcomes at the same ages despite different beginnings (Truscott & Malcolm, 2010).

The inappropriateness of the curriculum in terms of age/Year level expectations was a more significant concern for the teachers at Mamaruni School than the actual content of the curriculum (§7.2.2.4). Several described the difficulties they had had in trying to teach at a so-called age-appropriate level. Teachers who had begun the year planning their mathematics lessons according to the level at which they thought the students should be had eventually turned the curriculum back a page or two. They described their mathematics programs as more successful, with more student engagement and learning, once they started using their own judgement about what level to teach.

Under the present system, many if not most remote Indigenous students in the Northern Territory fail compulsory assessments of mathematics and numeracy. Indigenous students' low performance on the NAPLAN tests are widely publicised (Forgasz & Leder, 2012). Northern Territory students also receive a compulsory A–E grade according to their achievement against NTCF outcomes. The expectations determining these grades are determined by age/Year level and are the same for all Northern Territory students. Most Mamaruni School students consistently receive D or E grades in mathematics, which are "below expectations" and thus can be considered fail grades. This contrasts with English, where teachers can set expectations for individual students against the ESL outcomes and thus grant a student who has made progress an A or B grade. In mathematics, some students will have made substantial progress over a reporting period, but receive a fail because they are still below the externally determined level.

The sense of urgency is clearly articulated in the *Diagnostic Net* (NT DET, 2010b). Teachers are expected to make a "yes" or "no" judgement about whether students are meeting the expectations. As we saw earlier (§3.4.5.3), "Achievement that is anything less than that described in the expectations flags the urgency for children to 'catch up' and 'keep up' " (Perso, 2010, p. 8). However, other support material also states that "Beginning Phase EAL/D (English as an Additional Language/Dialect) learners are *more than likely* to be monitored as not meeting expectations" (NT DET, 2012b, p. 13, emphasis added). As most Early Years students in communities such as Minjilang where the students speak Indigenous languages at home are beginning EAL/D learners, they are *more than likely* to be judged that they haven't met expectations, despite the tacit acknowledgement that the expectations of the *Diagnostic Net* are unrealistic for these students.

Teaching in a school where one is required to give every student a "no" or fail grade contributes to the sense of urgency which is so powerfully promoted in the *Diagnostic Net*. At Mamaruni School, none of the local students are consistently meeting the expectations of a document such as the *Diagnostic Net*. Entire classes are therefore categorised as needing to "catch up." There is a major problem with the reporting of a "yes" or "no" judgement about a students' achievement in the case of students who are likely to receive "noes" all the way through their schooling (Masters, 2011). Students, teachers and families are unable to see student progress in such reports. Although I do not know how students and families feel about these fail grades, the teachers felt depressed about having to issue them.

These assessments claim to be justified by considering the expectations to be *age-appropriate*. The concept of age-appropriateness in mathematics education appears to be undergoing an extension from what is developmentally possible for learners to what is prescriptively desired by the system. There is an assumption of a type of normal development and of naturalness to schooling to the point where we are expected to believe there is naturalness to learning certain mathematical content at a certain age/Year level. The curriculum is perceived as dovetailing with normal development.

I asked a member of the Northern Territory Department of Education Curriculum Team what a teacher should do if a student in Year 3, for example, was not meeting expectations of the *Diagnostic Net*. She advised that the teacher should teach Year 3 expectations but "scaffold down" (Gay West, pers. comm., 28 May 2012). This advice was the opposite of Masters' (2011), who advised that a student who is not achieving at their expected Year level "may first need time to master foundational skills" (p. 23) at an earlier Year level. Where a group of students are working at a level below deemed by the system to be below what is age-

appropriate, approaches that leap in at that higher level run the risk of impeding the development of foundational skills and knowledge.

There is a tension between the desire of the teachers at Mamaruni School to set high expectations of learning in their mathematics class, and making learning accessible for the students. While the teachers in this study clearly made this decision in a professional manner, choosing to plan and teach lessons to engage rather than baffle their students, they then had to deal with the stress of knowing they were not teaching to a level at which their students could pass according to the system.

Despite being positioned by official curriculum expectations so that they will likely receive a fail D or E grade, a "no" in the *Diagnostic Net* and not achieve national benchmarks in numeracy, NAPLAN results on *MySchool* suggest that many remote Indigenous students make more progress at school than their non-Indigenous peers throughout Australia. Masters (2011) has identified that fact that "the performances of NT students *relative to the rest of the country* improve between Year 3 and Year 9" (p. 36, emphasis in original). Although Northern Territory students as a whole continue to have lower achievement than the rest of Australia, *the gap narrows* throughout their schooling.

MySchool also shows a narrowing of the gap between students at Mamaruni School and all Australian students in numeracy scores (Figures 8.4 and 8.5). These graphs only show students who sat the tests in at the same school both years. These results suggest that although their achievement scores remain well below the national average, Mamaruni School students are learning a significant amount of mathematics at school.

Figure 8.4. Numeracy progress at Mamaruni and matched schools, Years 3–5, 2009–2011 (ACARA, 2012b)

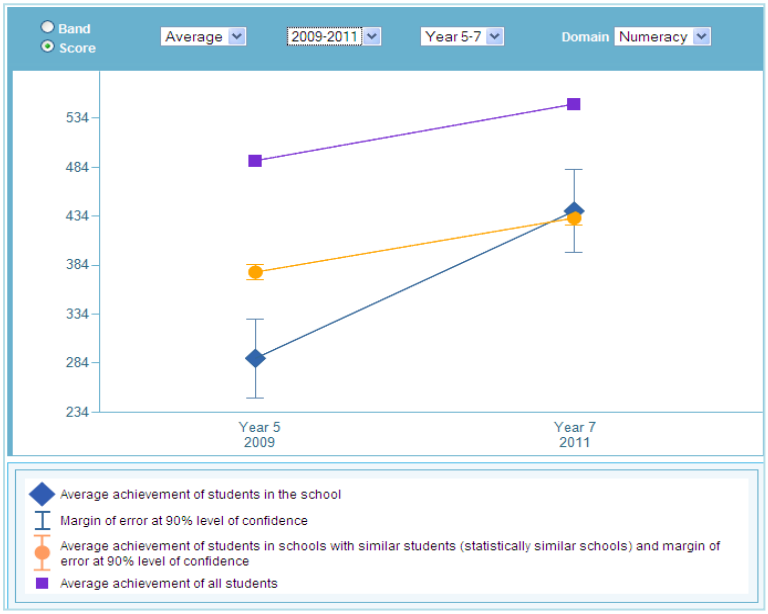


Figure 8.5. Numeracy progress at Mamaruni and matched schools, Years 5–7, 2009–2011 (ACARA, 2012b)

The Northern Territory has a high rate of early school leaving, and it is often the low achieving students who leave. Lower performing students are probably more likely to be among the students who missed the test in one or both of these two years. This could be a factor in the narrowing of the gap for Northern Territory students as a whole and for remote Indigenous students as schools such as Mamaruni. However, these graphs provide evidence that students who regularly attend school do make progress.

Language appears to be a factor in Mamaruni School students' performance on NAPLAN., particularly in the low scores in Year 3. Some of the so-called "statistically similar schools" include schools in very remote areas of New South Wales, where very few students speak Indigenous languages (Australian Bureau of Statistics, 2011). By Year 3, many Mamaruni School students are still Beginner Level (NT DET, 2009a) speakers of English. *MySchool* (ACARA, 2012b) also shows that some schools which are also very remote Northern Territory schools with Indigenous language speaking students show a low score in Year 3 and subsequent improvement similar to Mamaruni School.

Masters (2011) raises the question of how progress can be reported in such a situation. An in-school practice could be to set internal benchmarks for student learning that are achievable and that then can be celebrated by teachers and students (Heslop, 2003). The current system requires for teachers to spend time on assessments that their students will "more than likely" fail (NT DET, 2012b, p. 13). This leaves less time to set and celebrate realistic internal benchmarks, and to work on a more culturally responsive mathematics program.

Masters (2011) suggests improving the chances of Indigenous students meeting expectations and benchmarks by improving "school-readiness," and in particular to teaching English in the preschool years "at the earliest possible ages" (p. 40). This overlooks the fact that Indigenous children are often engaged in valuable learning of language, culture and society with their own families in these preschool years. While participation in good quality preschool education will increase "school-readiness," this should not be at the expense of Indigenous children's' right to develop their own language, culture and worldview. Care needs to be taken that pre-school education is not assimilationist, and does not impede conceptual development in the home language.

The expectations of the current system need to be realigned. Currently, in order to be successful and in fact to even pass at school, students need a level of English language knowledge when they start school that many Indigenous language speaking students in remote communities do not have. Expectations need to be achievable and realistic for Indigenous language speaking students.

The 2002 NTCF took account of the different learning trajectory of ESL learners. ESL learners were not expected to consistently meet the outcomes of the mainstream English Curriculum. It was understood that they could

> have difficulty coping with the specific language of subject areas and demonstrating abstract concepts through English. Where this happens, the ESL outcomes should be accessed for ESL learners so they can realise their potential. (NT DET, 2002, p.197)

Figure 8.6 shows a graphical relationship of how the relationship between the ESL outcomes and the mainstream English outcomes was imagined.

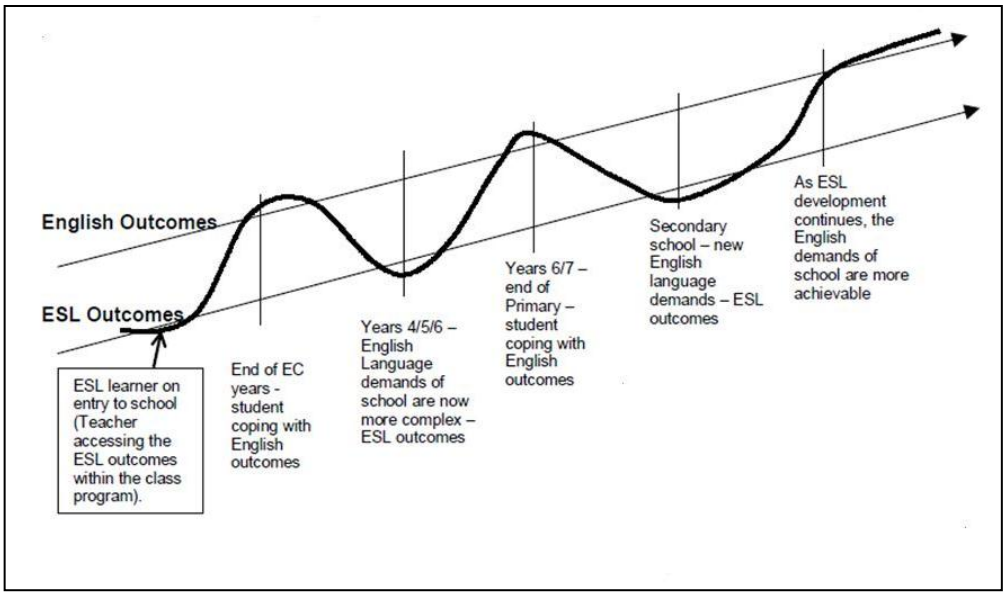


Figure 8.6. Relationship between English Outcomes and ESL Outcomes (NT DET, 2002, p. 196)

This diagram was not included in the 2009 version of the NTCF, which instead said

> as EAL learners develop their English knowledge, skills and behaviours, their learning will begin to correspond more and more to the progress outlined in the English Learning Area. (NT DET, 2009b, p. 8)

This was a significant and regressive change in expectations.

In an analysis of the literacy components of NAPLAN, Wigglesworth et al. (2011) point out that

> if NAPLAN is to be used as a diagnostic test of achievement and of teacher accomplishment in teaching English, for schools with predominantly ESL or EFL [English as a Foreign Language] students it makes sense to have two further tests based on the known progression of ESL and EFL learners, and on the kinds of difficulties they are likely to face at each stage of learning English. (p. 341)

This is also the case with mathematics, except that less is currently known about the usual progression of learning mathematics in ESL or EFL than about the usual progression of learning English.

These issues are not new. R. Collins (1999) found in respect to the Multilevel Assessment Program which predated NAPLAN in the Northern Territory that the Northern Territory Department of Education needed to find out "what are reasonable expectations for a student being tested in a language in which the student has limited proficiency" (p. 42). Unfortunately, this problem identified over twenty years ago with large scale testing for Indigenous language speaking students has not yet been solved or substantially addressed.

8.3.3 Other Factors Affecting Teacher Responsiveness

The teachers tried in various ways to be more culturally responsive in their mathematics teaching, and to make connections between mathematics and their students' out of school lives. One example presented here was Katie's tamarind lesson where the class went outside to gather tamarind pods (§7.4.2). Katie saw allowing the students to throw sticks to get the pods down out of the tree (Figure 7.4) as culturally responsive, as this is a local technique. However, the actual mathematics of the lesson, counting the pods and weighing them in a balance scale, were not at all things that locals would normally do with tamarind pods. The tamarind pods were simply standing in for any other countable and weighable material. This was reminiscent of the "cheap shortcut" mentioned by Eglash (2000) that "merely replaces Dick and Jane counting marbles with Tatuk and Esteban counting coconuts" (p. 20).

Katie's other attempts at cultural responsiveness included the use of familiar objects such as playing cards (§7.2.2.6). Shirley spoke about trying to ground teaching about 'before' and

'after' in the students' daily lives (§7.2.2.3). Leah had noted that her students were good with absolute directions outside the classroom, which she made use of playing direction-following games, but she didn't appear sure how to build on that within the classroom (§7.4). Because the teachers were all so new to the community, they were only able to respond to the culture as they learnt about it, and this mostly involved visible cultural practices rather than deeper, cognitively implicated practices.

The teachers at Mamaruni School considered that the students' mathematical learning connected to their out of school numeracy (§7.2.2.4). Familiarity with a practice or material in their home life, such the playing of card games, facilitated engagement and learning in the classroom. They also considered students' learning to depend in part of whether the students saw a need for the mathematics out of school. Thus students were considered more likely to want to learn if they saw the mathematics as contributing to their numeracy, understood as the application of mathematics in their actual lives and not the idealised numeracy of the school system. As Willis (1998) said, "we are not simply more or less numerate, rather we are more or less numerate with respect to particular settings or circumstances" (p. 35).

In remote communities, teachers want their students to gain the mathematical skills not just to be numerate in current community life but to be numerate in a possible life, for which there may as yet be no local role model. For example, teachers want their students to be able to become doctors, engineers or pilots, among many other things. Teachers assess their students' numeracy not in terms of whether the students are equipped for today's life for locals at Minjilang Community, but whether the students are equipped to be part of a life substantially different to that.

To this end, the teachers in this study focused on school mathematics. Intrinsic interest in students' ethno-numeracy, if it was present, was minor compared to the extrinsic goal of improving students' performance in school mathematics. Katie's focus was firmly on getting the children to learn Standard Australian English mathematics language, and this was despite the fact that she recognised that a mathematical concept was not the same as the word (§7.2.2.2).

The teachers reported different levels of preparation to teach mathematics at Mamaruni School, with the two teachers of the Early Years class feeling more prepared than the others (§7.2.2.5). Some of them reported that their lack of specific training in mathematics for ESL students affected their ability to program and teach effectively. Considering the importance given to mathematics and numeracy in primary education generally across Australia, and

specifically in a school such as Mamaruni School, where up to an hour and a half each day is devoted to dedicated mathematics lessons, there is a noticeable shortfall in training provided to teachers in this area. All of the teachers had at least a week's training in the school mandated literacy program, *Accelerated Literacy* (NALP, 2009–2012), but the only mathematics training any of them had received through the school was on-site training in some of the number aspects of *Count Me In Too* (NSW DET, 2001), which the teachers saw as a set of activities rather than as a program (§7.2.2.5). While the teachers all felt that language was one of the most significant issues affecting their mathematics teaching (§7.2.2.2), the training that they received did little to address this.

For the teachers, the assistant teachers were one of the most powerful sources of local cultural knowledge. While the quality of the relationship between teacher and assistant teacher in each class varied, the teachers generally valued the contributions that the assistant teachers made. The teachers recognised that the assistant teachers were essential to the success of lessons involving group work (§7.2.2.6). They also helped with interpreting the teacher's instructions (§7.2.2.3). However, the assistant teachers little direct input into planning lessons. There was little of the shared preparation time that is assumed in the Learning Together approach (NT DET, n.d.5) and needed for programs like *Talking Namba* (NT DET, 2011c). Assistant teachers did not share non-contact time with teachers during the day. The only time available for teachers and assistant teachers to plan together was the end of the day, and was generally spent in meetings or cleaning. Due to the difficulty of engaging cleaners at the school, both teachers and assistant teachers cleaned the school. However, the assistant teachers did more of the cleaning while teachers prepared lessons or wrote programs and reports. Some of the assistant teachers were also studying through Batchelor College, using the time after the students had left for this. The assistant teachers worked until 3.30 pm whereas the teachers often worked at the school until 5 or 6 pm and continued working at home. On Friday afternoons, the students went home immediately after lunch, yet this time, which could have been spent planning together, was spent cleaning the school by the direction of the principal. Conferences and professional development opportunities generally were offered separately for teachers and assistant teachers. Team planning time did not appear to be a priority at management level in the school.

A timetable where teachers and assistant teachers have planning time together at a reasonable hour, and where this is valued by management over, for example, cleaning the school, is a minimum requirement for teaching teams to connect, for assistant teachers to be able to share

their local cultural knowledge and for more thoughtful mathematics programs to be planned, culturally responsive or otherwise.

8.3.4 Sustainability

One of the major challenges for this project has been how to use the understandings gained in this research in an ongoing manner, both for mathematics education at Mamaruni School, and more generally for other teachers going into remote Indigenous communities. The brief tenure of teachers at Mamaruni School has implications for the viability and sustainability of culturally responsive mathematics programs. From 2009 to 2011 none of the incoming teachers at Mamaruni School stayed longer than a year. This gave them very little time to gain a rich understanding of the community as well as the various programs, curriculum documents and other system requirements. It takes time for teachers to gain cultural understanding in a new context. The teachers claimed to be willing to understand the students' culture. Although none of them had prior ESL teaching experience or training, in 2011 most of the teachers enrolled in a TESOL course during the year which helped them with their understanding of the linguistic and cultural factors in their teaching environment.

The full implications of brief teacher tenure became apparent during the course of the project. The teachers with whom I worked in 2010 and 2011, and whose views and experiences were recounted in Chapter 7, have all left Mamaruni School. Some of them have left the Northern Territory. Some are teaching in other remote Northern Territory schools using the experience and understanding that they gained on Croker Island to assist them in their teaching. But the specifics of the language-based understandings about spatial language on Croker Island may not be directly relevant to their new schools, where the students probably speak languages from other language families.

Short teacher tenure was one of the reasons that the *Building Community Capital to Support Sustainable Numeracy Education in Remote Locations* project focused on local Indigenous assistant teachers (Siemon et al., 2010). This is now manifesting in the *Talking Namba* program (NT DET, 2011c). It is based on the idea that local people are the ones who have deep understanding of their own community, of the languages, the students and the worldview.

In 2012, with her third cohort of new teachers in as many years, the principal realised that the teachers need cultural education at a community level. Bruce Birch, the linguist with the Iwaidja Documentation Program, gave a series of language and culture to the teachers at the school. More training in language and culture is also needed in orientation programs for new

teachers, but the linguistic diversity of the Top End means that it is difficult to cover relevant specifics for individual teachers' contexts, as Katie noted (§7.2.2.5). For example, this study revealed that Iwaidja and other languages of Minjilang talk about space differently to the more widely discussed desert languages (§9.1). Hence training needs to be offered at a school level as well as in preparation and induction programs.

In 2011, I concentrated on working in person with the teachers in the school, particularly Katie. The documentation of spatial language in Iwaidja needs to be turned into a form which is accessible to new teachers, presenting the linguistic findings in an accessible manner with recommendations and ideas for integrating them with mathematics lessons, and preferably with curriculum links. An online resource could link with other online material such as documentation of the findings which will appear on the *Iwaidja Inyman* website (2010). This documentation would take account of the brief tenure of teachers. To produce such a resource is a future goal which however depends on time and financial support.

8.3.5 Sequencing

One of my questions about the Early Years mathematics curriculum was whether its sequencing was appropriate for Indigenous language speaking students. In Chapter 3, I showed how the sequencing of space and location areas of mathematics curricula in Australia were based on Piagetian developmental assumptions (§3.4.5; Piaget & Inhelder, 1948/1956). I described how the order of acquisition of spatial concepts varied that described by Piaget in some cross-cultural contexts, and claimed that the order of language acquisition drives development of spatial concepts and that this is linguistically specific (§3.4.4.2).

In this chapter, we have also seen how the concept of age-appropriate learning has extended from what is developmentally possible into what is prescriptively regarded as necessary (§8.3.2). The designers of the *Diagnostic Net* seem very sure that it describes "the sequential building blocks that need to be learned in sequence [sic]" (Perso, 2010, p. 9). It seems very strange that the first of only two Year 1 expectations in *Location* is "know the meaning of *anticlockwise* and *clockwise*" (NT DET, 2010b, p. 47). Support material notes "if children do not know their left and right they are not ready to move onto the skills of clockwise and anti-clockwise" (NT DET, n.d.2, p. 1), and yet neither the Transition nor Year 1 expectations explicitly say students must know the meaning of left and right. As Katie felt, "it's not something that['s] really ... in the curriculum quite yet" (§7.2.2.3). Interestingly, the NTCF curriculum link for this expectation is at the Band 2 level, which is centred on Year 3.

The *Australian Curriculum Mathematics 3.0* (ACARA, 2012a) does not specify when terms such as ‘left’, ‘right’ or the cardinal compass point are to be introduced. However, they are implied by the suggestion that terms such as ‘clockwise’ and ‘anticlockwise’ be used in Year 1, and in using maps in Year 2. One of the work samples given for Year 2 shows a student using terms such as ‘north’ and ‘south’ to describe a route on a map, as well as ‘left’ (ACARA, 2011b, p. 20).

Many aspects of mathematics learning are sequential. Part of my argument against the prescriptive approach of documents such as the *Diagnostic Net* is that focusing on what a child “should” be learning at a particular age can mean that they miss out on foundational learning. But there is not necessarily only one correct sequence, and the right sequence for students who speak Australian languages may not be the same as the sequence in the curriculum. The researchers from the *Maths in the Kimberley* team claim that

> Perhaps one of the most pervasive factors that hinder success is the belief espoused by the linear model of mathematics ... mathematics learning should be seen as a network and ... learners have many paths through the maze of mathematical concepts. (Jorgensen et al., 2010, pp. 164–5)

The powerful directionality in Iwaidja (§5.5.1) led me to consider how one might go about introducing a topic such as vectors in the Early Years classroom (§6.4.4). This idea was not explored in the second phase of the project. It might seem bizarre to introduce a topic that is usually not encountered until the final years of high school to children who are not fluent in the language of instruction, and who are currently highly likely not to pass national benchmarks in mathematics. However, one of the emergent interpretations of the Iwaidja data was that for Iwaidja speakers there are no directionless points. A location always has a direction even when its motion is only potential. Using absolute directions with young children is feasible and in fact advisable when they speak a language where the absolute frame of reference is the dominant frame of reference. So too there may be ways to utilise the oriented perspective in Iwaidja and associated languages for advanced mathematics learning. It is difficult to find these ways when teachers and schools are constrained by the imperative of achieving curriculum outcomes; it needs brave and experimental innovation in mathematics programs.

An example of a program that inverts what are widely regarded as normal mathematics teaching sequences is the *Measure Up* program from Hawaii. Drawing on the work of Davydov (1975) and approaches followed in Russia, Dougherty (2007, 2010) and team have been conducting an innovative mathematics program. Rather than begin the Early Years mathematics lessons with number, they begin with direct comparison and measurement.

Children are encouraged to develop their own algebraic representations of problems. Their initial mathematics experiences are both concrete, in that children are expected to deal with real world problems, and encourage abstract and symbolic representations. The *Measure Up* program is not culturally specific or responsive, and in fact consciously targets students from as wide a range of socio-economic and ethnic backgrounds as possible. But it does show that in a carefully structured program, children are capable of mathematical thinking that is generally held to be in advance of age-appropriateness.

8.4 Conclusion

This chapter has described how the factors shaping mathematics education at Mamaruni School impacted upon the viability of developing a mathematics program that was more responsive to culture and language. In particular, these include teachers with brief tenure and an overwhelming set of mandated curriculum and assessment requirements and thus little time to consider imaginative and creative responses to the first phase of the research project. Teachers coming into remote schools need a single curriculum with appropriate mathematics outcomes specifically designed for Indigenous ESL learners, and they need supporting resources with explicit links to the curriculum. Teachers also need to be better prepared for teaching mathematics in an ESL environment before they come to remote communities, and they need ongoing training in local – to the community – cultural and linguistic specificities. Mathematics and numeracy assessment needs to take account of success and learning within ESL learning progressions. Schools such as Mamaruni School also need to value team planning time between teachers and assistant teachers.

Chapter 9
Conclusion

This project was motivated by the belief that the Northern Territory education system could be more responsive to the cultural and linguistic specificities of remote Indigenous students in how curriculum, schools and assessment practices approach mathematics education. I felt that not enough was known about these specificities, and in particular that little was known about mathematical concepts and languages which Indigenous language speaking children might use in their everyday lives.

The project thus had two main goals. The first was to investigate some of the spatial concepts and language of Iwaidja, adding to the documentation of this endangered language and to what is known about mathematical language in Australian languages. The second goal was to investigate how understanding Indigenous spatial concepts and language could help teachers be more culturally responsive in their mathematics teaching. This final chapter briefly restates the main findings of the project; discusses their significance, implications and limitations; and describes some of the avenues for further research that arose during the project.

9.1 Main Findings

There were two main research questions which each applied to one of the two phases of the project. Phase I addressed the question:

1. How is frame of reference expressed in Iwaidja?

Phase II addressed the question:

2. How can teachers' understanding of the frame of reference in Iwaidja be used to construct and teach a more culturally responsive Early Years mathematics program?

9.1.1 Iwaidja Spatial Language

The description of spatial language in Iwaidja in this thesis focuses primarily on spatial frames of reference, and also includes spatial verbs of motion elicited through route descriptions. The study found that Iwaidja uses all three frames of reference in small scale space: absolute, relative and intrinsic. Iwaidja also has other ways of specifying location such as deictic descriptions. Senior Iwaidja speakers use a wide variety of absolute terms, with

cardinal terms, wind directions and the land/sea axis all used frequently. They use the absolute frame of reference extensively in small scale space when other resources such as gesture are not available.

The study's findings regarding the relative and intrinsic frames of reference are also significant. The documentation of Iwaidja's use of relative 'right' and 'left' as well as relative 'in front' and 'behind' thus far appears to be unique in Australian languages. It is potentially an effect of contact with non-Australian languages, but if this is the case, it is not known whether is a recent effect of contact with English or the result of previous Macassan contact. It could also be a historical development in Iwaidja and other nearby languages in response to other factors, including environmental. The physical environment of peoples who live in the coastal and island regions of the Top End is greatly different from the arid Australian interior. It is therefore not surprising that the ways spatial frames of reference are used in the coastal language of Iwaidja differ from desert languages. It is very important to remember that there is not a single Indigenous way of talking and thinking about space, either from a linguistic or an educational perspective. Even to generalise the findings about spatial language in Iwaidja to other nearby languages such as Mawng and Kunwinjku, as this study tentatively proposed, must be done carefully.

Speakers' use of the intrinsic frame of reference in Iwaidja indicated that they paid a great deal of attention to situation internal features in spatial description. The strongly intrinsic use of 'in front' and 'behind' in Iwaidja concords with an oriented viewpoint, where oriented figures are ascribed a potential motion, rather than being regarded as occupying a fixed point in space. The inherent dynamism of this viewpoint is reinforced by ascribing orientation to non-faceted objects and by verb-rich discourse patterns.

Iwaidja's focus on processes rather than objects has implications for mathematics education, which has tended to link abstract concepts with nominalisation. We need to question both the purpose and the necessity of nominalisation in mathematics, especially when working with Indigenous students whose home languages are more verb-focused and dynamic than Indo-European languages.

9.1.2 Language Change and Shift

One of the sadder findings of the study was that none of the children at Minjilang are currently fluent in Iwaidja. At this stage it is not clear whether some of these children will eventually become fluent in Iwaidja as they grow older or whether Iwaidja is in its last

generation of being spoken. Language shift at Minjilang is towards (Aboriginal) English, Kunwinjku and Mawng.

Senior Iwaidja speakers use spatial frames of reference differently with their children to how they use them with their peers. The differences show the perception on the part of the senior speakers that the children will be more familiar with the relative frame of reference than the absolute, compared to their senior peers. This may be a judgement about the developmental capabilities of the children, with the adults believing that the children will not yet be familiar with the absolute terminology. It may also be due to a shift in Iwaidja away from the absolute towards the relative, caused by the influence of English and the Indo-European culture including schooling. This shift was observed in the children's use of frames of reference in English, with very little use of the absolute and substantial use of the relative.

A particularly interesting influence upon English from Iwaidja and/or Kunwinjku was observed in the use of the strongly intrinsic *front* and *back* in some of the children's English and mixed into Kunwinjku. This provides at least a partial possible explanation for the reported difficulties of Minjilang children to master Standard Australian English terminology such as the number 'before' and the number 'after'. The oriented perspective contributes to a semantic interrelation between cardinality and orientation/direction, which manifests as the lexical conflation of *first* and *in front,* and of *later, last* with *behind, in back of.* The number 'after' an oriented number can be the number 'behind' it, not the number 'in front of it' – that is, the number 'after' is the smaller number.

Spatial frame of reference provides a powerful way to understand the conceptual framework of these Indigenous language speaking students and how it diverges from the conceptualisation of their English speaking teachers. This study adds to the scope of what educators know about Indigenous spatial language in Australia. While needing to be careful about generalisations, teachers' awareness of this scope can assist them in understanding and responding to the ways people talk and think about space in the communities where they work.

9.1.3 Teacher Understanding

Most of the teachers who were interviewed for this project fit the popularly perpetuated profile of the remote teacher: relatively young and new to teaching, with no prior experience of Indigenous education. They were all also new to the Northern Territory, except for one returning after a long absence, and unfamiliar with the local curriculum and other requirements of the Northern Territory education system.

These teachers were committed, thoughtful and hardworking. They were able to become more culturally responsive as they learnt more and understood more about the local culture and their students. Their capacity to be culturally responsive in their mathematics teaching was adversely affected by a system promoted sense of urgency to teach age-related outcomes. The prioritising of teaching Standard Australian English over the teaching of mathematics in mathematics lessons also detracted from their attempts to teach in a culturally responsive manner. The study found that teachers might need to put aside the goal of Standard Australian English proficiency in some mathematics lessons in favour of engaging more with their students' thinking processes.

The study highlighted the fact that little is yet known about the acquisition of spatial language and concepts by speakers of Australian languages. Talking about "age-appropriate" mathematics learning makes little sense without some understanding of the normal progression of acquiring spatial frames of reference in their home languages. It is usual for Early Years mathematics curricula to advise first using the "everyday language" of the students in mathematical contexts before introducing more technical mathematical terms. Students who begin school with different everyday language to that used in the curriculum and in the school do not have the advantage of their early mathematics lessons building on the language and concepts which they use at home. To expect them to have the same outcomes as students who learn and speak English at home by Year 3, which is when the first national NAPLAN tests are conducted, is to expect a far more intensive period of learning than for those English speaking students. Inappropriate expectations of students mean that entire classes are labelled as "failing" from their first year at school even though their teachers report that many students are learning. Teachers, schools and the system need to set more appropriate and achievable expectations.

An insistence that remote Indigenous learning students need to achieve specified mathematics curriculum outcomes by a certain age is counterproductive if those outcomes do not take the students' language background into account among other cultural and environmental factors. The teachers at Mamaruni School were unsuccessful with their mathematics lessons when they tried to teach what they thought was age-appropriate content. They were more successful when they took into account their students' prior learning and taught at a curriculum level that they judged was suitable for their students. The teachers believed that making connections with students' out-of-school lives was an effective pedagogical technique. However, it was easier for them to attempt to use visible manifestations of cultural tradition rather than language features more subtly related to worldview and cognitive inclination.

9.2 Significance

The prevalence of spatial metaphor in mathematical language means that the significance of the way different languages talk about space extends throughout mathematics. This is the first study to apply the spatial frame of reference typology to mathematics education. There are problems common to all languages that languages solve differently. The problem that spatial frame of reference solves is how to specify the location of an object in relation to another object. Where the solution in one language has mathematical applications, then the way another language solves the same problem is potentially also the source of mathematical understanding or application.

The order of acquisition of spatial frames of reference in Indo-European languages provides a convincing explanation for the sequencing of the location strand of Early Years mathematics curricula. This sequence concords with the Piagetian stages of spatial thinking which relate to European children (Piaget & Inhelder, 1948/1956). However, this sequencing is not necessarily justified for children from other language backgrounds. The findings of this study remind us that studies of child development need to be interpreted in their cultural and linguistic context. What is normal development for a child learning an Indo-European language as their first language may not be normal development for a child learning an Australian language and vice versa. Therefore care needs to be taken in the use of concepts such as "age-appropriateness" that they do not involve the imposition of a norm from another culture and language.

Many of the spatial terms that were documented for the first time in this project were used by the senior consultants with each other but not by the caregivers speaking to the children. There is therefore a risk that some of these terms may be going out of use. Adding them to the dictionary preserves information about these terms which can be used by other linguists. The documentation of Iwaidja is also of great significance for Arrarrkbi, Iwaidja speaking people, especially considering the endangered situation of Iwaidja. Three consultants on this project passed away in 2012. Each of them contributed something unique to the project. The project is significant in documenting spatial language that may soon otherwise be lost.

9.3 Implications for Mathematics Education

The findings from this study have led to recommendations for teachers at Mamaruni School and other remote Indigenous schools. This study has also developed recommendations at a system level, in terms of curriculum, training and structure.

9.3.1 Recommendations for Teachers

The following recommendations emerged from the analysis of spatial language in Iwaidja and described in Chapters 5 and 6. The key sections of the results from which each recommendation emerged are referenced for each point. It is important that teachers:

1. Be explicit in differentiating between relative and intrinsic spatial instructions to students, and be aware that students may be more inclined to intrinsic than to relative thinking (§5.2.3; §6.3.3.2; §6.3.4.3).
2. Are aware of the importance that orientation has in spatial description and location for students. For example, if they ask a student to stand behind an object, and it does not appear that the student is in fact behind it, teachers should pay attention to the student's orientation. If the student is facing the object, they may consider themselves to be behind it, intrinsically speaking (§5.2.3; §5.5.1; §6.3.4.3; §6.3.4.9).
3. Use *verb based discourse patterns* and active attributes for talking about lines, angles and shapes. For example, describe a circle by its capability of rolling, or a square by its capability of sitting, in advance of focusing on the number of corners or edges (§5.3.1; §5.3.2; §5.4; §5.5.2). Focusing on these active attributes may be more useful to students than concentrating on naming parts.
4. Use fixed local landmarks when talking about directions in English. On Croker Island, these could include the sea, Cape Croker, the barge landing, sunrise and sunset. The English terms *north*, *south*, *east* and *west* could be taught through their equivalences with these directions (§5.2.2.4; §6.3.4.2).
5. Delay using *left* and *right* as directions until students have practiced and become comfortable with other aspects of the language of direction in English (§5.2.3.4; §6.3.4.6).
6. Use fixed directions to teach *left* and *right*. At Minjilang Community, if you are looking towards the sunrise, then *left* is towards Cape Croker and *right* is towards the barge landing (§5.2.3.4). This approach could be used instead of or in addition to using body-centred mnemonics such as remembering which hand is used for writing.
7. Introduce students to images or objects which are *incongruent counterparts* – mirror images of each other – in order to practice mirror image discrimination (§6.4.2). An appreciation of symmetry should not be assumed to include mirror image discrimination.

Clearly the details of recommendations 4 and 6 are specific to Minjilang Community and Croker Island. However, they could be adapted in another sun-focused community with local landmarks or cardinal terms. Recommendations 1 and 3 may be relevant in other communities with speakers of other languages. It is important that some investigation of the other

languages is conducted to determine whether the recommendation is appropriate for that community. Features of Iwaidja and Aboriginal English described in this thesis are likely to occur in other Indigenous Australian languages. Consideration of these features may enable teachers and researchers in other contexts to become aware of mathematically relevant variations that may occur in the languages with which they are concerned.

9.3.2 System Level Recommendations

Teachers in remote schools need:

1. A simple, *single*, appropriate curriculum for planning and assessment with mathematics outcomes specifically designed for Indigenous ESL learners (§7.2.2.4; §8.3.1; §8.3.3).
2. Appropriate teaching resources with explicit links to the curriculum (§7.2.2.4; §7.2.2.5).
3. Assessment and reporting scales which measure student success and learning, taking account of ESL learning progressions (§7.2.2.4; §8.3.2).
4. Team planning time with their assistant teachers during school hours which is valued by school management (§7.2.2.3; §7.2.2.6; §8.3.3).
5. Earlier and more targeted professional development in mathematics teaching for Indigenous ESL students. This needs to include learning about mathematical concepts in a multilingual environment (§7.2.2.5; §8.2; §8.3).

9.4 Limitations

One of the major limitations to the study was my own inability to speak Iwaidja, Mawng or Kunwinjku. The linguistic and non-linguistic activities of Phase I were designed to be administered by a fluent speaker in the target language. I was not able to do this, and my communication with participants throughout the sessions was in English. I was not able to monitor the interactions between the participants, particularly during the early sessions. In fact, in many sessions, I tried to minimise my speech so as not to unduly introduce English. Although I had hoped to learn some conversational Iwaidja throughout the project, this proved more difficult than expected, primarily due to the lack of contexts in which to learn. Apart from arranged recording sessions, I did not spend as much time as I had hoped with people who were speaking Iwaidja. This means that there is little naturalistic data about day-to-day use of Iwaidja to complement the structured research tasks. Nevertheless, as the study progressed, I was able to understand more of what was occurring between participants during sessions and at times to ask relevant questions (in English) at the end of a session.

My lack of knowledge of Mawng and Kunwinjku meant that I was reluctant to ask participants to do the tasks in those languages, despite the discovery during the course of the study that those were the languages most of the children preferred to use. I did not feel confident of my ability to learn enough of three languages in the research period to transcribe and translate data in Mawng and Kunwinjku as well as Iwaidja.

There is also the omission of younger adults speaking Iwaidja with each other. To date, the Iwaidja Documentation Project has involved elders with the aim of recording their knowledge while they are still alive. Repeating the tasks of this study with younger adults would help to answer questions about the vitality of Iwaidja and how Iwaidja is changing. I planned to do this in the latter part of 2011, but ceremonial commitments took the people with whom I had wished to work away from the community for several months.

Brief teacher tenure, the high-stress environment of the school, and the imperative to teach to the curriculum all constrained my ability to create a collaborative action research environment in the school. While most people at the school seemed to support the project in principle, it was difficult to help the staff to see the benefits of the project to themselves and their teaching. While some of the teachers with whom I worked in 2010 and 2011 may be using their newly gained knowledge to teach in a more culturally responsive manner in other schools, my work with them has not directly benefited the latest cohort of teachers at Mamaruni School. Because of this rapid staff turnover, the project still needs to be documented in an easily accessible form for new teachers.

9.5 Recommendations for Future Research

This project indicated many avenues for future research from both the linguistic perspective and the educational, as well as in the interdisciplinary area.

More extensive research into uses of frame of reference in all the main languages spoken on Croker Island, including frame of reference uses by individual speakers in multiple languages would enable a richer understanding of this topic. A question that was only partially addressed in the study was whether frame of reference use in Iwaidja is related to frame of reference use in Mawng and in Kunwinjku.

In particular, further research is warranted into the use of relative ‘left’ and ‘right’ in Iwaidja, Mawng and Kunwinjku, considering the use of this frame of reference is otherwise undocumented amongst Australian languages. The more frequent use of ‘left’ than ‘right’ would be of specific interest in such research. As well as being of interest linguistically, the

use of relative ‘left’ and ‘right’ are significant in mathematics particularly and in schooling more generally.

Other elements of the language of spatial location in Iwaidja which could be expanded upon by further investigation include the use of deixis, details of the absolute system such as the exact angles of wind directions and non-linguistic investigations regarding the use of the intrinsic frame of reference in cognition and memory.

The investigation of the language of motion in Iwaidja in this thesis is far from complete and could be conducted in more detail in order to produce a grammar of space for Iwaidja. This could include linguistic tasks that require the use of frames of reference in the language of motion. The path orientation of Iwaidja including ascribed orientation and ascribed motion also warrant further investigation.

As well as a more thorough description of Iwaidja, Mawng and Kunwinjku, more needs to be known about the order of acquisition of spatial concepts and language by children in these languages. This could contribute to the creation of appropriate mathematics achievement expectations for these students. Concurrently, more research is needed into the varieties of Aboriginal English that are spoken by students who speak Indigenous languages at home, as opposed to students who speak Aboriginal English as their first language. Such research needs to take into account multilingualism as a social norm in this region. The question of whether a mixed language is developing also needs to be addressed.

More broadly, the usual sequences of development of spatial language and spatial thinking in Australian languages need to be investigated further. More also needs to be known about the way child speakers of these languages learn English. Further investigations into both of these aspects could contribute to a better understanding of the development of mathematical language of Indigenous students who are learning English as a Second or Additional Language.

Investigation into the Iwaidja spoken by younger adults, the parents of today’s school children, could be used to bridge between what is known about the speech of the senior adults, documented in this study, and that of the children. Working with the younger adults might also help to understand more about the processes of language shift and change happening in Top End communities today.

Ethnographic investigation into social practices coupled with linguistic research could also be conducted to enrich theories of culturally preferred learning styles. This would need to be in the form of multimodal investigation into the relationship between spatial language and socio-

cultural and could focus in detail on one language such as Iwaidja or be undertaken with a range of languages and contexts. It would also need to take environment into account such as dominant geographic features.

The study revealed a relative paucity of research on the impact of grammatical structures on mathematics teaching and learning. Comparative research into how mathematics is learned and practiced in languages from a typological perspective is needed. Such research would benefit from careful consideration of the linguistic relativity hypothesis. One specific line of inquiry suggested by the research is the relationship between the use of the intrinsic frame of reference, the acquisition of mirror-image perception and mathematics education. Another more general knowledge gap is effect of the category of word (e.g. noun, verb, preposition) of mathematically significant terms or phrases in different languages.

The voices of the Indigenous assistant teachers were not represented in this thesis, now those of the children's families. Research into the educational aspirations of the community and the experiences, beliefs and practices of the assistant teachers working in the school would greatly enrich the capacity of future projects to be culturally responsive. The lack of local Indigenous representation in decision making suggests that such research might need to include use of a community development model.

9.6 Doing a Slow Research

The immediate benefits to the Iwaidja speaking community of this research are difficult to measure. The documentation of part of the Iwaidja language forms part of the larger Iwaidja Documentation Project which is valued by those concerned by the decline of their language. The project has been more limited in directly improving the educational experiences and outcomes of the students of Mamaruni School due to the brief tenure of Balanda teachers and the disempowerment of the Indigenous school staff. This thesis is not the most appropriate form to communicate the research outcomes to the school and the community. The intended reporting of the results in an interactive online form will hopefully better communicate the findings to these groups. In order to do a "slow research", I believe I need to continue to work with the school and the community, and not just walk away with this research to my academic career. This is part of the commitment that I have made to the people of Minjilang in good faith.

The project was also instrumental in raising the delicate issue of which languages the children of Minjilang are actually speaking. It was necessary to begin with Iwaidja as the language of

the Traditional Owners, but having given that initial respect to Iwaidja, the project has opened the doorway for future research on children's uses of the other languages, Mawng, Kunwinjku and Aboriginal English.

However, the benefits of this research extend beyond Croker Island to teachers of Indigenous language speaking students in other remote communities. This research is a case study that can be used as an illustrative example of both linguistic variation and school system constraints; it can help teachers to better understand their students and their students' cultures, and thus to be more responsive in their teaching. I hope that the research reported in this thesis will contribute to improved mathematics education for the students of Minjilang, Indigenous language speaking students across Australia, and other students in cross-cultural, multilingual learning environments. I understand that this thesis alone will not to that, but it is up to me to continue this work and to improve partnerships involved with this work. Finally, I hope I have done justice to the contributions of the Arrarrkbi participants young and old, as well as the teachers of Mamaruni School.

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Appendix A Plain Language Statements and Consent forms

Plain Language Statement – Caregivers

Invitation to Participate in a Research Project

Project title: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

Who is involved in the project?

This research project is being conducted by me, Cris Edmonds-Wathen. I am a teacher and linguist studying at RMIT University in Melbourne. My supervisor is Professor Dianne Siemon, in the School of Education.

The research is supported by Joy Williams. I can show you the letter of support if you want to see it. The Top End Group School is helping with this research by letting me work part-time in the school and paying for my flights. AIATSIS has provided funding to help with this research. This research project has been approved by the RMIT University Human Research Ethics Committee.

What will the researcher do?

I want to see if the teachers can help the kids to learn better. I have been trying to find out how people talk about where things are in Iwaidja. This will help me and the teachers plan better maths lessons for the kids, because we will understand more about how the kids think when they come to school. The part of maths this is connected to is called location, and it includes maps.

I will ask the children to work with another child, talking about where things are in Iwaidja and playing space games. I will be taping and videoing what they say and do. A space game is a special game made by a linguist for finding out about space in language.

I will plan lessons for the class about location. Activities will be a lot like normal maths lessons. Children will talk about things with the teacher and with each other. They will play games where there is lots of talking about where things are, and where there is lots of moving around, like Hide and Seek. They will do drawings and play games with things in the school. Some of this will be in English and some of it will be in Iwaidja. I will take notes and make videos of these lessons.

The research will happen in Terms 2 and 3, 2011.

What will the researchers do with the information they collect?

I will use this information to write a PhD thesis about Indigenous kids, language and mathematics. I will have copyright in the PhD. I will also use the information to write articles for journals and give papers at conferences. I won't include personal information without your consent.

I won't use any names to identify children who participate in this research. I will use a code name. I won't publish their photos unless you and they want me to. However, you should know that as the number of people who will participate in this research is very small, someone might still be able to identify you or your child.

I will keep the notes and videotapes in a locked filing cabinet at my house in Coconut Grove, Darwin for at least 5 years. After that, I will either destroy them, give them back to you or ask you whether you want me to give them to an appropriate Indigenous organisation. I would like to give them to AIATSIS for safekeeping.

What if I want to withdraw from the project?

You can withdraw from the project at anytime and withdraw any unprocessed audio and video data previously supplied. This means data that has not been transcribed or analysed.

How can I find out about the results of the project?

I can talk to you about the results of the research at a community meeting, or any other time if you want to contact me. I will make a booklet in simple English and Iwaidja that explains what we have found out and give you a copy. I will give you photos of your child joining in lessons.

Giving material to AIATSIS

If you agree, I propose to give a copy all of the notes, tapes and videos to AIATSIS for safekeeping. Please note that if I give personal information which identifies you to AIATSIS, the *Privacy Act 1989* (Cth) says that other people can only have access to it if you agree that they can. I will talk to you about who should be allowed to have access to this information, and how AIATSIS should keep it.

Benefits of the Project

This project might help your child to learn some parts of mathematics better. I can't promise that this will work. It might help the government to plan better for teaching Indigenous kids. It is only a small project.

Risks

Your child might not want to join in some of the activities. That's ok, no-one will force them to. If your child gets upset during the interviews or lessons, they can stop and talk to one of the teachers.

Questions and Complaints

If you are worried about the research project, you can ring up Cris on 0400 038 497 or 08 8985 1468 and talk to her about it.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251.Details of the complaints procedure are available from the above address.
You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Plain Language Statement – Consultants

Invitation to Participate in a Research Project

Project title: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

Who is involved in the project?

This research project is being conducted by me, Cris Edmonds-Wathen. I am a teacher and linguist studying at RMIT University in Melbourne. My supervisor is Professor Dianne Siemon, in the School of Education.

The research is supported by Joy Williams. I can show you the letter of support if you want to see it. The Top End Group School is helping with this research by letting me work part-time in the school and paying for my flights. AIATSIS has provided funding to help with this research. This research project has been approved by the RMIT University Human Research Ethics Committee.

What will the researcher do?

I want to see if the teachers can help the kids to learn better. I am trying to find out how people talk about where things are in Iwaidja. This will help me and the teachers plan better maths lessons for the kids, because we will understand more about how the kids think when they come to school. The part of maths this is connected to is called location, and it includes maps.

I am not trying to find out about where any special places are.

I will interview people one by one about how they talk about where things are in Iwaidja, taping and videoing what they say. I will also ask you to work with another Iwaidja person, talking about where things are in Iwaidja and playing space games taping and videoing what you two say and do. A space game is a special game made by a linguist for finding out space in language.

The research will begin in May 2010 and continue until June 2011.

What will the researchers do with the information they collect?

The information will be used to plan maths lessons in the Little Wamba class for the kids about location and mapping. I will work with the teachers and assistant teachers to plan and teach these lessons.

I will use this information to write a PhD thesis about Indigenous kids, language and mathematics. I will have copyright in the PhD. I will also use the information to write articles for journals and give papers at conferences. I won't include personal or culturally restricted information without your consent.

I won't use any names to identify people who participate in this research unless you want me to. If you don't want me to use your name, I will use a code name for you. However, you should know that as the number of people who will participate in this research is very small, someone might still be able to identify you.

I will keep the notes and videotapes in a locked filing cabinet at my house in Coconut Grove, Darwin for 5 years. After that, I will either destroy them, give them back to you or ask you whether you want me to give them to an appropriate Indigenous organisation. I would like to give them to AIATSIS for safekeeping.

What if I want to withdraw from the project?

You can withdraw from the project at anytime and withdraw any unprocessed audio and video data previously supplied. This means data that has not been transcribed or analysed. After the information has been used to plan lessons, you cannot withdraw the data anymore.

How can I find out about the results of the project?

I can talk to you about the results of the research at a community meeting, or any other time if you want to contact me. I will make a booklet in simple English and Iwaidja that explains what we have found out and give you a copy.

Giving material to AIATSIS

If you agree, I propose to give a copy of all of the notes, tapes and videos to AIATSIS for safekeeping. Please note that if I give personal information which identifies you to AIATSIS, the *Privacy Act 1989* (Cth) says that other people can only have access to it if you agree that they can. I will talk to you about who should be allowed to have access to this information, and how AIATSIS should keep it.

Questions and Complaints

If you are worried about the research project, you can ring up Cris on 0400 038 497 or 08 8985 1468 and talk to her about it.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251.Details of the complaints procedure are available from the above address.
You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Plain Language Statement – Group School Principal

Leonie Jones

Principal

Top End Group School

08 8999 3210

Invitation to Participate in a Research Project

Project title: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

Dear Leonie,

I am writing to ask your permission for some teachers and children in your school to participate in the above-named research project. It is being conducted by Cris Edmonds-Wathen, a PhD candidate at RMIT University under the supervision of Professor Dianne Siemon, School of Education, RMIT University.

This project will also form part of my PhD thesis. The project has been approved by the Human Research Ethics Committee at RMIT University and the Northern Territory Department of Education. AIATSIS has provided funding to help with this research.

What is this research about?

This study is about the languages that 5-7 year old children use to talk about space and location. I want to find out about how people, including children talk about space and location in Iwaidja in order to look at the way we teach these mathematics areas in English at Mamaruni School. I am looking at Iwaidja because it is an endangered language and because I have some experience of the children and community at Minjilang. The Northern Territory Curriculum Framework talks about using the "everyday language" space and location for children at this level, so I want to find out what that everyday language is for the students. Then I can make some suggestions about better ways to teach this area for the teachers.

What will I have to do, and what will the participants have to do?

Aside from signing a consent form, you will not need to do anything for this project. If you agree that teachers in your school may participate, I will interview them before and after the project. I will also work with them to plan maths lessons in location, and conduct those lessons with them in class. The total time commitment of teachers will be approximately 10 hours out of class, as well as approximately 5 hours in class.

If you agree that students in your school may participate, I will interview them talking about space and location in Iwaidja with another child. They will also participate in maths lessons in class that I will plan with the teachers. These lessons and interviews will be audio and video recorded.

What will happen with the information?

Any information provided will be kept confidential. The names of the school and participants will be replaced by a code in the research notes and the research report. I will remove any references to personal information that might allow someone to guess the identity of the school and participants. However, you should note that as the number of people we seek to interview is very small, it is possible that someone may still be able to identify the school or participants.

In addition, as with all research conducted at RMIT University, confidentiality will be safeguarded subject to any legal requirements. Data will be kept for a minimum of five years.

What if I want to withdraw from the project, and what if participants want to withdraw from the project?

Participation in this research is purely on a voluntary basis, and you or the participants may withdraw any unprocessed audio and video data previously supplied. This means data that has not been transcribed or analysed.

How can I find out about the results of the project?

I can talk to you about the results of the research at a community meeting, or any other time if you want to contact me. We will also make a booklet of the findings, which I can provide to you.

Questions and Complaints

If you are worried about the research project, you can ring up Cris on 0400 038 497 or 08 8985 1468 and talk to her about it.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251.Details of the complaints procedure are available from the above address.
You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Plain Language Statement – Teaching Principal

Fiona Spiers

Teaching Principal

Mamaruni School

08 8999 3210

Invitation to Participate in a Research Project

Project title: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

Dear Fiona,

I am writing to ask your permission for some teachers and children in your school to participate in the above-named research project. It is being conducted by Cris Edmonds-Wathen, a PhD candidate at RMIT University under the supervision of Professor Dianne Siemon, School of Education, RMIT University.

This project will also form part of my PhD thesis. The project has been approved by the Human Research Ethics Committee at RMIT University and the Northern Territory Department of Education. AIATSIS has provided funding to help with this research.

What is this research about?

This study is about the languages that 5-7 year old children use to talk about space and location. I want to find out about how people, including children talk about space and location in Iwaidja in order to look at the way we teach these mathematics areas in English at Mamaruni School. I am looking at Iwaidja because it is an endangered language and because I have some experience of the children and community at Minjilang. The Northern Territory Curriculum Framework talks about using the "everyday language" space and location for children at this level, so I want to find out what that everyday language is for the students. Then I can make some suggestions about better ways to teach this area for the teachers.

What will I have to do, and what will the participants have to do?

Aside from signing a consent form, you will not need to do anything for this project. If you agree that teachers in your school may participate, I will interview them before and after the project. I will also work with them to plan maths lessons in location, and conduct those lessons with them in class. The total time commitment of teachers will be approximately 10 hours out of class, as well as approximately 5 hours in class.

If you agree that students in your school may participate, I will interview them talking about space and location in Iwaidja with another child. They will also participate in maths lessons in class that I will plan with the teachers. These lessons and interviews will be audio and video recorded.

What will happen with the information?

Any information provided will be kept confidential. The names of the school and participants will be replaced by a code in the research notes and the research report. I will remove any references to personal information that might allow someone to guess the identity of the school and participants. However, you should note that as the number of people we seek to interview is very small, it is possible that someone may still be able to identify the school or participants.

In addition, as with all research conducted at RMIT University, confidentiality will be safeguarded subject to any legal requirements. Data will be kept for a minimum of five years.

What if I want to withdraw from the project, and what if participants want to withdraw from the project?

Participation in this research is purely on a voluntary basis, and you or the participants may withdraw any unprocessed audio and video data previously supplied. This means data that has not been transcribed or analysed.

How can I find out about the results of the project?

I can talk to you about the results of the research at a community meeting, or any other time if you want to contact me. We will also make a booklet of the findings, which I can provide to you.

Questions and Complaints

If you are worried about the research project, you can ring up Cris on 0400 038 497 or 08 8985 1468 and talk to her about it.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251.Details of the complaints procedure are available from the above address.
You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Plain Language Statement – Teachers

Invitation to Participate in a Research Project

Project title: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

You are invited to participate in the above research project, which is being conducted by Cris Edmonds-Wathen, a PhD candidate at RMIT University under the supervision of Professor Dianne Siemon, School of Education, RMIT University.

This project will also form part of my PhD thesis. The project has been approved by the Human Research Ethics Committee at RMIT University and the Northern Territory Department of Education. AIATSIS has provided funding to help with this research.

What is this research about?

This research is about the everyday language of space and location in Iwaidja and how teachers can use an understanding of that language to teach space and location to their Iwaidja speaking students.

What will I have to do?

If you agree to participate, I will interview you at the start and end of the project, about your understandings of Indigenous language of space and location. I will show you the analyses I make of the everyday language of space and location in Iwaidja and we will work together to plan mathematics lessons that takes account of these analyses. We will then work together to implement these lessons in class, and evaluate them together. The total time commitment will be approximately 10 hours out of class, as well as approximately 5 hours in class.

The research will happen in 2011.

What will happen with the information?

Any information provided to me will be kept confidential. Your name will be replaced by a code name in the research notes and the research report. I will remove any references to personal information that might allow someone to guess your identity; however, you should note that as the number of people we seek to interview is very small, it is possible that someone may still be able to identify you.

In addition, as with all research conducted at RMIT University, confidentiality will be safeguarded subject to any legal requirements. I will keep the notes and videotapes in a locked filing cabinet at my house in Coconut Grove, Darwin for at least 5 years. After that, I will either destroy them, give them back to you or ask you whether you want me to give them to an appropriate Indigenous organisation. I would like to give them to AIATSIS for safekeeping.

What if I want to withdraw from the project?

Participation in this research is purely on a voluntary basis and you may withdraw from the research at any time and withdraw any unprocessed audio and video data previously supplied. This means data that has not been transcribed or analysed.

How can I find out about the results of the project?

I can talk to you about the results of the research at a community meeting, or any other time if you want to contact me. I will also make a booklet of the results, which I will give a copy of to you.

Giving material to AIATSIS

If you agree, I propose to give a copy of all of the notes, tapes and videos to AIATSIS for safekeeping. Please note that if I give personal information which identifies you to AIATSIS, the *Privacy Act 1989* (Cth) says that other people can only have access to it if you agree that they can. I will talk to you about who should be allowed to have access to this information, and how AIATSIS should keep it.

Questions and Complaints

If you are worried about the research project, you can ring up Cris on 0400 038 497 or 08 8985 1468 and talk to her about it.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251.Details of the complaints procedure are available from the above address.
You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Consent form - Consultant

re: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

1. I consent to being part of the study conducted by Ms. Cris Edmonds-Wathen from RMIT University YES/NO

2. I understand that this will involve Cris audio and video recording me talking about space and location in Iwaidja with Cris and with another person. I understand that the recordings will be used for research purposes, to look at the types of languages I use in these situations. I also understand that the results will be used to examine how children learn about space and location at school. YES/NO

3. I understand that Cris wants to write about the research in a thesis for RMIT University. I understand that Cris will write the thesis by herself and she will hold the copyright. Some of the things I say or do might be in that thesis. I understand that Cris might also want to write about the research in an article or book, or talk about it at a conference. Cris will grant me an irrevocable perpetual license to use the copyright material for any purpose whatsoever. YES / NO

4. I understand that my name, where I live and how old I am will be used in this study, and can be mentioned in any thesis, books or articles or conference papers that come out of this research. I don't mind if people find out these things about me from reading these things AND Cris will check with me before she puts the thesis, books or articles or conference papers out that it contains only the right kinds of personal information.

YES/NO

OR

My name will not be used in this study, and will be replaced by a code. YES/NO

5. I understand that as with all research conducted at RMIT University confidentiality will be safeguarded subject to any legal requirements. However, I know that participation in this study is voluntary, I can withdraw from the project at any time, and I am free to withdraw any unprocessed audio and video recordings previously supplied. I understand that I will get paid. This is a payment for my time, not a salary or a regular job. YES/NO

6. I understand that the researchers want to protect the audio and video recordings made of me by archiving them in a safe place such as the Australian Institute of Aboriginal and Torres Strait Islander Studies. I agree to the researchers archiving the audio and video recordings under access and copying restrictions of my choice.

YES/NO

7. I confirm that the small sample size of this study, and the use of video recordings, means that it may be possible for people to identify me. YES/NO

Participant's Consent

Participant: _____ **Date:** _____

(Signature)

Witness: _____ **Date:** _____

(Signature)

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251. Details of the complaints procedure are available from the above address. You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Consent form - Caregiver

re: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

1. I consent to my child being part of the study conducted by Ms. Cris Edmonds-Wathen from RMIT University YES / NO

2. I understand that this will involve Cris audio and video recording my child at school during maths lessons. I understand that this will also involve Cris asking my child to talk about space and location with another child in Iwaidja. My child and I will not be paid for participating in this research. I understand that the recordings will be used for research purposes, to look at the types of languages my child uses in these situations. I also understand that the results will be used to examine how Iwaidja children learn about space and location at school. YES / NO

3. My child's name will not be used at all in this study, and will be replaced by a code. I understand that as with all research conducted at RMIT University confidentiality will be safeguarded subject to any legal requirements. However, I know that participation in this study is voluntary, we can withdraw from the project at any time, and we are free to withdraw any unprocessed audio and video recordings previously supplied. YES/ NO

4. I understand that Cris wants to write about the research in a thesis for RMIT University. I understand that Cris will write the thesis by herself and she will hold the copyright. Some of the things my child says or does say might be in that thesis. I understand that Cris might also want to write about the research in an article or book, or talk about it at a conference. Cris will grant me and my child an irrevocable perpetual license to use the copyright material for any purpose whatsoever. YES / NO

5. I understand that the researchers want to protect the audio and video recordings made of my child and family by archiving them in a safe place such as the Australian Institute of Aboriginal and Torres Strait Islander Studies. I agree to the researchers archiving the audio and video recordings under access and copying restrictions of my choice. YES/NO

6. My name and my child's name will be replaced by a code in research notes and reports. However, I confirm that the small sample size of this study, and the use of video recordings, means that it may be possible for people to identify us. YES/ NO

Where participant is under 18 years of age:

I consent to the participation of _____ in the above project.

Signature: (1) (2) **Date:** _____

(Signatures of parents or guardians)

Witness: _____ **Date:** _____

(Signature)

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251. Details of the complaints procedure are available from the above address. You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Consent form – Principal

re: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

1. I consent to my students and teachers in my school being part of the study conducted by Ms. Cris Edmonds-Wathen from RMIT University.

YES / NO

2. I understand that this will involve Cris interviewing teachers and working with them to plan mathematics lessons. It will also involve Cris interviewing students and helping the teachers run mathematics lessons. Cris will make audio and video records of these activities. The study will run over one term.

YES / NO

3. I understand that the recordings will be used for research purposes, to look at the everyday language of space and location of the students and how teachers can use that in teaching mathematics.

YES / NO

4. The name of the school and participants will not be used at all in this study, and will be replaced by a code. I understand that as with all research conducted at RMIT University, confidentiality will be safeguarded subject to any legal requirements. I know that participation in this study is voluntary and that I can withdraw from the project at any time.

YES / NO

Participant's Consent

Participant: _____ **Date:** _____

(Signature)

Witness: _____ **Date:** _____

(Signature)

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251.
Details of the complaints procedure are available from the above address.
You can also contact the AIATSIS Ethics Committee on 02 6246 1111.

Consent form – Teachers

re: Frame of reference in Iwaidja: towards a culturally relevant early years mathematics program

1. I consent to being part of the study conducted by Ms. Cris Edmonds-Wathen from RMIT University.

YES / NO

2. I understand that this will involve Cris interviewing me at the start and end of the project and working with me to plan mathematics lessons in the area of space and location. Cris will audio record the interviews and take notes of the planning sessions. I will work with Cris to present the mathematics lessons that we plan in class and I consent to being video recorded during these lessons. I also understand that the results will be used to examine how Iwaidja children learn about space and location at school, and how they use their everyday language of space and location.

YES / NO

3. My name will not be used at all in this study, and will be replaced by a code. I understand that as with all research conducted at RMIT University, confidentiality will be safeguarded subject to any legal requirements. However, I know that participation in this study is voluntary, that I can withdraw from the project at any time, and I am free to withdraw any unprocessed audio and video recordings previously supplied.

YES / NO

4. I understand that the researchers want to protect the audio and video recordings made of the children by archiving them in a safe place such as the Australian Institute of Aboriginal and Torres Strait Islander Studies. I agree to the researchers archiving the audio and video recordings which I appear in under access and copying restrictions of my choice.

YES/NO

5. My name will be replaced by a code in research notes and reports. However, I confirm that the small sample size of this study, and the use of video recordings, means that it may be possible for me to be identified.

YES/ NO

Participant's Consent

Participant: _____ **Date:** _____

(Signature)

Witness: _____ **Date:** _____

(Signature)

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.

Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 2251. Details of the complaints procedure are available from the above address. You can also contact the AIATSIS Ethics Committee on 02 6246 1111

Appendix B Maps from Map Task

There were three different maps created for this task. Figures A.1 and A.2 show two of these. The maps differ in the position of some of the features, for example the mangrove tree is on the beach in Map 1 and near the magpie goose in Map 2. Some features are also different: Map 1 shows a group of pandanus trees in the lower left, and Map 2 shows a fire between the hill and the magpie goose.

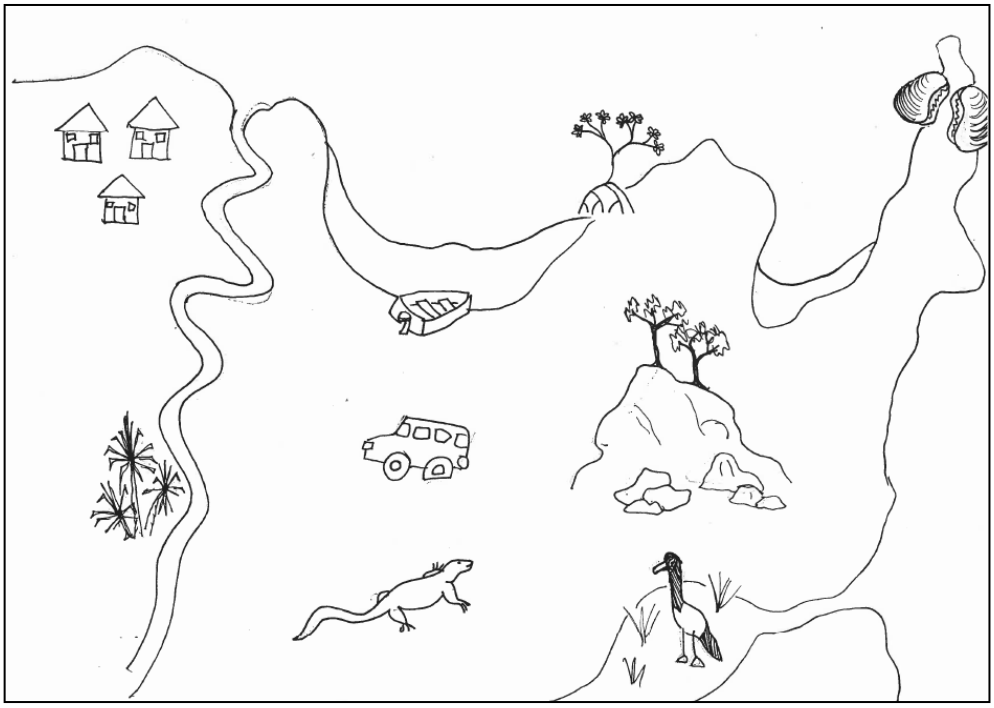


Figure A.1. Blank Map 1

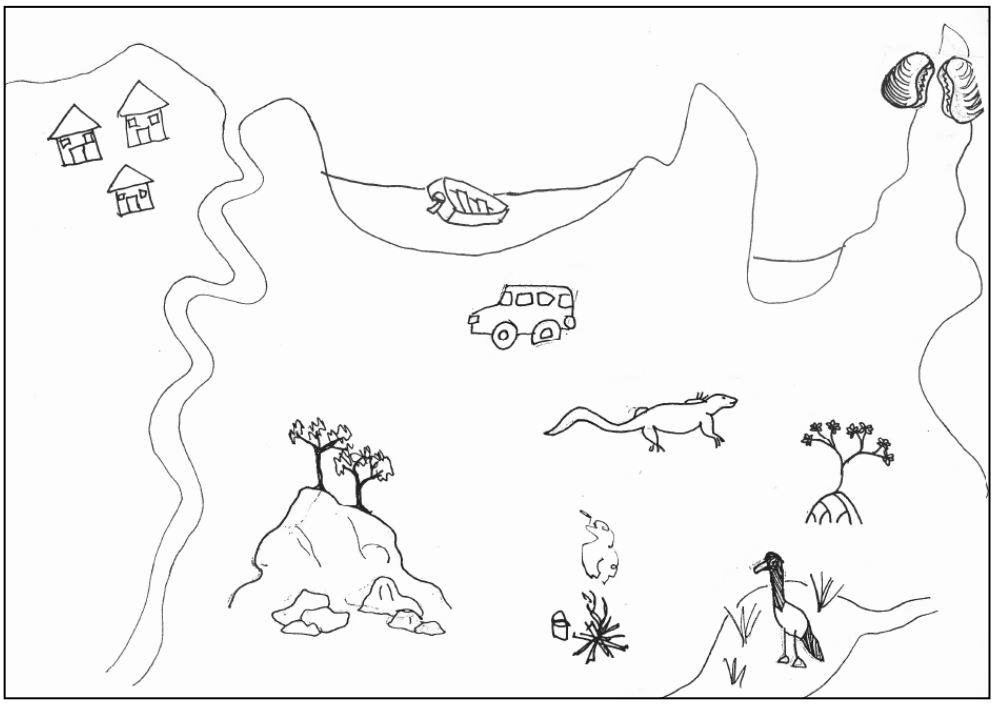


Figure A.2. Blank Map 2

The maps that were given to Directors had routes drawn on them. In the first trial, the Matcher and the Director were given the same map. Figure A.3 shows the route that was given to MM (based on Map 1).

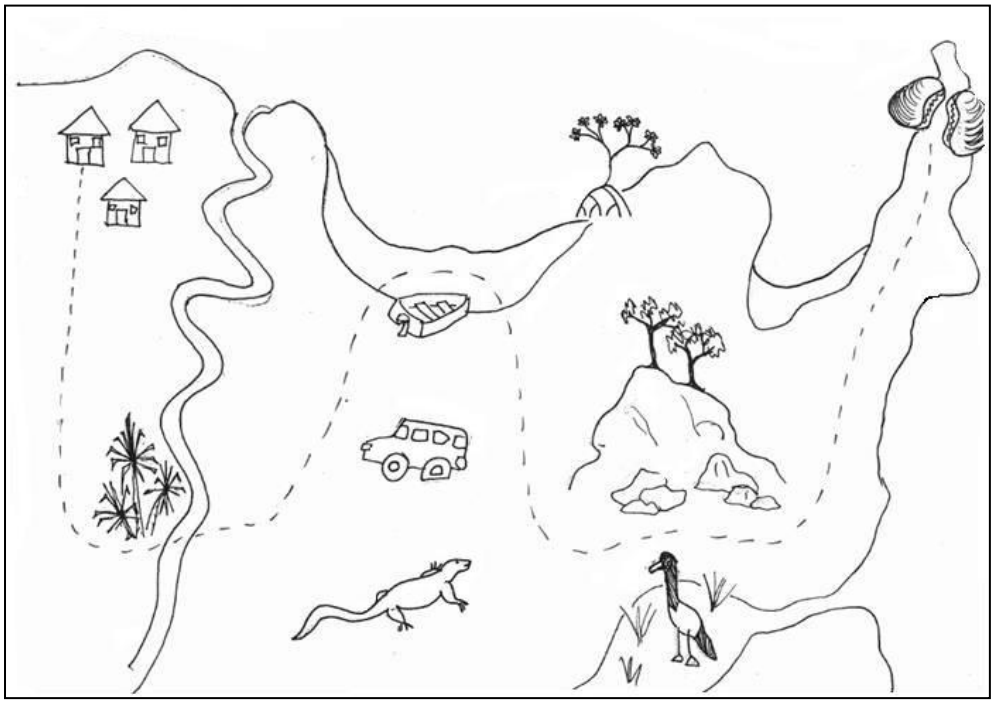


Figure A.4. MM Director Map

RG was given a blank version and drew in a route in response to MM's directions. Figure A.4 shows RG's map completed as Matcher.

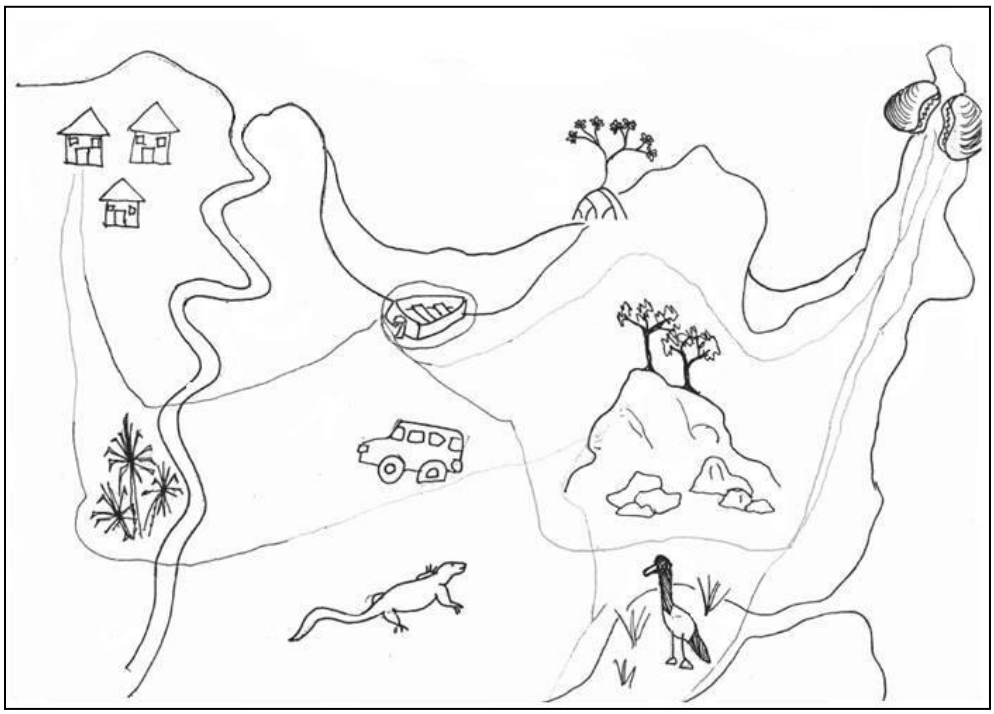


Figure A.4. RG Matcher Map

In subsequent trials, the Director and the Matcher were given different maps. Figure A.5 shows the Director's map that was given to CM. It is the third map. Figure A.6 shows DG's completed Matcher map. Appendix C shows part of the transcript from this session.

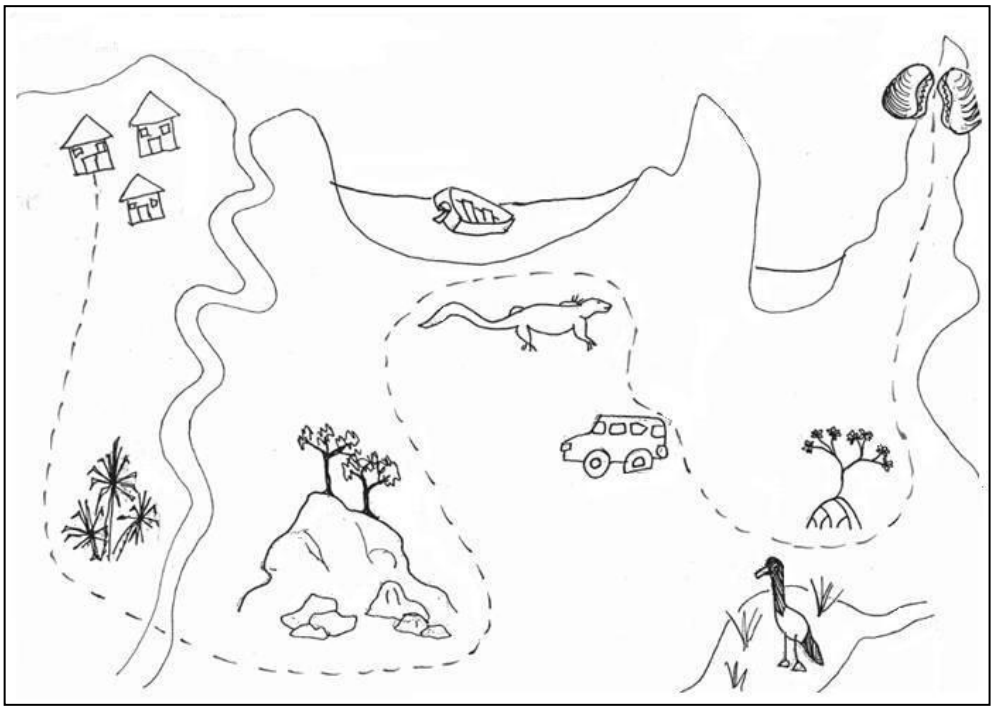


Figure A.5. CM Director Map (Map 3)

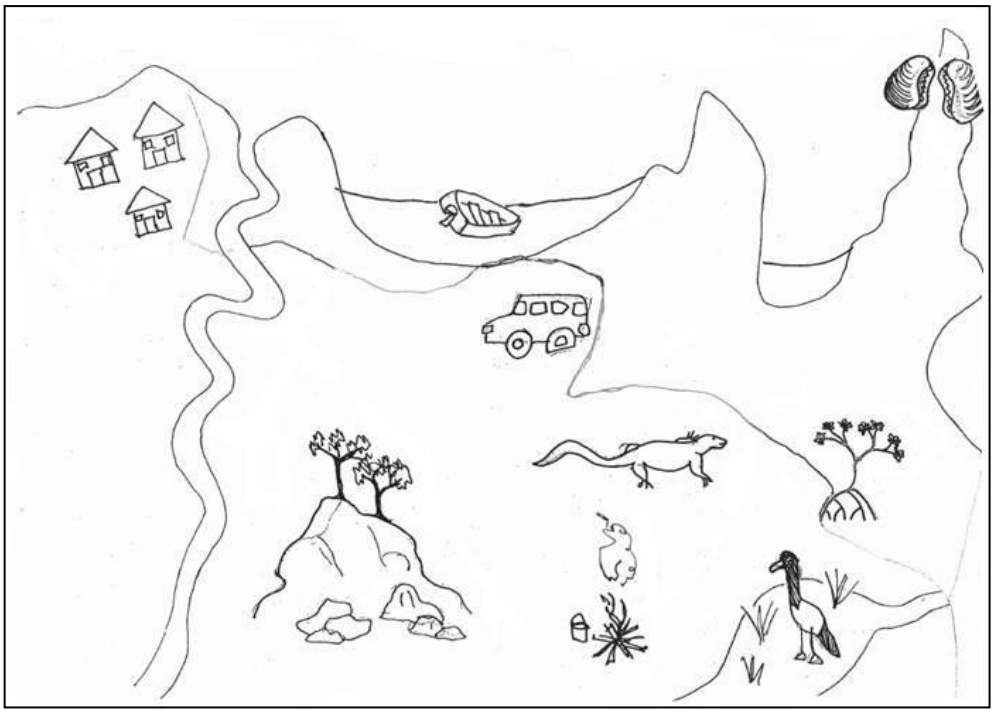


Figure A.6. DG Matcher Map

Appendix C Map Task Transcript (Example)

Participants: CM (Director) & DG (Matcher)
File: dvR_101207_A_01.eaf
00:00 – 08:38 min:sec

The double question mark ?? indicates unintelligible utterances.

CM **Alanud abalkbang jumung mudika alan**
CM trans. *There's a road that comes out from that car track*

CM **kurrambalk bani,**
CM trans. *where the house is,*

CM **kurrambalk bani.**
CM trans. *where the house is.*

CM **Banbani kurrambalk jumung ngamin ngamburryak riki wakaldakan ajbud,**
CM trans. *The houses are opposite where my chest is, on the side where the beach is,*

CM **wuka makumbu wakaldakan.**
CM trans. *on the south side.*

CM **Barakbarda kurrambalk lda alanud abalkbang awara.**
CM trans. *There's a house and there's a track coming out.*

CM **Murrhala ??**
CM trans. *The pandanus ??*

CM **Murrhala ari wuka wakaldakan wuwud wurrying manyij,**
CM trans. *The pandanus is below on the west side,*

CM **alanud wakaldakan abalkbang manyij**
CM trans. *the road is on the east side*

DG **wuka murrhala.**
DG trans. *where the pandanus is.*

CM **Murrhala ari wakaldakan wurrying manyij.**
CM trans. *The pandanus is on the west side.*

CM **Alanud awaran wuka jumung kurrambalk.**
CM trans. *The road comes right up to the house.*

CM **??**
CM trans. *??*

CM **Anbirrk ari ?? kartbarrkiki arlirr.**
CM trans. *The hill is there ?? two trees on it*

CM **wakaldakan wurrying manyij artbung lda alanud wakaldakan abalkbang muwarn.**
CM trans. *(it) is on the west side again and the road is on the east side.*

CM **Yabi yawanubung jumung ari kabala,**
CM trans. *He turned and he went towards the boat,*

CM **wakaldakan mirrnayaj ubilka warrkarrk,**
CM trans. *on the side of crocodile or goanna,*

DG **warrkarrk,**
DG trans. *goanna,*

CM **riki aju**

CM trans. *this one lying (there)*

CM **wakaldakan abalkbang manyij wuka birawan warrkarrk.**
CM trans. *on the east side where the drawing of the goanna is.*

CM **Alanud wakaldakan wurrying manyij yurrngud.**
CM trans. *The track is on the west side on top.*

CM **Awaran jumung mudika wulurr.**
CM trans. *He came where the back of the car is.*

CM **Alan awara jumung mudika wulurr.**
CM trans. *The road came where the back of the car is.*

DG **Iyi.**
DG trans. *Yes.*

CM **Kardayan narrhardi kurrkarda,**
CM trans. *Do you see the goose on the other side,*

CM **Yirrarn ari lda jamin alanud wara mangawala?**
CM trans. *there's a mangrove tree and the road goes in the middle?*

CM **??**
CM trans. *??*

CM **Yabulakun wuka jumung arrayi bani,**
CM trans. *It went down to where the oysters are,*

CM **alan.**
CM trans. *the road.*

CM **??**
CM trans. *??*

DG **Iyu?**
DG trans. *Is it?*

CM **Kawadbung.**
CM trans. *You found it.*

DG **Kawadbung.**
DG trans. *You found it.*

DG **Ay nganduka mana ruka yurrngud?**
DG trans. *Hey, where, maybe on top?*

CM **Alanud awara wuka jumung kurrambalk abanbani.**
CM trans. *The road goes where the houses are.*

DG **Ba wurdaka malany?**
DG trans. *What's first?*

CM **Awaran alan jumung rtadbihi rildurldalkung.**
CM trans. *The track goes across the creek.*

CM **Yaralkung ba rtadbihi yawurtin kurrkarda jumung bani ?? anbirrk.**
CM trans. *He went across the creek to the other side where sits ??*

CM **Arlirr aldindi ngarrkarrk,**
CM trans. *There are two trees,*

CM **??**
CM trans. *??*

CM **wakaldakan abalkbang manyij warrwak,**
CM trans. *on the east side behind,*

CM **wakaldakan wurrying manyij wuwud jumung ari kabala**
CM trans. *below on the west side where the boat is*

CM **aju.**

CM trans. *lying.*

CM **?? ari mudika**
CM trans. *?? the car stands*

CM **wakaldakan jumung yirrarn.**
CM trans. *on the side where the mangrove is.*

CM **Narrhardi bani lda balarra**
CM trans. *There's a goose sitting and in the middle*

CM **?? mayinmul yawara jumung ari ??**
CM trans. *?? headland he goes to where it's standing ??*

DG **yirrarn.**
DG trans. *the mangrove.*

DG **Bikunga ruka ari?**
DG trans. *What's this one standing?*

CM **Yirrarn ari wakaldakan wurrying manyij, narrhardi abalkbang manyij and mudika balarra alanud,**
CM trans. *The mangrove is standing on the west side, the goose is on the east the truck is in the middle and the track is in the middle,*

DG **Abalkbang manyij ari,**
DG trans. *It's in the east,*

DG **lda yirrarn?**
DG trans. *and the mangrove?*

CM **Yirrarn ?? wurrying manyij.**
CM trans. *The mangrove ?? in the west.*

DG **Wurrying manyij.**
DG trans. *west.*

CM **Narrhardi abalkbang manyij.**
CM trans. *The goose is east.*

DG **Nganduka wakaldakan, nurlinurli or maruj?**
DG trans. *Which side is it on, right or left?*

CM **Riki yabalarran mudika alan yirrarn lda narrhardi,**
CM trans. *The road went between the mangrove and the goose,*

CM **abalarra.**
CM trans. *in the middle.*

DG **Yirrarn lda narrhardi.**
DG trans. *Mangrove and goose.*

CM **Iyi.**
CM trans. *Yes.*

CM **Ari wilkbajiny jumung ari,**
CM trans. *I pointed where he's standing,*

CM **lda ruka alanud yabulakun wuka.**
CM trans. *the road goes down here.*

DG **?? karlu.**
DG trans. *?? no.*

DG **Alanud ?? abulakun jumung narrhardi bani, mudika ba alan.**
DG trans. *The road ?? goes down to where the goose sits, the car track.*

CM **?? yirrarn ari**
CM trans. *?? the mangrove tree is*

CM **kurrkarda lda narrhadi kurrkarda lda balarra ba mudika alan.**
CM trans. *on the side and the goose is on the side and the car track is in the middle.*

DG **Yirrarn balarra.**
DG trans. *The mangrove is in the middle.*

CM **Karlu.**
CM trans. *No.*

CM **Mudika alan balarra.**
CM trans. *The car track is in the middle.*

DG **Nganduka wakaldakan makumbu or nganduka?**
DG trans. *Which side is south or where?*

CM **??**
CM trans. *??*

CM **?? yirrarn.**
CM trans. *?? mangrove.*

DG **Nurlinurli maruj?**
DG trans. *Right or left?*

CM **Wurrying manyij wakaldakan**
CM trans. *ON the west side.*

DG **Aa.**
DG trans. *Oh.*

DG **??**
DG trans. *??*

CM **Narrhardi abalkbang manyij.**
CM trans. *The goose is on the east.*

DG **Lda ruka karlu abanamin ruka.**
DG trans. *I won't draw this one.*

CM **Yangmanirra wuka jumung mudika alan jumung awara.**
CM trans. *Go back where the car track is.*

CM **Abalkbang burdan kurrambalk awaran yabalkbang wuka jumung arrarrnan bungalkbukbul,**
CM trans. *He came out from the house and he came along to the place where they crack oysters,*

CM **mayinmul.**
CM trans. *point.*

DG **Burdan kurrambalk ?? wuka kabala.**
DG trans. *From the house ?? to the boat.*

CM **??**
CM trans. *??*

DG **Burdan kabala abirawun.**
DG trans. *From the boat I draw.*

CM **Kurrambalk ba abin riki,**
CM trans. *The house is here,*

CM **wakaldakan wuka makumbu.**
CM trans. *on the south side.*

DG **Makumbu.**
DG trans. *South.*

CM **Mm.**
CM trans. *Yes.*

DG **Riki makumbu riki yabanmirawun wuka makumbu yabanamin wuka**
DG trans. *This one is south I'll draw south where ??*

CM **Ruka alarran mudika awara.**
CM trans. *The car went in the middle.*

DG **Riki maruka rimirrawul**
DG trans. *Who did this drawing?*

DG **Abanara abanamin banangartbanjildiny kani.**
DG trans. *It's going to come and meet together here.*

CM **Banayirramayun jumung mudika wulurr.**
CM trans. *It passes by the back of the truck.*

CM **??**
CM trans. *??*

DG **Rika abirawun wuka yabanara maitbi ...**
DG trans. *This is what I'm drawing maybe I'll go ...*

DG **Karlu, karlu, riki yabin iyi, maitbi ...**
DG trans. *No, no, it goes like this, maybe ...*

DG **Ruka, ruka, ruka, aa, barduwa.**
DG trans. *This one, this one, this one, ah, that's it.*

CM **Mayinmul aburanama.**
CM trans. *Where that point comes along.*

DG **Awara jumung kabala.**
DG trans. *He comes where the boat is.*

DG **Anngalidba, awaran wuka kabala ari barda akarnangkan ngalaj mudika ari kurrkarda.**
DG trans. *Listen, he came where the boat is then he turned off where the car is on the other side.*

CM **??**
CM trans. *??*

DG **?? barduwa.**
DG trans. *?? finished.*

CM **?? artbung ?? alarra**
CM trans. *?? again ?? middle*

DG **Warrkarrk wakaldakan wuka ...**
DG trans. *The goanna is on the side ...*

CM **Makumbu.**
CM trans. *South.*

DG **Aa?**
DG trans. *Oh?*

CM **??**
CM trans. *??*

DG **Yawaran rimarraywung wuka yirrarn,**
DG trans. *He went past the mangrove,*

CM **yawakaldakan wuka ajbud alanud.**
CM trans. *on the beach side, the road.*

DG **Ba mudika,**
DG trans. *The truck,*

DG **mudika rimarrayung artbung .**
DG trans. *he passed the truck again.*

CM **Awaran rimarraywung ba mudika.**

CM trans. *He came and passed the car.*

DG **Rukburuka right kabilawung?**
DG trans. *Did you draw the picture right?*

DG **Ruka mudika ari yawaran wuka yirrarn artbung.**
DG trans. *The car went where the mangrove tree is again.*

CM **??**
CM trans. *??*

DG **Ba yirrarn, ba riki nganduka yabin wuka jumung arrarrnan kunak.**
DG trans. *The mangrove tree, he went to where they get oysters.*

CM **??**
CM trans. *??*

DG **Ba yakarnangkan.**
DG trans. *He turned off.*

CM **Karlu rtuwa awangmara bukakun.**
CM trans. *He wasn't coming running down.*

DG **Yabulakun yubukbara?**
DG trans. *Did he go down?*

CM **Mm.**
CM trans. *Yes.*

DG **Yawaran ruka yirrarn,**
DG trans. *He went where the mangrove,*

DG **lda yirrarn ari.**
DG trans. *where the mangrove tree is.*

CM **Yirrarn ari narrhardi bani alan balarra**
CM trans. *The mangrove is (on one side) and the goose (is on the other) and the road is in the middle.*

DG **Balarra ba yiwalarrun.**
DG trans. *In the middle and finished.*

CM **Abulakun kani jumung mayinmul jumung aju arrarrnan.**
CM trans. *He came down here to the point where the oysters are.*

DG **Aa.**
DG trans. *Oh.*

CM **Abulakun ari jumung bidbarran.**
CM trans. *He came down there where the white.*

CM **??**
CM trans. *??*

DG **Lda narrhardi?**
DG trans. *And the goose?*

CM **??**
CM trans. *??*

CM **Mudika alan balarra yirrarn narrhardi.**
CM trans. *The car track goes in the middle of the mangrove and the goose.*

DG **Mudika alan awaran ngalaj wuka kabala burdan.**
DG trans. *The car track came from where the boat is.*

CM **A kabala burdan.**
CM trans. *From the boat.*

DG **Burdan ba kurrambalk.**

DG trans. *From the house.*

CM **Kirrimul warrkarrk aju riwudbarraywung.**
CM trans. *It passed in front of where the goanna is.*

CM **Artirran ararnukbung rimarlmarraywung wuka jumung mudika wulurr.**
CM trans. *It comes back, turns off and passes behind the back of the car.*

DG **Malany jumung arringan rukburuka kurrambalk ba nganduka arawan?**
DG trans. *He started from that house and where did he go?*

CM **Kurrambalk burdan one more murrhala ari.**
CM trans. *From the house again to the pandanus tree.*

CM **Murrhala wakaldakan wurrying manyij, abalkbang manyij arrarrnan.**
CM trans. *The pandanus is on the west side and the oysters are on the east.*

CM **Rildurldalkung rtadbihi, awurtin rtadbihi.**
CM trans. *He went across the creek, the creek goes up.*

DG **Ba, ba, baraka ruka kamirrawung kuldingka ruka?**
DG trans. *The, the, this here is what she drew, didn't she?*

DG **Ngarrkarrk lda wardad kurrambalk rimarraywung karlu**
DG trans. *Did he pass the three houses?*

CM **Wurdaka abalkbang burdan ngarrkarrk lda wardad kurrambalk, wardad bani angbuldakbanakbi.**
CM trans. *It starts from where those three houses are, one that's sitting behind.*

DG **Ruka manju birukunaj wumanayan ba kurrambalk.**
DG trans. *What's this have a look at the house.*

DG ***??***

DG trans. *??*

CM **Ari riwilbaki barakwarda.**
CM trans. *He stood up and pointed.*

DG **Ruka ari wakaldakan Wurruri.**
DG trans. *This one is on the side of Templer Island.*

DG **Wurlinurli baraka nurlinurli a maruj?**
DG trans. *Right, that’s right or left?*

CM **Ruka jumung ngawani wakaldakan nurlinurli,**
CM trans. *On the side where I'm sitting is on the right,*

CM **wuka jumung ngabi amin ngamburryak.**
CM trans. *where I'm facing my chest.*

CM **Nurlinurli karlu baraka lda maruj ari.**
CM trans. *Not on the right side but he stands on the left.*

DG **Maruj ari.**
DG trans. *He stands on the left.*

CM **Ya.**
CM trans. *Yes.*

DG **Eh, barduwa.**
DG trans. *Yes, finished*

Appendix D Man and Tree Task Transcript (Example)

Participants: MM (Director) & JW (Matcher)
File: dvR_100522.eaf
31:58 – 45:44 min:sec
The double question mark ?? indicates unintelligible utterances.

MM chooses R24 1st card

MM **Kanayalma ba wurdaka ba warrkbi lda ...**
MM trans. *Look for the one where the man is in front and ...*

MM **arlirr ari warrwak.**
MM trans. *the tree is behind.*

JW **Warrkbi wurdaka?**
JW trans. *The man is in front?*

MM **Warrkbi wurdaka arlirr warrwak ari.**
MM trans. *The man is in front, the tree is behind.*

JW shows Rx3 to MM (R13?)

JW **Kindi?**
JW trans. *This one?*

MM **Karlu.**
MM trans. *No.*

JW **Warrkbi wurdaka, arlirr warrwak, I see,**
JW trans. *Man in front, tree behind, I see.*

JW **Ruka?**
JW trans. *This one?*

JW shows Rx3 to MM

MM **Karlu.**
MM trans. *No.*

MM **Ba arlirr wakaldakan wuka nuyi lda warrkbi kani wakaldakan wuka ngabi ngawani.**
MM trans. *The tree is on your side and the man is here on the side where I'm sitting.*

JW **Arlirr wakaldakan?**
JW trans. *The tree is on which side?*

MM **Nuyi angbani. Ngabi warrkbi kani.**
MM trans. *Where you are sitting. The man is here on mine.*

JW shows R22 to MM

JW **Kindi?**
JW trans. *Like this?*

MM **Karlu.**
MM trans. *No.*

JW **Nganduka angminy?**
JW trans. *What did you say?*

MM *Warrkbi wurdaka.*

MM trans. *The man is in front.*

MM **Angmirrkburlngany warrkbi wurdaka ?? kindi jumung nuyi angbani.**
MM trans. *I was saying to you the man is in front ?? where you are sitting.*

MM **Arlirr ari warrwak.**
MM trans. *The tree is behind.*

JW **Warrkbi wurdaka.**
JW trans. *The man is in front.*

MM **Mm.**
MM trans. *Yes.*

JW **Arlirr warrwak.**
JW trans. *The tree is behind.*

MM **Iyi.**
MM trans. *Yes.*

JW shows Rxx to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Karlu.**
MM trans. *No.*

JW shows R24 to MM
MM **Rukung kirrwarda.**
MM trans. *He's showing his back.*

JW **Kindi?**
JW trans. *Like this?*

MM **Barakbarda**
MM trans. *That's it.*

JW **Ay?**
JW trans. *Hey?*

MM **Iyi**
MM trans. *Yes.*

MM chooses R43 2nd card
MM **Arlirr ari wuka yawurrying manyij**
MM trans. *The tree is in the west*

MM **lda warrkbi ari**
MM trans. *and the man is*

MM **abalkbang manyij yawukan wuka ...**
MM trans. *there in the east looking at ...*

JW **Ay?**
JW trans. *Hey?*

MM **... yawukan wubaka**
MM trans. *... looking away*

MM **kani awukan jumung ngabi ngawani.**
MM trans. *to here where I'm sitting.*

JW **Ba warrkbi?**
JW trans. *The man?*

MM **Iyi.**
MM trans. *Yes.*

JW shows R43 to MM
JW **Kindi?**
JW trans. *Like this?*

JW **Ay?**
JW trans. *Hey?*

MM **Iyi**
MM trans. *Yes.*

MM and JW both show R43 to camera

MM chooses R33 3rd card

MM **Badba warrkbi wurdaka.**
MM trans. *In this one the man is in front.*

MM **Might be? angmungurlkbarrki or kindi.**
MM trans. *Might be looking down or something.*

MM **Arlirr ari wuka warrwak**
MM trans. *The tree is there behind*

MM **yawurrying manyij**
MM trans. *in the west*

MM **lda warrkbi jumung abalkbang manyij ari.**
MM trans. *and the man is to the east.*

JW shows R33 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Yo.**
MM trans. *Yes.*

JW **Ay?**
JW trans. *Hey?*

MM **Yo.**
MM trans. *Yes.*

MM chooses R41 4th card
MM **Badba warrkbi ari artbung yawurrying manyij lda arlirr kani awakaldakan ari artbung.**
MM trans. *In this one the man is in the west again and the tree is here on this side again.*

JW shows R41 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Iyi.**
MM trans. *Yes.*

MM chooses R23 5th card
MM **Arlirr ari wuka lda**
MM trans. *The tree is there and*

MM **ba warrkbi yawukan wuka walim.**
MM trans. *The man is looking away to the south.*

MM **Ba arlirr ari wuka abalk..., yawurrying manyij.**
MM trans. *The tree is in the eas..., west.*

JW shows R41 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Iyi.**
MM trans. ***Yes.***
MM chooses R22 6th card

MM **Ba arlirr ari wakaldakan ruka walim lda warrkbi kani ari jumung ngabi ngawani.**
MM trans. *The man is on the south side and the man is here on the side where I am sitting.*

MM **Bat yawukan wuka jumung walim.**
MM trans. *But he's looking south.*

JW **Ba warrkbi?**
JW trans. *The man?*

MM **Iyi.**

MM trans. *Yes.*

JW **Warrkbi nganduka angminy yawukan?**
JW trans. *Where did you say the man was looking?*

MM **Yawukan wuka walim.**
MM trans. *He's looking south.*

JW **Ba arlirr nganduka ari?**
JW trans. *And where is the tree?*

MM **Arlirr ??? ari yabin**
MM trans. *The tree ?? is standing*

JW **wakaldakan warrin.**
JW trans. *on the inland side.*

MM **Wurdaka arlirr bingkan warrwak ba warrkbi.**
MM trans. *The tree is in front and then the man comes behind.*

JW shows R22 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Yo.**
MM trans. *Yes.*

MM chooses R21 7th card
MM **Arlirr yawurdaka ...**
MM trans. *The tree is ...*

MM **Arlirr**
MM trans. *The tree*

MM **ari kani**
MM trans. *is here*

MM **abalkbang manyij, warrkbi ari wuka jumung yawurrying manyij,**
MM trans. *in the east, the man is there in the west,*

MM **yawukan wuka walim**
MM trans. *looking south.*

JW shows R21 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Yo.**
MM trans. *Yes.*

MM chooses R32 8th card
MM **Badba ba arlirr wakaldakan wuka nuyi angbani lda warrkbi**
MM trans. *In this one the tree is on the side where you are sitting and the man*

MM **kani jumung ngabi ngawani,**
MM trans. *is here where I am sitting,*

MM **lda mana angmungurlkbarrkjiny karlu wukan.**
MM trans. *and maybe he's looking down, he's not looking (at me).*

JW shows Rxx to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Karlu.**
MM trans. *No.*

JW **Nganduka angminy warrkbi wakaldakan ...**
JW trans. *Which side did you say the man was on ...*

JW **Ngabi ngawani?**

JW trans. *Where I'm sitting?*

MM **Ngabi ngawani.**
MM trans. *Where I'm sitting.*

MM **Arlirr wakaldakan jumung nuyi angbani.**
MM trans. *The tree is on the side where you are sitting.*

JW shows R32 to MM
JW **Kindi?**
JW trans. *like this?*

MM **Iyi.**
MM trans. *Yes.*

MM chooses R13 9th card
MM **Warrkbi wurdaka birta biru rayan ari kalkbarran.**
MM trans. *The man is in front, what's he looking at, he's staring.*

MM **Arlirr ari wuka warrwak.**
MM trans. *The tree is behind.*

JW shows R13 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Mm.**
MM trans. *Yes.*

JW **Ay?**
JW trans. *Hey?*

MM **Yo.**
MM trans. *Yes.*

MM chooses R14 10th card
MM **Warrkbi ..**
MM trans. *The man ..*

MM **Warrkbi ari wuka walim,**
MM trans. *The man is to the south,*

MM **ba arlirr ari kani wuka ngabi ngawani.**
MM trans. *the tree is here where I'm sitting.*

JW **Ay?**
JW trans. *Hey?*

MM **Wukan ari birukurnaj rayan.**
MM trans. *He's looking at something.*

JW shows R14 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Mm.**
MM trans. *Yes.*

MM chooses R31 11th card
MM **Arlirr ari wurdaka,**
MM trans. *The tree is in front,*

MM **Warrkbi ari warrwak, angmungurlkbarrkjiny**
MM trans. *The man is behind, looking at the ground.*

JW shows R31 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Iyi.**
MM trans. *Yes.*

MM chooses R11 12th card

MM **Arlirr wurdaka lda warrkbi bingkan warrwak,**
MM trans. *The tree is in front and the man comes behind,*

MM **ari rayan ba arlirr,**
MM trans. *looking at the tree.*

JW **Kindi?**
JW trans. *Like this?*

JW shows R11 to MM
MM **MM mm.**
MM trans. *Yes.*

MM chooses R34 13th card
MM **Badba angmungurlkbarrkjiny.**
MM trans. *In this one he's looking down at the ground.*

MM **Arlirr ari kani,**
MM trans. *The tree is here,*

MM **jumung ngabi ngawani,**
MM trans. *where I'm sitting,*

MM **lda warrkbi wuka nuyi angbani.**
MM trans. *and the man is where you are sitting.*

JW shows R34 to MM
MM **Yo.**
MM trans. *Yes.*

MM chooses R44 14th card
MM **Arlirr wurdaka lda ba warrkbi, ari rukung rtamburryak,**
MM trans. *The tree is in front and the man is giving his chest (facing it)*

MM **rayan ba arlirr.**
MM trans. *looking at the tree.*

JW shows R44 to MM
JW **Kindi?**
JW trans. *Like this?*

MM **Eh.**
MM trans. *Yes.*

MM chooses R42 15th card
MM **Warrkbi ...**
MM trans. *The man ...*

MM **wurdaka lda arlirr bingkan warrwak.**
MM trans. *is in front and the tree is coming behind.*

JW shows R42 to MM
JW **Ruka?**
JW trans. *This one?*

MM **Mm.**
MM trans. *Yes.*

MM chooses R12 16th card
MM **Ba arlirr ari wuka**
MM trans. *The tree is to*

MM **walim**
MM trans. *the south*

MM **lda warrkbi kani awakaldakan ari.**
MM trans. *and the man is here on this side.*

JW shows R12 to MM

Appendix E Man and Tree Task Results (Example)

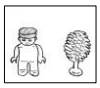
The results from each session were compiled in tables. The phrases in which each term occurred were included in the relevant cells to enable analysis such as whether a term such as *warrwak* 'behind' was used intrinsically or relatively, or whether the term was uses for standing or facing information. Each term or phrase was included only once per card, even if the speaker had repeated it several times. Colour coding was used for frame of reference, as shown:

Intrinsic	Relative	Absolute	Ambiguous	Deictic

As an example, Table E.1 shows the summary results from MM's session as Director. An exception to only showing one phrase per word occurs for card *R22*, where there are two phrases in the cell for walim 'south'. In her description of this card, MM used walim 'south' in two ways, for standing and for facing information. The transcription of this session is shown in Appendix D.

Table E.2 shows a numerical version of the same results as Table E.1, with the final column showing for how many cards each term was used. Again, each term was counted only once per card. Where categories were counted rather than terms, each category was counted once per card. For example, while MM used absolute terms 13 times, she used them about only eight cards.

Table E.1. MM Man and Tree task summary

MM 110522 B	 *R11*	 *R12*	 *R13*	 *R14*	 *R21*	 *R22*	 *R23*	 *R24*
Card number	12th card	16th card	9th card	10th card	7th card	6th card	5th card	1st card
abalkbang manyij 'east'					*arlirr ari kani abalkbang manyij* 'the tree is standing here in the east'			
(nuyi)angbani '(you) sit'								*ba arlirr wakaldakan wuka nuyi* 'the tree is on your side'
angmung-urlkbarrki 'look at ground'								
kani 'here'		*warrkbi kani awakaldakan ari* 'the man is here standing on this side'			*arlirr ari kani* 'the tree is standing here'			
kirrwarda 'back'								*rukung kirrwarda* 'he gave it his back'
(ngabi) ngawani '(I) sit'				*ba arlirr ari kani wuka ngabi ngawani* 'the tree is standing here where I am sitting.		*warrkbi kani ari jumung ngabi ngawani* 'the man is standing here where I am sitting'		*warrkbi kani wakaldakan wuka ngabi ngawani* 'the man is here on the side where I am sitting'
rayan 'look'	*ari rayan ba arlirr* 'he's standing looking at the tree'		*birta biru rayan ari kalkbarran* 'what's he looking at, he's staring'	*wukan ari birukurnaj rayan* 'he's looking at something'				
rtamburryak 'chest'								
walim 'south'		*ba arlirr ari wuka walim* 'the tree is standing to the south'		*warrkbi ari wuka walim* 'the man is standing to the south'	*yawukan wuka walim* 'he's looking south'	*arlirr ari wakaldakan wuka walim* 'the tree is on the south side'; *yawukan wuka jumung walim* 'he's looking south'	*warrkbi yawukan wuka walim* 'the man is looking south'	
warrwak 'behind'	*warrkbi bingkan warrwak* 'the man is coming behind'		*arlirr ari wuka warrwak* 'the tree is standing behind'			*bingkan warrwak ba warrkbi* 'the man is coming behind'		*arlirr ari warrwak* 'the tree is standing behind'
wukan 'look'				*wukan ari birukurnaj rayan* 'he's looking at something'	*yawukan wuka walim* 'he's looking south'	*yawukan wuka jumung walim* 'he's looking south'	*warrkbi yawukan wuka walim* 'the man is looking south'	
wurdaka 'in front'	*arlirr wurdaka* 'the tree is in front'		*warrkbi wurdaka* 'the man is in front'			*wurdaka arlirr* 'the tree is in front'		*wurdaka ba warrkbi* 'the man is in front'
wurrying manyij 'west'					*warrkbi ari wuka jumung yawurrying manyij* 'the man is standing in the west'		*arlirr ari wuka yawurrying manyij* 'the tree is standing in the west'	

MM 110522 B	 *R31*	 *R32*	 *R33*	 *R34*	 *R41*	 *R42*	 *R43*	 *R44*
Card number	11th card	8th card	3rd card	13th card	4th card	15th card	2nd card	14th card
abalkbang manyij 'east'			*warrkbi jumung abalkbang manyij ari* 'the man is standing in the east'				*warrkbi ari abalkbang manyij* 'the man is standing in the east'	
(nuyi)angbani '(you) sit'		*ba arlirr wakaldakan wuka nuyi angbani* 'the tree is on the side where you are sitting'		*warrkbi wuka nuyi angbani* 'the man is on the side where you are sitting'				
angmung-urlkbarrki 'look at ground'	*angmung-urlkbarrkjiny* 'he's looking at the ground'	*angmung-urlkbarrkjiny* 'he's looking at the ground'	*angmung-urlkbarrkjiny* 'he's looking at the ground'	*angmung-urlkbarrkjiny* 'he's looking at the ground'				
kani 'here'					*arlirr kani awakaldakan ari* 'the tree is standing here on this side'			
kirrwarda 'back'								
(ngabi) ngawani '(I) sit'		*warrkbi kani jumung ngabi ngawani* 'the man is here where I am sitting'		*arlirr ari kani, jumung ngabi ngawani* 'the tree is standing here where I am sitting'			*awukan jumung ngabi ngawani* 'he's looking here where I am sitting'	
rayan 'look'								*rayan ba arlirr* 'he's looking at the tree'
rtamburryak 'chest'								*ba warrkbi ari rukung rtamburryak* 'the man stands he gave it his chest (he's facing it)'
walim 'south'								
warrwak 'behind'	*warrkbi ari warrwak* 'the man is standing behind'		*arlirr ari wuka warrwak* 'the tree is standing behind'			*arlirr bingkan warrwak* 'the tree is coming behind'		
wukan 'look'							*yawukan wubaka kani awukan jumung ngabi ngawani* 'he's looking over there, looking here where I am sitting'	
wurdaka 'in front'	*arlirr ari wurdaka* 'the tree is standing in front'		*warrkbi wurdaka* 'the man is in front'			*warrkbi wurdaka* 'the man is in front'		*arlirr wurdaka* 'the tree is in front'
wurrying manyij 'west'			*arlirr ari yawurrying manyij* 'the tree is standing in the west'		*warrkbi ari artbung yawurrying manyij* 'the man is standing in the west again'		*arlirr ari wuka yawurrying manyij* 'the tree is standing in the west'	

Table E.2. MM Man and Tree task summary, numerical

MM 110522 B	R11	R12	R13	R14	R21	R22	R23	R24	R31	R32	R33	R34	R41	R42	R43	R44	No. of cards
abalkbang manyij 'east'					1						1				1		3
(nuyi)ang bani '(you) sit'								1		1		1					3
angmung-urlkbarrki 'look at									1	1	1	1					4
kani 'here'		1			1								1				3
kirrwarda 'back'								1									1
(ngabi) ngawani '(I) sit'				1		1		1		1		1			1		6
rayan 'look'	1		1	1												1	4
rtamburry ak 'chest'																1	1
walim 'south'		1		1	1	1	1										5
warrwak 'behind'	1		1			1		1	1		1			1			7
wukan 'look'				1	1	1	1								1		5
wurdaka 'in front'	1		1			1		1	1		1			1		1	8
wurrying manyij 'west'											1		1		1		5

Appendix F Teacher Interview Questions

1. Pre-interview – start of Phase II

I would like to interview you about our mathematics research project. The questions are about your thoughts, feelings and beliefs about mathematics teaching. They are not about judging whether you are a good or bad teacher or anything like that. I just want to get an idea about your general beliefs about mathematics teaching and about how our project fits in with that.

I'm happy to tell you about what I think too, but I'd like to ask you these questions first so that I don't influence what you say too much. I've got some questions here, but if you don't want to answer any of them, that's ok. You can turn off the recorder at any time. Is that ok?

- What comes into your mind first when you think about mathematics? What do you think mathematics is?
- How do you see you role as a teacher of mathematics? Could you look at these cards and tell me which one applies best to you? (SNMY sort (Siemon, 2005)
- What do you think are the important issues and factors in teaching mathematics to Indigenous children? How do you take account of these in your practice?
- What do you think is the role of language in mathematics teaching and learning?
- Could you tell me about your students' strengths in mathematics?
- How well prepared do you feel to teach your students mathematics? What specific preparation have you had, for example professional development courses? What sort of training do you feel would help you?
- How suitable do you find the mathematics curriculum for your students?
- Tell me about a maths lesson that you taught that you thought was successful.
- Tell me about one that didn't work.
- How do you think you could improve your mathematics teaching? What help would you need to do this?
- How do you feel about participating in this research project? What are some of the strengths as a mathematics teacher that you bring to the project?
- This project is about space and location. How do you think space fits into the mathematics curriculum and into mathematics teaching? How important is it in mathematics?
- Are you aware of differences in the way that different cultures and language groups have in talking and thinking about space? What sort of implications do you think this could have for teaching mathematics to someone from another language background?
- Are there any questions you would like to ask me about the project?
- Is there anything else you would like to add?

2. Post-interview – end of Phase II

- Have you found the talks we've had about spatial language in Iwaidja useful? In your maths lessons? In your general teaching?
- If so, how have they been useful?
- Can you tell me about using something that we've discussed in your maths teaching?
- A maths lesson that involved spatial language?
- What do you think of now as your students' strengths in mathematics?
- How are the students with 'before' and 'after' in terms of numbers?
- Left and right?
- Clockwise?
- Have you any reflections on what you've learned this year about mathematics teaching and your students?

Appendix G Scaffolding Numeracy in the Middle Years Card Sort

Dianne Siemon, 2005

SCAFFOLDING NUMERACY IN THE MIDDLE YEARS LINKAGE PROJECT 2003-2006

Card Sort

1. Present the first set of cards and ask the teacher to choose the one that most closely corresponds to his/her views about mathematics.

Problem solver

Maths may consist of rules, facts and strategies that are useful in solving every-day problems. It might also be seen as a universal body of knowledge which is discovered over time. But fundamentally, I believe maths develops and changes in response to human needs and cultures.

Platonist

Maths may develop and change in response to human needs and cultures. It might also consist of rules, facts and strategies that are useful in solving every-day problems. But fundamentally, I believe maths is a universal body of knowledge which is discovered over time.

Instrumentalist

Maths may be seen as a universal body of knowledge which is discovered over time. It might also develop and change in response to human needs and cultures. But fundamentally, I believe maths consists of rules, facts and strategies that are useful in solving every-day problems.

2. Present the second set of cards and ask the teacher to choose the one that most closely corresponds to the way they generally teach mathematics.

Instructor

In my teaching of maths I primarily focus on mastering skills, giving some attention to developing understanding of concepts and problem posing and problem solving.

Explainer

In my teaching of maths I primarily focus on developing understanding of concepts, giving some attention to mastering skills and problem posing and problem solving

Facilitator

In my teaching of maths I primarily focus on problem posing and problem solving, giving some attention to mastering skills and developing understanding of concepts.

Views about mathematics

Maths may consist of rules, facts and strategies that are useful in solving every-day problems. It might also be seen as a universal body of knowledge which is discovered over time. But fundamentally, I believe maths develops and changes in response to human needs and cultures.

Maths may develop and change in response to human needs and cultures. It might also consist of rules, facts and strategies that are useful in solving every-day problems. But fundamentally, I believe maths is a universal body of knowledge which is discovered over time.

Maths may be seen as a universal body of knowledge which is discovered over time. It might also develop and change in response to human needs and cultures. But fundamentally, I believe maths consists of rules, facts and strategies that are useful in solving every-day problems.

Teaching mathematics

In my teaching of maths I primarily focus on mastering skills, giving some attention to developing understanding of concepts and problem posing and problem solving.

In my teaching of maths I primarily focus on developing understanding of concepts, giving some attention to mastering skills and problem posing and problem solving.

In my teaching of maths I primarily focus on problem posing and problem solving, giving some attention to mastering skills and developing understanding of concepts.

Appendix H Iwaidja Spatial Dictionary

A - a

abalkbang manyij *n.* 1) sunrise. 2) east. **Warrkbi abalkbang manyij wakaldakan.** The man's on the east side. **Ngadbin manyij abalkbang lda wurrying. Ba karlu. Karraba birrkburlngan.** We say that the sun rises and sets. But no. The earth is turning.

alima *v.t.* approach, go toward; visit. **Bani kirrimul bangayirrak ijalkud ngarraban ba yiwarruj kudnalima kirrimul janad.** He's just sitting at home. We've got all that knowledge. You should go and visit him. *Prdm:* ralimang.

alnga *v.t.* go around, circle. **Bani balarra. Ara burlukba balnga.** He sits in the middle. They dance around him. **RG: Abanalnga kabala nga? MM: Kabanalnga ba kabala yukbanirra yukbanawulakun.** RG: I go around the boat, don't I? MM: You go around the boat and then you come back down. *See:* **-marralngan, -ngardalnga, -ldakburdal nga**; **-marralngan, -ngardalnga, -alnga**.

anganyburrurtikiny *dev. n.* north. **Ajikbiny marldu ngunyun anganyburrurtikiny.** The wind sprang up from the north.

angbuldalkban *v.ang.* 1) he or she takes a short cut. 2) he or she goes across.

ara *v.i.* 1) go. **Ara.** They go, are going. **Ijbara.** They go, are going away. **Ayuwara.** They come, are coming. **Awara.** He / she is coming. **Ijbaran Warruwi ijuwuwani.** They went to Goulburn Island (and) they're staying there. 2) (when chained with other verb) keep, continue. **Aju wara.** (Of fire that has 'taken'): it's burning now, it keeps burning. 3) (of dynamic entity) be, be located, there be. **Wara ngalaldi balkbany birukurnaj mana marndingunyuny mana manbiri.** There is a smooth circle on the surface of the water where something has surfaced, maybe a dugong, maybe a turtle. **Nganduka warnjuj? Ijbaran wuka.** Where's that female [i.e., your sister]? She went that way. The third person plural form of the verb is used as a polite, or distancing, form, when a brother is referring to his sister, or vice versa. *Prdm:* PST **aran**. Dual has irregular form **-naka**.

ardilwarrki go east, eastwards. **Kirrimul karlu ijalkud bardilwarrki baraka. Wuka jimurru. Karlu. Yangbayan kirrimul wuka Warlka.** Like he's not really going east. No. He's facing towards Warlka [the bargelanding on Croker Island]. *[Note:* Man and Tree R13*]*

arlarrngbu *v.t.* straighten e.g. spear shaft by warming in fire. **Ngarrawarlarrngbun ngarrabunya kujali, wurrurtbin, kuranganin.** We warm the harpoon shaft in the fire until it's straight. **Artirran ararlarrngbung abulakuny awaran.** He came back straight down.

arnukbun *v.t.* snap, get crabs; turn. **Yartirran yarnukbun jumung murrhala ari.** He turned back to where the pandanus tree is. *Prdm:* rarnukbun [rarnukbung, barnukbun].

awalawal *n.* north. *See:* **Murdululi, mayinmul**.

awukawuk *adverb.* in the vicinity of. **Kabala ari nimarrk awukawuk.** The boat's almost out in the deep water. **Ngabilijanad ngadbunbani ajbud awukawuk.** Us two live near the beach. *See:* **binyu awukawuk**.

awukawuk *adverb.* be at an angle to. **Rtamburryak yabin wuka jumung abalkbang manyij, lda binyung awukawuk.** He's facing towards the east, but at an angle. *See:* **-minyu; awukawuk**.

B - b

balarrakan *v.i.* be straight, lie straight, stretched out. **Balarrakan bawurr.** He's holding his arm straight, stretched out. **Ngayalding ngawalarrakandung.** I was stretched out asleep

barra *[Phon:* baarra*] n.* 1) north-west wind, wet season wind. 2) west. *From:* Makassarese **báraq**, Mal barat 'west wind, rainwind'. *[Phon:* always pronounced with a long vowel; possibly as a result of original Makassarese pronunciation*]*

binyu *v.i.* be across; be at right angles to. **Wuka rtarrkal ngayaldi ngaminyu** I'm lying across the doorway. **Ruka malany aju binyu?** Why is she lying across it? **Aju binyu wuka alan. Angmungalwung.** It's lying across the road, blocking the way. **Banambi arrawudba rtadbihi binyu.** We put fish-weirs across

creeks.

burdan *inflected preposition.* from. **Yawardama ba radbihi, burdan awurlkbarrakanud.** The tradition continues from the old people. **Abiyardmang burdan ldalha.** I like (food) from the sea. **Kaladarr burdan warrin** The flowers are from the bush country. *[Phon:* PL transcribe as **burran***]*

I - i

irran *vi.* return, go/come back (depending on direction on prefix), (in coverb constructions with following noun) back to. **Barda yangmanawulakun yangmanirda nuyimung ldalha.** Then you go down back to your place in the sea. *Prdm:* PR **artirda**, PST **artirdan**, PR FUT **ayuwirda**.

J - j

jirtbirdan *n.* 1) dawn. 2) east. **Warrkbi wakaldakan abalkbang manyij. Wuka jirtbirdan.** The man is to the east, where the dawn breaks.

jimurru *n.* 1) south-easterly trade wind. **Rildaharlbungku rurrka wirrarrang barda riyurrkbang. Ba jimurru. Awurlkbarrakanud angbunmakbang ngarrung. Mambirrkurang ba rtadbihi wakaldakang abalkbang manyij. Wurrying manyij bartuwa.** The south-easterly wind pulls the seaweed to the shore, then covers it. The old people used to tell us that. It closes the creeks on the east side [of the island]. The west side is ok. 2) south-east, south-easterly direction. *From:* from Makassarese, Buginese **tímoroq**, Malay **timur** 'east wind'.

K - k

kani *loc. adv.* here.

kurrkamaj *n.* one side, half. **Warrkbi makumbu yawukan lda arlirr ari wuka barra, wakaldakan kurrkamaj ma, maruj. Kadalku kurrkamaj! Nuyimung kurrkamaj lda ngabimung kurrkamaj.** Prototypically spatial, not quantitative. The meaning of half extends from the meaning of one side. Applies only to solid objects that can be cut (or ripped or broken), such as a dough, not to quantities such as a bag of flour or a liquid. *[Note:* Man and Tree R13*]*

kurrkarda *n.* the other side, on the other side, across. **kurrkara kurrkara** on both sides

kurrkardimarrk *loc.* the southern coast of Cobourg Peninsula and the sea and islands in that vicinity. *See:* **kurrkarda**.

L - l

ldakbanakbi *v.ang.* last, come last. **Wurdaka abalkbang burdan ngarrkarrk lda wardad kurrambalk, wardad bani angbuldakbanakbi.** It starts from where those three houses are, from the one that's last.

ldakburdalnga *v.t.* go around. **Barakbarda rtuwa rildakburdalngan. Awaran mangawala j... ari abalkbang manyij wakaldakan. Anbirrk mardan yawaran rildakburdalngan wuka.** It just went around that [pandanus]. It came straight to where .., it's on the east side. He went around the little hill. *See:* **-marralngan, -ngardalnga, -alnga**.

ldakidban *v.t.* step over, jump. *Prdm:* rildakidban [rildakidbany, buldakidban].

ldalkba *v.ang.* 1) take a short cut. 2) go across.

ldalku *v.t.* 1) cut. **Yawaran barda rildalkuny, arlirr bunyak adawirr. Rildalkuny wunman karlu, arijumardal.** So he went and cut a hollow log. He tried to cut it but it was no use, it was too small. 2) spear, hit with thrown spear. **Riwirrung janad ruli, rimangung angkumardyingang rildalkungang.** He dragged (the spear) with his foot, picked it up and slotted it into his spearthrower and speared him. *Prdm:* 1SG>3SG forms: PRES aralkung FUT abaldalkung, P aralkuny, PH/PC aralkungang, FRUST aldalkunyi OPT aralku, IMPER kaldalku (or yangkaldalku). 3) — *v.i.* cut oneself. *Prdm:* ralkun [ralkuny, aldalkun]. 4) cross. **Yaralkung ba rtadbihi yawurtin kurrkarda jumung bani anbirrk.** It went across the creek, on the other side it went up to the hill.

ldarrunmin *v.i.* be side by side. **Aldindi aldarrunmin.** The two of them are standing side by side. *Syn:* **-ngunyulunmin**. *Prdm:* kurarrunmin, ararrunmin, ngararrunmin. *[Note:* Man and Tree R32*]*

ldulku *v.i.* be tight (in something), be stuck; stand behind. **Ngabi nginyildiny bajubaju ngaldulkuny.** I put it on, it was too tight for me. **Ararikiny buldirrki, maju ngaldadbinymany rulkuny.** I put (my clothes) in the bag and tried to pull the zip shut, but it stuck. **Arlirr ari wurdaka janad ari arildurlkung warrwak.** The tree is standing in front, he is behind it.

ldurldalkun *v.t.* 1) cross, go across. **Mudakari lda anbirrk lda birr yangkabaldurldalkung** The truck and the hill are there)and then you go across.

M - m

majada *adv.* single file, in line. **Ban majada.** They standing or moving in single file. **Ijbuyaldi yaban majada.** They're lying in line. **Kudbunayanjing abany majada ayuwara.** Look at them they're coming in single file.

makumbu *n.* south. **Yangbayan kirrimul uka, makumbu.** He's looking over there, to the south.

malkba *v.i.* 1) come out, turn up, appear, emerge, arrive. **Angmalkbany kunayang lda kunburrun.** You arrived and I saw you and recognized you. **Barduwa lda balkbany wimung anildakburliwan.** Then he came out and talked to them.

— *v.t.* 2) take out, remove, pull out. 2.2) refers to the person's father's skin and related animals (see examples). *Prdm:* rimalkbany, anamalkbanyi, bumalkban. *Prdm:* PST **-malkbany**.

mangunyuni *coverb/adverb.* beside. **Ari mangunyuni jumung arlirr.** He's standing beside the tree. **Arlirr mangunyuni ari, wakaldakan makumbu. Janad wakaldakan ruka badba barra, nimarrk.** The tree is standing beside him, on the south side. He's on the other side, the northwest side, the ocean side. *See:* **-ngunyunmarraywung**. *[Note:* Man and Tree R34 Man and Tree R12*]*

marlmarraywung *v.t.* pass behind. **Kirrimul warrkarrk aju riwudbarraywung. Artirran ararnukbung rimarlmarraywung wuka jumung mutika wulurr.** It passes in front of where the goanna is. It comes back, turns off and passes behind the back of the car. *See:* **-wudbarraywung, -marraywung, -ngun yunmarraywung**.

marrajba *v.ang. (v.i.).* walk, go for a walk. *Prdm:* NPST angkumarrajbang. PL148 has full paradigm.

marralnga *v.i.* turn around. **Abarralngany walmad.** The rain is coming from the other direction. **Abarralngany Barra.** The wind has turned to the north-west.

marralngan *v.ang.* go around, go in a circle. **Nganamarralngaka.** I'll circle it. There is no nominal for 'circle'. "Circularity as an action" and the expression of shape through verbs s discussed in Bill Barton's The Language of Mathematics (Springer, 2009), p.29. Barton is inspired by the dynamic expression of space in Navajo (Pinxton, Van Dooren, & Harvey, The Anthropology of Space, 1983). *See:* **-alnga, -ngardalnga, -ldakburdalnga**; **-marralngan, -ngardalnga, -alnga**. *Prdm:* barralngan [barralngany, amarralngan].

marraywung 1) *v. t.* pass, pass by. **Ngarrkarrk arlirr aldindi mardan kirrimul Rimarraywung yawarang mangawala ajbud jumung kabala ari.** There are two trees there, small ones. It goes past them and runs along the beach where boat is. 2)

— *v. t.* fan. **Kabanayan baraka arijumardan awudban. Kabanamang imajak kabanamarraywudbung.** Have a look at that child that I put down. Get a goosewing fan and fan him. *See:* **-wudbarraywung, -marlmarraywung, -ngunyunmarraywung**.

maruj *n.* 1) left hand. 2) left (direction). **Maruj jarrabalamanma. Ngarrkarrk jarrabalamanma. Yawukun janad, rimalamanma janad, nurlinurli rimalamanma, maruj yawukun, maruj wara birr.** We pass [the pieces of rope ply] to the left. We're turning two. He passes his string on in turn, twisting it to the right and passing it to the left. It keeps on going to the left.

mayinmul *n.* headland, point. Mayinmul can be used to refer specifically to Cape Croker. Cape Croker is not only the northernmost point of Croker Island, but also of Western Arnhem Land. It appears to have the conventionalized meaning of 'north'. *See:* **Murdululi, awalawal**.

minyminy *n.* 1) rib. **rukung minyminy** be side on to 2) cut of dugong: rib-bone with associated meat.

Murdululi *n. prop.* place name 'Cape Croker'. **Like, wardakbudarr ari jamin, bad yawukan wuka . . . wuka - Murdululi.** He's quite a long way away, looking to . . . over

there - Cape Croker. Cape Croker is not only the northernmost point of Croker Island, but also of Western Arnhem Land. It appears to have the conventionalized meaning of 'north'. *See:* **awalawal, mayinmul**.

muwarn *n.* 1) sun. 2) sun skin: one of the matriphratry symbols, associated with the **yarriyarniny** 'skin' or matrimoiety. 3) watch. **Ngabi ngangkardakbin muwarn.** I am wearing a watch.

N - n

ngalaj *prep.* 1) with; together with. **Ijbaran ngalaj wamung** They went with them **ijbaran yap ngalaj wimung balanda** they were fishing, the balanda was with them **ngalaj wimung** everybody **ngalaj kandijawa** all the flour **ngalaj jumung** one man **ngalaj ngarrurrung** all of us 2) (when immediately preceding kinship verb) forms dyadic expressions of type 'husband and wife'.
— *adv.* **Awunbani wanadjanad ngalaj rimakan.** The two of them are sitting together, husband and wife. **ngalaj kawulang** mother and child 3) where.
— *rel.pron.* **Yawurtin ngalaj arrarrnan.** He went up to where the oysters are. *[Note:* The use of this term as a relative pronoun is restricted to certain speakers. Other speakers use 'jumung' or 'ba jumung' in this context.*]*

ngardalnga *v.t.* go around. **Kabanayan mana ajbud aju. Kabanangardalnga barakwarda yukbanawulakun.** You see the sand there. Go around that and come down. *See:* **-alnga, , -ldakburdalnga, -marralngan**.

ngardbalkbung *v.t.* stand on top of. **Riki kirrimul ringardalkbung ba arlirr kirrimul.** This one, it's like he's standing on top of the tree

ngarnangkan *v.i.* diverging from the main route, onto another road, detour, turn off. **Anngalidba, awaran wuka kabala ari barda akarnangkan ngalaj mudika ari kurrkarda.** Listen, he came to where the boat is then he turned off where the car is on the other side. **Ijbaran murrkud. Ijbunganangkany birta nganduka ijuminy.** They all went off. Then they turned off and now where are they?

ngarrunmin *v.i.* be the same height as. **Ari yawukan makumbu. Jamin ari arlirr angarrunmin.** He's looking south. The tree is the same height as him.

ngirrardama *v.t.* They are standing behind each other. **Aldi anmungirrardama lda wamin.** They standing behind each other (e.g., in queue.

ngirrunmin *v.i.* be back to back. **Ba aldarrunmin. Angirrunmin.** They are standing 'level', back to back. *[Note:* Man and Tree R31 alternate form -ngirrunmikbin*]*

ngirrwarda *n.* 1) back, upper. **Ngawurnyaka karlwirruk, mardyawu awakbun, awudban ngangirrwarda.** I warm the cobble stone and wrap it in paperbark, to warm my back with (if I'm suffering from pains). **rukung kirrwarda** he has his back turned 2) hull, of canoe.

ngunyulunmin *v.i.* be side by side. **Angunyulunmin awukawuk.** They're side by side at a slight angle. **Angunyulunmin. Ari wardak lda jamin.** They're side by side, far away from each other. *Syn:* **-ldarrunmin**. *[Note:* Man and Tree R43 Man and Tree R12*]*

ngunyun *prep.* at; in; in the vicinity of; somewhere around; thereabouts; in the area of. **Birta birukurnaj rayan yari. Wubaka yabin rtamburryak. Ngunyun Murdululi.** What can he be looking at? He's facing that way right over there. Somewhere around Cape Croker. **Janara, janawingkan ngunyun Marramarrani, nganurnbarra.** I'm going, When I get somewhere near Marramarrani I'll camp. **Nangila, ngandu ngunyun kawudban ba rrubiya.** Nangila, whereabouts did you put the money? **Rturtu, nganduka mana ngunyun awudban?** Hang on a minute, let me think whereabouts did I put it. **Jaran arariny ngunyun mudika.** I went and put it in the car. **Nganduka aju ba inindaj? Kani ngunyun kurrambalk minyminy.** Where's the pandanus hook? Here at the side of the house.

ngunyunmarraywung *v.t.* pass beside. **Angmanamin start barakbarda jumung banbani. Abanildurldalkung rtadbihi. Kabanangunyunmarraywun baraka dinghy.** You start there where [the houses] are. It will cross the creek. Then you will pass beside the dinghy. *See:* **-marraywung, -marlmarraywung, -wu dbarraywung, mangunyuni**.

nguranganin 1) *v.i.* be straight. **Ngarrawarlarrngbun ngarrabunya kujali, wurrurtbin, kuranganin.** We warm the harpoon shaft in the fire until it's straight. **Bidawukbung ba kirrimul kuranganin, kuranganikin.** It [the fish] has straight markings (stripes). *Prdm:* [kuranganang, anguranganin]. 2)
— *v.i.* go straight. **Angmananguranganin rtuwa i kabananurrkbun mutika muli.** You come straight down here and then you come around the back of the truck. 3)
— *v.t.* straighten. **Adbanamarrkan kujali.**

Arrabananguranganí ruka wurlan. We'll light a fire and we'll straighten these spear shafts. **Nanguj maju ananguranganá wurlan lda arlarrarr ba kujali.** We were going to straighten the spear shafts yesterday but there was no firewood.

ngurrkalkung *v. t.* be side on, be on one's side, turn on side. **Binyu ari. Ringurrkalkung.** He's standing side on. He's sideways. **Narrud ijbara bungurrkalkung buldakijba ba wardyad.** The surgeon fish swim on their sides along the rocks **Kurrana aju ringurrkalkung. Banamaju wanji ba kurrana.** The moon is lying on its side. It's going to die soon. **Wara yurrngud yabajbunkuny. Yawaran managwala ringurrkalkung. Mana banimani.** The plane took off. It flew and banked. It's going to land. This refers to the waxing or waning crescent moon.

nimarrk *n.* 1) middle, in the middle. can be used, for example, to refer to the middle part of a boat (IwNo19Ma05). 2) deep water.

nurlinurli *n.* 1) right hand. 2) to the right. **Maruj jarrabalamanma, ngarrkarrk jarrabalamanma. Yawukun janad, rimalamanma janad, nurlinurli rimalamanma, maruj yawukun, maruj wara birr.** We pass (the pieces of rope ply) to the left, we are turning three strings. He passes his string on in turn, twisting it to the right and passing it to the left.

R - r

rtamburryak *n. inflected.* 1) chest. **Baraka warrkbi, rtamburryak yabin wuka, jumung abalkbang manyij.** The man is facing that way, east. **Rukung rtamburryak [lda] jamin, mana yawakaldakan baraka arlirr wuka makumbu.** They're facing each other, and the tree's on the south side. *See:* **-amburryak**. 2) cut of dugong: chest meat in front of flippers. *See:* **fv|{-amburryak**}. *Pl:* **amburryak**.

ruka *prep.* locative preposition: in, at, on. **Banawirldimbina ruka manyij.** It will dry in the sun.

rukung kirrwarda *constr.* have back turned, have back to. **Rukung kirrwarda baraka arlirr barakbarda yawakaldakan walim.** He has his back to the tree which is there to the south *See:* **-ngirrwarda**.

U - u

urdaka *vi.* 1) be in front, ahead, before, first, earlier in relation to something else, often used in conjunction with **warrwak = behind, later, etc**. **Kudbanamin jumung mana janurdaka wuka Kartbiljurju.** Go and tell her I'm going on ahead to Cherry Beach. **Ba riki warrulany ba ruka yiwarruj ba ngarrumbukang ba awurlkbarrakanud ardakang.** But this, children, is the knowledge given to us by the old people who came before us. 2) be in front of, be first. **Arlirr warrwak yawakaldakan wuka wurrying manyij. Janad, warrkbi, wurdaka.** The tree is behind on the west side and he, the man, is in front. 3) go home. **Janad awurdaka.** He's coming home. **Ngabi janurdaka kayirrk, kuburr kunmanayan.** Well, I'll head home now, I'll see you tomorrow. **Ma yanganurdaka.** Well, you should be heading home. *Prdm:* kurrurduldaka, arrurduldaka, ardaldaka.

urrying *vi.* go into or be in water; go underwater; bathe; have shower, etc. **Ngabi karlu nganurryingurrying. Ngabi rtuwa abanajukun. Ngadburryingnurrying.** I'm not going to have a shower. I'll just wait for her, and the two of us will have a shower together. *See:* **wurrying manyij**. *Prdm:* wurrying, arryingarrying, ijburrying, nganurrying, yawurrying, adbanurrying, adburryingnurryin, kudburryingnurrying.

urti *vi.* 1) come/go up out of the sea, come/go ashore. **Ayuwunakan artikiny barda Didit, artikiny ijbanakandung, ijburdikiny ijuwingkukung wubukbarda jumung kabal wubaka lda kani.** They (two) came ashore at Didit. They came ashore at Didit, and they kept going until they arrived at a place between the floodplains and the sea. 2) ascend, come/go up. *Prdm:* Pym: wurtin [wurtiny, anawurtina, artin].

W - w

wakaldakan *v.i.* be on the [...] side, e.g. to be on the east side. **The man abalkbang manyij wakaldakan.** The tree is on the east side. **Arlirr wakaldakan nuyi angbani.** The tree is

on your side. **Balkbany wakaldakan.** It emerged partially on one side.

walarra *v.i.* be in the middle. *Prdm:* balarra [balarrang, awalarra].

walim *n.* south. **Yawukan wuka, jumung walim.** He's looking over there, to the south. *See:* **makumbu**. *From:* Kunwinjku 'walem'.

warakbarda *loc. adv.* ? way off, far away. *[Phon:* check transcription; may be **wardakbarda***]*

wardak *loc. adv.* far away, distant. **Like, wardakbudarr ari jamin, bad yawukan wuka . . . wuka - Murdululi.** He's quite a long way away, looking to . . . over there - Cape Croker.

wardama *v.t.* 1) follow, go along after. **Anbardama lda wamin.** They are following one another. 2) follow, observe (e.g. tradition, rule). **Abardama ba radbihi, ngabi radbihi abardama.** I follow the law.

— *v.i.* be followed, persist, continue (especially - perhaps only - with 'away' form of prefix). **Yawardama ba radbihi, burdan awarlkbarrakanud.** The tradition continues from the old people.

warrin *n.* inland, bush. **Kaladarr burran warrin.** The flowers are from the bush country.

warrwak *adv.* 1) behind. **Arlirr wurdaka mardan, lda janad warrwak mardan.** The tree is slightly in front, and he is behind, slightly 2) later on, afterwards. **Janara kayirrk nyanirra warrwak.** I'll go and I'll come back later. **Nayalding lda nyanirra abanamang warrwak.** Leave it and I'll come back and get it later.

wubaka *loc. adv.* somewhere, over there; further than **wubaki**. **Ijuwingkukung wubukbarda jumung kabal wubaka lda kani. Wara murralalmurralal warakbarda.** They arrived at a place between the floodplains and the sea. A clear place. *See:* **wubaki**.

wudbarraywung *v.t.* pass in front. **Kirrimul warrkarrk aju riwudbarraywung. Artirran ararnukbung rimarlmarraywung wuka jumung mutika wulurr.** It passes in front of where the goanna is. It comes back, turns off and passes behind the back of the car. **Malany awaran nganduwudbarraywung lda yawaran? Namina ngartung,"Angbani kundakijba."** Why did she walk past in front of me and then just go? She should have said, "You're sitting and I am passing you." *See:* **-marraywung, -marlmarraywung, -ngu nyunmarraywung**.

wuka *loc. adv.* over there, that way.

wuka *prep.* at, in, on, to: general locative marker. **Kudbanamin jumung mana janurdaka wuka Kartbiljurju.** Go ahead tell her I'm going ahead to Cherry Beach. **Rukburduka ngunjurl lda manbiri. Awunbaning kujbul wuka ldalha. Ngunjurl najaman. Manbiri nabarryi.** This is the story of the long-necked turtle and the green sea turtle, who used to live together in the sea. The long-necked turtle was the elder brother. The green sea turtle was the younger one. **Banawildimbin wuka manyij.** It will dry in the sun. *[Phon:* Frequently occurs in heavily reduced forms 'uk' or 'u', e.g., 'ngadbulakun uk ajbud'.*]*

wulaku *vi.* go down, descend. *Prdm:* NPST **wulakun**.

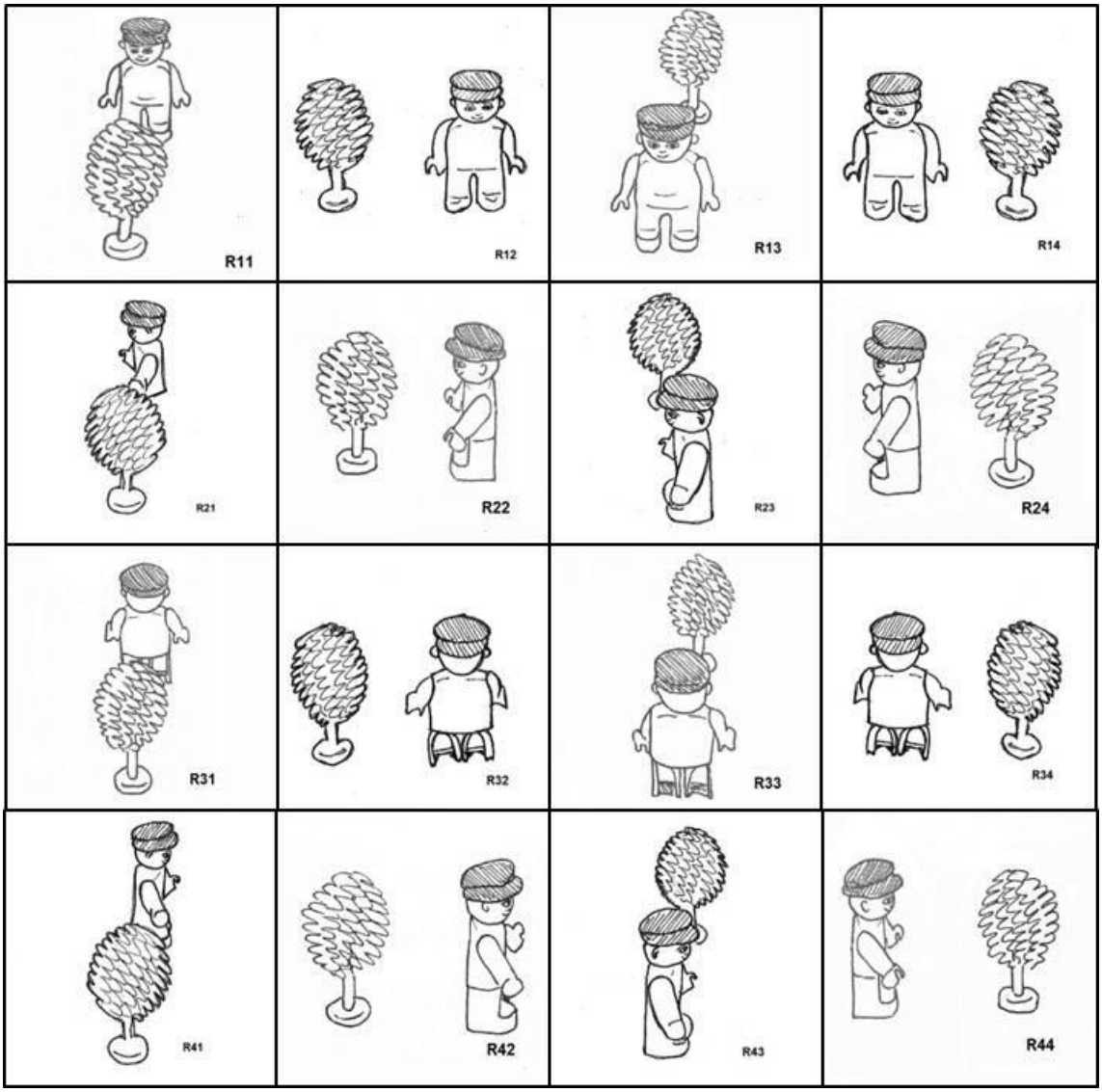
wurrying manyij *constr.* 1) sunset. 2) west. **Baraka rtamburryak wurrying manyij.** He's facing west. *See:* **-urrying**.

wuwud *n.* 1) down; down there. 2) (in many contexts) down to the beach. **Ngabi janawulakun wuwud.** I'll go down to the beach. may be used as positional, in which case it follows the nounwith respect to which the position is being calculated.

Y - y

yurrngud *n.* up high, the top. **Ubaj burran wuwud riwilbung yawaran yurrngud.** He split off the waters below (and) they went up into the sky.

Attachment A – Man and Tree Images



Man and Tree cards, Anne Senghas version (after Terrill & Burenhult, 2008, p. 96)