

THE ROLES OF LANGUAGE AND THOUGHT
IN CONCEPTUAL REPRESENTATIONS

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ABSTRACT

This thesis examines the roles of language and thought in conceptual representation. Some researchers suggest that concepts across different cultures are universal, with different linguistic labels or referents attached to them, a position known as cognitive determinism. However, others claim that language influences the way people think resulting in variations in conceptual representations across language groups, a view known as linguistic determinism. This debate regarding the roles of language and experience in conceptual representations is known as the language-thought debate. However, the current positions in the language-thought debate fail to account for subtle effects of language evident in several cross-linguistic studies. In this thesis, we propose that the roles of language and experience be expanded to include subtle views as well as strong ones, in order to promote a systematic investigation of this area.

Three studies explored the role of language in cognition. First, we established the role of task demands in the representations of everyday concepts. The findings from the first study are generalised to representations of other common, everyday concepts considered in the thesis, such as spatial (chapter four) and action concepts (chapter five). Next, we explored whether vocabulary differences in English when discussing spatio-temporal concepts influence the representations of them. The findings suggest that language has a subtle effect on spatio-temporal concepts. Finally, we investigate how variations in verb structure influence action concepts in a cross-linguistic environment. The results suggest that considering the role of language as mutually exclusive positions is not viable and that there is greater empirical benefit in investigating subtle effects of language on cognition.

TABLE OF CONTENTS

Title	i
Abstract	ii
Table of Contents	iii
List of Tables.....	vi
List of Figures	viii
Declaration	x
Statement of Copyright	x
Acknowledgements	xi

Chapter One

Introduction.....	1
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Chapter Two The Language-Thought Debate

2.1 Introduction	4
2.2 What are conceptual representations.....	5
2.3 Does language influence conceptual representations?.....	11
2.3.1 Linguistic determinism.....	12
2.3.2 Linguistic Relativity position.....	16
2.3.3 Thinking for Speaking.....	19
2.3.4 The roles of Perception and Language in concepts.....	21
2.3.5 Universal hypothesis	23
2.4 The different aspects of language that have been examined.....	33
2.5 The different aspects of 'Thought' that have been measured	43
2.6 Research Questions	47
2.7 Summary	50

Chapter Three When is an Uncle not an uncle: The role of task demands in conceptual representation	
3.1 Introduction.....	53
3.2 Conceptual representation and task demands	55
3.3 Featural aspects of concepts affected by task demands.....	60
3.4 Present Study	63
3.4.1 Experiment 1	65
3.4.2 Experiment 2	71
3.5 Summary and General Discussion.....	78
 Chapter Four Language versus Experience in Spatio-temporal Concepts	
4.1 Introduction.....	82
4.2 Spatial reference frame assignment and priming of reference frames	84
4.3 Motion in Space and Time	88
4.3.1 Motion in Space.....	90
4.3.2 Motion in Time.....	90
4.4 The Schema Mapping Hypothesis (SMH).....	93
4.5 Research Questions.....	97
4.5.1 Are representations of motion in space and time borrowed, or separate?.....	97
4.5.2 What directs spatio-temporal concepts—language or experience?.....	100
4.6 Present Study.....	107
4.6.1 Experiment One.....	108
4.6.2 Experiment Two	121
4.6.3 Experiment Three	127
4.6.4 Experiment Four.....	135
4.7 Summary and General Discussion.....	139

Chapter Five	The Role of Language in Verb Concepts	
5.1	Introduction.....	147
5.2	Methodological Concerns.....	148
5.3	Previous cross-linguistic research on verbal morphology.....	152
5.4	Characteristics of verb forms.....	153
5.4.1	Verbs in Tamil.....	155
5.4.2	Verbs in Mandarin.....	157
5.5	Present Study.....	163
5.5.1	Experiment 1(Pilot Study).....	165
5.5.2	Experiment 2.....	178
5.5.3	Experiment 3.....	191
5.6	Summary and General Discussion.....	211
Chapter Six	Summary and Discussion	
6.1	Review of the language-thought debate.....	221
6.2	Relevance of findings to the language-thought debate.....	223
6.3	Related issues on conceptual representation.....	227
Appendix A	232
Appendix B	234
References	235

LIST OF TABLES

Table 3.1. List of test stimuli and corresponding characteristic and defining features as identified by Keil and Batterman.....	67
Table 3.2. Mean judges' scores (min = 1; max = 3) of participants' responses by Question type and Story type	76
Table 4.1. Overview of prime and target tasks in experiments 1 to 4.....	108
Table 4.2. Overview of results in Experiments 1 to 4.....	141
Table 5.1. Present, past and future tense inflections of the verb <i>to eat</i> in Tamil.....	156
Table 5.2. Present, past and future tense inflections of the verb <i>to eat</i> in English, Tamil and Mandarin.....	162
Table 5.3. Summary of results from baseline and experimental conditions	189
Table 5.4. Summary of predictions for Tamil and Mandarin speakers in the experimental condition.....	195
Table 5.5. Mean response latencies (in msec) for object pairs by language group	198
Table 5.6. Mean response index (0 – 1) for object pairs by language group	199
Table 5.7. Mean response latencies(in msec) by participants' responses for object pairs.....	201
Table 5.8. Mean response latencies (in msec) for action pairs by language group	203
Table 5.9. Mean response index (0 – 1) for action pairs by language group	204
Table 5.10. Mean response latencies(in msec) by participants' responses for action pairs.....	205

Table 5.11. Summary of Tamil and Mandarin speakers' results from the baseline condition.....	207
Table 5.12. Summary of Tamil and Mandarin speakers' results from the experimental condition.....	209
Table 5.13. Summary of conclusions from the study.....	214
Table 6.1. Overview of findings from this thesis regarding the role of language in cognition.....	227

LIST OF FIGURES

Figure 2.1: Taxonomy for the noun—GERMAN SHEPHERD	8
Figure 2.2: The role of language in thought as represented on a continuum of influence.....	13
Figure 2.3: A picture from the storybook <i>Frog, Where Are You?</i> (Mayers, 1969)....	22
Figure 4.1. Schematic diagram representing S/OM schema of motion	92
Figure 4.2. Schematic diagram representing S/EM schema of motion.....	92
Figure 4.3. Schematic diagram representing T/OM schema of motion	92
Figure 4.4. Schematic diagram representing T/EM schema of motion.....	92
Figure 4.5. Percentage of participants who overcame the S/EM bias of the target and performed the task in a S/OM manner	105
Figure 4.6. Position of coffee mugs (representing pillars shown in the S/OM virtual environment) in relation to the participant.....	111
Figure 4.7. Position of wooden chests in the S/EM virtual environment in relation to the participant.....	113
Figure 4.8. Responses to the ambiguous spatial target in the baseline and experimental conditions	118
Figure 4.9. Responses to ambiguous temporal question in the baseline and experimental conditions	125
Figure 4.10. Position of trees in the S/OM virtual environment in relation to the participant.....	129

Figure 4.11. Responses to ambiguous spatial questions in the baseline and experimental conditions	134
Figure 4.12. Responses to ambiguous temporal question in the baseline and experimental conditions	138
Figure 5.1. Picture sets of an agent with inanimate themes in three variants	168
Figure 5.2. Picture sets of an agent with animate themes in three variants	168
Figure 5.3. Three different picture combination pairs	169
Figure 5.4. Mean ratings (1-7) for picture similarity for Action Change (B-AC) and Theme Change (B-TC) pairs, by linguistic group of participants.....	172
Figure 5.5. Different picture combination pairs in the baseline condition	182
Figure 5.6. Different picture combination pairs in the experimental condition.....	183
Figure 5.7. Mean ratings (1-7) for picture similarity for Object pairs (same, same type and different), by linguistic group of participants.....	187
Figure 5.8. Mean ratings (1-7) for picture similarity for Action Change (B-AC) and Theme Change (B-TC) pairs, by linguistic group of participants.....	188

DECLARATION

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CHAPTER ONE

INTRODUCTION

"What's in a name? That which we call a rose
By any other word would smell as sweet."

From *Romeo and Juliet*, Act II, Scene 2, Lines 47- 48.

Beyond resonance with poets and lovers, Romeo's words bring to mind an interesting debate regarding the role of language in conceptual representation. Some psychologists would agree that a label given to a flower does not influence the way people conceptualise it. Supporters of this position, known as cognitive determinism, assert that concepts across different cultures are universal, with different linguistic labels or referents attached to them. An opposing proposal known as linguistic determinism is that object labels do influence the representations of the concept in question, resulting in variations in conceptual representations across language groups.

The ongoing debate regarding the roles of language and experience in conceptual representations is known as the language-thought debate. The construct of 'language' is often expressed as either linguistic labels (e.g., vocabulary differences for objects) or grammatical patterns (e.g., verbal morphology); and the construct of 'experience' is characterised by perceptual and sensory experiences. The

influence of these constructs on ‘thought’ is measured by a variety of tasks, including question-and-answer sessions, sorting tasks, and similarity judgements.

Initial research in the language-thought debate by Whorf (1956) and Carroll and Casagrande (1958) supported the premise that linguistic structures influence thought patterns. However, subsequent research (e.g., Berlin & Kay, 1969; Rosch Heider, 1972; Rosch Heider & Olivier, 1972) provided evidence that conceptual representations are universal and are unaffected by linguistic differences. Recently, researchers have investigated the relationship between language and cognition in various areas such as object concepts (e.g., Malt, Sloman, Gennari, Shi, & Wang, 1999), mathematical concepts (e.g., Miura & Okamoto, 1989), event concepts (e.g., Slobin, 1987; 1996), spatial concepts (e.g., Li & Gleitman, 2002; Pederson, Danziger, Wilkins, Levinson, Kita, & Senft, 1998) and colour concepts (e.g., Davies, 1997; Roberson, Davidoff, & Davies, 2000).

Despite the range of conceptual representations examined, the findings on the role of language in cognition are mixed. One reason that the results have not provided a clear answer on linguistic influence is because researchers have adopted mutually exclusive positions—that language either has an influence or does not—leaving little room for less deterministic effects in thinking. However, the results from various cross-linguistic studies suggest that certain conceptual representations are less modular and consequently are more influenced by variations in language, whereas other concepts appear to be largely unaffected by linguistic differences. Consequently, the division of linguistic influence into opposing positions is overly simplistic and fails to capture more subtle linguistic effects on cognition.

In this thesis we resituate the language-thought debate and investigate both strong and subtle linguistic effects. Strong effects of language relate to its influence during language-learning, where conceptual representations are moulded by linguistic patterns. As a result, people's representations of concepts are preset according to their linguistic boundaries. For example, in some languages, different path markers are used to distinguish between spontaneous and caused motion. In English, spatial terms like *in/out*, *on/off*, denote both spontaneous and caused motion, however Korean speakers consistently refer to spontaneous and caused motion with two distinct path markers. Other differences include how past events are encoded. For example, in Spanish, there are two distinct patterns for expressing the past tense that require the speaker to consider the duration of the event (i.e., a one-time occurrence or a continual experience). Some researchers argue that linguistic patterns such as these affect the thought patterns of the speaker from an early stage and, to a large extent, determine how corresponding concepts are represented.

Subtle effects include the influence of language only when speaking. For example, when a Spanish speaker is referring to an event in the past, the past tense morphology will influence his representation of events because his thinking is confined to those linguistic parameters. However, when not speaking, his event concepts are not confined to the linguistic patterns. This premise corresponds with proposals suggested by other researchers who argue that although language can affect certain conceptual representations, it does not preclude alternative ways of thinking. Another manifestation of subtle linguistic effects is that certain conceptual representations that are distinctly encoded in a language are accessed with greater ease and speed.

In this thesis, we explore varying influences of language on cognition. First, we examine behavioural differences in an English-speaking population when exposed to different spatial conditions. Once a linguistic effect is established, we then extend the research to explore the role of language in a cross-linguistic environment. The findings suggest that considering the role of language as mutually exclusive positions is not viable and that there is greater empirical benefit in investigating subtle effects of language on cognition.

CHAPTER TWO

THE LANGUAGE-THOUGHT DEBATE

2.1 Introduction

The Language-Thought debate focuses on whether forms of linguistic expressions have a unique influence on the thoughts and actions of their users. Some argue that languages mould the thought of their speakers, a view known as linguistic determinism (e.g., Whorf, 1956). However, others claim that language reflects previously available concepts, a position termed as cognitive determinism (e.g., Bloom & Keil, 2002; Jakendoff, 1990; Macnamara, 1972).

Several different disciplines, such as psychology, anthropology, and linguistics, have contributed to the Language-Thought debate. Despite a large amount of research in this area, there is no clear perspective on the role of language in cognition. This is possibly because the research question—Does language influence thought?—suggests that language either has an influence or does not, leaving little room for middle ground. The results of this debate, however, have not been so clear-cut, and there has been support for both positions. In light of the mixed results, we first readdress the question of the role of language in thought as a more tractable premise based on previous empirical studies. Within these theoretical boundaries, we raise several research questions to clarify the nature of this debate. First, we review what aspects of language have been examined in various cross-

linguistic studies on colour categorisation, spatial representations, and other research areas. Next, we determine how the notion of ‘thought’ has been measured in the language-thought debate. Having identified clear empirical parameters, three studies designed to distinguish the varying degrees of linguistic influence on conceptual representation are introduced.

2.2 Conceptual representations

In this thesis, conceptual representations refer to an internal system that organises knowledge about the world. The information that is extracted from experiences such as tending a garden, riding a bicycle, cooking a meal, is important in directing future behaviour. However, there is a vast amount of information that can be stored, and people often select what aspects of an event will be most useful. For example, it is not parsimonious to remember what every leaf in a garden looks like, but it is helpful to be able to distinguish between a weed and a plant. Likewise, it is not necessary to remember what every dog looks like, it is only useful to have a general knowledge of dogs in order to be able to identify one. In order to economise on the amount of information that needs to be remembered, knowledge is organised in categories; for example, we know that weeds and plants are living things that need sun and water.

The process of organising knowledge and storing conceptual representations is complex and has been explored by psychologists and philosophers for years. Early research by Bruner, Goodnow and Austin (1956) confirmed the use of rules in how people organise and divide objects and events into meaningful categories. However, their research was restricted to participants’ performance on artificial categories, such as shapes, and might not be applicable to behaviour in real-world situations. Subsequent research has suggested that natural categories such as animals and plants

aren't organised by a clear-cut set of rules (e.g., Rosch, 1973). In this section, we present a brief overview of different theories and models of conceptual representations (see Hampton, 1997; Komatsu, 1992, for more detailed reviews).

The definition-based view

Katz and Fodor (1963) proposed that concepts are represented with a set of defining attributes. In order to be considered as a member of a conceptual category, an object should possess these features, which are also common to other members of the concept. For example, the concept of *bachelor* is represented by the following present and absent features:

HUMAN	+
MALE	+
ADULT	+
MARRIED	--

According to Smith and Medin (1981; see also Collins & Quillian, 1969), conceptual information is represented taxonomically, and each level of the taxonomy has strict and clear-cut divisions. All the features represented in the superordinate levels are communicated to objects in each subordinate level and the information that is transmitted from one level to the next provides for a 'summary of representation' for the entire set. Figure 2.1 illustrates how information is communicated for the noun GERMAN SHEPHERD.

ANIMAL—Superordinate class



MAMMAL—Superordinate class



DOG—Superordinate class



GERMAN SHEPHERD

Figure 2.1: Taxonomy for the noun—GERMAN SHEPHERD

The noun GERMAN SHEPHERD inherits all the features from the preceding classes, such as those belonging to an animal—*breathes, eats*; those features belonging to a mammal—*is warm-blooded, has lungs, gives birth to young*; and those belonging to a dog—*barks*. This summary representation for members of a set is also applicable to all other members of a set. For example, other dogs such as a cocker spaniel or a poodle, inherit the features from the preceding classes of *dog, mammal, and animal*. In this view, there is a strong coherence in concepts, because members are united by a shared set of defining features. There is also the understanding that the boundaries between each level are rigid and well-defined.

Despite the advantages of representing information taxonomically, several researchers have challenged the premise that taxonomic divisions are considered as strict and clear-cut. McCloskey and Glucksberg (1978) investigated how boundaries are represented and found considerable disagreement and variations in between-subject and within-subject ratings in category decisions. Rather than supporting the role of clear-cut categorical boundaries, participants' responses revealed an

imprecision in processing concepts, which suggested that boundaries between taxonomic divisions are more fuzzy than they are well-defined (see also Barsalou, 1989; and Komatsu, 1992, for further discussion and criticisms of the role of definitions and boundaries in conceptual representation). There is also a problem with identifying 'defining features'. For example, in concepts such as *game* or *sport*, it is not immediately evident what information all games and sports share that is defining (cf. Wittgenstein, 1958).

The prototypical view

Instead of a set of defining features determining category members, Rosch (1975) claimed that people make decisions on categorisation based on the "level of goodness of example" or typicality. The prototypical member captures the central tendencies of a category, thus, the more similar a stimulus is to the prototype, the more likely it is to belong to the same category. For example, a *chair* is a highly typical member of the concept *furniture*, however *rug* is not (p. 200). Typical members of a concept are verified as members of a concept faster than less typical members. For example, a *robin* is verified as a member of a *bird* concept faster than an *ostrich*. Further, people compare stimuli with a member that is the best example of a category when deciding whether a new stimulus belongs to a category.

Although the prototype view was supported by an extensive amount of empirical work (e.g., Ortony, 1979; A. Tversky, 1977; B. Tversky, 1989; B. Tversky & Hemenway, 1984), there was some dissatisfaction with the premise that the representation of a concept could be captured by typical members. Hampton (1981) discovered that the representation of abstract concepts, such as *crime*, *belief*, *a rule*, *science* and others, were not constrained by prototypical features. Abstract concepts

have a greater flexibility in representation than concrete concepts such as *furniture* and *animals*. Hampton suggested that the role of typical features in conceptual representation might not be as generalisable to other concepts as Rosch (1975) predicted (however, see Ross & Makin, 1997, and Nosofsky, 1986, for variants of the prototype model that address some of its shortcomings).

The explanation-based view

Proponents of this position suggest that background knowledge of the world contributes to conceptual representation (e.g., Carey, 1985; Keil, 1989; Murphy and Medin, 1985; Smith and Medin, 1981). Although concepts may be represented by defining or prototypical features, conceptual judgments are driven by the connections between these features, rather than the features themselves. Consider the following scenario (from Murphy and Medin, 1985, p. 295-296): "Suppose that all the soda cans you have come into contact with have been 7.5 cm in diameter and that all the silver dollars you have seen have been 4.0 cm in diameter. Suppose further that you are told that some entity has a diameter of 5.0 and you are asked whether it is more likely to be a soda can or a silver dollar". Murphy and Medin found that participants were more likely to judge this novel object as a soda can because its size is a variable feature, whereas silver dollars are mandated by law to be a certain size. The results confirm that people rely on knowledge about relationships between features, rather than features alone in conceptual representation. Further research by Medin, Wattenmaker and Hampson (1987), Rips (1989) and Rips and Collins, (1993) confirms the role of underlying theoretical knowledge, rather than definitions or prototypical features, in conceptual representations.

The Perceptual Symbols Model

A more recent view of conceptual representation is Barsalou's (1999) perceptual symbols model, where people store a visual rather than verbal representation of the salient features of a concept. Barsalou posited that the perceptual system functions like a recording device to capture physical images that later translate into a comprehensive representational system (see also Pulvermuller, 1999). The images are records of unconscious neural connections that construct simulations of events or objects in a frame. Frames are the perceptual vantage point of the viewer, for example, if one views the side of a car, then those objects are 'framed'. Multiple frames from perceptual information make up a 'simulator'. A simulator captures objects and experiences, and allows people to retrieve these stored images, and re-represent them in creative and novel ways.

According to Barsalou, a simulator has the same function as a concept: "it is the knowledge and accompanying processes that allow an individual to represent some kind of entity or event adequately" (p. 15). A simulator replaces a static and amodal view of conceptual representation, and is a more dynamic and realistic approach using a perceptual pattern matching system. For example, "if the simulator for a category can produce a satisfactory simulation of a perceived entity, the entity belongs in the category. If the simulator cannot produce a satisfactory simulation, the entity is not a category member" (p. 16).

In this thesis, we take a neutral position regarding the exact nature of conceptual representation. It is evident that people store representations of concepts that allow us to recognise them and interact with them on a daily basis. Despite the

differing positions on how these representations are stored, there seems to be an underlying assumption that conceptual representation consists of different features, rather than being a unitary representation. The question of interest in this thesis is whether language plays a role in these representations.

2.3 Does language influence conceptual representations?

In the language-thought debate, this question has often been answered as either yes—language influences conceptual representations (linguistic relativity); or no—representations are universal (cognitive determinism). The former position is rooted in the Whorfian proposal (1956) that language determines thought. Drawing from his observations of various Native American languages, Whorf suggested that different linguistic expressions affect representations of the corresponding concepts. Based on more recent investigations of different speakers' behavioural patterns, Levinson (1992, p. 133) proposed the following syllogism to express a milder, but nonetheless important view of the role of language in thought:

1) languages vary in semantic structure

2) semantic categories determine aspects of individual thinking:

Therefore;

3) aspects of individuals' thinking differ across linguistic communities according to the language they speak.

The second position—conceptual representations are universal—holds that people have pre-existing concepts that are mapped to linguistic referents (e.g., Fodor, 1975; Jakendoff, 1990). Consequently, differences in linguistic expressions do not affect conceptual representations but only reflect antecedently existing conceptual differences. The notion of universality in thinking is supported by early

research on colour categories (e.g., Berlin & Kay, 1969; Rosch Heider, 1972; Rosch Heider & Olivier, 1972).

The ensuing debate over the validity of these two positions has not provided researchers with a clearer picture of the role of language in conceptual representations. This ambiguity might be because the dichotomous view of the role of language in thought—it either has an influence or does not—has resulted in an oversimplification of cognitive processes. In light of evidence from recent research, which suggests that language affects some conceptual representations (e.g., Gentner & Bororditsky, 2001; Slobin, 1997), it may be more productive to view the role of language on a continuum of influence, rather than represented as a dichotomy. The different positions highlighted in Figure 2.2 reflect empirical findings from various cross-linguistic studies and are detailed below.

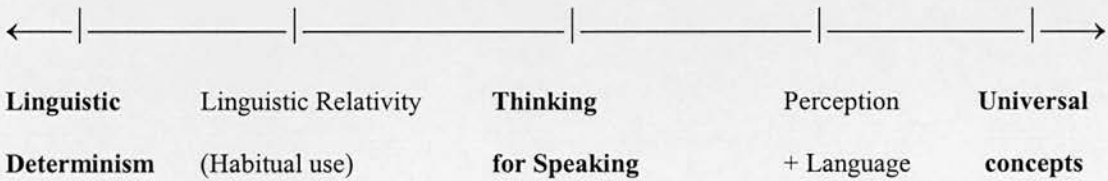


Figure 2.2: The role of language in thought as represented on a continuum of influence

2.3.1 Linguistic determinism

The deterministic role of language in this position is often illustrated (inappropriately so) with Franz Boas’ example of the Eskimo people and their many words for snow in contrast to one English word (Boas, 1911).¹ Boas’ original purpose in highlighting this information was to distinguish between independent and derived morphology for

¹ Although Boas did not adopt a deterministic outlook of the role of language in cognition, his *snow* illustration has been misrepresented and perpetuated to indicate that language determines how people think (see Pullum, 1991, for further discussion). Its mention here illustrates the deterministic premise of this position.

natural kinds. For example, the different forms of snow in English are based on the word *snow*, however these phrases in Eskimo have distinct roots: *aput*—‘snow on the ground’; *gana*—falling snow; *piqsirpoq*—drifting snow; and *qimuqsuq*—a snow drift (Boas’ examples, from Pullum, 1991, p. 163). Boas’ intention was simply to highlight that different languages classify experiences differently.² However, his student, Edward Sapir strengthened his claims and argued that language directs daily life into something more than a mass of random experiences. He stated that “it is quite an illusion to imagine that one adjusts to reality essentially without the use of language and that language is merely an incidental means of solving specific problems of communication or reflection. The fact of the matter is that the ‘real world’ is to a large extent unconsciously built up on the language habits of the group. We see and hear and otherwise experience very largely as we do because the language habits of our community predispose certain choices of interpretation” (Sapir in Whorf’s *The relation of habitual thought and behaviour to language*, 1956, p. 134).

Benjamin Whorf supported Sapir’s claims with comprehensive case studies outlining linguistic differences such as temporal statements, pluralisation, and quantification. Although Whorf agreed that language and experience do affect each other, he argued that because language is a system, rather than a mere collection of sounds and symbols, it ultimately constrains the coding and interpretation of sensory experiences: “language is not merely a reproducing instrument for voicing ideas but

² Boas’ position on the role of language was milder than Sapir’s or Whorf’s as he claimed that linguistic classifications of experience reflect but don’t dictate thought. He also argued that because of the grammatical variance between languages, certain categories are not expressed linguistically. In order to compensate for this lack, a language will normally have a substitute form of a conceptual expression that contributes to representing what Boas referred to as a ‘complete concept’. Although linguistic constraints might prohibit a speaker from directly expressing certain concepts, substitution phraseology is used to represent the concept in question.

rather is itself the shaper of ideas, the program and guide for the individual's mental activity" (Whorf, 1956, p. 212).

Whorf's research can be divided into two sections—his early research on English and other European lexicons, and his later exploration of Native American Indian grammar. Governing Whorf's research activities was the question of why different language groups would engage in the same reality in such different ways. His early observations of the English lexicon were as a fire inspector. He noticed that people would smoke around empty fire drums and then discard their cigarettes in them, causing a fire. Whorf believed that language was determining their thinking and ultimately their actions. He observed that the word *empty* is frequently used to refer to a physically vacant space. People acted carelessly around the empty fire drums because they failed to take into account that although the drums were physically *empty* (i.e., from solid materials), they nevertheless contained flammable gases. Whorf's other lexical observations include *limestone*, *waste water*, and *scrap lead*, and gender terms in English and Latin and German (for a more comprehensive review of his early work, see Lucy, 1992a). While these observations are informative, they represent individual lexical accounts rather than patterns of linguistic differences.

His subsequent research compared grammatical patterns in different languages. Initially, he examined commonalities between European languages, grouping them together into what he termed as Standard Average European (SAE). However, Whorf felt that his own language biased his view of reality, and the only way to effectively examine the influence of language on thought was to examine what he termed as 'exotic' languages—languages that do not share any grammatical

similarities with European languages, such as Native American Indian languages. In particular, he was concerned with how concepts of space, time and matter differ between languages. He believed that these concepts weren't universal and that linguistic variations were responsible for the different conceptual representations. For example, in his study of the Hopi language he noticed that "it is seen to contain no words, grammatical forms, constructions or expressions that refer directly to what we call 'time', or to past, present, or future, or to enduring or lasting, or to motion as kinematic rather than dynamic (i.e., as a continuous translation in space and time rather than as an exhibition of dynamic effort in a certain process)." (p. 57-58). This difference in linguistic descriptions of time causes Hopi speakers to conceptualise time distinctly from English speakers. While Western languages describe time on a continuum: "as like a space of strictly limited dimensions, or sometimes as like a motion upon such a space" (p. 158), in Hopi, time is a duration, "inconceivable in terms of space or motion" (p. 158) and is directly linked to consciousness (see also Lee, 1996).

Whorf also observed linguistic differences when talking about matter. For example, in Hopi there is only one noun—*masa'ytaka*—that covers everything that flies, such as insects and planes. A separate noun, however, delineates birds. He used this and many other examples to propose that language plays a strong role in dividing how people think about substantive nouns. Whorf also claimed that the different sentence structures of Indo-European languages, where sentences are often partitioned into subjects and predicates, and American Indian languages, where no such division exists, lead the different language groups to represent concepts distinctively. Other grammatical differences between these two language groups

relate to tense changes in verbs. Hopi makes no distinction between past, present and future tenses; whereas English speakers are required to delineate actions, such as *I walked the dog*; or *I will walk the dog*. Whorf believed that because language impacts cognition significantly, to change one's language would actually result in the loss of the thought processes as represented by the original linguistic structure.

Although Whorf committed himself to documenting linguistic differences between Native American Indian languages and Standard Average European, he did not extend his work to examine the effect of language on behavioural patterns in these two linguistic communities. As such, his work only highlights lexical and grammatical differences between European and Native American Indian languages, without actually confirming his premise that such differences allow people to “dissect nature along lines laid down by our native languages” (p. 213).

2.3.2 Linguistic Relativity position

Proponents of this position take a less deterministic view of the role of language, arguing that although language does not determine conceptual representation, it plays some role in thinking. Early researchers such as Carroll and Casagrande (1958) explored Whorf's premise that conceptual patterns correspond to language-specific differences. In one experiment, they presented Hopi (Native American Indians) and English speakers with triads of pictures, representing different actions, such as spilling, pouring and others, and asked them to group a pair of actions together. They predicted that the Hopi and English speakers would choose different pairs because of the different verbs in their language. For example, Hopi speakers use the same word to represent *spilling* and *pouring*, however, they have different verbs to express *spilling/pouring* liquid versus other substances. English speakers

distinguish between how liquids are poured (e.g., spilled versus poured) rather than type of substance being poured. Carroll and Casagrande predicted that Hopi speakers would pair pictures according to the type of material being spilled or poured, while English speakers would distinguish between the action of spilling and pouring. The findings suggest that the participants paired the pictures in a manner that corresponded with their respective linguistic structures.

Recent studies in this area have continued to investigate language effects on thinking in cross-linguistic environments. Miura and Okamoto (1989) explored lexical differences in counting strategies in Japanese and English. Japanese and American children were asked to group single unit blocks and blocks of 10 units to make the total 42. As Japanese follows a number system where numbers above 10 are expressed in multiples of 10 thus 16 is 'ten-six' and 20 is 'two-tens', Miura and Okamoto predicted that Japanese children would be more likely to use blocks of 10, instead of unit blocks. The predictions were confirmed as the children's actions corresponded with the number marking in each language—the Japanese children were twice as likely to use blocks of 10 compared to American children, while the latter group tended to use 42 single units. When asked to think of another way of making up the same number, however, the English-speaking children did use the blocks of 10. The finding illustrates that the influence of a particular language does not necessarily preclude the ability to perceive a situation in a different way, but that habitual thinking is consistent with corresponding linguistic structures.

A related proposal suggests that linguistic differences not only influence conceptual representations, they also affect how quickly concepts are processed. This effect is readily observable when translating between languages. According to

linguistic determinism, language directs how people think, and therefore, if one language does not have the syntax to express an idea, speakers of that language would be unlikely to think along those lines—as in Whorf's example of differences in Hopi and English speakers' temporal concepts (1956; see section 2.2.1). However, Hunt and Agnoli (1991) argued that despite grammatical or lexical differences, all statements in one language are translatable into another. The question is not one of whether common experiences are similarly expressed, or even translatable, but rather of at what cost this translation occurs. They proposed that some expressions are more naturally and succinctly expressed in one language over another. For example, they highlighted a term *mokita* in the Kiriwina language of New Guinea which means "truth everybody knows but nobody speaks" (p. 377; Rheingold, 1988). Although there is not a corresponding term in English, the concept is familiar to us. According to Hunt and Agnoli, when a phrase or description is common (i.e., frequently and succinctly communicated) in a language, speakers exert relatively less effort processing these ideas. Therefore, Kiriwina speakers will spend relatively less time processing the concept *mokita* than English speakers, even though both language groups have an understanding of that concept.

Although this idea is applied to cross-linguistic communities, it can also account for words used in society today that were not used in the past. For example, surfers (ocean, not internet) have developed short phrases and one-word descriptions for waves (Hunt and Agnoli's example). While these phrases were not used in the past, this does not imply that early surfers were unaware of differences in waves. Rather, it suggests that today's surfers spend less processing time accessing their wave-concepts than early surfers.

In this position, language plays a less deterministic, but nonetheless important role in conceptual representations. Cross-linguistic studies indicate that differences in grammatical patterns influence cognition. It is important to note that although speakers are more likely to think consistently with their language, this does not preclude them from thinking in different ways (e.g., Miura & Okamoto, 1989). Furthermore, some researchers (e.g., Hunt & Agnoli, 1991) theorise that having a lexical entry for a concept also speeds up speakers' processing time. While this idea has some support from other areas of study (e.g., Miller's chunking, 1956), little work has been done to confirm the validity of this premise in the language-thought debate.³

2.3.3 Thinking for Speaking

Slobin (1987; 1996) suggested that Whorf's controversial premise—'language determines thought'—be substituted with the phrase 'thinking for speaking'. This substitution, he argued, allows for a reflection of on-line processing, as well as an exclusive focus "on those parts of utterances that are required by the grammatical organisation of the language" (1996, p. 71). Slobin argued that grammatical markings force the speaker to consider the expression of his experience. For example, English speakers have to remember whether it was one person or two people at the door (as they cannot simply say 'there is person at the door' without identifying the number of people). Likewise, the two distinct structures for expressing the past tense in Spanish force the speaker to consider the duration of the event, for example, was it a one-time occurrence— '*Corri en el parque (I ran in the park [once])*'; or a continual experience— '*Corria en el parque (I ran in the park*

³ Although Miller's notion of chunking applies to short-term memory capacity, it can also account for general processing of information.

[every day])’.⁴ Other researchers have made similar suggestions that language patterns affect how experiences are encoded. For example, Levinson noted “these are language-specific distinctions that seem to require noticing special properties of the world so that one is ready to encode them linguistically should the need arise” (1996, p. 27).

This view is based on the premise that linguistic patterns only play a role in conceptual representations during speaking. Drawing from narratives produced by various linguistic communities (e.g., Spanish, Turkish and Hebrew), Slobin argued that difference linguistic expressions used by these speakers are indicative of different semantic perspectives. For example, in Turkish, there are two past tense inflections—one to refer to events that were witnessed and another for events that one infers. As a result of this distinction, Turkish participants described the events in the picture below differently (Figure 2.3). They stated that ‘the dog was running’ (an observed event) and ‘the boy apparently fell’ (an inferred event). The grammatical structure in English does not prohibit people from observing the difference that the Turkish speakers make, for example, we can say that: **Apparently** the boy fell; or **It seems** that the boy fell (Slobin, 1996, p. 74), however, we are not grammatically obligated to do so. Because people are sensitive to individual grammatical patterns, Slobin argued that thoughts are confined to particular linguistic parameters, while speaking. Although Slobin is careful to state that there might be an overlap between linguistic perspectives, the range of ideas that each language group communicates varies, confirming that there is some relativity in thinking.

⁴ While English allows us to make a similar distinction, it is not necessary to recount the duration of past events, while it is in Spanish.

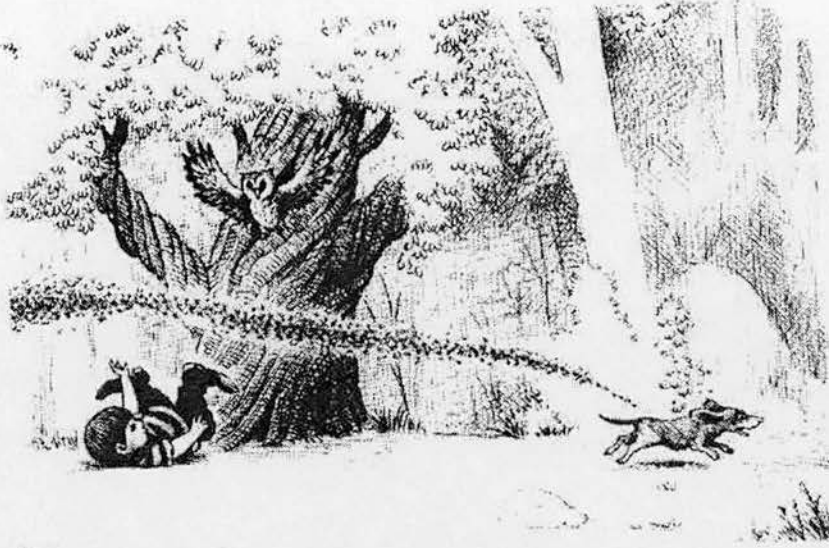


Figure 2.3: A picture from the storybook *Frog, Where Are You?* (Mayers, 1969)

Recent empirical work by Boroditsky (2001; also Boroditsky, & Ramscar, 2002) supports the premise of thinking for speaking. She discovered that altering motion labels can change the way people think about time. Native English speakers were taught the Mandarin vertical representation of time using statements such as “Monday is *above* Tuesday” and “Nixon was president *above* Clinton” (p. 88) and then given linguistic spatial primes and targets. The results indicated that the English participants responded more quickly to the *above/below* targets rather than the *before/after* sentences, which are more familiar in English. This finding supports Slobin’s premise that while speaking, cognitive processes are constrained by language-specific parameters.

2.3.4 The roles of Perception and Language in concepts

Findings from cross-linguistic studies provide indications of both the effects and non-effects of language. One suggestion for reconciling this disparity is that perception and language have a shared influence on cognition. Specifically,

linguistic effects are most visible when there are weak universal or perceptual tendencies (Gentner & Boroditsky, 2001; Imai & Gentner, 1997; Munnich, Landau, & Doshier, 2001). For example, objects are generally identified by physical appearance (at least initially) and as a result, are more likely to be categorised based on perceptually salient features. However, other concepts, such as verbs, are more likely to be learnt from conversations, and thus are more sensitive to syntactic patterns (Gleitman, 1994).

Several developmental studies indicate that object concepts are bootstrapped by perception. Cross-linguistic studies on Korean, Mandarin and Italian children identified an early (concrete) noun advantage, despite these languages having more frequent verb input (e.g., Au, Dapretto, & Song, 1994; Gelman & Tardiff, 1998). In light of this research, Gentner and Boroditsky (2001) argued that noun partitions tend to follow natural (i.e., perceptual) partitions, leaving the individual to learn linguistic referents for pre-grouped concrete objects.

Findings from adult populations reported by Malt, Sloman, Gennari, Shi, and Wang (1999), lend some support to the notion that objects are perceptually grounded. In a cross-linguistic study, English, Spanish, and Mandarin speakers were presented with photos of 60 different containers, and were asked to sort them into groups based on physical, functional or overall similarity. The photos were then shuffled and redistributed to the participants, who gave names to the containers. The results revealed that while the three different language groups clearly generated very different names for the containers, the sorting tasks based on the various similarity criteria showed only negligible differences. The responses indicated a dissociation between the perception and naming of the containers. Further, the sorting tasks

revealed that the difference in naming of the containers did not appear to affect the perceptual similarity of the objects.

Verbs on the other hand, are considered central to language processing, and semantically mutable. The unique syntactic patterns prohibit different speakers from learning denotational terms exclusively from experience. Several cross-linguistic studies confirmed that certain concepts are heavily influenced by linguistic patterns (e.g., Choi & Bowerman, 1991; Imai & Mazuka, 1997; Lucy, 1992a).

In this position, language exerts varying degrees of influence on conceptual representations. With more perceptually salient concepts, such as objects, language plays a more minimal role, presumably because people rely less on language and more on perception when encoding them. With less perceptually salient objects such as events however, language plays a more integral role in processing, possibly due to the complexity of verb structures. This position seems to account for some of the disparity in cross-linguistic data. Further, it also appears feasible on an intuitive level; however, no empirical work has compared language effects of both objects and events in the same cross-linguistic populations.

2.3.5 Universal hypothesis

The premise in this position is that different language groups share a commonality in thinking despite lexical and grammatical variations. We highlight two modalities that account for a common representational system. First, we look at the role of perception in colour categories, an area initially explored in the early 1950s. Next, we explore a more general modality—sensory experiences. Although this modality includes perception, it extends to other senses involved in physical experiences, such as touch, sound and smell. According to the Embodiment theory (Lakoff & Johnson,

1999; also Glenberg, 1997), daily physical experiences drive conceptual representations.

The role of perception: Research on colour categories

Colour categories were one of the first topics studied to assess the role of language in cognition. Early research in this area supported the linguistic relativity hypothesis, however, subsequent research suggested that language does not play a major role in influencing colour concepts.⁵ Although it is not clear whether colour words characterise a structurally important role in English or any other language, Brown and Lenneberg's (1954) research on English coding of the colour lexicon provide some clue as to why colour was chosen as an adequate representation of linguistic categories. They decided to use colour categories, rather than natural kind categories such as snow (cf. Boas' example of linguistic relativity, section 2.3.1), because they considered colour concepts to "have boundaries that can be plotted on a known dimension" (p. 458). The inherently psychophysical dimensions of colour categories—hue, brightness, and saturation—suggested an ideal tool to explore the roles of perception and language in thought. Two tasks are commonly used to evaluate colour categories: a naming task, where the participant has to describe certain colour samples, and a recognition or memory task, where the participant identifies the original sample colours from a large array of others.

For their study, Brown and Lennenberg chose 24 colour stimuli from an array of 240 colours from the Munsell array. English and Zuni speakers, a Native American Indian people, performed the naming and memory tasks. Brown and Lennenberg discovered that English speakers had no difficulty making lexical and

⁵ Lucy (1992) divided colour research into two periods: research supporting the linguistic relativity theory was conducted between 1953-68, whereas the latter studies between 1969-78 provided support for the universalist hypothesis.

perceptual distinctions between orange and yellow, a due to the different labels available for the two colours. The Zuni speakers however, consistently confused these two colours, possibly the result of a single label for orange and yellow. Further, the results suggested that highly codable colours (i.e., agreement in name and name length) were remembered more easily in the memory task. Brown and Lennenberg argued that colour terms that are lexicalised are stored more efficiently in memory (see also Lennenberg and Roberts, 1956). However, the results were not replicated when using low-saturation colour stimuli from the Farnsworth-Munsell colour array (see Burham & Clark, 1955; Lennenberg, 1961).

Berlin and Kay (1969) suggested that a commonality between languages that have many colour terms and those who only have a few, is that all languages derive their basic or focal colour terms from a set of 11 colours. They developed criteria for identifying basic colour terms; for example, a basic term cannot rely on another colour term to describe it (i.e., *turquoise* is explained in reference to blue and green); it must be a frequently used term (i.e., *red* rather than *burgundy*); and its application cannot be restricted to one category (i.e., *brunette* is only used to describe hair colour). They tested participants from different language groups on two tasks. First, participants were asked to generate colour terms without any colour stimuli, then they were shown colour chips from a Munsell array and had to pick out the corresponding colour stimulus. Berlin and Kay discovered that participants from most language groups agreed on which colour tiles represented the basic colour terms, such as red, blue, green. This finding indicated a commonality in perception of basic colours, despite label differences.

Based on Berlin and Kay's research (1969) on basic colours, Rosch Heider (1972) tested the correlation between naming (codability) and memory for English speakers and for an aboriginal people group—the Dani tribe in Irian Jaya. The Dani language describes colour in two terms, dividing the colour space not into hues (e.g., red, blue, green, etc.), as English does, but in terms of brightness (i.e., light/dark). Rosch Heider investigated differences between English and Dani speakers' memory for basic and non-basic colours. She used a similar methodology to Brown and Lennenberg (1954). The Dani and English speakers were presented with colour chips and performed a naming and a short-term memory task. The results indicated that the English speakers performed better than the Dani speakers in the memory task; however, both the Dani and English speakers remembered the basic colours better than the non-basic colours. Even though the Dani tribe had two colour terms, they were able to learn and recognise the eleven basic colours as identified by Berlin & Kay better than the non-focal colours. Rosch Heider concluded that the similarities between the Dani and English speakers' performance in the memory task suggested that there was little evidence for the influence of language on colour concepts.

Although Rosch Heider's empirical support of perceptual dominance in colour categories was widely accepted, a few researchers were sceptical. In particular, Lucy and Shweder (1979) argued that the Dani and English speakers in Rosch Heider's study (1972) identified the basic colours despite differences in colour labels because the basic colour tiles were more discriminable than non-basic colour ones. With a modified colour array where all colours were produced at comparable levels of discriminability, basic colours were not recalled more than non-

basic colours.⁶ However, both language groups remembered more basic colours in a short-term memory task, than in a long-term memory task with a 30 minute interval. Although there are pockets of empirical work producing some support for the influence of language on colour categories (e.g., Brown & Lennenberg, 1956; Lucy & Shweder, 1979; Garro, 1986), most of the research in this area largely supports the universalist position.

Recently, there has been a resurgence in empirical work on colour categories. Davies and Corbett (1997) conducted a cross-cultural study of Russian, English and Setswana speakers. In Setswana, there is a single term *blue* or *green*, and in Russian and English, there are two basic colour terms. The results indicated that in a triad sorting task where participants were asked to pair two out of the three colour tiles, sorting was consistent with linguistic divisions of colour space, particularly comparing the English and Setswana participants. However, in a sorting task where participants sorted a representative sample of 65 colour tiles into groups with similar members, colour grouping was similar across languages, despite differences in colour terms. Davies and Corbett's conservative suggestion was that differences in the triad task could be a result of cultural or educational differences, as it was harder to control for these factors across the target countries. They concluded that although the data supports perceptual salience of colours across languages, there may be room for weak language effects (see also Davies, 1998; and Davies, Sowden, Jerrett, Jerrett & Corbett, 1998 for further exposition of this study).

Roberson, Davidoff, and Davies (2000) conducted a study on colour categorisation on Berinmo and English speakers. Roberson et al. originally wanted to

⁶ Lucy and Shweder suggested that this disparity in discriminability of colour tiles biased Berlin and Kay's results as well.

work with a people group who had two basic colour terms, such as the Dani tribe. However, they found that "no other culture has since been found to have as few as two basic colour terms; indeed, Rosch Heider herself (1972) casts some doubt as to whether the Dani might have had as few as two basic terms" (p. 370). Instead, the Berinmo people, a hunter-gatherer people from Papua New Guinea, were selected as the comparison group in their study because their language contained a sufficiently limited number of labels to compare the effects of linguistic influence versus perceptual universality. They have five basic colour names compared to eleven focal colours that are universally recognised, according to Berlin and Kay (1969). To ensure that low performance levels in the memory task were not the result of minimal education, as Rosch Heider suggested, Roberson et al. gave Berinmo and English participants a visuo-spatial memory task (the Corsi block test). Memory skills in this standardised test were comparable between the target populations. Participants were trained to form pairs between basic and non-basic colours and pictures, rather than words. The responses suggested that the Berinmo speakers were guided by their linguistic labels for five basic colours, and responses in a series of colour tasks were significantly aligned with linguistic differences, rather than colour universals.

A series of different tasks investigated the role of Categorical Perception (CP), the notion that changes in a variable along a continuum are perceived as discrete categorical changes, rather than gradual differences. Further, within-category differences are often judged to be smaller than between-category differences, even though they are equidistant. If there were no correlations between linguistic codings and CP, this would stand as evidence for a universal perceptual

system. However, if category boundaries correspond with linguistic labels, there is some support for the linguistic relativity hypothesis (see Harnad, 1987; and Goldstone, 1994). Roberson et al. investigated whether CP was affected by the different language structures of the target populations, for example, were categorical decisions made by Berinmo and English speakers consistent with linguistic differences, or did they represent a 'universal' perception of focal colours, specifically, would the eight focal colours be more readily recognisable regardless of label differences? Results from all three tasks—a matching task from colour triads, learning colour categories, and a short-term recognition task—indicated that CP corresponded significantly with linguistic labels of the Berinmo and English participants, rather than perceptual universals. Roberson et al. argued that the results "uphold the view that the structure of linguistic categories distorts perception by stretching perceptual distances at category boundaries" (p. 394), a view in line with Harnad's (1987) and Goldstone's (1994).

Early cross-cultural investigations of colour labels (e.g., Berlin & Kay, 1969; Rosch Heider, 1972; Rosch Heider & Olivier, 1972) were largely responsible for shifting the focus in the language-thought debate from linguistic relativity to a universalist position. However, research on colour categories in general has met with several criticisms. A major drawback of these studies is that the colour category research focuses on the use of individual lexical terms expressed in experimentally monitored memory tasks, rather than in daily language use in a particular culture. Further, there is some objection to using colour categories to investigate the roles of language and experience. For example, Lucy (1992a) and Lyons (1999) argued that colour terms are contingent on objects, for example, *red* is not principally a colour

term but a typical colour of tomatoes and fire engines. This reference to objects suggests that colour terms themselves are not a representative set of words.

However, Roberson et al. disagreed, stating that "the fact that a colour term may also be used to apply to the appearance of particular objects does not disallow its separate use as an abstract colour term" (p. 370).

Research on colour categories is arguably complex. Initial research in colour categories was undertaken to confirm the linguistic relativity hypothesis (Brown & Lennenberg, 1954), however later research failed to replicate the relationship between labels and perception of colour concepts. Subsequent work by Rosch Heider (1972; Rosch Heider & Olivier, 1972) challenged the view that colour space is arbitrarily divided, and argued for a universality in colour perception. Although early research by Rosch Heider was taken as unequivocal evidence for the universal hypothesis, recent empirical work (e.g., Davies, 1998; Roberson et al., 2000) suggested that language can modulate effects in colour perception.

The role of sensory experience: The Embodiment theory

In this section, we review the role of experience in cognition. According to Glenberg and Robertson (2000; also Glenberg, 1997), the interaction between 'objects and bodily abilities' sets the stage for an 'embodied cognition'. Bodily abilities or physical activities, such as sitting on a chair, or walking down a street, drive conceptual representations.⁷

The Embodiment theory (Lakoff & Johnson, 1999, see also Lakoff & Kovecses, 1987) elaborates the relationship between experiences and cognition by claiming that embodied (or physical) experiences direct how people think about

⁷ Glenberg noted that this process is not necessarily aligned with a Gibsonian notion of perception, although there is a strong connection with physical experiences.

abstract concepts. From daily experiences, people form an understanding of events and cluster them in a category that allows us to function more effectively in daily life. Based on the premise that abstract ideas are understood via concrete experiences, Lakoff and Johnson argued that language is grounded in everyday experiences. The daily vocabulary used to convey ideas is known as ‘primary metaphors’ and is grounded in childhood experiences as a result of conflation. For example, children observe two different events and draw an association between them, such as the association between love and the warmth of a hug, or friendship and the exchange of an object. Although children are later able to differentiate between the two domains, Johnson (1997) claimed that there is often a strong cross-domain association. Grady (1997) extended the notion of conflation and argued that through sensorimotor experiences, people form hundreds of associations that serve as Conceptual Metaphors. An example is the Conceptual Metaphor SIMILARITY IS CLOSENESS where experiences of similar objects are clustered together to make the connection between similarity and proximity in space.⁸

The relationship between embodied experiences and concepts is expressed through language. Consider the following statements for the Conceptual Metaphor ARGUMENT IS WAR:

Example 1: Your claims are *indefensible*

Example 2: He *attacked* every weak point in my argument

Example 3: They *shot* down all of his arguments.

These statements highlight similarities between the two concepts, ARGUMENT and WAR. Wars are similar to arguments in that there are winners and losers, positions

⁸ Following Lakoff and Johnson's example, all Conceptual Metaphors are capitalised.

are attacked and defended, and one can gain or lose ground. The premise of the Conceptual Metaphor Hypothesis is that metaphors are processed by mapping information from experiences in a base domain to an abstract target domain. In this example, the embodied base domain is ARGUMENT, and WAR is the abstract target. The relationship between the base and target domain is expressed linguistically by the primary metaphors in Examples 1 to 3. Another example of how a base domain influences a target domain is the Conceptual Metaphor LOVE IS A JOURNEY. In this case, embodied experiences of JOURNEY, the base domain, direct the understanding of LOVE, the abstract target domain. Statements such as *We are going nowhere in this relationship* highlight similarities between the two concepts.

The Embodiment theory is a general approach to understanding why there is universality in thinking. Lakoff and Johnson stated that “the mind is....embodied in such a way that our conceptual systems draw largely upon the commonalities of our bodies and of the environments we live in. The result is that much of a person’s conceptual system is either universal or widespread across language and cultures” (p. 6). Despite linguistic variations, people share common experiences, which leads to a commonality in thinking.

According to the universal hypothesis, the premise is not that language divides cognitive space. Instead, supporters of this position claim that people share universal representations, and language differences are indicative of different referents, not cognitive differences. Two modalities that account for a shared representational system were highlighted: perception and sensory experiences.

2.4 The different aspects of language that have been examined

Cross-linguistic research on the influence of language on cognition can be divided into two areas: investigations on label or vocabulary differences, and studies on grammatical patterns. Early researchers such as Whorf (1956) documented vocabulary differences between American Indian languages and Standard Average European languages when speaking about time, space and matter (see section 2.3.1). More recently, researchers have continued to explore vocabulary differences between languages, for example, in counting strategies (Miura & Okamoto, 1989; see section 2.3.2), object labels (Malt et al., 1999; see section 2.3.4), and colour categories (e.g., Berlin & Kay, 1969; Davies et al., 1998; Roberson et al., 2000; Rosch Heider, 1972; Rosch Heider & Olivier, 1972; see section 2.3.5).

An alternative method of exploring linguistic effects is to focus on the grammar of a language, as there are variations in what is encoded. For example, while languages, such as Spanish, French, German, distinguish the status of the addressee, English does not:

English	-----you-----
Spanish	----- <i>usted</i> ----- ----- <i>tu</i> -----

Studies compared grammatical patterns of different language groups include research on actions, such as early work by Carroll and Casagrande (1958; see section 2.3.2), and more recent work by Slobin (1997; see section 2.3.3). We review additional research relevant to the language-thought debate; first those related to

label differences, such as object classifications and spatial representations; and next, grammatical differences in reasoning skills.

Object classifications

Research on object categories has been fundamental in early studies on the role of language in cognition (e.g., Carroll & Casagrande, 1958). In fact, discrete physical objects have a unique contribution in exploring cognitive and linguistic development (e.g., Giralt & Bloom, 2000; Macnamara, 1972; Smith, 1996; Tversky, 1989). Given its importance in cognitive process, several cross-linguistic studies have explored the interaction between language and object representations.

Early work by Carroll and Casagrande (1958) explored whether different labels for objects in English and Navaho would influence how participants performed in a matching task. For example, in Navaho, when handling objects there is a different verb to distinguish a long, rigid object such as a stick, from a flat, flexible object like cloth. Carroll and Casagrande matched Navaho-dominant speakers with English-dominant Navaho speakers. Participants had to match a target, a blue rope, with one of two pictures: a picture of a yellow rope and another of a blue stick. Carroll and Casagrande predicted that the obligatory verb classification would increase the Navaho-dominant children's sensitivity to form over colour in objects, and they should match the target picture with the picture of the yellow rope. The English-dominant Navaho children should pair the blue rope with the blue stick there is no grammatical obligation to focus on form over colour. The results confirmed this prediction, however, white middle-class American children also chose form over colour. Carroll and Casagrande argued that this result was due to cultural factors, and in fact, the English-dominant Navaho children were better suited as a control

group for this study, as they shared cultural similarities with the Navaho-dominant speakers, while the middle-class white Americans did not.

Recent research on novel count nouns in English, French and Spanish confirmed that linguistic variations were consistent with language use. Based on the premise that children may extend a novel count noun, but not a novel adjective, to other members of the same basic or superordinate level category, Waxman, Senghas, and Benveniste (1997) presented pre-school children with target objects that were introduced with either novel count nouns (e.g., "This is a fopin"), or novel adjectives (e.g., "This is a fopish one"; Waxman et al.'s examples). The findings indicated that all three language groups extended the novel count nouns to other category members. However, extensions of the novel adjectives were not uniform across the three languages—the English and French children did not extend novel adjectives to other members of the same category, however the Spanish speakers did, a pattern corresponding with linguistic patterns. In light of these findings, Waxman et al. suggested that the relationship between linguistic patterns and conceptual representation be given further consideration.

Other research on nouns has concentrated on the mass-count distinction present in English. For example, Gathercole and Min (1997) investigated Korean, Spanish and English children's proclivity to match novel object stimuli with corresponding objects that share shape or substance features. In English, there is a mass-count distinction that divides nouns into two groups. Mass nouns (e.g., *water*) are only expressed in the singular, while count nouns (e.g., *chair*) can be both singular and plural. Spanish shares a common characteristic with English, in that it has an obligatory singular/plural marking. Consequently, English and Spanish

children tend to show preferences for a shape bias in objects. However, a corresponding singular/plural marking is not found in Korean, making speakers more attentive to a substance bias. Gathercole and Min asked children to pair a novel stimulus with either a shape-linked or a substance-linked feature, in order to observe what features they would be most sensitive to. The results suggested that linguistic structures influence what features people habitually attend to, as Korean children matched novel stimuli with objects with similar substance features more often than their English and Spanish counterparts.

A similar study by Imai and Gentner (1997) explored the mass-count distinction in inanimate nouns between English and Japanese speakers. The task was a matching task used in other studies (e.g., Carroll & Casagrande, 1958; Gathercole & Min, 1997). The children had to match a novel object (a substance—e.g., sand in an S-shape; a simple object—e.g., a kidney-shaped piece of paraffin; or a complex object—e.g., a wood whisk) with one of two objects—a match in shape but not material, or a match in material but not shape. Although Japanese does not express a mass-count distinction, children in both languages showed differentiation between complex objects and substances as early as 2 years of age. However, there was evidence of linguistic input as the American and Japanese children matched the simple objects and the substances differently. Imai and Gentner (1997) proposed that certain aspects of language learning are constrained by linguistic boundaries.

Other studies have explored usage of noun phrases. For example, from examining child-directed speech from caregivers interacting with their 19-23-month-old English and Mandarin children, Gelman & Tardif (1998) posited that although people share universal notions of 'kind' concepts, conversation (as measured by the

frequency of expressions) is constrained by the unique linguistic constructions. Choi and Gopnick (1995; Gopnik, Choi, & Baumberger, 1996) also explored communalities and differences in language use of English and Korean children. In contrast to English, nouns and verbs in Korean are dominant forms in early learning. Conversations between mother and child revealed that Korean mothers used more action verbs than object nouns, and participated in an activity-oriented communication with their children more often compared to the American mothers. Choi and Gopnick proposed that while verb learning is available across languages, usage is strongly encouraged by language-specific grammar and input (however, see Maital, Dromi, Sagi, & Bornstein, 2000, for the suggestion that early noun learning in Hebrew children is strikingly similar to English, despite broad grammatical differences).

Spatial representations

Some researchers argue that spatial cognition is universal and precedes spatial language development (Clark, 1973; Landau, 1994; Landau & Jackendoff, 1993; Munnich, Landau & Doshier, 2001; Talmy, 1983). However, recent research has echoed earlier claims by Whorf (1956) that spatial concepts are moulded by language (Levinson, 1996; Lucy, 1992). Developmental research provides further corroborating evidence that language-specific spatial distinctions influence representations from an early age (e.g., Bowerman, 1993; 1996; Choi & Bowerman, 1991). The issue however is not so straightforward, as recent work by Imai and Gentner (1997) indicated that both systems affect each other.

Researchers have approached this subject from various angles. One approach is founded on the premise that gestures provide a window into thought patterns

during speaking (e.g., Goldin-Meadow, Alibali, & Church, 1993; McNeill, 1992; McNeill & Duncan, 2000). In particular gestures for motion events bear a striking correspondence with grammatical distinctions (e.g., Özyürek & Kita, 1999). Based on the parallels between gestures and thinking, Allen, Kito and Özyürek (in progress) are investigating English, Turkish, and Japanese speakers' gestures while encoding motion events in their speech. Based on recordings of short motion sequences from children and adults, Allen, et al. are exploring the how different elements of motion events develop lexically and semantically, how these elements of motion events are presented in gestures developmentally, and how the development of gestural representations correlate with the acquisition of language-specific semantic distinctions.

A different method of exploring the relationship between spatial cognition and language is to explore how language and conceptual coding in the spatial domain covary. There are two dominant views of spatial orientation—egocentric and geocentric. The first orientation interprets directions and spatial locations relative to the individual and commonly uses terms such as *left/right* to describe orientation. The geocentric position interprets spatial positions relative to something external such as landmarks and other cues based outside the individual. Descriptors include phrases such as *the bottom of the hill*, and *east of here*. There is ample evidence that some Western languages frequently rely on egocentric spatial descriptions, whereas other more remote language groups (such as the Mayan language, Tzeltal) commonly use geocentric terms (Brown & Levinson, 2000).

Levinson and his colleagues have provided the most comprehensive findings in the area of spatial categories. After first recording differences in speaking about

spatial positions in various language groups, they then explored whether these differences in linguistic spatial expressions affected their spatial reasoning (Pederson, Danziger, Wilkins, Levinson, Kita, & Senft, 1998). In order to test this, participants were seated at a table and asked to remember the position of an array of objects. After a short period, they were then turned around and seated at a different table in the opposite orientation of the initial one and asked to reconstruct the spatial array. Participants could either reconstruct the array in relation to themselves (an egocentric orientation; i.e., objects that were on the participant's left in the initial array would now also be placed on their left, despite their different spatial position) or they could place the objects in an absolute position (a geocentric orientation; i.e., objects that were facing north in the initial array would also be placed accordingly, regardless of the individual's perspective change). According to Pederson et al., the results establish parallels in spatial memory and linguistic input, and it is apparent from their studies that different languages do induce distinct conceptual codings. For example, Dutch speakers, like English speakers constructed the spatial array in an egocentric fashion, consistent with the relative system of spatial reference in Dutch. However, Tzeltal speakers (a Mayan language spoke in Chiapas Mexico) constructed the spatial array in a geocentric fashion, consistent with the absolute system of spatial reference in Tzeltal.

Their findings however, have been challenged by Li and Gleitman (2002; see also Papafragou, Massey, & Gleitman, 2002), who argued that similar results can be achieved with a monolingual English speaking population by altering spatial cues present in the experimental environment. For example, three groups of native English speakers participated in a replication of the methodology used in Pederson et

al.'s study—the first group completed the experiment in a room with the shades closed (i.e., there were minimal external cues); another was in the same room with the shades open, and the final group participated in the experiment outdoors (as the Tenejapan speakers had in Pederson et al.'s study). The rationale for varying the testing environment was to explore the effects of the environment and external cues on spatial recall. The results of the first group were in line with Pederson et al.'s findings—object reconstruction was egocentric. However, in the second group, participants who were in the room with the shades open relied more on external cues, although their spatial reconstructions were only marginally different from the first group. In the final group, there was a significant difference in the object reconstructions between them and the first group, suggesting that when participating in the study outdoors, volunteers relied more on the external cues to assist their memory. Li and Gleitman posited that while all participants were native English speakers, altering the environment to include richer cues also altered their spatial responses. This proposal shifts the contribution of language to other non-linguistic external cues in spatial representation. They further suggest that the results obtained by Levinson and colleagues could satisfactorily be explained by differences in ecology and education, rather than language (however, see Levinson, Kita, Haun, & Rasch, 2002, for a defence of their position and explication of the weakness in Li & Gleitman's premise of universality in spatial concepts).

Reasoning

Bloom's research on counterfactual reasoning in Mandarin speakers (1981) is one of the more convoluted findings in the language-thought debate. While conducting a political poll in Hong Kong, he discovered that many Mandarin speakers had

difficulty answering questions that required counterfactual reasoning, for example: If X had won, then we would have financial growth. When he inquired why, he received answers such as “It’s just not Mandarin” and “We don’t think this way”. Upon closer inspection of Mandarin grammar, he discovered that Mandarin speakers rarely use function words, such as *but, if, therefore*, unlike English speakers. This observation lead him to suggest that “language, by whether it labels or does not label any specific mode of categorising experience, cannot determine whether speakers will think that way, but can encourage them to develop a labelled cognitive schema specific to that mode of thought” (p. 20).

Bloom argued that the Mandarin language does not have the grammatical structure to express counterfactual reasoning, and only permits a form of quasi counterfactual reasoning where the speaker uses knowledge of past situations in order to assess the current situation. For example, in English, we say, “*If John had come earlier, they would have arrived at the movies on time*” (Bloom’s example, p. 19). In Mandarin, the equivalent translation of this statement would be: “*If John came earlier, they arrived at the movies on time*” (p. 19). Thus, expressing counterfactual statements in Mandarin relies on knowledge of previous rather than hypothetical situations, whereas English speakers depend on specific grammatical markings that allude to hypothetical thinking. Bloom explored counterfactual reasoning among Mandarin speakers and discovered that English speakers performed better than the Mandarin speakers did, and bilingual speakers seemed to perform better when participating in the experiment in English rather than Mandarin.

However, Bloom’s research was heavily criticised by Au (1983) who disputed that the absence of an Anglicised grammatical structure when expressing

counterfactuals hinders the Mandarin speaker from understanding counterfactuals as English speakers do. The debate between Au and Bloom included both technical and theoretical issues and resulted in several modified experimental designs. Technical issues in the debate were varied. One issue related to the subject pool, as Bloom argued that Au's participants were Mandarin speakers who had been well taught in English and were planning to study in an English university, and thus, were biased by the English grammatical structure. On the other hand, his participants were all Mandarin speakers with minimal contact with the English language. Another issue was the validity of the design, as Au contended that Bloom tested the bilingual group first with the Mandarin counterfactuals and then the English ones, resulting in a group that was not counterbalanced to ensure that the bilingual speakers did not infer the correct responses by the time they were presented with the English counterfactuals.

This debate is interesting, possibly because of the irony of the research—Bloom intended the study to function as an example of the role of language in non-linguistic behaviour, however, his language-driven design precluded this. Although the outcome of their debate is ultimately inconclusive, it is important to remember that Bloom's experiments were conducted to analyse everyday behaviour, and combined empirical analysis with cultural observations—a step beyond observing label differences between language groups when identifying artefacts or natural kinds.

The diversity in cross-linguistic findings illustrates the need to represent the role of language in cognition on a continuum rather than as opposing positions.

Before we begin our investigation in examining the varying influences of language, we first discuss previous measures employed to assess the construct of ‘thought’.

2.5 The different aspects of ‘Thought’ that have been measured

The difficulty in investigating the role of language on thought is in developing appropriate measures for the mental constructs behind perception, reasoning and other cognitive processes sometimes referred to as thought processes.⁹ In this thesis, ‘thought’ refers to how concepts are represented—a falsifiable premise measured by behavioural responses—in particular, language-explicit responses and language-implicit responses. Language-explicit responses are verbal responses, where the participant is required to produce a narrative or respond in a question and answer session. This type of response is often considered a direct method of examining the influence of linguistic differences on conceptual thinking because the participant verbalises his actions in an experimental environment. In contrast, language-implicit responses require a participant to perform a task without verbal communication with the experimenter. These measures include sorting tasks and memory tasks.

Language-explicit responses such as a question and answer session, were used by Bloom (1981) in his study of counterfactual thinking with Mandarin speakers in Hong Kong. The participants had to respond to a series of counterfactual political scenarios. Their responses allowed Bloom to observe how grammatical patterns in Mandarin influenced the reasoning processes of the participants.

Researchers such as Slobin (1997) examined narratives produced by Turkish, English, Spanish, and Hebrew children and adults in order to identify unique grammatical patterns and found that the events in the picture stimuli that were

⁹ Some refer to ‘thought’ as an internal language or a ‘mentalese’ with tokens corresponding to propositions, e.g., Fodor (1975); others refer to thought as a stream of consciousness activity, e.g., Jorian (1998).

considered salient by each language group corresponded with their particular grammatical structure (see section 2.3.3 for further discussion).

Bowerman (1996; in press; also Choi & Bowerman, 1991) studied differences between conversations of Korean and English children and observed that speakers of both languages expressed Path markers (*in/out*) distinctly. English children used spatial terms like *in/out*, *on/off*, to denote both spontaneous and caused motion, for example “when they climbed *out* of the bathtub or took something *out* of the pan” (p. 165). However, in Korean, there are two distinct ways of referring to spontaneous and caused motion, and as a result, Korean children were very conscious of this differentiation and consistently referred to the two types of motion with separate terms throughout the experimental session. Bowerman argued that if there were a ‘universal sensorimotor concept’ guiding language, there wouldn’t be observable differences in how each language group categorises and refers to objects spatially. While children may notice certain properties of different objects and locations, they cannot assess which property is vital for representing the scene spatially. Instead, linguistic expressions direct children to attend perceptually to some features over others, because “languages use surprisingly different criteria to calculate similarity and differences among spatial configurations, and this means that their spatial categories cross-cut and intersect each other in complex ways” (p. 160).

Although Bowerman argued that language directs perception, one could argue that the evidence of different spatial terms across languages does not discount the possibility of universal spatial concepts with unique referents. Furthermore, while language-explicit response patterns offer an open-ended method of

investigation, it is also a somewhat circular substantiation of the influential role of language, as proponents of the linguistic relativity hypothesis and universalist hypothesis would agree that people are confined to specific grammatical parameters when expressing concepts. This does not necessarily intimate that grammatical structures are influencing thinking patterns. In light of this, although these narrative differences are interesting, they don't provide a clear answer on the role of language on conceptual representations.

An alternative method for measuring 'thought' is language-implicit responses, which includes sorting tasks (e.g., Carroll & Casagrande, 1958; Gathercole & Min, 1987; Malt et al, 1999), similarity judgements (e.g., Gennari Sloman, Malt & Fitch, 2002), memory tasks (Roberson et al., 2000), and measuring response latencies.

Sorting tasks are simple matching tasks that require the participant to pair a target stimulus with one out of two pictures. The target picture is a combination of two factors represented separately in the two different pictures. For example, in early studies such as Carroll and Casagrande's (1958), children were presented with a triad of pictures—a target picture: a blue rope; and two choices: a picture of a yellow rope and another of a blue stick. Recent studies, such as Gathercole and Min (1987) also used a similar triad picture design when exploring shape verses substance bias in objects between Spanish, English and Korean children. In Malt et al.'s study (1999) participants were asked to sort 60 photos of containers into categories of physical, functional and overall similarity.

Similarity judgement tasks are related to sorting tasks, the main difference is that instead of selecting an appropriate match, the participant has to rate the

relationship of two pictures on a Likert scale. These tasks are considered as a good measure of how effectively people appropriate relevant past experiences to a target stimulus. In this instance, the task is used to evaluate how linguistic expressions influence the perceived similarity of two events. Gennari, et al. (2002) asked English and Spanish participants to rate how similar a target motion event was to one of two motion events; for example how similar was a film clip of a person walking into a room to a clip of a person either striding to a room (same path); or walking out of the room (same manner). In English, motion verbs combine a Path (i.e., direction of movement, leaving, entering) and Manner of movement (such as *walking*, *striding*, *running*). In Spanish and other Romance languages, Turkish and Hebrew however, motion verbs usually express Path (e.g., *entrar*), with an optional adverb to express Manner (*entrar caminando*—Gennari et al.’s example). If language does influence perception of similarity, then the Spanish participants would choose the same path event as more similar to the target clip, whereas English participants would not show a preference for either same path or manner event.

Measuring response latencies or processing time of the participant allows the researcher to investigate on-line cognitive processes during a task. One can assume that a long response latency indicates that the participants is taking some time in processing the task, which could be result of a conflict between perceptual and linguistic input. Response latencies can be taken from a variety of tasks, including sorting tasks and similarity judgements (see Gernsbacher, 1994, for a review of various studies that use response latencies).

Another effective method of assessing the contribution of language is a memory-dependent task. By presenting participants with an array, investigators can

explore whether linguistic coding assists recall, and if recall corresponds to linguistic coding. One particular research area that has relied on memory dependent measures is colour categories. Roberson et al. (2000) found that memory dependent measures provided an additional insight in to the role of language.

The benefit of language-implicit methods such as sorting tasks, similarity judgments, response latencies, and memory-dependent measures is that they provide an indirect measure of the influence of language on behaviour, and in some cases, even perceptual attention to one feature over another.

2.6 Research Questions

Given the diversity in research findings on the role of language in thought, viewing the influence of language on a continuum allows for a more comprehensive investigation. The aspects of language that have been examined focused on vocabulary and grammatical differences. Two types of behavioural response, such as language-explicit and language-implicit responses, have been used to measure the construct of thought. We can investigate the extent of the influence on language in conceptual representations with several falsifiable premises. The first question relates to the assessment of thought.

1. Are certain conceptual features context-dependent?

One difficulty in measuring the construct of 'thought' using behavioural responses is that the responses could possibly be a result of the task, rather than an appropriate indication of cognitive processes. In light of this possibility, in chapter 3, we examine how task demands influence representations of everyday concepts, such as *uncle* and *hat*. Previous research indicates that task demands may have a subtle effect on conceptual representation and only influence the features that are accessed (e.g.,

Hampton, 1998; Rips, 1989; Smith & Sloman, 1994; Wu & Barsalou, under review); or they may also have a stronger influence and alter the substance of a concept (e.g., Malt et al., 1999; Spellman & Holyoak, 1992). The question of the role of task demands in conceptual representation is further complicated by a proposal by Keil and Batterman (1984) that children's conceptual representations shift in the course of development, moving from a reliance on characteristic features to more defining representations as they get older. For example, young children will remember that characteristic features of a *hat* are that it is black and made of felt. However, as children grow older they represent defining features of a concept—with *hat*, the important defining feature is that it is worn on our head.

Before we can investigate the role of language in cognition, we must first establish the nature of the influence task demands exert in conceptual representation. In chapter three, we present two experiments that establish that the task demands clearly affect outcomes and possibly representations.

2. When the task is invariant, are concepts affected by the context (linguistic or embodied) they're used in?

Chapter four examines how the labels used when talking about space and time affect how people conceptualise them. A commonality between spatial and temporal concepts is that they share a similar metaphoric system for describing motion (McTaggart, 1908). The first system, the ego-moving system, is when the individual moves from one point to another, spatially, or from the past to the future, temporally. The next system of motion is the object- (or time-) moving, when the individual is stationary and observes objects, or time, moving towards him/her. The two motion systems are considered to be based on everyday experiences, such as

walking down a street, waiting at a bus stop and watching the traffic go by, or anticipating an event (e.g., Lakoff & Johnson, 1999). In addition to this sharing of motion systems, similar labels, such as *forward*, *back*, *ahead*, are used interchangeably when talking about spatial and temporal concepts. For example, when discussing spatial motion, it is common to hear the following: “Walk in *front* of the red car”; and temporal motion as: “The holidays are *ahead/in front* of us”. The shared motion systems and labels affords some measure in investigating whether it is similar labels that are directing conceptual representations of space and time; or if experience of motion plays a vital role in spatial and temporal representations.

The study comprises of four experiments where participants were required to interact with a virtual reality environment and then respond to an ambiguous target question. The findings indicate that interacting with a virtual environment was sufficient in influencing spatio-temporal concepts, however language was able to override this priming.

3. Given that language plays a role in conceptual representations, does habitually speaking about something affect how people think about it?

Based on the findings in the previous chapter that language is able to override the influence of perceptual experiences, the study in chapter five investigated the relationship between verb patterns and event concepts in a cross-linguistic environment. In Tamil like English, verbs are inflected to indicate tense changes, however, this classification is optional in Mandarin. This difference in grammatical patterns provides an avenue to investigate whether habitually speaking about actions influences how people think about them.

There are three experiments in this study. The Mandarin and Tamil speakers rate the similarity of picture pairs depicting actions at different stages with different agents. Findings from this study revealed a subtle influence of language on verb concepts in the target populations.

2.7 Summary

In this thesis, we explore the role of language in conceptual representations.

Although there are various theories and models of conceptual representation, we do not advocate one position over another. Instead, based on commonalities shared by the different positions, we adopt the position that concepts are represented by different features, and focus on the role language plays in these representations.

Given the diversity in research findings in the language-thought debate, it is more productive to view the role of language in thought on a continuum of influence, ranging from a deterministic role to a position of reflecting pre-established concepts. Research findings in colour categorisation, object classifications, event representations, spatial representations and reasoning skills confirm the value of plotting linguistic influence on a continuum rather than as opposing positions. Previous cross-linguistic studies have examined two aspects of language: differences in vocabulary, and variations in grammatical patterns. The construct of thought in these studies has been measured with two types of behavioural responses: language-explicit responses, such as narratives, and question and answer sessions; and language-implicit responses, such as sorting tasks, memory tasks, similarity judgements, and measuring response latencies.

The goal of this thesis is to explore strong and subtle effects of the role of language in cognition. First, we establish the role of task demands in the

representations of everyday concepts. The findings from the first study can be generalised to representations of other common, everyday concepts considered in the thesis, such as spatial (chapter four) and action concepts (chapter five). Next, we explore whether vocabulary differences in discussing spatio-temporal concepts influence the representations of them. Finally, we investigate how variations in verb structure influence action concepts in a cross-linguistic environment.

CHAPTER THREE

WHEN IS AN UNCLE NOT AN UNCLE: THE ROLE OF TASK DEMANDS IN CONCEPTUAL REPRESENTATIONS

3.1 Introduction

In the thesis, we explore the role language plays in concepts that are used everyday, such as spatial and event concepts. One proposal in the previous chapter was that the elusive notion of ‘thought’ in the language-thought debate can be measured using two types of behavioural response: language-explicit responses (e.g., narratives) and language-implicit responses (e.g., sorting tasks). However, the difficulty in measuring thought using behavioural responses is that the responses could be a result of the task, rather than an accurate indication of cognitive processes. In light of this possibility, we begin the inquiry of the role of language in conceptual representation by first exploring the effect of task demands on behavioural responses in an experimental setting.

The study is based on the premise that a concept consists of different features, rather than a unitary representation (see section 2.2 for further discussion). Further, some researchers (e.g., Barsalou, 1982) suggest that only a subset of a concept’s features is represented. This subset of features is either context-

independent (i.e., they are accessed in all instances that the concept is activated) or context-dependent (i.e., they are only accessed in relevant contexts). The latter view is prevalent in recent proposals of context-based conceptual models (e.g., Glenberg & Robertson, 2000; Landauer & Dumais, 1997; McDonald & Ramscar, 2001) and some researchers suggest that even weakly salient features of a concept can be extracted in the right context. For example, Barsalou (1989) demonstrated that although *floating* is not a salient property of the concept *basketball*, it is extracted under the context of *things that can float* (a category which has items where *floating* is a salient property, such as a sailboat). Armstrong, Gleitman and Gleitman (1983) also suggested that different methodological contexts elicited different responses from participants (see Landau, 1982, for similar findings with young children). Markman and Dietrich (2000) furthered this idea, proposing that goals and contextual environments can manipulate conceptual representations as well.

It is apparent that conceptual representation is affected to some extent by extrinsic factors, but the effect might be subtle. It is possible that task demands only affect the access (or the measurement) of concepts, but not the substance of concepts. An alternative proposal is that the effect of task demands is less subtle and can alter the substance of concepts. It is critical to identify the exact influence of task demands on conceptual representation before behavioural responses are taken as an indication of linguistic influence on cognition.

In the chapter, we first highlight how task demands affect conceptual representations. Following is a brief discussion of what conceptual features are most receptive to task demands. Given that some features are context-dependent, we investigate how task demands affect conceptual representation. In particular, we

explore whether task demands affect the accessibility of conceptual features or the substance of concepts. Two experiments, based on previous research by Keil and Batterman (1984), explore how task demands affect common, everyday concepts. By focusing on everyday concepts, we can generalise the findings from this study to other common concepts considered in the thesis, such as spatial (chapter four) and event concepts (chapter five).

3.2 Conceptual representation and task demands

In this section, we review findings from research on the following concepts: events, natural kinds and objects. Although it is evident that there are other theoretical issues involved in the cognitive tasks presented, they also illustrate how task demands influence conceptual representations.

Event concepts

Resolving how events are represented is not easy. What does seem easier to identify is how task demands, in particular analogies, influence which conceptual features are considered as most relevant.

Reasoning by analogy is a problem-solving method where knowledge of previous problems with similar structures is used to find the best way to solve the current problem. This process is illustrated by the statement: A is to B as C is to D. According to Sternberg (1977), the first step is to identify the relationship between A and B in the problem. Then we extract similarities between A and C before finally mapping the relationship between C and D on to A and B. Barsalou (1992) illustrated this process with the following example: "someone who has worked at the complex for a while could simply explain to you that the layout is analogous to a starfish. On hearing this analogy, you might transfer knowledge about starfish to the

office complex. Thus the knowledge that a starfish has a circular body, with five legs extending from it radially and symmetrically would lead to the belief that the office complex contains a center circular body, with five tapered buildings extending from it in a radially symmetric pattern" (p. 110). Although some of the physical features of a starfish are extracted in order to understand the layout of the building, other normally salient features of starfish, such as its stiff body, spiny skin and ability to regenerate body parts, are not considered in this analogical mapping. How do we decide which features to extract and which to leave aside when reasoning analogically?¹ The simplest explanation for analogy is that most of the time it involves the more general mechanism of pattern matching, whereas in some cases it involves a more elaborate thinking process.

Researchers have investigated the underlying mechanisms for extracting and mapping similarities between C and D on to A and B, such as similarity or structure based retrieval (e.g., Gentner 1983; 1989; Gentner & Clement, 1988). The findings contribute to a greater understanding of how analogies are used, but we highlight the fact that different conceptual features that might not be considered as salient independently are extracted in light of an analogical problem, as in the above example of the starfish and office complex. Holyoak and Thagard (1989) suggested that in everyday life, the analogy that people use affects how a problem is solved. For example, during the Gulf war, those who were against the USA from taking action against Saddam Hussein used the Vietnam War as an analogy. They argued that the Kuwaiti desert was just impenetrable as the jungles in Vietnam, and Iraq had an equally formidable army. Those who were persuaded by the Vietnam analogy

¹ Some researchers suggest that an analogy can be drawn between any two phenomena (see Goodman, 1972, and Gentner, 1983, for further discussion on the role of similarity in cognitive processes).

agreed that an attack on Iraq would be as disastrous as the Vietnam War was. However, those who felt that the USA should take action against Saddam used World War II as an analogy. Saddam was likened to Hitler and Kuwait to Poland. In light of the WWII analogy, the public felt that they had an obligation to protect the small Middle Eastern countries.

Previous research confirms that the use of different analogies influence how events are conceptualised. In one particular study (Gilovich, 1981), participants were presented with the following hypothetical crisis that followed one of two analogical cues: “The crisis involved a threatened attack by a large totalitarian country against a small democratic country”. The first analogy contained events similar to the WWII—there was a “blitzkrieg” invasion and minority refugees fled the country in boxcars. In contrast, the second analogy was similar to events during the Vietnam War—the invasion was a “quickstrike” and the refugees fled in small boats up to a nearby gulf. Participants who read the second analogical cue were more likely to respond to the hypothetical crisis with interventionist suggestions compared to those who read the first analogy.

Spellman and Holyoak (1992) conducted a similar study and prefaced the Gulf war scenario with a WWII analogy. Both versions of the analogy began with Hitler’s conquest of Austria, Czechoslovakia and Poland, however one version emphasised the role of Churchill and Britain, whereas the other focused on Roosevelt and the efforts of the USA. After reading these different historical perspectives, participants were asked to map features of the Gulf war on to events in WWII. Those who read the Churchill versions were more inclined to map Bush Sr to Churchill and the USA to Britain, whereas those who read the second version found

the relationship between Bush Sr and Roosevelt more closely aligned. Spellman and Holyoak suggested that features of an event representation can be influenced and even altered through the use of different analogies.

Natural kinds

There have been several studies on representations of natural kinds (e.g., Atran, 1998; Braisby, 2001; Medin & Atran, 1999; Rips, 1989; Smith, 2000) and a long-standing debate on what features in natural kinds are most commonly extracted (e.g. Atran, Medin, Lynch, Vapnarsky, Ek & Sousa, 2001). Notwithstanding this debate, we review how task demands highlight different salient features of the same concept.

Research on a hypothetical creature (Rips, 1989; also Rips & Collins, 1993) best illustrates how asking participants to perform two different tasks—a category decision and a similarity judgment—can lead to a dissociation in representation. In a fictitious scenario, a creature called a sorp possesses prototypical bird-like characteristics (e.g., has two wings, two legs, lives in a nest in a tree) but is exposed to hazardous chemicals. As a result, the physical appearance of the sorp changes to take on more prototypical insect characteristics (grows four more legs, has a translucent outer shell). When participants were asked to make a category decision, participants relied on the initial bird-like features and were more likely to consider the sorp as a bird. However, when asked to rate the similarity of a sorp to either a bird or an insect, they extracted the most recent physical appearance of the creature and rated it as more similar to an insect (see also Braisby, 2001, for similar findings on food categorisation).

Despite Rips' findings, other researchers have found that the different task demands do not appear to have affected the substance of a bird or insect concept. For

example, when Smith and Sloman (1994) replicated Rips' experiment, participants were not influenced by the different tasks and relied on similar features to generate their responses (see also Hahn, 1999; Hampton, 1998).²

Recent work by Barsalou (1999, also Wu & Barsalou, under review) has further illustrated how task demands effectively highlight different representations.³ One group of participants was asked to describe an object, such as *lawn*, whereas another group was asked to picture a *lawn* and then describe it (Solomon & Barsalou, under review). They found that participants who were asked to visually construct an object and then describe it, produced richer and more complex simulations of both the target object and its surroundings. Research by Wu and Barsalou confirmed this finding, as simulations of participants varied—neutral participants (i.e., those who were not asked to visualise an object) constructed relatively sketchy simulations, whereas imagery participants reported more detailed simulations. It is important to note that participants in the neutral condition did generate some physical properties of the object even though they were instructed not to visualise the object.⁴ However, participants in the imagery condition consistently produced more detailed information than the neutral participants. In these findings, it appears that the different tasks did not radically alter the substance of conceptual representations; instead more visual features were accessed in the imagery condition compared to the neutral condition.

² Smith and Sloman suggested that the use of spare description in other stimuli might have induced rule-based mechanisms rather similarity-based judgements. When they used using richer descriptions in their study, judgements for the similarity and categorisation task were similar.

³ Barsalou's model, known as the associate-scan model, is an alternative to previous amodal accounts of conceptual representation. He suggested that when people store perceptual simulations of objects, they also store related aspects of the physical environment of objects.

⁴ Wu and Barsalou suggested that words might automatically activate certain perceptual properties (see Glaser, 1992, for further discussion on word-activated images).

Object concepts

Although representations of object concepts seem to be driven by similarity (e.g., Goldstone, Medin & Gentner, 1991), recent research suggests that task demands can also influence feature saliency. In a cross-cultural study of English, Chinese and Spanish speakers, Malt and her colleagues (Malt et al., 1999; see section 2.3.4 for further discussion of this study) discovered that participants responded differently to the same object stimuli. When asked to sort objects into categories of either functional similarity or physical similarity, participants organised the stimuli in different ways. For example, when sorting objects into categories of physical similarity, participants relied on common perceptually salient features that were shared between objects. However, when sorting objects in categories of functional similarity, common physical features were disregarded and participants focused on whether the objects had a shared use, for example, they poured liquid.

Although the cognitive tasks discussed in this section are highly theory-laden constructs and are simplified here, the findings also illustrate how task demands influence conceptual representation. In light of this, we review different features that are affected by task demands.

3.3 Featural aspects of concepts affected by task demands

The chapter addresses whether task demands affect the access or the substance of a concept. Results from previous studies are mixed; in some studies it is evident that the substance of the concept is not altered significantly by differing task demands (e.g., Hampton, 1998; Rips, 1989; Smith & Sloman, 1994; Wu & Barsalou, under review), but in others it is not as clear whether only the access of conceptual features is affected (e.g., Malt et al., 1999; Spellman & Holyoak, 1992).

The role of task demands in conceptual representation is confounded by the proposal that the substance of a concept changes over time. Keil and Batterman (1984) argued that subtle changes in conceptual representation occur by age. Young children represent the (under 6 years) characteristic features of an *uncle*, for example, he is their parents' friend who loves them, visits, and brings gifts. However, as children grow older (11-12 years), they represent defining features of a concept—with *uncle*, the critical defining feature is that he is mum or dad's brother. Gopnick and Meltzoff (1997) advanced the idea that the substance of children's conceptual representations is progressive, with typicality or characteristic features as a foundational element in representation, moving on to a reliance on definitions, to finally a theory-based system of cognition (Medin and Ortony, 1989). This developmental change in the substance of concepts indicates that relationship between task demands and conceptual representation is at the very least complex.

In order to gain a clearer understanding of the relationship between task demands and conceptual representation, we review what featural aspects are more likely to be accessed in conceptual representation. Two types of features—defining and characteristic—are vital in conceptual representation.⁵

The reliance on defining features in conceptual representation is a position developed by early researchers (e.g., Katz, 1972; also referred to as necessary and sufficient features, Smith & Medin, 1981; and 'present' and 'absent' features, Katz & Fodor, 1963). Early research by Bruner, Goodnow and Austin (1956) confirmed that people relied most on conjunctive properties when determining categories. Subsequent research posits that conceptual representation is governed by sets of

⁵ Even more recent conceptual models (e.g., Medin & Ortony, 1989; Barsalou, 1998) are partially derived from early views promoting the importance of defining and characteristic features.

necessary and sufficient features (see Smith & Medin, 1981). For example, for the concept *bird*, 'breathes air' is a necessary feature for all members, whereas 'flies' is a sufficient feature that not all members must possess. The idea of clear-cut and well-defined category membership has been extended to combined concepts, such as "X is a pet dog", where the statement is considered as true if "X is a pet" and "X is a dog" (Osherson & Smith, 1981).

The application of definitions in conceptual representation is appealing on several levels. The prominence of rules and defining features reveals how objects are grouped together, and presents a strong coherence between category members because they are united by a shared set of features. Further, the hierarchical system of representation allows information to be easily transmitted from one level to another, as all features present in superordinate levels are applicable to corresponding subordinate levels. Despite the advantages of necessary and sufficient features in categorisation, there is evidence repudiating the claims of this position. In particular, category membership is not always as clear-cut as projected and is in fact more 'fuzzy' and graded (e.g., Barsalou, 1985; Hampton, 1982; McCloskey & Glucksberg, 1978,). Further, despite attempts to outline necessary and sufficient features that are clearly salient, there is still much confusion over which features are considered as necessary or sufficient, and researchers have suggested that people frequently rely on background assumptions when making category decisions (e.g., Barsalou, 1983; Hampton, 1979). Consequently, these difficulties have led researchers to generate alternative theories to explain category membership.

Rosch, Simpson and Miller (1976) proposed a move away from defining features to a more 'prototypical' approach. For example, the category *bird* is

represented by typical features abstracted from daily experiences. The prototypical member of a category captures the central perceptual tendencies of a category, thus, the more similar a stimulus is to the prototype, the more likely it is to belong to the same category. Rips, Shoben and Smith (1973) and Rosch (1973) found that when subjects were presented with statements with high typicality such as, *A table is furniture* versus a low typicality statement such as *A lamp is furniture*, participants judged the target object as a category member more quickly for highly typical objects, in this instance, a table. A welcome advantage of this position is the idea of graded or weighted typicality (i.e., an object that shares properties with many members of the same category is a more typical member than an object that only has properties in common with a few members). This notion of weightedness helps, to some extent, explain the 'fuzzy' boundaries that frequently occur in conceptual representation.

Although conceptual models based exclusively on either defining or characteristic features are no longer viable, defining and characteristic features continue to play an important role in more recent models (e.g., Medin & Ortony, 1989; Glenberg & Robertson, 2000). We now examine how external factors influence these representations.

3.4 Present Study⁶

The premise that certain conceptual features are context-dependent is supported by previous research. In the study, we investigate whether a subtle change in context such as differing task demands influences conceptual representation. In particular, we explore whether task demands affect how concepts are accessed or if they affect

⁶ Experiments 1 and 2 were in a poster session presented at the XII ESCOP and XVIII BPS Cognitive Section Conference (Alloway & Ramscar, 2001).

the substance of concepts. The study is based on previous research by Keil and Batterman (1984), who argued that the substance of a concept changes developmentally. They highlighted an informal division in conceptual representation, beginning with characteristic features, and progressing to a dependence on definitions. Developmental evidence such as this might distinguish changes in the access of concepts from substance changes in concepts over time. We can manipulate the experimental context in an adult population to investigate the role of task demands in conceptual representation.

The first experiment established whether the conceptual features in the everyday concepts in the test stimuli were biased to one representation. For example, we investigated whether the concept of *hat* was more frequently represented with defining features, but the concept of *news* more likely to be represented with characteristic features. Participants were presented with stories containing either defining or characteristic properties of a target concept in an open-ended questionnaire format. They were asked to determine what concept the features in the story referred to. Responses were evaluated to determine whether defining or characteristic features were more effective in directing category judgments.

Based on the findings, the second experiment investigated whether task demands affected the access or the substance of concepts. The stories were the same sets as used in experiment 1, with a manipulation of the context. Participants were asked to determine whether defining or characteristic features were more reflective of a target concept, depending on one of two different contextual conditions.

3.4.1 Experiment 1

The first experiment investigates whether some features are more salient than others when representing everyday concepts, for example, are defining features more salient than characteristic features for the concept of *news* but not for the concept of *church*?

Participants

Participants were 36 undergraduate students from the University of Edinburgh, who volunteered for the experiment. They were native English speakers. None of them were aware of the nature of the experiment.

Materials

There were a total of 14 stimulus pairs selected for the study: ten test items and four filler items. Of the ten stimulus pairs, nine were from the original 17 story pairs used in Keil and Batterman's study (1984), and an additional pictorial stimulus was generated by us. Each test stimulus had two versions: one that contained defining features, but not characteristic features; and the other that conveyed characteristic features, but not defining features. In order to simplify our investigation of how people represent simple, everyday concepts, the other eight story pairs from Keil and Batterman's study were not used. These stories included social terms such as *lie*, because it is unclear exactly how characteristic and defining features of such terms are represented, and might even be represented distinctly from objects (see Keil and Batterman, 1984; and Keil, 1989, for a further discussion of this); and other items that might have been culturally unique to the USA, such as *cupcake*. The four filler stimuli were included to prevent a task bias. There was only one version for each of the four filler items, and the stories contained neither characteristic nor defining

features of the concept in question. Here is an example test and filler stimulus (see Table 3.1 for a complete list of test stimuli and associated features):

Test Stimulus: *News*

Story D: -characteristic/+definition

You turn on the tv and these children are singing and dancing to loud rock and roll music—and they're singing everything that happened in the world that day—the weather, the fires, the robberies. They even sometimes hold up crayon drawings to show what they were talking about.

Story C: +characteristic/-definition

You turn on the radio and there is this man talking very seriously about foreign countries, wars, fires, and robberies. He is reading from a book that was recorded last year.

Filler Stimulus: *Party*



(Neither characteristic nor defining features were listed)

There is a long queue of people who have been standing there for several hours.

There are wearing blue overcoats and look very serious. Some of them are holding papers with diagrams and discussing them quietly with their colleagues.

Table 3.1

List of test stimuli and corresponding characteristic and defining features as identified by Keil and Batterman

Item	Characteristic feature	Defining feature
Hat	Black, felt, shaped like a hat	Wear on head
News	Man talking seriously about foreign events, news, fires, robberies	Current events
Uncle	Parents' friend who loves you, visits, and brings gifts	Mum/dad's brother
Museum	Beautiful building with columns, cracks in floor and walls, and is covered with paintings and statues	Pay money to see exhibitions
Church	Beautiful building with a point on top, stained glass windows with scenes from the Bible, has a bell	Place of worship
Jail	Ugly building in the slums, bars on windows, rats in the corners, people are poor, and only eat bread and water	Place where you go when you do wrong things/can't leave
Robber	Smelly, mean man, has a gun in his pocket	Someone who steals things
Factory	Big, concrete, ugly building, with lots of smoke stacks and chimneys on roof/warehouse where things are stored to keep warm	Place where things are made/produced
Vacation ⁷	Stay in different hotels, eat fine foods	Time off work
Triangle	Looks equilateral 	Has 3 sides 

⁷ Because *vacation* is more commonly used in North America, it was substituted with the term *holiday* for the benefit of the British participants.

Procedure

Participants were presented with stories in an open-ended questionnaire format. They were instructed to: Read the following short paragraphs. We would like you to give us the words you would use in these situations in your ordinary speech—this is not a test of whether you know the "right" description or answer in each case. We'd like you to use words in the way you normally would in—for example—chatting to a friend. Please limit your answers to either **one** or **two** words. Thank you. (emphasis in the instructions). These instructions intentionally de-emphasised the 'dictionary' representation of the selected concepts, in order to extract more natural, everyday representations of concepts.

Each participant only received one of the two versions of each story, and stories were counter-balanced so that half the stories contained characteristic but not defining features, whereas the other stories reflected defining rather than characteristic features.⁸ The four filler items were included in both questionnaire versions. At the end of each of the 14 stories, participants had to write down a one or two word answer to the following open-ended question: *How would you describe or refer to this situation/place/object when talking to your friend?* Again, these questions encouraged the participants to reflect on their customary representations, rather than more scholastic interpretations of the concepts in question.

Scoring

Two independent judges were required to estimate the extent the participants' responses depended on characteristic and defining features in the appropriate

⁸ This procedure differed from the one adopted by Keil and Batterman in their study, as participants were presented with both versions of the story aloud with a forced choice question at the end.

stories.⁹ They used the same scoring method as in Keil and Batterman's study (1984) and were informed what the defining and characteristic features were for each concept. Participants' responses were scored based on correctness. For example, "if a +characteristic/-definition story was deemed a valid instance of the term, or if a -characteristic/+definition story was deemed an invalid instance, a score of 1 was given. A score of 2 was given for a class of related responses. Most common were those cases where a child referred to both characteristic and defining features and indicated that both were necessary for the story to be an instance of the concept. These scores were more common in the -characteristic/+definition cases, where a child would explicitly state that, in addition to the defining features, certain characteristic features were also required. A score of 2 was also given for cases where the child seemed to rely primarily on defining features, but incorrect ones (e.g., an uncle is your father's father. Finally, a score of 2 was assigned in those cases where a child oscillated between a correct and incorrect response. A score of 3 was given for those cases where defining features seemed to predominate. Thus, the -characteristic/+definition stories were judged to be valid instances of the term while the +characteristic/-definition stories were not" (p. 228).

Judges were told what the 'correct' defining and characteristic features were as predetermined by Keil and Batterman. For example, if a participant correctly identified the concept of *news* from the characteristic description, the response was given a score of 1, however, if the concept was incorrectly identified from this description, the responses was scored as 3. If a participant correctly identified the concept of *news* from the defining features in the description, the response scored as

⁹ Many thanks to Dan Yartlett and Nicola R. for their assistance in scoring participants' responses.

3, whereas an incorrect response in this condition was scored as 1. Judges using this scoring system achieved a 95% agreement rating. All items that were scored differently were discussed between them and then rescored.

Hypothesis

Based on the premise that a concept consists of different features, rather than a unitary representation, the prediction is that participants will be able to judge the concept in question from stories with either characteristic or defining features. As both these features are equally salient, participants will not show a preference for identifying concepts from either feature description. Accordingly, the mean judges' scores of both story versions should be close to a score of 2, rather than a mean score of close to 1 for characteristic stories, and 3 for defining stories.

Results and Discussion

Although participants only received one version of each story, they responded to 5 stories with characteristic features, and 5 stories with defining features (responses to the 4 filler stories were not scored). The judges' scores for each response were averaged to obtain a mean for each story version. The independent factor was Story type (Story C: +characteristic/-definition and Story D: -characteristic/+definition) and the dependent measure was the participants' responses, represented by the mean judges' scores. In the analyses below, t_1 refers to results from the by-participants analysis, and t_2 refers to the by-items analysis.¹⁰

The mean response scores by the judges (with standard deviations in parentheses) were 1.9 (.33) for Story C, and 2 (.4) for Story D. Scores closer to 3 represent responses reflecting defining features, and scores closer to 1 represent

¹⁰ A paired sample t-test was used in the by-items analysis because the items were more similar to each other than the other items.

responses with characteristic features. Although mean scores for Story D are a little higher than scores for Story C, there does not appear to be a large difference in the nature of responses to stories with either characteristic or defining features. Paired-sample t-tests confirmed that there was no difference between Story type, $t_1(35)=0.78, p = .44; t_2(9)=0.25, p = .81$.¹¹

The findings in this experiment confirm the hypothesis that concepts are represented with different features. Participants were able to generate category decisions from either defining or characteristic features in the stories. Since the concepts in the test stimuli are not biased by any particular representation (neither defining nor characteristic features), we investigate the next question: Do task demands affect the access or substance of everyday concepts?

3.4.2 Experiment 2

Experiment 2 is based on the finding from the previous experiment that some everyday concepts are represented with different features. In order to assess the effect of task demands on conceptual representation, an additional factor that manipulated the task was included.

Participants

Sixty undergraduate students from the University of Edinburgh volunteered for the experiment. They were all native English speakers, were not aware of the nature of the experiment, and had not participated in the previous experiment. The participants

¹¹ In order to investigate the effect of a potentially different view of what characteristic and defining features are in a concept, the participants' responses in experiment 1 and 2 were rescored using a second scoring method (Score Alternative). A pair of different judges was given the scoring guide (i.e., what numbers 1 to 3 represent) but used intuition to determine what the corresponding defining and characteristic features should be for each concept. Initially, there was a 64% agreement rating, but the subsequent resolution was unanimous. Judges' mean scores of participants' responses (with standard deviations in parentheses) were 2.3 (.44) for Story C and 2 (.58) for Story D. Paired-sample t-tests revealed a significant difference between Story type in the by-participants' analyses, $t_1(35) = 2.98, p = .005$; but not in the by-items analyses, $t_2(9) = 1.2, p = .3$. Participants were able to generate decisions from either characteristic or defining features of the concepts in question.

were randomly allocated to one of two question conditions (Question Characteristic or Question Defining). Participants had not volunteered for the previous experiment.

Materials

The stimuli used in this experiment were the same 14 stories used in experiment 1. There were also two versions of each of the 10 test items (Story C: +characteristics/-definitions and Story D: -definitions/+characteristics). All four filler stories were the same as in the previous experiment.

Procedure

Each participant was tested individually in a room. The procedure used in this experiment was different from that employed in Experiment 1 (and the procedure used by Keil and Batterman, 1984). Instead of an open-ended questionnaire format, the stories were read aloud in one of two conditions. In the first condition, participants heard the stories and were asked the following question: *Could it be a (particular term)?* This first question (Question Defining) was the same question asked in Keil and Batterman's study.

In the second condition (Question Characteristic), participants were given the following instructions: Often there is a difference between dictionary definitions and the way we actually use words in our everyday speech. In this experiment, we are interested in how you use words, not in how you think they are defined. We would like you to listen to the following scenarios and tell us how you might use the words we ask you about in relation to them. At the end of each story, participants were asked this question: *Do you think it's likely in your ordinary, everyday speech, you'd call it a (particular term)?*

The participants were instructed to listen to the stories and respond at the end whether they thought the descriptions in the story fit the target item presented at the end of the story. The story was also repeated once if requested. From the response transcripts in Keil and Batterman's study, the experimenter appeared to highlight particular features of the stories to children. For example, after hearing the child's response to Story D for *factory*, the experimenter asked, "They're making buttons. Is that a factory?" (p. 230). The experimenter's role here was only to ask questions for clarification, rather than offer leading questions. All participants' responses were recorded using a Sony cassette-corder and then transcribed.

Stories were counter-balanced so that half the stories contained characteristic features but not definitions, whereas the other stories reflected defining features rather than characteristics ones. When read aloud, each story was an average of 15-20 seconds long.

Scoring

The judges used the same scoring system as in experiment 1 and scored participants' responses based on the criteria set out by Keil and Batterman. Any incongruous scores were resolved by discussion between the two judges. There was a 97% agreement rating (in Keil and Batterman's study, the agreement rate was 91%). All disagreements were unanimously resolved by discussion.

Hypothesis

The experiment explores whether task demands affect conceptual access or substance. If task demands affect the substance of the concepts, then one story version should be more effective in influencing conceptual judgements over the other story. However, based on the findings in Experiment 1 that the concepts

judgements were equally accessible from either feature description, it is more likely that conceptual content does not change, instead access varies with the task. If this premise is correct, then conceptual judgements should differ with the different questions. Based on the proposal made by early researchers on categorisation that concepts are represented by necessary and sufficient features in the statement 'X is a (factory)' (e.g., Katz & Fodor, 1963; Osherson & Smith, 1981; see section 3.3 for further discussion), it was our intuition that Question D would influence participants to focus on defining features in concepts. In the second condition, because Question C led participants to focus on typical features of a concept abstracted from daily experiences, our intuition was that participants would rely on characteristic features of a concept in their responses (Rosch, 1975; see section 3.3).

Results

Participants answered one of two open-ended questions (Question D or C), and judges scored their responses. Consider some of the answers to Question D for the *news* stimulus (Story Characteristic):

E: Could it be news?

P: Eh, no, it's not up-to-date

News stimulus (Story Defining):

E: Could it be news?

P: Um, yes, because they're talking about contemporary issues.

Responses to the *jail* stimulus (Story Characteristic) to Question D:

E: Could it be a jail?

P: No, not if they can leave whenever they want to.

Responses to the *jail* stimulus (Story Defining) to Question D:

E: Could it be a jail?

P: Yes, they can't leave.

In these first few examples, participants' responses reflect a strong sense of appropriating defining features to the stimulus. They appeared undeterred by the corresponding characteristic features, and instead mentioned that in order for them to identify the concept correctly, it must possess the necessary features. Below are responses to stimuli presented with Question C.

Responses to the *news* stimulus (Story Characteristic) to Question C:

E: Do you think it's likely in your ordinary, everyday speech, you'd call it news?

P: Yes, I would, because it's giving me new information and the information that he's giving me is the same type of information that I would see on a tv program called news, or that I would hear on something that had the label 'news', rather than other information.

Responses to the *news* stimulus (Story Defining) to Question C:

E: Do you think it's likely in your ordinary, everyday speech, you'd call it news?

P: No, news is normally bad news, not normally people dancing around explaining it.

Responses to the *jail* stimulus (Story Characteristic) to Question C:

E: Do you think it's likely in your ordinary, everyday speech, you'd call it a jail?

P: Yes, probably because of the image of the building and their social status.

Responses to the *jail* stimulus (Story Defining) to Question C:

E: Do you think it's likely in your ordinary, everyday speech, you'd call it a jail?

P: No, because you wouldn't expect all these nice things in a jail.

The interview transcripts revealed that when asked Question D, participants reflected more on the defining features of an object or place. However, when presented with Question C, participants relied on characteristic features instead.

As in experiment 1, the judges' scores for each response were averaged separately for stories with characteristic and defining features. The mean scores across Question and Story conditions appear different (see Table 3.2). A mean score closer to 1 refer to a reliance on characteristic features of the object, and a mean score closer to 3 represents the role of definitions in the responses. The scores for Question D are closer to 3, representing responses affected by defining features. In Question C, responses seem to reflect the characteristic features of the stories and are closer to 1.

Table 3.2

Mean judges' scores (min = 1; max = 3) of participants' responses by Question type and Story type

Question type	Story type	
	Characteristic	Defining
Question D	2.6 (0.35)	2.8 (0.27)
Question C	2.2 (0.37)	1.7 (0.46)

Note. Standard deviations are in parentheses; scores closer to 3 represent responses reflecting defining features, and scores closer to 1 represent responses with characteristic features

There were two independent factors: Question type (Question Defining or Characteristic), and Story type (Story C: Characteristic; or Story D: Defining).

Analyses on the judges' scores representing the participants' responses were

conducted with participants (F_1 ; Question type = between, Story type = within) and items (F_2 ; Question type = between, Story type = within) as random factors.

A two-way mixed design ANOVA confirmed a reliable difference in the type of question participants were presented with, $F_1(1,58)=125.6, p < .001$; $F_2(1,18) = 36.34, p < .001$. There was no main effect for Story type, $F_1(1,58) = 2.6, p = .11$; $F_2(1,18) = 1.1, p = .31$. The interaction between the two factors was significant, $F_1(1,58)=22.6, p < .001$; $F_2(1,18) = 17.5, p < .001$, suggesting the differing contexts the questions provided influenced participants responses to the stories.¹² Post-hoc Sheffe's tests confirm that different conceptual features were accessed depending on the question type ($p < .005$), but not the story type.

Discussion

The results confirm the hypothesis that different task demands (represented by the different questions) affect the access but not the substance of conceptual features. When participants were asked if the target concept was an accurate reflection of features presented in the story (Question D), they relied on defining features to make that decision. Participants were not swayed by characteristic features of concepts in their conceptual decision and confirmed that the target could only be considered as the concept in question if it possessed the corresponding defining features. For example, when presented with the story describing the physical appearance of a cathedral (e.g., had a steeple, bell, and stained glass windows) that was used to keep plants (Story Characteristic), participants insisted that if it wasn't being used as a

¹² Mean judges' scores of participants' responses in the Score Alternative system for Question C were (*SD* in parentheses): 2.6 (.34) and 2.8 (.29); Question D were: 2.3 (.43) and 1.9 (.49) for Story C and D respectively. A two-way mixed design ANOVA confirmed a reliable difference in the type of question participants were presented with, $F_1(1,58)= 70, p < .001$; $F_2(1,18) = 34.5, p < .001$. There was a main effect for Story type in the by-participants analyses, $F_1(1,58) = 6.3, p = .02$; but not in the by-items analyses, $F_2(1,18) = 3.4, p = .08$. The interaction between the two factors was significant, $F_1(1,58)= 17.6, p < .001$; $F_2(1,18) = 15.2, p < .001$, suggesting the differing contexts the questions provided influenced access of conceptual features.

'place of worship', then they did not consider it to be a church. However, when asked if they would refer to the target concept as such in their everyday conversations based on the properties presented in the story (Question C), participants were affected by characteristic (or prototypical) features. In the example of the church above, participants were more likely to consider it as a church, despite the fact that it was used to store plants, rather than a place of worship. The findings confirm that different features of concepts are accessed depending on the task, for example, in casual conversation, people rely on characteristic features, however, when asked in a more formal situation, they use definitions. The interaction between question type and story type confirm that the representation of conceptual features is context-dependent. The post-hoc tests also confirm that the question type significantly affected what conceptual features were accessed but did not alter the substance of the concept.

The main effect of question type further confirmed that responses differed according to the task. When examining the effect of the different story types, the results replicated the findings in Experiment 1, which indicated that participants did not prefer one feature type to another in conceptual judgments.

3.5 Summary and General Discussion

The chapter is based on the premise that a concept consists of different features that are either context-independent or context-dependent. As previous research confirms that certain cognitive tasks are sensitive to extrinsic factors, the study explored whether task demands influence the access or the substance of concepts. In order to investigate the role of task demands in conceptual representation, the study was based on previous research by Keil and Batterman (1984). They suggested that

children's conceptual representations shift in the course of development, moving from a reliance on characteristic (or prototypical) features to more defining representations as they get older.

In experiment 1, participants were shown a series of stories with one of two feature types: Story characteristics or Story Definitions. Participants were asked to determine what concept was described in the story based on the features listed. We explored whether the everyday concepts in the test stimuli were better represented by one conceptual feature over another. If this were the case, one feature type should have a greater influence on participants' conceptual judgments compared to the other (e.g., characteristic features may guide conceptual representation more than defining features). However, if the everyday concepts in question were not biased to one representation, then participants should be able to determine the concept in question from either feature description (i.e., neither defining nor characteristic features in the descriptions should present a greater influence on participants' responses). The results indicated that there was no reliable difference in the features extracted to identify the target concepts. Participants were able to make conceptual judgments equally well from either feature description.

Experiment 2 investigated whether task demands affect the access or the substance of concepts. Participants were presented with one of two types of feature types (defining versus characteristic) of a target stimulus embedded within a story, and had to decide whether those features accurately represented the target. The task was manipulated in two ways—Question D required the participants to answer whether the properties in the story reflected the target concept, whereas Question C asked the participants to consider whether they would use the features in the story to

refer to the target concept in daily conversation. As in the previous experiment, there was no difference in the influence of the two features in the stories. However, the type of question participants responded to biased which feature they accessed when making conceptual judgments. When participants were asked Question D—“*Could it be a X?*”, they relied more heavily on defining features to make their decision. However, when asked how they would refer to the target item in daily conversation (Question C), participants tended to consider characteristic features in their answers. Conceptual features alone did not predispose representations, instead they were accessed depending on the task demand.

The findings confirm that different features make up conceptual representations, and people access these features in response to a particular context. Although the study does not distinguish between the different theories or models, from the findings we conjecture that concepts are invariant and different tasks highlight how different aspects of the concept are accessed. Such a fluid account of conceptual representation suggests that some features of a concept will be more representative than others in light of differing contexts, goals and objectives. This perspective challenges the traditional view of concepts where conceptual features are represented independently from each other (we return to this discussion in chapter 6).

Further, the results confirm recent arguments that the application of developmental research of conceptual representation to adult cognition is too simplistic. Both experiments suggest that adults are fully capable of storing different conceptual features and are able to access them without difficulty according to the contextual requirements. This is very different from Keil and Batterman’s suggestion

that representations are formed incrementally and operate on a continuum, beginning with characteristic features, moving to defining properties (see also Gopnick & Meltzoff, 1997). The findings from this study appear to support the premise external factors, such as task demands, affect how conceptual features are accessed. For example, in the right context, adults can behave like children, with respect to the types of conceptual features considered salient in representations. Like young children, they can also consider characteristic features as important in conceptual judgments. This finding gives reason to doubt Keil and Batterman's assertions that the substance of conceptual representations changes over time. Perhaps it is not that conceptual representations change but instead external demands, such as goals and objectives, differ as we grow older.

The everyday concepts selected by Keil and Batterman were modified to allow us to generalise the findings to other common, everyday concepts considered in the thesis, such as spatial (chapter four) and action concepts (chapter five). The important aspect that these two experiments highlight is that task demands in an experimental condition play a vital role in conceptual representations. In order to ensure that the subsequent findings are an accurate representation of the role of language in thought, it is important to maintain consistency across experimental conditions. We can then ask: What is the influence of language when the task is constant? In the following two chapters, we explore this question experimentally. First, we investigate how context—linguistic or experiential—affects representation of spatio-temporal concepts when the task is invariant. Next, we explore how variations in verb structure influence action concepts in a cross-linguistic environment.

CHAPTER FOUR

SEEING AHEAD:

LANGUAGE VERSUS EXPERIENCE IN SPATIO-TEMPORAL CONCEPTS

4.1 Introduction

The discussion of the role of language in conceptual representation is not an easy question to tackle. In an adult vocabulary, the association between labels and concepts has become so interconnected that it is often difficult to determine whether language has influenced a particular concept or is a reflection of it. Although colour categories dominated early research in the Language-Thought debate, recent investigations have focused on a broader and more central cognitive domain across languages—spatial perspective. This investigation has centred largely on the difference between relative terms (or egocentric terms, such as *left/right*) and absolute descriptors (also referred to as geocentric like *east/west*; or allocentric labels that focus on intrinsic properties of external objects—the foot of the mountain, the front of the house, cf. Munnich et al., 2001). Levinson and colleagues have examined differences in how in Dutch and Tzeltal (a Mayan language spoke in Chiapas Mexico) speakers structure space (Brown & Levinson, 2000; Pederson et al., 1998). Although Dutch, like English, highlights a relative system of spatial

reference, Tzeltal employs an absolute system. Brown and Levinson were interested in whether this language difference would influence how volunteers encoded a tabletop array. Participants observed the location of objects and then reconstructed them in what they thought to be the 'same' spatial arrangement. Across the three experiments, the Dutch and Tzeltal speakers' object arrangements corresponded with their linguistic structure: the Dutch reconstructed the array according to a relative system, whereas the Tzeltal speakers favoured an absolute system. Pederson et al. (1998; Pederson, 1995) also found that object reconstructions were consistent with spatial terms in different cross-linguistic communities such as Japanese, Longgu, Arrandic and Tamil (however see Munnich et al., 2001; and Li & Gleitman, 2002, for an alternative explanation of their results; see section 2.4 for further discussion in this area).

One criticism with cross-linguistic research in general is that cultural effects can confound the results, and consequently they don't present an accurate representation of linguistic influence on cognition. While still preserving the research interest in language effects, we eliminate the potential cultural interference by focusing on monolingual English speakers in this study. In working with English speakers however, we are unable to explore the relative/absolute difference because English uses relative rather than absolute terms to describe spatial properties (e.g., 'Pass the spoon to the *left* of the cup', rather than 'Pass the spoon to the *east* of the cup'). The reliance on relative spatial terms extends to the discussion of temporal concepts (i.e., in English, we are more inclined to refer to events in relation to ourselves rather than to an absolute temporal system). The use of deictic terms that

are interchangeable between space and time affords some measure of demarcation between the separate influences of language and experience.

The understanding of space and time is often predicated on motion, for example, people represent spatial concepts based on motion past objects and places; and time on motion past events. Words that describe motion in space, such as *front*, *past*, *ahead*, *after*, are often similar to words that discuss motion in time (Clark, 1973; Traugott, 1978). For example, when discussing spatial motion, it is common to hear the following: “Walk in *front* of the red car”; and temporal motion as: “The holidays are *ahead/in front* of us”. Some researchers argue that the sharing of ‘motion terms’ between two separate conceptual domains is merely the evidence of local polysemies (e.g., Murphy, 1996). However, other researchers claim that the sharing of such terms indicates that abstract concepts such as time are grounded in experiential concepts like space (e.g., Lakoff & Johnson, 1999). This debate is heightened by the fact that often times, words used to delineate motion such as *front*, *ahead*, *after*, can be ambiguous. For example in a statement like “Pick up the mug in *front*”, it is unclear if *in front* refers to the speaker or to the listener. It is this ambiguity that affords us some scope in studying the influences of language and experience. By teasing apart these separate influences, we can investigate whether language is directing the comprehension of such deictic terms, or if people form an understanding of motion from their experiences and use language as an indicator to communicate these concepts.

In order to understand the separate roles of language and experience in spatial and temporal concepts, we first identify two different systems of motion and their linguistic expressions in space and time. Next, we review evidence that these

two motion schemas are psychologically valid expressions for spatio-temporal concepts. Based on this premise, we highlight two research questions. First, given the similarity in labels when discussing space and time, are representations of motion in space and time borrowed or separate? And secondly, because these motion terms can be ambiguous, what directs spatio-temporal concepts—language or experience? A set of four experiments provides some demarcation between the roles of experience and language on conceptual understanding of motion in space and time.

4.2 Spatial reference frame assignment and priming of reference frames

There are several approaches to discussing spatial relationships, which are thought to play an important role in spatial cognition (see Couclelis, Golledge, Gale, & Tobler, 1987). These spatial reference frames are evidenced across different languages and are classified as intrinsic, relative, and absolute relations (Levinson, 1996). In an intrinsic relation, the location of an object is determined according to the intrinsic spatial properties of a reference object. A relative reference frame is contingent on the perspective of the viewer, and an object is judged as *above/below* or *front/behind* based on this additional orientation. An absolute relation is one that refers to an object's location with respect to external surroundings, such as those provided by gravity or cardinal directions.

As indicated by the different reference frames, spatial relational terms, such as *above/below* or *front/behind*, can lead to ambiguity in conversations. For example, when hearing the statement that 'A is in front', the listener has to decide if the speaker is adopting intrinsic, relative, and absolute reference frame. Compounding this difficulty is the suggestion that humans have an intrinsic reference scheme, for example, the *top* is taken to be the head of a person, and the *bottom*, his feet; *left* and

right correspond with the labels assigned to the left and right sides of the human body; the *front* is associated with the orientation of the perceptual organs (i.e., the eyes), and the *back* is the opposite location (see Fillmore, 1971; Miller & Johnson-Laird, 1976). This intrinsic human reference scheme is also generalisable to animals based on a 'coincidence' and an 'encounter' situation (Herskovits, 1986). In the coincidence situation, an animal adopts a similar orientation to the intrinsic assignments of *front/behind*, *top/bottom*, and *left/right* of a human. It is important to note however, that the human intrinsic reference frame is not directly mapped on to an animal, instead the spatial assignments correspond to an animal's natural physical orientation. For example, the *front* of a dog is not its stomach as it is for humans, but the front of its head.

Objects can also be given similar spatial assignments. In a coincidence encounter, the *front* of an object is thought to be the front in its natural orientation. In an encounter situation, spatial terms are assigned relative to the viewer's perspective. However, the assignment of spatial relations to inanimate objects is complicated by a third possible reference frame—the accidental intrinsic scheme. In this scheme, symmetrical objects take on the spatial features unique to the environment they are placed or occur in. For example, an object such as a tree, will adopt spatial perspectives of *front* and *back* of the street, and the *front* of the tree is the part encountered by the viewer, whereas the *back* is the side unseen from the viewer's perspective from the street (Fillmore, 1982).

When using spatial references such as *front* and *back*, there is evidence suggesting that people are influenced by intrinsic or relative rather than absolute reference frames. In particular, developmental research has indicated that young

children assign intrinsic spatial labels to an object when the reference object has an inherent front and back (e.g., Harris & Strommen, 1972). Adult research has further supported the notion that reference frames are activated automatically. Carlson-Radvansky and Logan (1997) identified several factors that can influence the choice of reference frames that an individual can adopt. These include inherent characteristics of an object, such as movement, spatial coordination between the speaker and the listener, and the perspective of the scene.

Given that there are multiple reference frames available when discussing spatial relations, it is useful to understand some of the factors that play an influential role in the selection of these spatial frames. Of particular interest is the role of priming in the type of reference frames that are accessed to interpret an ambiguous spatial scene. Carlson-Radvansky and Jiang (1998) found that negative priming of a particular spatial reference frame inhibited the selection of an alternative reference frame. Participants were shown pairs of pictures depicting *above* and *below* spatial relations. The pairs were matched so that the term *above* in the prime and the probe pictures was assigned on either in an intrinsic frame (e.g., a black square positioned above a pocket watch) or a coincidental frame (e.g., black square positioned above a football). The pictures were also rotated so the spatial position of the square could be interpreted according to an absolute axis or an intrinsic axis. Participants then verified the spatial relations depicted in the probe trial, which were always represented according to an intrinsic reference frame. The data indicate that participants' responses to the probe were slower when presented with a conflicting prime trial (i.e., pictures depicting an absolute spatial frame).

These findings are consistent with the idea that although participants' preference for specific reference frames in space is contingent on the manner in which they approached the spatial context, negative priming can serve as an inhibitory mechanism in spatial relations. This study also demonstrates how inhibition can assist in the selection of one reference frame when multiple spatial frames are activated simultaneously.

4.3 Motion in Space and Time

An important association between the domains of space and time is that both are represented by two similar systems of motion—Ego Moving and Object (or Time) Moving. Although these motion schemas have been treated extensively by philosophical discussions (e.g., McTaggart, 1908), interest in the psychological validity of such schemas is relatively recent. Empirical work however, has confirmed that people conceptualise motion in space and time according to these two motion systems (Boroditsky, 2000; Gentner & Imai, 1992; McGlone & Harding, 1998; see section 4.3).

Stemming from a common representation of motion, both the spatial and temporal domains use similar expressions. For example in the spatial domain, people refer to objects as being “in *front* of me or *behind* him”. In the temporal domain, similar expressions are used to describe events, such as “Christmas is *ahead* of us” or “We’ve *passed* our holiday season now”. Although space is a three-dimensional concept, temporal motion terms have two properties in common with spatial terms. First, time is generally conceived as a uni-dimensional concept, thus, common spatial labels such as *front/back* and *up/down* are more frequently used than multidimensional terms like *deep/shallow*. Secondly, because events are ordered

sequentially, directional terms like *front/back*, rather than symmetrical ones such as *left/right* are used. Although it may not be common to use words such as *front* to discuss time, in this chapter, such terms like *front/back*, *forward/behind* are used as generic (or ‘umbrella’) terms to represent similar linguistic assignments such as *ahead of/past*, *moving forward/moved past* in the domains of space and time.

Fillmore (1978) suggested that the assignment of deictic terms—such as *front/back* or *ahead/behind*—particularly in spatial concepts, is contingent on two factors: the animate being’s perceptual organs, and the direction in which it is moving. For humans, the location of our eyes coincides with the direction of movement and thus, that part of the anatomy is considered as the *front*.¹ The direction of motion is also important in the application of the term *front* in both the spatial and temporal domains. In the Ego-Moving system, *front* is used to designate an object/event furthest away from the individual, as the trajectory of motion is in that direction. In the Object-Moving system, the term *front* is assigned to the object/event closest to the individual as the path of motion has reversed directions (note: the following schemas of motion for space and time are presented using the labels that are traditionally used in the literature to refer to them. However, for the purpose of clarity in distinguishing between the domain of space and time, each schema of motion will be prefaced with an **S** to represent **space** or **T** representing **time**).

¹ There are a few exceptions to the rule, such as a crab, which walks sideways, rather than forwards. In such instances, Fillmore claims that the “location of the main organs of perception outweighs the direction-of-movement criterion” (p.33), in which case the *front* of the crab corresponds with the front of its physical body.

4.3.1 Motion in Space

In this section, we highlight two systems of motion for spatial concepts. The first system reflects the direction of motion of objects, and the following, motion of the individual.

1) Object-Moving Metaphor (S/OM)

In this schema of motion, the individual is stationary and objects move towards him.

A realistic example of the S/OM system is when an individual is waiting at a bus stop and observes vehicles coming towards him. The individual assigns the term *front* to the object closest towards him, for example, in Figure 4.1, the term *front* is assigned to the white rock.

2) Ego-Moving Metaphor (S/EM)

In this schema of motion, the objects are stationary and it is the individual who is moving. We experience the S/EM system when we are walking on a street past shops, houses, and parked cars; or in a room past tables and chairs. Here, the term *front* is assigned to the object furthest away from the individual. In Figure 4.2 below, the black rock is labelled as *front*.

4.3.2 Motion in Time

The motion schemas represented in the temporal domain correspond to the motion schemas in the domain of space.²

1) Time (Object) Moving metaphor (T/OM)

The direction of time in this schema is represented as going from the future to the past. This is illustrated by a simple example: In the month of February, Christmas is

² It is important to note that the following discussion of events in time refer to events as subjective to the viewer, rather than in relation to each other (see McTaggart, 1908, for a distinction between the two systems). Thus, terms used to describe motion, such as *front/back*, *forward/backward* are deictic terms. In contrast, an absolute system uses terms such as *earlier/later*, which describe events in fixed relation to each other, for example, in a calendar year, Easter is always earlier than Christmas.

in the future. In a few months it will move to the present and then to the past. The individual is a stationary observer as time (represented by events) "flows" past him. This schema of motion is the temporal equivalent of the OM metaphor in the domain of space. Thus, a similar rationale is used when assigning deictic terms such as *front/back* and *ahead/behind*, and for phrases such as—The concert is *behind* (*has passed*) us. In Figure 4.3, the observer would say, 'Monday is *ahead* of me', as that is the nearest event to the stationary individual on this trajectory of motion.

2) Ego-Moving metaphor (T/EM)

In this schema, the ego or the individual goes along a timeline from the past to the future. The observer is seen as moving forward through time, passing temporal events that are seen as stationary points. It is the temporal equivalent of the spatial EM system, where the observer moves forward through space. In this system, *front* is used to designate an event furthest from the individual's forward trajectory of motion. Consequently, phrases such as—We look *forward* to a new year are common. In Figure 4.4, the observer would say 'Friday is *ahead* of me', as that is the future event furthest from the moving individual.



Figure 4.1. Schematic diagram representing S/OM schema of motion

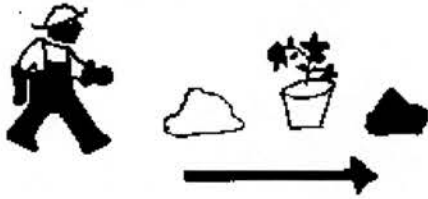


Figure 4.2. Schematic diagram representing S/EM schema of motion

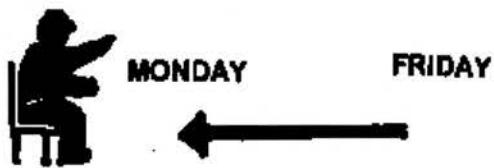


Figure 4.3. Schematic diagram representing T/OM schema of motion

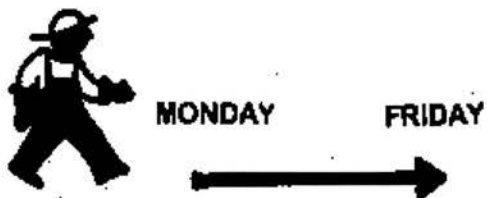


Figure 4.4. Schematic diagram representing T/EM schema of motion

4.4 The Schema Mapping Hypothesis (SMH)

Proponents of the Schema Mapping hypothesis (SMH) posit that the two motion systems in space and time—Ego Moving and Object/Time Moving—are psychologically valid (Gentner & Imai, 1992).³ There are two main premises of the SMH. The first is that knowledge of motion in the spatial domain directs understanding of temporal concepts. Secondly, the two motion systems—Ego Moving and Object/Time Moving—are distinct systems, and therefore a processing cost is incurred when shifting between systems.

Premise 1: Knowledge of spatial motion aids temporal understanding

Support for the first premise is found in metaphor research. In the Domain Mapping hypothesis (also known as the Conceptual Metaphor theory, Lakoff & Johnson, 1980; 1999; see section 2.5 and 4.4.1), the premise is that experiences from a concrete domain are used to understand an abstract domain. For example, in the Conceptual Metaphor ANGER IS FIRE, the following statement: *She was burning mad when he broke her expensive vase*, illustrates an association between anger and fire, where representations from the base domain, FIRE, are accessed to understand the target domain of ANGER. According to Lakoff and Johnson, the separate base and target domains in the Domain Mapping hypothesis are psychologically real. Representations from the base domain aid people's understanding of the target domain (as in the Conceptual Metaphor theory).

The SMH is similar to the Domain Mapping Hypothesis because information from one domain is mapped to another—in this case, representation of spatial motion aids temporal understanding. However, the SMH is distinct from the Domain

³ Gentner and Imai (1992) refer to the two motion systems—Ego Moving and Object/Time Moving—as metaphors.

Mapping hypothesis in two ways. First, the space/time metaphors (i.e., Ego-Moving and Object/Time-Moving) are so highly conventionalised in everyday language that “people rarely notice that there are two different space/time mapping systems in their everyday language” (Gentner & Imai, 1992, p.512). Secondly, in domain mappings, representations are mapped between two different conceptual representations, such as ANGER and FIRE. However, because the conceptual differences between spatial and temporal concepts are relatively subtle, Gentner and Imai argued that these representations are rooted in the same base and target domain, not different ones. Thus, mappings between the spatio-temporal metaphors are schema or system mappings, instead of domain mappings.

Premise 2: The two motion systems—Ego Moving and Object/Time Moving—are distinct systems

Gentner and Imai (1992) tested the second premise of the SMH that the two systems for sequencing events, the Ego-Moving and Object/Time-Moving schema, are psychologically valid and distinct. To reiterate the allocations of the term *front* in the temporal domain: in the T/EM system, *front* is assigned to a future or later event; and in the T/OM system, *front* is assigned to the event closest to the individual. Gentner and Imai investigated the claim that because the T/EM and T/OM motion systems are distinct, there will be a processing cost when shifting between systems.

In the first experiment, participants were presented with blocks of sentences in either a consistent or an inconsistent system (i.e., T/EM primes and T/EM targets; or T/EM primes and T/OM targets). An example T/EM sentence is: “The holiday season is just *ahead* of us” (p. 512), whereas the following is a T/OM sentence: “Christmas is six days *ahead* of New Year’s Day” (p.512). Gentner and Imai

predicted that there would be some cost in switching from one schema of motion (T/EM) to another (T/OM). Thus, participants would respond faster to sentences in a consistent system, compared to sentences in an inconsistent system. The results confirmed that response times were shorter when the prime and target sentences were consistent. The increase in reaction time for inconsistent sentences indicates that participants were switching between two distinct systems of motion, causing a disruption in processing time.

In the second experiment, the test sentences were slightly altered to make use of only three locative terms—*ahead*, *before* and *behind*, in order to eliminate local effects (terms that are specific to one system of motion, but not the other, for example, *front/back* is more commonly used for motion in space, than in time) and to try to test global mapping effects. Gentner and Imai predicted that if people are primed in one schema of motion and then presented with an ambiguous sentence, such as *Wednesday's meeting has been moved forward two days. What day will the meeting be held on now?*, they should answer in a schema consistent manner. The results confirmed their hypothesis—participants primed in the T/EM schema tended to answer *Friday* to the ambiguous sentence, whereas participants primed in the T/OM schema were more likely to answer *Monday*. Taken together, the increase in processing time for inconsistent schemas in experiment one and schema-consistent responses in experiment two confirm that the two motion systems are distinct.

McGlone and Harding (1998) were concerned that the increase in processing time between inconsistent schemas (T/EM primes and T/OM targets) in Gentner and Imai's study was a result of various extraneous factors, rather than schematic differences. They highlighted the following problems and replicated the experiment

with a modified design. The first problem was that there might have been a response bias because reaction time increased only when the same spatio-temporal term was repeated in both the prime and target sentences, for example, *Christmas is six days ahead of New Year's day* (T/OM), and *The holiday season is just ahead of us* (T/EM). The increased reaction time might have been a result of the repeated spatio-temporal term rather than a perspective remapping. The next problem was that the use of familiar events, such as Christmas and New Year might have influenced the reaction times in the remappings because the participants are fully aware that Christmas occurs earlier than New Year. The final problem that McGlone and Harding highlighted in Gentner and Imai's study was that the use of different grammatical structures—active versus passive voice, rather than the perspective changes—T/EM versus T/OM—might have influenced the reaction time. For example, the use of different grammatical structures in the following sentences reflecting T/EM and T/OM respectively might be responsible for the longer response times in experiment one, rather than the different systems of motion: “We have *passed* the deadline”—active voice; versus “The deadline has *passed*”—passive voice (p. 1214).

McGlone and Harding replicated Gentner and Imai's experiment using sentence blocks that contained modified grammatical structures with a consistent subject to decrease the possibility of confounding factors on processing time of the statements. They presented participants with questions about days of the week - relative to Wednesday - that were posed in either the T/EM or the T/OM schema of motion. In each case, participants read the statements and indicated the day of the week that a given event had occurred or was going to occur. At the end of each

priming block statements, participants read an ambiguous statement, such as *The reception scheduled for next Wednesday has been moved forward two days*, and then indicated what day of the week this event was now going to take place. Participants who answered blocks of T/EM priming questions consistently assigned *forward* to the future—the meeting was now on Friday. Participants who answered priming blocks of T/OM questions were more likely to disambiguate *forward* consistently with this system of motion, assigning the new meeting day to Monday. The results were consistent with those of Gentner and Imai's. Both studies confirm that the two motion systems—T/EM and T/OM—are valid and distinct representations.

4.5 Research Questions

Given that these motion schemas are psychologically valid, we ask the following questions. First, given the similarity in labels when discussing space and time, are representations of motion in space and time borrowed or separate? And secondly, because these motion terms can be ambiguous, what directs spatio-temporal concepts—language or experience?

4.5.1 Are representations of motion in space and time borrowed, or separate?

The similarity in the vocabulary used to discuss motion in space and time has given rise to a debate on how spatio-temporal representations are formed. According to Lakoff and Johnson (1999), temporal concepts are borrowed from the spatial domain.⁴ The information extracted from the spatial base domain is the result of daily physical experiences that help formulate temporal representations (see section 2.3.5 for more examples of mappings from the base to target domains). For example,

⁴ Although Gentner and Imai (1992) argued that spatial concepts influence time, their premise is that space/time metaphors are from the *same* domain, not separate ones.

sensorimotor experiences of motion in a spatial domain (such as walking, driving, moving to pick up objects, to name a few), direct conceptualisation of motion in a temporal domain (e.g., approaching holidays, important events). As there are two means of experiencing motion in space (as discussed above: S/OM and S/EM), experiences are mapped on to the abstract domain of time and assist in developing two similar schemas of motion (T/OM and T/EM).

However, Murphy (1996) argued that although conceptual domains (space and time, in this instance) have separate representations, there is often structural similarity between domains. When salient features of each domain correspond, this results in the sharing of representations. To refer to the earlier example of the Conceptual Metaphor in section 2.3.5—ARGUMENT IS WAR—Murphy claimed that both the domains of ARGUMENT and WAR share some of their separate representations, such as the potential consequences. In this case, both the spatial and temporal domains share similar representations of motion. Murphy argued that one domain does not causally influence the other. Rather, the separate representations in each domain lead to a symmetrical relationship between the two domains. This means that while the representation of motion in the domain of space influences the domain of time (as Lakoff and Johnson suggested), the motion systems in the temporal domain can also influence the spatial domain.

Although results from Gentner and Imai's (1992) and McGlone and Harding's (1998) study confirm that the two motion schemas—T/EM and T/OM—are psychologically real and distinct, they did not investigate whether these two motion systems have borrowed or separate representations. Research by Boroditsky (2000; also Boroditsky, 1998) addressed this issue. In the first

experiment, participants were presented with a similar schema priming to McGlone and Harding, using either S/EM or S/OM pictorial primes with an ambiguous temporal statement as the target, for example: *Next Wednesday's meeting has been moved forward two days*. The results confirmed that participants preferred to disambiguate the target question consistently with the system of motion they were exposed to. Participants who received S/EM primes were more likely to answer the question as Friday, whereas those who saw S/OM primes thought the meeting had been moved to Monday. This finding supported the premise that understanding of motion in temporal concepts is borrowed from the representation of motion in space.

In a second experiment, participants were presented with a cross-domain extension of the paradigm used in earlier experiments in the following conditions—linguistic prime to spatial target; linguistic prime to temporal target; temporal prime to temporal target; temporal prime to spatial target—with either consistent (EM prime and EM target/ OM prime and OM target) or inconsistent (EM prime and OM target/OM prime and EM target) questions. Both dependent measures—responses and response times—revealed that participants responded more accurately and quicker with consistent questions in all the conditions, except in the time to space condition. Boroditsky suggested that lack of priming from the domain of time to space is reason to reject Murphy's position that representations from the two schemas of motion are shared equally between domains, resulting in a symmetrical relationship. Instead, the results suggest that representations of temporal motion are borrowed, rather than separate from the domain of space.

4.5.2 What directs spatio-temporal concepts—language or experience?

Previous research has contributed significantly to the discussion of motion in space and time. Initial empirical work by Gentner and Imai (1992) and McGlone and Harding (1998) confirmed the Schema Mapping hypothesis that two separate systems of motion—Ego-Moving and Time-Moving—are psychologically real. Research by Boroditsky (2000) extended this premise and examined the influence of spatial representations of motion on temporal ones. The findings suggested that representations of motion in time are borrowed from those in space, rather than existing as separate representations as Murphy (1996) suggested. We now examine the second research question—what directs spatio-temporal concepts—language or experience? Given the influence of spatial concepts on temporal ones, we can investigate whether experience of motion in space or language used to describe spatial motion is mapped to temporal understanding. There are three possibilities for the role of language in spatio-temporal representations:

a) Linguistic expressions are shared between spatial and temporal domains.

Murphy argued that the similar words depicting motion in the domain of space and time are merely polysemous words, a result of sharing—not borrowing—between the two independent domains. Although space and time are separate representations, there is a symmetrical relationship between the two and similar relationships are mapped on to each other. However, as results from Boroditsky (2000) indicated that the relationship between spatial and temporal concepts is neither shared nor symmetrical, this position will not be considered.

b) Linguistic expressions in space and time are a reflection of experiences—universalist position

The Conceptual Metaphor theory explains that physical interaction with the world influences how people represent an abstract domain. In line with the universalist position, Lakoff and Johnson argued that experiences in a spatial environment influence temporal concepts. By experience, they referred to embodied situations encountered on a daily basis. Language, in particular metaphor, reflects the influence of spatial experience on abstract concepts such as time.⁵ They give the following example: “Consider a literal motion-situation in which you are walking down an alley and you see an intersection up ahead of you. You might say to your companion, ‘I don’t know what’s *up ahead of us*.’” (1999, p. 152). The term *up ahead of us* refers to a spatial location that represents a S/EM schema. You then cross-map this schema of motion onto your understanding of time when you use phrases such as: “I don’t know what’s *up ahead of us* in the next century” (p. 153). In an otherwise abstract domain, people conceptualise time by events (like objects in the spatial domain) and move forward along these points. Thus, temporal terms like *front/back*, (generically speaking) and *ahead/behind* are a reflection of a conceptual representation of motion mapped from sensory experiences in space.⁶

⁵ Lakoff and Johnson extended metaphor use beyond the traditional reference (e.g., *kick the bucket*) to refer to a manner of speaking (e.g., *up ahead of us*).

⁶ Although Lakoff and Johnson (1999) argued that Boroditsky (2000) confirmed the role of experience in spatio-temporal conceptual representations, it is unclear if the EM and OM pictorial primes were sufficiently 'embodied' to induce motion. Participants could have represented the motion schemas without 'experiencing' them.

c) Linguistic expressions can influence representation of motion in spatio-temporal concepts—linguistic relativity position

Previous research confirmed that representations of motion in space influence understanding of motion in time (Gentner & Imai, 1992). The premise of this position is that linguistic representation plays some role in shaping motion schemas. The labels that describe motion in space are mapped on to temporal understanding. Gentner and Imai (1997) proposed the Schema Mapping hypothesis (SMH) to explain the relationship between spatial and temporal representations (see section 4.3). Although both the Conceptual Metaphor theory (CMT) and the SMH posit that spatial concepts influence temporal understanding, the main difference between the two positions is *what* directs spatio-temporal representations. According to the CMT, experience of motion in space influences understanding of motion in time. Further, not only are conceptual representations derived from experience, language is predicated on them. However, according to the SMH, mappings between schemas are knowledge-based and do not have to originate from experience. According to Gentner's structure-mapping theory (1983; also Falkenhainer, Forbus, & Gentner, 1989), a theory that accounts for mappings between conceptual domains (including the SMH), language-driven knowledge assists the analogies that are made between two domains.⁷ The structure-mapping theory is a tiered approach to matching shared predicates in order to detect relational commonalities between two domains. Foremost is the systematicity principle that people prefer mapping higher order relations (or arguments) between domains/schemas. Consider the example of the

⁷ There is a debate about analogical mapping, however it centers on *how* mappings are made, rather than whether experience or language directs these mappings (e.g., Forbus, Gentner & Law, 1995; Keane, Ledgeway & Duff, 1994; Holyoak & Thagard, 1989; Ramscar, under review).

conceptual mapping between the *solar system* and an *atom*). In this analogy, the sun and planets in the solar-system domain are analogous to the nucleus and electrons in the atom domain. There are a number of common higher-order relations. First, the sun has more mass than the planets, as has the nucleus than the electrons. As a result of this, the sun's mass attracts the planets, as the nucleus' mass causes the electrons to revolve around it. However the similarity ends there as Gentner and Clement (1988) point out that "object descriptions are disregarded; there is no attempt to match the nucleus with the sun in color, size or temperature" (p. 313).⁸

In this example, people only have linguistic awareness of these concepts and relationships, not perceptual/embodied knowledge, yet are able to map between domains based on relational commonalities. However, the critic might maintain that experience can still direct knowledge-based mappings, especially in an area rich in sensory experiences such as spatio-temporal concepts. As such, the role of language, in particular in spatio-temporal concepts, is still unresolved.

In order to compare the effects of experience and language on representation of motion, Alloway, Ramscar, and Corley (1999) used a linguistic prime and target. The prime was an interactive environment. Consistent with the S/OM schema, it was a video game where the participant was represented by a stationary anti-aircraft gun located in the bottom middle of the screen. Parachuters fell from the top of the screen and the participant's goal was to shoot as many parachuters as s/he could before they fell to the ground. Participants were instructed to progress to level four and could replenish their ammunition after every level. In the S/OM schema, the

⁸ Although some researchers (e.g., Tversky 1977) argued that feature overlap is necessary for a good analogical mapping, Gentner argued that good analogical mapping relies on common relational structure beyond "literal similarity" mappings (Gentner & Markman, 1994; Markman & Gentner, 1997).

term *front* was assigned to the parachuters near the bottom of a 20 cm by 27 cm (8" x 10.5") computer screen, closest to the participant. The target task, biased towards a S/EM schema, was a three-way switch box, and participants were requested to *Move the switch forward*. Light bulbs on both sides of the box indicated which direction the switch had been moved to. A baseline condition confirmed the S/EM system of motion in this task, as 100% of the participants assigned the term *front* in the direction away from the participant.

There were two experimental conditions—an embodied/non-linguistic condition and a linguistic condition. Participants in the first condition played the S/OM video game and then performed the target task. As these participants did not receive a linguistic prime, this allowed us to observe the effect of embodied priming on spatial representation. After they had completed the target task, they were presented with a priming check question to ensure that the priming was effective and observed by the participant. Participants in the second condition—the linguistic condition—played the same S/OM video game, but they received an explicit linguistic prime before performing the target task. The linguistic prime required them to verbalise their assignment of the term *front* during the priming task. They had to answer true or false to the following statement: During the game, it was more important to shoot the parachuters in the *front*.

We predicted that if experience affects conceptual understanding, then participants primed in the embodied S/OM video game task should perform the target task in a schema consistent manner to the priming task. This meant that the participant would overcome the natural S/EM bias of the target task, and move the switch toward them, in a manner consistent with the S/OM schema of the game.

The results revealed a significant difference between the two groups in how they interpreted *front* in the target task; $\chi^2(1, N = 43) = 12.31, p < .001$ (see Figure 4.5). Participants in both the non-linguistic/embodied and the linguistic condition were influenced by the priming in the S/OM video game, as evidenced by a high percentage of correct answers to the priming check question—81% in the embodied condition, and 92% in the linguistic condition. However, only the participants in the linguistic condition cross-mapped this motion schema on to the target task. These participants overcame the natural S/EM bias of the target task, and interpreted *front* in the target task in a schema consistent manner as the S/OM video game.

Participants who were interacting with the S/OM embodied environment but did not receive a linguistic prime, were less likely to cross-map the representation of motion from the prime task to the target task.

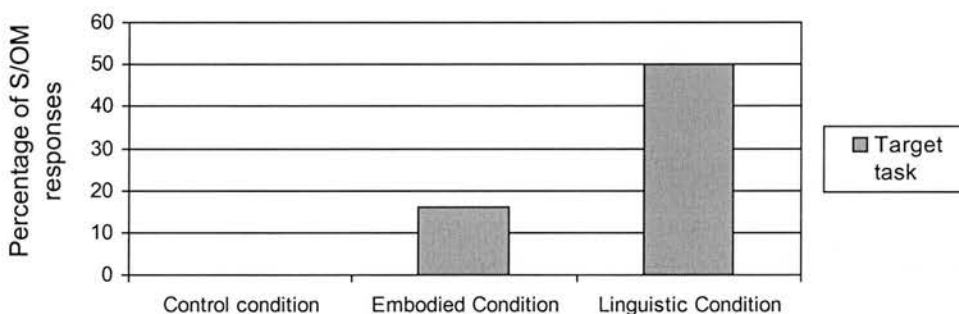


Figure 4.5. Percentage of participants who overcame the S/EM bias of the target and performed the task in a S/OM manner⁹

The results indicated that participants who verbalised the S/OM schema of motion were more likely to overcome the natural S/EM bias of the target task and map the term *front* consistently with a S/OM of the video game. Participants who

⁹ Numbers reflected in this graph only represent participants who answered the priming check question correctly.

were immersed in the S/OM video game but were not asked to represent any system of motion did not transfer their experience in a S/OM motion system to the target task. The findings support the premise that there are two separate systems of motion in the domain of space. However, embodied experience of motion was not sufficient to influence spatial perspective, instead linguistically representing a particular schema of motion plays a strong role in influencing spatial perspective.

Although the experiment communicates new information regarding the role of language and visual experience in spatial concepts, a few shortcomings might have confounded the results. One criticism of the experiment is that the primes did not reflect a real-life embodied experience, and do not actually compare to daily 'embodied experiences', and thus, were ineffective in directing participants' attention to an Object-Moving perspective. Although participants who did not receive a direct linguistic prime during the game were not obligated to represent a S/OM perspective of motion, they were influenced by the Object-Moving perspective as evidenced by the high percentage of correct responses to the priming check question. However, the sceptic might remain unconvinced that the video game prime convincingly portrayed a S/OM perspective of motion, and consequently, was not an effective measure of the role of experience in conceptual understanding of space. The motion of the objects in the experiment (S/OM schema) does correspond with experiences people have in life, for example, when we are stationary and watch cars, buses, and other vehicles move towards and past us, however the primes were admittedly artificial. Consequently, the following experiments require the volunteers to interact with a virtual environment, rather than play a two-dimensional game.

The sceptic might further argue that because the embodied prime (playing the game) might not have been sufficiently interactive, any question presented verbally could affect the participants' representations. If this is the case, then the investigation of the separate influences of language and experience on spatial perspective was ineffective. Consequently, in the following experiments, participants in both conditions received a verbal question, but only one group was required to represent spatial properties in a particular schema. Participants who received a question relating to the interactive environment rather than any spatial properties, served as the control group to illustrate that only specifically representing spatial terms like *front* rather than any unrelated linguistic phrase, will influence concepts of motion.

A final concern is that this study was limited because it only examined the separate influences of language and experience within the domain of space. Thus, Experiment 2 and 4 explore the separate influences of spatial exposure on temporal understanding.

4.6 Present Study

Building on previous experiments exploring conceptual representation of motion, this study consists of four experiments, using a similar prime and target design.

Participants were immersed in an embodied environment, a virtual reality game, with one of two conditions—a linguistic prime and a non-spatial question.¹⁰ Experiments 1 and 2 involved the participant in an Ego-moving environment, whereas in Experiments 3 and 4, participants experienced an Object-Moving environment. In Experiments 1 and 3 of both the EM and OM environments, the target task is a

¹⁰ Although participants in both conditions received a verbal question, condition one is referred to as the linguistic condition in order to emphasise the explicit role of language, in contrast to the role of experience represented by the virtual environment in condition two.

spatial task. In Experiments 2 and 4, there is a temporal target question. Both spatial and temporal targets are ambiguous in order to observe whether language (represented by the linguistic prime) or experience (i.e., the motion system in the virtual environment) influences participants' perspective of motion (see Table 4.1).

Table 4.1

Overview of prime and target tasks in experiments 1 to 4

Experiment	Virtual Environment		Target task	
	Ego-Moving	Object-Moving	Spatial	Temporal
1	X		X	
2	X			X
3		X	X	
4		X		X

4.6.1 Experiment 1¹¹

In this experiment, participants played a S/EM virtual reality game and were presented with an ambiguous spatial task, after receiving either a linguistic prime or non-spatial question, in order to investigate the roles of language and experience respectively, between the two schemas of motion in the domain of space.

Participants

Eighty-one students from the University of Edinburgh and various secondary schools in the UK participated in this experiment. Of these, 20 students volunteered for the pre-test condition, 25 for the baseline condition, and the remainder for the experimental condition. There was a 5% error rate in the experimental condition and

¹¹ Experiments 1 and 2 were presented at the 23rd Conference of the Cognitive Science Society (Alloway, Ramscar & Corley, 2001).

these data were not included in the analyses.¹² Of the remaining 34 participants in the experimental condition (mean age = 16; S.D. = 0.65), the demographic information from questionnaires showed that out of the 12 male and 22 female participants, only 3% played video games on a weekly basis. This was a benefit to the experiment, as the novelty of the virtual reality game would increase the effectiveness of the embodied priming. As all participants were familiar with using a computer, and with 83% relying more on the arrow keys than the computer mouse to navigate when typing, the use of arrow keys for navigating in the virtual environment was not problematic for the participants.

Materials

In order to create a particularly convincing Ego Moving environment, volunteers played a pre-existing section of the virtual reality computer game, *UnReal*, that was modified slightly for this experiment.¹³ The section of the game that was used consisted of a first person perspective game and involved the volunteer walking through a courtyard environment to complete a given task—find the location of a young woman. Shortly after the participant started playing the game, s/he encountered two pillars in a row: first a green pillar, then a red pillar, that were the objects in the S/OM linguistic prime question—*During the game, the green pillar is in front of the red pillar—True/False*. There were also doors on the buildings in the courtyard; some were open, and others were closed. The doors were the objects of the true/false question that did not refer to spatial properties of the environment—*During the game, most of the doors are open*.

¹² The error rate in all four experiments refers to the percentage of volunteers who did not answer the linguistic prime question correctly.

¹³ Many thanks to Jon Haywood Sykes for his assistance in programming the virtual reality environments used in experiments 1 to 4.

All monsters and game characters were removed from the game. The only person participants encountered in the environment was the object of the task—the virtual young woman, who was specially designed for the experiment. She congratulated participants upon successfully completing the task, and then asked them to perform the target task—*Move to the front chest*. On the young woman's right, there were two chests, with no discernible front or back (unlike other objects, such as a car, or a house). These were added from the *UnReal* directory of furniture to maintain continuity in the environment. The game was projected onto a 368 cm by 282 cm size screen, with 640 by 480 pixels, in order to magnify the virtual effects of the game.

Pre-Test

The purpose of the pre-test was to confirm that people interpret *front* in an S/OM manner when presented with two objects in a line.

Materials

In order to confirm the S/OM nature of the prime question: *During the game, the green pillar is in front of the red pillar*, a blue and an orange coffee mug were set up in the same manner as the pillars in the video game. Coffee mugs were used instead of the pillars to preserve ecological validity as participants were tested in isolation, rather than in the context of the VR environment.

Procedure

Each participant was tested individually. He stood in front of a table with the two coffee mugs (see Figure 4.6). Half the participants were then asked the following true/false question: *The blue mug is in front of the orange mug*. The question was also asked in the reverse to eliminate an affirmative response bias. Thus, the

remaining participants answered true or false to the following question: *The orange mug is in front of the blue mug.*

Hypothesis

If the prime question were biased towards a S/OM system of motion, then a significant proportion of the participants would assign the term *front* to the blue mug, rather than the orange mug.

Results

Out of the 20 participants, 18 of them interpreted the term *front* to refer to the blue mug, and the rest referred to the orange mug as the *front* mug. A chi-square indicated that there was significant difference between the volunteers' responses, $\chi^2(1) = 12.80, p < .001$. These results reveal that when an individual has to assign the term *front* to one of two objects positioned in a row, the position of the objects are judged relative to each other (rather than the viewer), and the term *front* is interpreted in a S/OM system of motion.

Participant	Blue mug	Orange mug
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Figure 4.6. Position of coffee mugs (representing pillars shown in the S/OM virtual environment) in relation to the participant

Baseline Condition

The baseline condition confirmed the ambiguity of the target spatial task—the assignment of the term *front* to one of two wooden chests—when the participant has to judge the *front* object in relation to himself (a S/EM system).

Procedure

Each participant was seated in front of the projector screen and was tested individually. The virtual game was set at the point in front of the two chests, which were positioned in a row (see Figure 4.7). Participants did not play the game and were only instructed to *Move to the front chest*, using the arrow keys on the computer keyboard. The target task was performed in isolation to test how participants would interpret the term *front* when asked to move to one of two objects in a line.

Hypothesis

If the target task was ambiguous, then participants should not show a significant preference for assigning the term *front* to either chest A or B.

Results

Out of the 25 participants, 48% of them interpreted the term *front* to refer to chest A, and the rest assigned *front* to chest B. A chi-square indicated that there was no difference between the volunteers' responses, $\chi^2(1) = 0.04$, $p = .84$. The results confirm the ambiguity of assigning the term *front* to two objects, when the individual judges the position of these objects relative to his position.



Participant



Chest A



Chest B

Figure 4.7. Position of wooden chests in the S/EM virtual environment in relation to the participant

Experimental Condition

Procedure

Each participant was tested individually. They were asked to fill in a brief questionnaire, requesting demographic information, as well as familiarity with computers and video games. At the end of the questionnaire were the following instructions: Your task is to find the location of a young woman. Try your best to navigate around the environment in order to find her. During this game, it is important to try and remember some key landmarks, such as a **pair of brightly coloured pillars as you enter a path**, as well as the **doors on the buildings**. After you have been playing for some time, you will hear a question requiring a true or false answer. This question will be about the game. Try to answer it correctly and speak your answer loudly (emphasis in the instructions).

The participants were then lead to the playing area where the virtual reality game was set up and were told to use the arrow keys on the keyboard when navigating through the environment. They were then left alone to play the game. The experimenter was on hand however, should the volunteers have any difficulty manoeuvring around the environment.

There were two experimental conditions. In the first condition, volunteers received a pre-recorded linguistic prime specific to the assignment of the term *front* approximately four minutes into playing the game. The linguistic prime, which was confirmed as a S/OM question in the pre-test above, was the following true/false question: *During the game, the green pillar is in front of the red pillar.* The correct answer to the S/OM prime question was true, as the green pillar was located in front of the red pillar from a S/OM perspective. The question was also asked in the inverse to counter-act an affirmative response bias. Thus, half of the participants in this condition answered the following question: *During the game, the red pillar is in front of the green pillar.* The answer to this question was false from a S/OM perspective.¹⁴

In the second condition, volunteers received a pre-recorded question that did not refer to spatial properties of any objects in the environment. Approximately four minutes into playing the game, participants had to answer true or false to the following question: *During the game, most of the doors are open.* The correct answer to this question was true; however, the amount of doors the participant saw depended on the route s/he chose in navigating around the environment to complete the task. The question was also presented in the inverse to avoid any particular response bias, and half of the participants in this condition answered the following question: *During the game, most of the doors are closed.* Responses in this condition were not scored for correctness.

¹⁴ A critic might argue that the S/OM linguistic prime will be biased by the interaction in a S/EM virtual environment. This is not the case as the pillars appeared in the virtual environment in the first 2-3 seconds of the volunteer's exposure to the environment. Because they were instructed to attend to orientation/position of these pillars, there is reason to suggest that they were encoded in a S/OM perspective (as confirmed by the baseline). Memory research indicates that an image passes from the sensory storage to short-term storage within seconds when the viewer is directed to attend to the image (Atkinson & Shiffrin, 1968; Shiffrin, 1988).

After receiving either a linguistic prime or non-spatial question, participants continued to navigate around the environment for a minimum of two more minutes. Once the participants found the virtual young woman, she congratulated them and asked them to complete the target task, using the game console: *Move to the front chest*. Upon completion of the target task, participants were given a short debriefing.

Hypotheses

As the experiment investigates the respective influences of experience and language on motion in space concepts, there are two possible hypotheses. The first hypothesis (Hypothesis LI) is a variant of the linguistic relativity position, whereas the next (Hypothesis LR) is aligned with the claims of the universalist position. Both hypotheses are based on the premise of the Schema Mapping hypothesis that the two distinct schemas of motion—Ego-Moving and Object-Moving—are psychologically valid.

Language-as-an-influence (Hypothesis LI)

Supporters of this position suggest that because these two systems of motion are real, the type of motion participants represent in the virtual environment will influence their performance on the target task. Consequently, participants who engage in the virtual environment and receive a non-spatial question that does not require them to linguistically represent a particular schema of motion (condition two), will be influenced by the Ego-Moving system in the virtual environment. They will assign *front* to the wooden chest furthest away from them (chest B).

However, if language does influence representation of motion in space, then participants who receive the linguistic S/OM prime (condition one) will overcome the S/EM perspective of the game and represent motion in an Object-Moving

schema when answering the target task. The term *front* in the target task will be disambiguated to refer to the wooden chest closest to the individual (chest A in Figure 4.8).

Language-as-a- reflection hypothesis (Hypothesis LR)

Based on the argument that experiences direct conceptual representations, the prediction is that perceptual experience of a particular environment will influence motion in spatial concepts. Thus, experiencing motion in a S/EM virtual environment will influence the participants to cross-map this information onto the target task, and assign *front* to the wooden chest furthest from them (chest B), consistent with a S/EM schema of motion. The dominance of perceptual experience should influence the participants regardless of the question (linguistic prime versus non-spatial) they receive.

Analyses of Results

In all four experiments, the analyses are conducted as follows in the experimental condition: an overall analysis of the baseline and two experimental conditions—condition one (linguistic prime) and condition two (non-spatial question)—using a Kruskal-Wallis test. Next, three chi-square analyses are conducted—the first two between the baseline condition and each experimental condition (i.e., baseline condition and linguistic prime; and baseline condition and non-spatial question); and the final analysis between the two experimental conditions.

Results

Out of the total 36 participants, two of the participants did not answer the prime question consistently (i.e., to the linguistic S/OM prime: *During the game, the green*

pillar is in front of the red pillar, they answered false when the correct answer was true). These data were not used in the following analyses.

The responses to the target task indicated that the type of question the participants received significantly affected their response to the target task. In the baseline condition, 48% of participants assigned the term *front* to the chest closest to them (chest A). When participants received the linguistic prime, requiring them to specifically represent a S/OM schema of motion, the percentage of participants who interpreted the *front* chest as chest A increased to 75%, despite playing the S/EM game for a further 2-3 minutes. However, when participants were simply immersed in an embodied S/EM schema of motion (the non-spatial question), 83% of them were influenced by the virtual environment and interpreted the *front* chest consistently with a S/EM schema of motion (chest B). This percentage is higher than the 52% of participants in the baseline condition who assigned *front* to Chest B (see Figure 4.8).

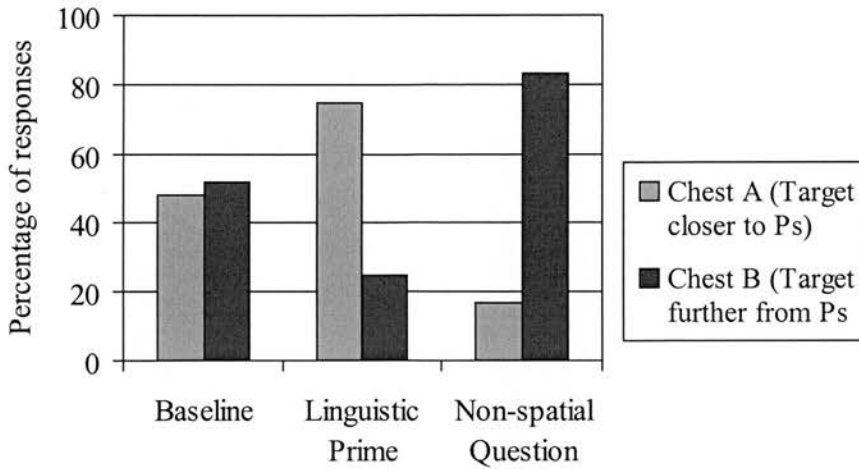


Figure 4.8. Responses to the ambiguous spatial target in the baseline and experimental conditions

An overall analysis of participants' responses to the target task using a Kruskal-Wallis revealed that the number of target responses were significantly different across all three conditions, $\chi^2(2) = 18, p < .001$. When comparing responses in each experimental condition with those in the baseline condition, a chi-square revealed differences as well: the baseline and linguistic prime condition¹⁵, $\chi^2(1) = 2.9, p = .08$; the baseline and non-spatial question condition, $\chi^2(1) = 4.5, p = .03$. In a final analysis between the two experimental conditions, a chi-square revealed that there is a significant effect on the type of question participants' received on how they interpreted the term *front* to apply to an ambiguous target task, $\chi^2(1) = 11.7, p < .001$.

¹⁵ Although the latter analysis was not significant at a higher level, it showed a trend in the predicted direction (and the appropriate level of significance would be obtained with a few more participants, suggesting that linguistic representation does have an effect on spatial perspective).

Discussion

The initial Kruskal-Wallis analysis revealed a difference in how participants disambiguated the target task across the baseline and experimental conditions. The subsequent analyses indicated that the experimental conditions differed from the baseline condition, suggesting that the prime question influenced their assignment of the term *front* in an otherwise ambiguous task. When comparing responses between the two experimental conditions, the findings confirm that the type of question participants received affected their perspective of motion.

These results support Hypothesis LI, as participants were significantly influenced by the system of motion they represented when they performed the target task. Indeed, participants who were exposed to a linguistic prime in a S/OM system overcame the schema of motion they were experiencing (S/EM), and responded in a schema-consistent manner with the linguistic prime, rather than the virtual environment. Participants who received a non-spatial question, unrelated to any system of motion, were not required to linguistically represent any particular schema of motion. Consequently, they were influenced by the S/EM representation of motion in the virtual environment, and responded to the spatial task accordingly. As the target task was confirmed as an ambiguous task, it is interesting to note that the participants' representation of motion in space affected how they disambiguated the term *front*. Although representing a particular experience can affect conceptual thinking, as evidenced by the target responses of participants in condition two, linguistic representation is also a significant component in the conceptual process.

The second hypothesis—Hypothesis LR—highlighted the role of experience in influencing the representation of motion in spatial concepts. The prediction was

that participants in both conditions would be impelled by the S/EM system of motion in the virtual environment they were engaged in, and assign *front* to the wooden chest in a consistent manner—furthest away from them (chest B). However, this was not the case as the type of question participants were exposed to affected their responses. Although the experience of interacting with the virtual environment influenced their spatial perspective, so did linguistically representing an alternative schema of motion. This finding suggests that language is not subservient to experiences, but rather plays an influential role in representations as well.

Although the video prime in this experiment was less artificial than the one used in the original study (Alloway et al., 1999), as it involved the participant more, there might be some criticism against the embodied prime as participants only perceived the visual environment, rather than physically experienced it. However, Lishman and Lee (1973) argued that perception is powerful enough to direct kinaesthesia or movement. They claimed that a person “relies heavily on visual kinaesthesia,in many situations, for example, driving, and swimming in a current, a person is *dependent* on vision to sense how he is moving relative to the static environment” (p. 288, emphasis theirs). They also suggested that people experience a sensation of motion when visual scenes change although they are stationary. They conducted a series of experiments where a participant was placed in a stationary trolley in a moving room. The room was moved independently from the trolley located in it, so the participant saw the room move, although the trolley s/he was standing in was stationary. According to Lishman and Lee, the participant perceived the trolley to move as well, even though it was stationary. The participant also swayed together with the room “in an apparent attempt to keep himself stable

with respect to his ‘static’ environment” (p. 292). Participants felt the experience was like being on a boat, and several felt quite nauseated afterwards.

In the virtual reality experiment, several participants had similar experiences and even commented on feeling rather nauseous after playing the video game for a few minutes. One participant asked if she could leave because she felt so nauseated. Often, participants’ shoulders would move in sync with a right or left turn they made in the virtual environment, and they even remarked on feeling dizzy after completing the experiment. This influence suggests that perception directs a person’s sense of motion, and visually experiencing motion in virtual reality provides a similar sensation to a physical experience of motion.

4.6.2 Experiment Two

The first experiment explored the separate influences of language and experience on the spatial concept of motion. Experiment 2 extends the finding to explore the roles of language and experience when mapping information of motion from the domain of space to time. Participants were immersed in a similar S/EM virtual environment and were presented with an ambiguous temporal target task after receiving either a linguistic prime or non-spatial question.

Participants

Sixty-seven students from the University of Edinburgh volunteered to take part in this experiment. Twenty-eight students participated in the baseline condition, and the rest volunteered for the experimental conditions (mean age = 22.4 , S.D. = 6.7).

There was an 8% error rate in the experimental condition, and these data were not used in the following analyses. The demographic information from the questionnaires revealed that out of the 17 males and 19 females, all of them were

familiar with using a computer. This familiarity with using the arrow keys on the keyboard allowed participants to focus on the virtual environment rather than being preoccupied with learning how to use the keys to navigate. Only 3% of them played virtual reality computer games on a weekly basis, increasing the influence of the virtual environment. Participants had not volunteered for the previous experiment.

Materials

The participants played the same video game as described in Experiment 1.

Baseline Condition

This condition tested the ambiguity of the target temporal question.¹⁶

Procedure

This condition confirmed the ambiguity of the target question: *Next Wednesday's meeting has been moved forward two days. What day is the meeting now that is has been rescheduled?* Participants were tested individually on a Wednesday. While performing an unrelated task, they were asked to respond to the target question.

Results

Out of the twenty-eight subjects, 60% responded that *Monday* was the day of the new meeting, and the rest answered *Friday*. A chi-square showed no difference between the two responses, $\chi^2(1) = 1.29$, $p = .26$. These results confirm the ambiguity of assigning the term *forward* in the target question.

¹⁶ Although Boroditsky (2000), Gentner and Imai (1992), and McGlone and Harding (1998), regarded this target question as ambiguous in research, the baseline confirmed its ambiguity for British participants.

Experimental Condition

Procedure

All trials were conducted on a Wednesday. Each participant was tested individually in the virtual reality lab and was asked to fill in a brief questionnaire with the same instructions as outlined in Experiment 1. Participants were also informed that they would be required to return next Wednesday if they were successful in accomplishing the task in the game. This information provided a connection between the target question and the experiment, as the participants would interpret 'Next Wednesday's meeting' as a further experiment, rather than an unrelated question.

Participants were then shown the game and began playing. As in Experiment 1, questions in both conditions were counterbalanced. Approximately four minutes into playing the game, the participants in the first condition received a linguistic prime emphasising the assignment of *front* in a S/OM perspective. They had to respond with either true or false to the following question: *During the game, the green pillar is in front of the red pillar.* The correct answer to this prime question was true. In the second condition, instead of receiving a linguistic prime, the participants received the following non-spatial question approximately four minutes into playing the game: *During this game, most of the doors are open—true or false.*

After the participants had successfully completed the task (all participants were successful), they were congratulated by the experimenter and then informed that "Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?" Once participants had given their answer to the experimenter, they received a short debriefing.

Hypotheses

The two hypotheses in this experiment are similar to those in Experiment 1. As the first experiment confirmed the influence of language when representing motion in a spatial domain, this experiment explores the role of language in the transfer of information from the domain of space to time. The following hypotheses are based on the premise of the Schema Mapping hypothesis that the two distinct schemas of motion—Ego-Moving and Object-Moving—are psychologically valid.

Language-as-an-influence (Hypothesis LI)

Participants who engage in the virtual environment and receive the linguistic S/OM prime (condition one) should overcome the S/EM perspective the game offers and represent motion in an Object-Moving schema when answering the target task. The term *forward* in the target task will be disambiguated to refer to Monday, as this day is closest to the individual. Participants in condition two who receive a non-spatial question will not linguistically represent a particular schema of motion, and thus, would be influenced by their experience in the Ego-Moving virtual environment. They should assign *forward* to Friday, as this day is furthest away from them, according to the S/EM perspective.

Language-as-a-reflection hypothesis (Hypothesis LR)

As language is considered as a reflection of conceptual representations, rather than an influence on them, the dominance of experience in this instance should influence the participants regardless of the question (linguistic prime versus non-spatial) they receive. Thus, experiencing motion in a S/EM virtual environment should influence the participants to cross-map this information onto the temporal target task, and assign *forward* to Friday, consistent with this schema of motion.

Results

Out of the total 39 participants, three of the participants did not answer the prime question consistently (i.e., to the S/OM prime: “During the game, the green pillar is in front of the red pillar”, they answered false when the correct answer was true). Participants’ responses indicate that the type of prime participants were presented with significantly affected how they disambiguated the target temporal question. Out of the participants who received the linguistic S/OM prime during the game, 65% were more likely to interpret the term *forward* from Wednesday as Monday rather than Friday. Participants in the second condition did not receive a linguistic prime and thus, were influenced by the embodied S/EM game. From these participants, 74% considered the new meeting day to be Friday rather than Monday (see Figure 4.9).

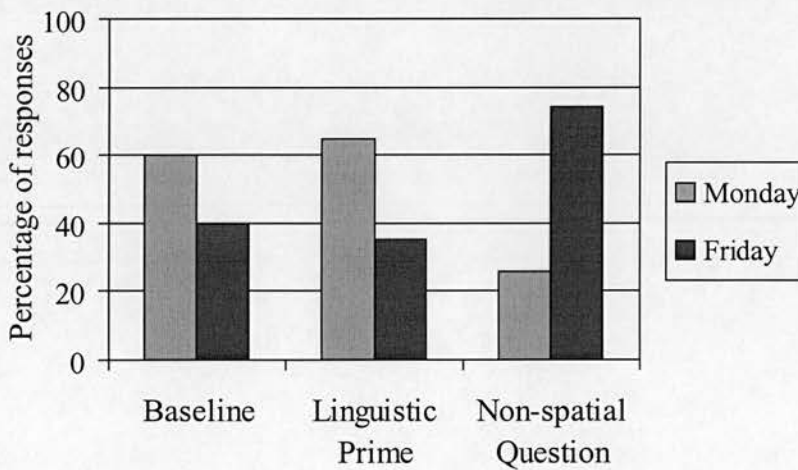


Figure 4.9. Responses to ambiguous temporal question in the baseline and experimental conditions

The Kruskal-Wallis analysis assessed the responses to the ambiguous temporal question in all three conditions. This finding was significant, suggesting that the different conditions affected volunteers' perspective of temporal motion, $\chi^2(2) = 21, p < .001$. The next two chi-square analyses compared each experimental condition with the baseline condition: the baseline and linguistic prime condition, $\chi^2(1) = 0.07, p = .79$; and the baseline and non-spatial question condition, $\chi^2(1) = 5.4, p = .02$. A final chi-square analysis between experimental conditions revealed that the type of question participants received significantly influenced how they disambiguated *forward* in the temporal target task, $\chi^2(1) = 5.4, p = .02$.

Discussion

The overall analysis reveals that the condition participants were exposed to had a significant effect on how they disambiguated *forward* in the target task. Closer inspection of the chi-square results indicate that although the linguistic prime did not produce a significantly different response from the baseline condition, it appeared to counteract the effects of the Ego-Moving game. The system of motion that participants represented had the greatest influence on how they responded to the target task, supporting Hypothesis LI. Participants who received a non-spatial question (condition two), did not linguistically represent any particular schema of motion, and thus, were influenced by the S/EM nature of the virtual environment. They disambiguated the term *forward* in a schema-consistent manner, and responded *Friday* to the target question. However, participants who received the linguistic prime question (condition one) overcame the S/EM bias of the game and responded to the target question as *Monday*, consistent with the S/OM motion system of the linguistic prime. Although participants who did not receive any spatial input were

consequently more responsive to the experiential cues they received in the video game and represented motion accordingly, linguistic representation also played a role in constructing volunteers' temporal concepts. The results indicate that participants were able to overcome the perspective of the virtual environment and represent *front* in the target task consistently with the prime question. This finding contradicts the claims that language is merely the expression of concepts derived from experiences, and suggests that language influences cognition.

The predication in Hypothesis LR was that S/EM virtual environment will influence participants in both conditions to respond that the meeting would be on Friday. Although these results confirm the notion that people map information from the domain of space to time, as representing motion in a spatial task influenced their concepts of motion in the temporal target task, there is no indication that perceptual experience exclusively directed participants' responses in the target question.

4.6.3 Experiment Three

The first two experiments required the participants to interact with an Ego-Moving virtual environment; in the next two experiments, the participants are immersed in an Object-Moving environment. In this experiment, we examine how they respond to an ambiguous spatial target task after interacting with a S/OM virtual reality.

Participants

The participants were 46 students from the University of Edinburgh and various secondary schools in the UK. Out of these, 18 participated in the pre-test, and the rest volunteered for the experimental condition (mean age = 18, S.D. = 4.0). There was a 12% error rate in the experimental condition, and these data were not used in the following analyses. The demographic information from the questionnaires

revealed that out of the 12 males and 16 females in the experimental condition, all of them used a computer on a regular basis, an advantage that allowed them to engage in the virtual environment without technical concerns (such as how to use the arrow keys). Further, only 14% of participants consistently played virtual reality games on a weekly basis, minimising a familiarity bias of a virtual environment. None of the volunteers had participated in the earlier VR experiments.

Materials

Although the virtual environment used in this experiment was from the same VR game (*UnReal*) as in the earlier two experiments, a new environment was designed to represent a S/OM perspective. This particular environment was enclosed (i.e., the environment was a cave), with a doorway at the back (represented at the top middle of the screen). The individual was confined to one location, represented at the bottom middle of the screen. On the left side of the screen there were two different types of trees, placed in a vertical line, similar to the position of the red and green pillars in experiments 1 and 2. On the right side of the screen, there was a large winged monster that remained there for the first two to three minutes of the game. It was the object of the S/EM linguistic prime—*During the game, the winged creature is in front of other creatures*. From the doorway at the back of the environment, creatures that looked human (i.e., they had two legs, two arms, etc.) approached the individual. As the individual was restricted to one location, the motion of the creatures coming towards the participant represented an Object-Moving environment. The layout of this environment represented motion in the OM environment horizontally (i.e., front to back). This differed from the vertical representation of the OM schema motion in the initial study (Alloway et al., 1999),

where the top of the screen represented the sky, and the bottom of the screen was the ground.

The target task in this environment was to identify the *front* tree. As the position of the trees is similar to the chests in Experiment 1, the ambiguity in determining the *front* object has already been established (see figure 4.10 for the position of the trees. The trees presented below are not the exact shape and size of the actual trees portrayed in the environment, as those trees were taken from a nature directory in the *UnReal* game). Trees were used instead of the wooden chests in Experiment 1 to maintain consistency with the outdoor environment portrayed here. As in the previous two experiments, the virtual environment was amplified onto a 368 cm by 282 cm size white screen, with 640 by 480 pixels.



Participant

Tree A

Tree B

Figure 4.10. Position of trees in the S/OM virtual environment in relation to the participant

Pre-test

The pre-test confirmed the Ego-Moving perspective of the linguistic prime question.

Procedure

Participants sat stationary in front of the big screen and were not asked to play the virtual game. They were then presented with the prime question—*During the game, the winged creature is in front of other creatures*—while watching the other creatures run from behind the winged monster (i.e., from the back of the screen to the front). In order to answer the above question as *true*, the participant would have to switch perspective to take up the view of the other creatures. By doing so, they would adopt an Ego-Moving perspective, as they would view themselves as running forward through the cave. Half the participants heard the question in the reverse order—*During the game, the winged creature is behind the other creatures*.

Results

Out of the 18 participants, 89% responded correctly to the prime question. A chi-square indicated that the difference between the two responses was significant, $\chi(1) = 10.9, p < .001$, confirming that the prime question reflects an Ego-Moving perspective.

Experimental Condition

Procedure

Each participant was tested individually in the virtual reality lab and was asked to fill in a brief questionnaire with the following instructions:

Your goal is to SURVIVE the attack of all the creatures. You will have to play the game for 5 minutes without being killed, and hopefully kill many creatures. You will use the mouse to shoot. In order to help you reach your goal, here are a few hints:

- 1) The most dangerous creatures are the ones with a red gun, so try to shoot them first. However, they have a secret cloaking device, which means when they are a silver colour, they will not be affected by your bullets.
- 2) You only have a limited number of bullets, so use them wisely.
- 3) To shoot more effectively, use the green cross on the screen to identify your target. For example, if the green cross is directly on a creature, and you shoot, you will succeed in killing it.
- 4) Finally, be sure to take note of a big creature with wings that will appear at the beginning of the game. Although it cannot harm you, you will be asked about it later.

While you are playing the game, you will be asked a true or false question about the game. Give your answer out aloud. Thank you and enjoy your experience!

(emphasis in instructions).

After reading the instructions, participants began playing the game. There were two counterbalanced conditions. Approximately four minutes into playing the game, the participants received either a linguistic prime or a non-spatial question. In the first condition, the linguistic prime emphasised the assignment of *front* in a S/EM perspective. They had to respond with either true or false to the following question: *During the game, the winged creature is in front of the other creatures.* The correct answer to this prime question was true. Half of the participants in this condition received the question in the inverse—*During the game, the winged creature is behind other creatures.* In the second condition, instead of receiving a linguistic prime, the participants received the following non-spatial question approximately

four minutes into playing the game: *During this game, there are a lot of creatures to shoot—true or false*. Responses in this condition were not scored for correctness.

If the participants failed to survive for five consecutive minutes in the environment, the game was restarted. This took a total of 3-4 seconds. The participants were then required to interact with the environment for a minimum of four further minutes. Once participants had successfully survived the environment for an average of six minutes, a pre-recorded voice congratulated them for their survival skills and then presented them with the target task: *Shoot the front tree*, using the game console. The experimenter noted which tree had been shot. At the end of the experiment, they received a short debriefing.

Hypotheses

The two hypotheses in this experiment reflect how participants respond to the target question and are based on the premise of the Schema Mapping hypothesis that the two distinct schemas of motion—Ego-Moving and Object-Moving—are psychologically valid.

Language-as-an influence (Hypothesis LI)

Proponents of this hypothesis argue that linguistic representation can influence conceptual representation of motion in the target task. Thus, participants who receive the linguistic S/EM prime (condition one) should represent motion accordingly and overcome the S/OM perspective of the game when answering the target task. The term *front* in the target task will be disambiguated to refer to tree B (in Figure 4.10), as this tree is furthest from the individual. Participants in condition two who receive a non-spatial question will not linguistically represent a particular schema of motion,

and will be influenced by the Object-Moving perspective in the virtual environment instead. They should assign *front* to tree A, as this is closest to them.

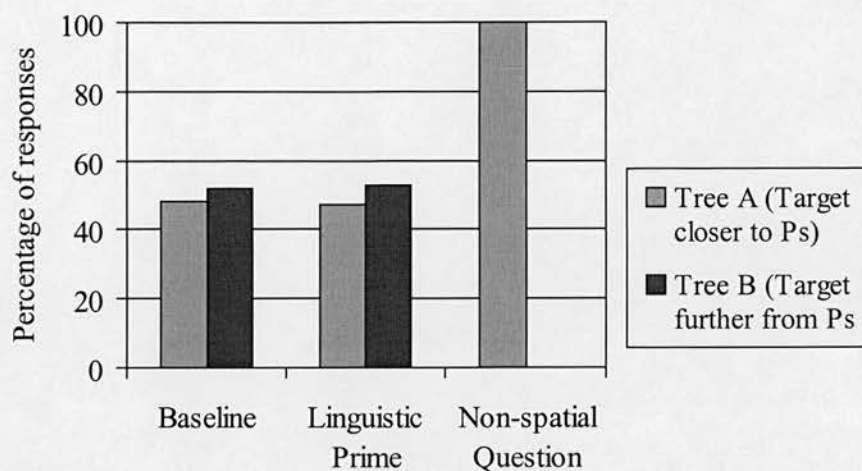
Language-as-a-reflection (Hypothesis LR)

As conceptual representations are something people have in common despite linguistic differences, the perceptual experience in a S/OM environment should influence how participants disambiguate *front* in the target question. Regardless of whether they receive a linguistic prime or non-spatial question, participants should be persuaded by the S/OM perspective and consider tree A as the *front* object.

Results

In condition two, 100% of the 13 participants in the second condition shot tree A, interpreting the term *front* consistently with a S/OM perspective. In the linguistic prime condition, 47% volunteers interpreted *front* as tree A, and the rest shot tree B (see figure 4.11 for responses).

The Kruskal-Wallis analysis revealed a significant difference between target responses across the three conditions, $\chi^2(2) = 40.06, p < .001$. Three separate chi-square analyses were conducted. There was not a significant difference between the baseline and linguistic prime conditions, $\chi^2(1) = 0.01, p = .94$; however, the responses in the baseline and non-spatial question conditions were significantly different, $\chi^2(1) = 8.1, p < .005$. Finally, an analysis of both the experimental conditions—linguistic prime and non-spatial question—indicate a significant difference in the target of choice, $\chi^2(1) = 7.3, p = .007$ (all chi-square analyses were conducted with a Yates' corrected chi-square because of low cell counts in condition two).



4.11. Responses to ambiguous spatial questions in the baseline and experimental conditions

Discussion

The results from the experimental condition confirm that there is a significant difference in how participants assigned *front* in the target task. When simply interacting with the S/OM virtual environment, participants unanimously chose tree A as the *front* tree. However, participants in condition 1, who received a linguistic prime overcame the Object-Moving environment and mapped *front* consistently with the Ego-Moving prime. As in Experiment 2, although responses to the ambiguous spatial task did not differ significantly in the baseline condition and the linguistic prime condition, the S/EM motion system represented in the prime appeared to counteract the S/OM effects of the virtual environment.

These findings support the premise that language is able to influence spatial representations of motion (Hypothesis LI). A significant number of participants switched from the S/OM nature of the game to represent *front* in the target task

consistently with the S/EM linguistic prime. Participants who received a non-spatial question mapped *front* consistently from the S/OM virtual environment to the target task. However, contrary to the predications of Hypothesis LR, the embodied experience of the virtual reality was not sufficient to influence participants who received a linguistic prime in a conflicting motion schema.

4.6.4 Experiment 4

This experiment immersed participants in a S/OM environment, as in Experiment 3. Instead of a spatial target question, participants received the same temporal target used in Experiment 2 to investigate the role of language when mapping spatial representations on to temporal concepts.

Participants

Twenty-two students from the University of Edinburgh students volunteered for this experiment (mean age = 21, S.D. = 4.2). They had not taken part in previous experiments and were not aware of the nature of this study. There was a 10% error rate in the experimental condition, and these data were not used in the following analyses. The demographic information from the questionnaires revealed that out of the 6 males and 16 females in the experimental condition, all of them used a computer regularly, at least on a daily basis. This allowed them to engage in the virtual environment without technical concerns (such as how to use the arrow keys). Further, only 3% of participants had played virtual reality games before, maximising the embodied influence of a virtual environment.

Materials

The virtual environment in this experiment was the same as the one used in Experiment 3. Instead of a spatial target question, the ambiguous target was the same

temporal question used in Experiment 2—*Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?*

Procedure

All testing sessions were conducted on a Wednesday. Participants filled in a questionnaire requesting demographic information and previous experience in playing virtual reality games. They then received the same instructions given to participants in Experiment 3, and were taken to the testing room. Before they began playing the virtual reality game, they were told that if they were successful in the task, they would be asked to return the following Wednesday. This information functioned as a connection between the virtual game and the target temporal question presented at the end of the game.

As in the previous experiment, there were two counterbalanced experimental conditions. Participants heard one of two questions approximately four minutes into playing the virtual game. In the first condition, participants received the following linguistic prime: *During the game, the winged creature is in front of the other creatures—true or false.* Participants in condition two answered the following non-spatial question: *During this game, there are a lot of creatures to shoot—true or false.*

After playing the virtual game for an average of six minutes, and succeeding in surviving the monsters' attacks, they were congratulated. They were then informed that "*Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?*" The experimenter recorded their response and debriefed them.

Hypotheses

Both hypotheses in this experiment are based on the premise that spatial representation can influence temporal understanding, as established by Gentner and Imai's research (1992) on the SMH.

Language-as-an influence (Hypothesis LI)

Based on the findings in Experiment 2, we suggest that language is able to influence temporal representations of motion. In particular, participants who receive the linguistic prime will be more influenced by the Ego-Moving nature of the question and respond to the target meeting as Friday, despite interacting with a S/OM environment. However, participants who answer the non-spatial question will not be influenced by an alternative system of motion. Thus, they will be more sensitive to the Object-Moving environment of the game and will consider the new meeting day to be Monday, consistent with this motion schema.

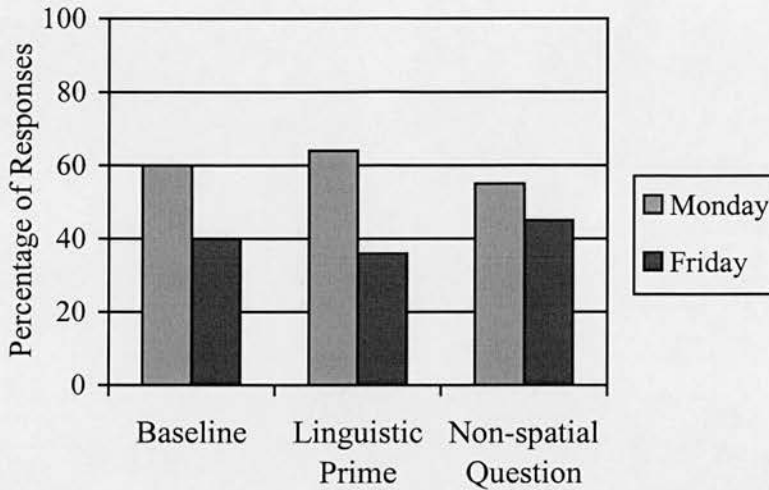
Language-as-a-reflection (Hypothesis LR)

This hypothesis operates on the premise that the representations that people form are universal and language serves as an index of, rather than an influence on, knowledge. Consequently, participants in both conditions should be influenced by the spatial environment of the virtual game and transfer this information to how they think about motion in time. Thus, participants should anticipate the new meeting on Monday, rather than Friday, consistent with the S/OM schema of motion.

Results

When comparing the two experimental conditions, there does not appear to be a large difference in how participants answered the temporal question (see figure 4.12 responses). Only 36% of participants who received the S/EM linguistic prime

disambiguated *forward* consistently as Friday, and 45% of volunteers who received the non-spatial question responded that the meeting would be held on Friday.



4.12. Responses to ambiguous temporal question in the baseline and experimental conditions

The Kruskal-Wallis test on all three conditions indicates that there is a difference in target responses between the three conditions—baseline, linguistic prime and non-spatial question, $\chi^2(2) = 16, p < .001$. Further chi-square analyses were conducted—first on the baseline (from Experiment 2) and linguistic prime condition, $\chi^2(1) = 0.03, p = .80$. Next, the baseline and the non-spatial condition, $\chi^2(1) = 0.12, p = .70$. In the final analysis between experimental conditions, there is no difference between the two groups— $\chi^2(1) = 0.2, p = .70$.

Discussion

Although the overall analysis indicated a difference in target responses across conditions, individual analyses suggest that there is no difference between the linguistic prime condition and non-spatial question condition. It appears that neither condition significantly influenced participants' responses to the target. Further, the percentages of responses from participants in the linguistic prime condition indicate trends in the wrong direction, as participants in this condition should have responded *Friday* to the target question. This finding was unexpected as previous experiments confirmed that information is mapped from a spatial domain to a temporal domain (experiment 2 and Boroditsky, 2000); and that language plays a role in representations of motion (experiments 1 to 3). An immediate explanation for this finding could be the small sample size, which was due to time constraints. The previous three experiments had a minimum sample group of 28 (in experiment 3, with 36 and 39 in experiment 1 and 2 respectively), but there were only 22 volunteers in this experiment. Increasing the numbers of volunteers could yield numerical trends in the right direction.

4.7 Summary and General Discussion

People use similar labels to describe motion in space and time, such as *front/back* or *ahead/behind*. Deictic terms such as these are often understood in the context of two schemas of motion that are evident in both spatial and temporal domains—Ego-Moving and Object/Time-Moving. Research by Gentner and Imai (1992) and McGlone and Harding (1998) confirmed the Schema Mapping hypothesis that these two separate motion systems are psychologically real and distinct.

Based on the reality of the Ego-Moving and Object/Time-Moving motion systems, we asked two questions. First, are representations of motion in space and time borrowed or separate? And secondly, because motion terms can be ambiguous, what directs spatio-temporal concepts—language or experience?

In answer to the first question, Lakoff and Johnson (1999) argued that an abstract understanding of time is borrowed from concrete experiences of space. Murphy (1996) however, claimed that representations of space and time are separate, but they share some structural similarities. Boroditsky's study (2000) addressed this debate. The results indicated that representation of motion in space influences temporal understanding. However, temporal concepts do not affect spatial representation, resulting in an asymmetrical, not shared relationship.

The second question is based on the premise that spatial concepts influence temporal concepts: Do experiences or labels of motion in space influence temporal understanding? There are three theories that account for the role of language in a spatio-temporal context. First, some researchers (e.g., Murphy, 1996) argue that the sharing of similar expressions for motion in space and time are evidence for local polysemies. However, as Boroditsky (2000) refuted this premise, this position was not considered. An alternative suggestion by Lakoff and Johnson (1999) is that language reflects the influence of experience of spatial motion on the understanding of time. For example, motion terms, such as *front*, *ahead*, *behind*, which are all contingent on sensory experiences in space are cross-mapped on to a discussion of time when similar expressions, such as *forward*, *ahead*, *past* are used. A final suggestion, which draws some support from the Structure-mapping theory (Gentner, 1983; 1989), is that the language used to express motion in space can influence

temporal concepts. A study by Alloway et al. (1999) provided some support for this position. The experiments presented in the chapter distinguish in further detail the role of language as a reflection or an influence in spatio-temporal concepts.

Table 4.2

Overview of results in Experiments 1 to 4

Exp	VR Environment	Condition	Ambiguous Target	Assignment of <i>front</i> in target
1	Ego-Moving	OM Linguistic prime	Spatial target	OM consistent
		Non-spatial question		EM consistent
2	Ego-Moving	OM Linguistic prime	Temporal target	OM consistent
		Non-spatial question		EM consistent
3	Object-Moving	EM Linguistic prime	Spatial target	EM consistent
		Non-spatial question		OM consistent
4	Object-Moving	EM Linguistic prime	Temporal target	Mixed responses
		Non-spatial question		Mixed responses

All four experiments are based on the premise of the Schema Mapping hypothesis that the two schemas of motion—Ego-Moving and Object (Time)-Moving—are psychologically real. The findings from the study indicate that the representation of these systems of motion plays a significant role in the disambiguation of target tasks (see Table 4.2). Both Experiments 1 and 2 immersed volunteers in a S/EM environment, whereas in Experiments 3 and 4 participants interacted with a S/OM virtual reality. Experiments 1 and 3 illustrate the relationship between these two systems of motion—Object-Moving and Ego-Moving—in a space-to-space mapping (i.e., spatial environment to a spatial target). Experiment 2

and 4 extend the findings to substantiate the influence of different spatial schemas of motion on the conceptualisation of temporal motion.

The findings from the first three experiments reveal that specifically representing a particular schema of motion influences how a target task is disambiguated.¹⁷ For participants who received the non-linguistic prime (condition 2 in all four experiments), interacting with the virtual environment was powerful enough to significantly influence participants to adopt the same perspective when executing the ambiguous target task. Participants in the linguistic prime condition (condition 1 in all four experiments) had a more challenging time in performing the target task because they had to overcome the dominant system of motion they were immersed in. These experiments confirm that participants' linguistic representations influenced their disambiguation of the target task in a manner contrary to the virtual environment. Although the percentage of participants who disambiguated the target compatibly with the linguistic prime was not always high (and sometimes not significantly different from the baseline condition), it is important to note that participants were not performing the target task in isolation, as in the baseline condition. Instead, they were interacting with a virtual environment that represented a perspective of motion opposite from the prime. In order for the linguistic prime to be effective, they had to overcome the spatial influence of the environment. The results verify that the spatial influence of the virtual environment was reduced

¹⁷ An alternative interpretation of the results in experiments one to three, is that the presence of a different spatial reference frame in the form of the spatial prime, inhibited the participants' selection of the spatial perspective of the virtual environment (see Carlson- Radvansky & Logan, 1997). It is possible that the possible that the spatial primes did not cause the participants to 'switch' motion perspectives when responding to the ambiguous target, but rather inhibited the response aligned with the virtual environment. This may account for the nonsignificant differences between target responses in the baseline condition and the spatial prime condition in experiments two and three.

sufficiently, as perspective of motion in the linguistic prime was cross-mapped on to the target task.

Related field studies conducted by Boroditsky and Ramscar (2002) concur with these findings, as they found that when people specifically represent an experience, this goes some way in influencing spatio-temporal concepts. They asked people at the airport, train stations, and a racetrack an ambiguous temporal question: *Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?* Individuals who were representing motion in some form—for example, just landing at a destination, anticipating a train journey, or betting on more races—were more inclined to answer *Friday*, consistent with an Ego-Moving schema. They compared these findings to a situation where individuals were asked to manoeuvre along a track. Interestingly, volunteers in this scenario did not show a preference for a particular schema of motion when answering the target question, despite the fact that they were moving through space. Boroditsky et al. suggested that representations of spatial experiences are distinguishable from common sensorimotor experiences. People need to represent spatial experiences in some way in order to maximise their influence on temporal concepts. These findings are in-line with the results presented in the series of experiments here, as participants' representations of a particular schema of motion (linguistic or experiential) influenced their responses to the ambiguous target task.

Further research by Boroditsky (2001) indicated that if motion labels are changed, temporal concepts are altered. English speakers talk about time horizontally, but Chinese speakers use additional vertical terms (*shàng* and *xià*) to

discuss time.¹⁸ Boroditsky proposed that because English speakers frequently talk about time in horizontal terms, whereas Mandarin speakers use vertical terms, researchers can investigate whether talking about time influences how people think about time. The first experiment compared response times of English and Mandarin speakers to one of two target temporal sentences—relative sentences using *before/after* terms and absolute sentences with terms like *earlier/later*. There were two pictorial prime types: horizontal spatial relations, such as *The white worm is behind the black worm* and vertical spatial relations like *The black ball is above the white ball* (Boroditsky's examples). The results revealed a significant main effect for prime type for English speakers but no interaction between prime type and target type. However, for the Mandarin volunteers, there was no main effect for prime type, but an interaction between prime and target sentences. Boroditsky claimed that these findings confirmed that English speakers rely on horizontal terms to express time, and consequently were faster in responding to sentences with relative motion terms. Because the Mandarin speakers performed the task in English, they were receptive to both relative and absolute temporal systems.

In the second experiment, Boroditsky taught native English speakers the Chinese vertical representation of time using statements such as *Monday is above Tuesday* and *Nixon was president above Clinton*. The experimental design was the same as in Experiment 1. The trained native English speakers' responses were similar to the Mandarin volunteers in the first experiment—there was no main effect for prime (horizontal vs. vertical), but there was an interaction between prime type and target type. This finding suggests that having learnt the Chinese way of talking

¹⁸ This is conceptually similar to the use of absolute terms—*earlier* and *later*—in English.

about time, English speakers were more likely to think about time in an absolute reference (*earlier/later* targets) when prefaced with vertical linguistic primes, in addition to responding faster to relative references (*before/after* target sentences) after horizontal linguistic primes. It appears that changing the motion labels commonly used can affect how people think about time.

Taken together, the findings from this study and related research (e.g., Boroditsky & Ramscar, 2002, and Boroditsky, 2001) contradict the premise of the universalist position that language is a reflection of the relationship between experiences and concepts. It is evident from experiments 1 to 4 that language is able to influence conceptual representation of space and time. This view is in-line with Slobin's premise of 'thinking for speaking' (see section 2.3.3) as verbalising a particular motion schema influenced participants' concept of motion. It is possible that spatio-temporal concepts have relatively little modularity and are sensitive to immediate changes in visual and linguistic environments. As these experiments only explored the immediate effect of language on thought, further investigation is needed to identify whether language plays a more dominant role in conceptual representations.

The research in this chapter explored whether spatio-temporal concepts are affected by the linguistic or embodied context they are used in. In order to investigate this issue, this study focused on one area of language: the labels used to describe motion and provides evidence that language plays a role in conceptual representations, albeit when speaking. The study in the following chapter explores whether language plays a more dominant role in conceptual representations by investigating the influence of different grammatical patterns on cognition. Because

people are confined to the grammar parameters of their language when talking, we can investigate whether habitually speaking about something affects how people think about it. The study in chapter five compares how Chinese and Tamil speakers represent verb concepts. Although the Chinese grammar does not require speakers to express tense changes, Tamil, a language whose verb structure is similar to English, does. This difference in grammatical patterns allows us to investigate whether habitually speaking about actions influences how people think about them.

CHAPTER FIVE

SPEAK BEFORE YOU THINK:

THE ROLE OF LANGUAGE IN VERB CONCEPTS

5.1 Introduction

The research in the previous chapter went some way in establishing the respective influences of sensory experience and language on spatio-temporal concepts. As the findings support the premise that immediate representations of experiences—sensory and linguistic—have an influential role on conceptual understanding, in this chapter we explore whether habitually speaking within specific grammatical constraints influences cognitive representations. In particular, we investigate the relationship between verb morphology and events concepts in speakers of Tamil and Mandarin.

Verbs represent an important relationship between language and knowledge of the world, and play an important role in both developmental and cross-linguistic research (see Berman & Slobin, 1994, for a brief review; and Antinucci & Miller, 1976, for early work in morphology and event construction). Additionally, the fact that some languages have explicit tense markers and others don't offers the opportunity to compare event representations across languages. Such comparative studies would

contribute to the debate on universal versus language-specific conceptual representations.

This chapter is organised as follows. As the study is cross-linguistic, the following section highlights some methodological concerns that accompany cross-linguistic research. Next, there is a short review of cross-linguistic work on verbal morphology. Immediately following is a brief discussion of general characteristics of verb forms, and an outline of Tamil and Mandarin verbal morphology. In particular, we review tense and aspect markers in these languages. Finally, we present three cross-linguistic experiments on the potential influence of verbal morphology on event concepts in Tamil and Mandarin speakers.

5.2 Methodological Concerns

Although cross-linguistic research is a rich source of information in the language-thought debate, it is not without complications. However, rather than abandoning cross-linguistic research, researchers should be aware of important methodological concerns that arise when working with different language groups. The following methodological issues are discussed: the roles of culture and of education, the linguistic differences under investigation, and the instructions and stimuli presented to participants.

The role of culture

It is hard to define exactly what constitutes one's 'culture', but it is easier to recognise that there are certain factors unique to a country, and even an area, county or state, that influence its inhabitants. Any cross-cultural study unavoidably faces the dilemma of cultural influence on research findings. For example, the study by Malt et al. (1999; see section 2.4.2) incorporated speakers from three different countries—Argentina, China,

and the USA. Although the findings indicated that in a naming task, all three language groups produced different labeling patterns, the skeptic could argue that any observable differences were due to cultural rather than linguistic differences. One approach to minimising cultural confounds is to test two different language groups that reside in a similar cultural environment. For example, the USA plays host to several linguistic populations that are not indigenous and maintain their native language, such as Mandarin or Spanish, as their primary form of communication. Although similar geographical location of language groups does not imply similar cultural backgrounds, it does suggest that cultural experiences are at least more homogenous than if the language groups in question reside in different countries.

A related concern when investigating how linguistic differences affect thought is whether speakers should perform the experiment in their native language. In Carroll and Casagrande's study (1958), the Hopi speakers were bilingual and performed the experiment in English, rather than in Hopi. However, if there is any validity in Slobin's premise of thinking for speaking (see section 2.3.3), then surely speaking in English rather than Hopi would influence them to adopt a different speech pattern (and therefore, a different thought pattern), thus, affecting their responses. In order to obtain an accurate measure of the role of language in cognition, participants should perform the task in their native language.

The role of education (literacy)

Another often overlooked confounding factor is education, as schooled and unschooled populations behave very differently (Li & Gleitman, 2002; Lucy, 1992b). In particular, recent research on spatial reasoning (e.g., Lucy, 1992; Pederson, 1995; Pederson,

Danziger, Wilkins, Levinson, Kita & Senft, 1998) has been criticised as biased by differences in education. In a study by Pederson (1995), the more rural Tenejapan Tzeltal participants showed an absolute bias in spatial reasoning, whereas the Japanese and Dutch volunteers displayed a relative bias. Although participants' spatial reasoning corresponded with their linguistic patterns, Li and Gleitman (2002) argued that their reasoning abilities might be a reflection of educational differences instead. When Pederson tested two distinct Tamil communities, their responses paralleled their schooling levels as well (i.e., the less schooled population displayed an absolute bias, whereas the more educated population showed a relative bias). Li and Gleitman (2002) suggested that this similarity intimates the overlooked influence of education on research findings.

In some instances however, education appears to play no role in cognition. In colour-category research (Davidoff et al., 2000), age-matched Berinmo and English speakers performed similarly on a visuo-spatial memory test, indicating that their memory abilities were neither impaired nor enhanced by educational levels.¹ Although education may influence some dependent measures more than others, it is important to consider its effect on any cross-linguistic study and control for it when possible.

Linguistic differences under investigation

In a comparative study, it is important to ensure that the grammatical structures or label differences under investigation represent a pattern of thinking rather than an isolated occurrence. Label differences are more likely to be mistaken for reflections of an

¹ The English volunteers were attending university, whereas the Berinmo speakers did not have higher education.

underlying thought pattern, when in fact, they are merely isolated lexical differences (e.g., Whorf's observations of *empty* fire drums, 1956, see section 2.3.1). Similarly, many early researchers examined variances in linguistic labels, rather than grammatical patterns, in 'exotic' languages. One example is research by Carroll and Casagrande (1958) that investigated the different expressions for pouring liquid. Although their results revealed differences between English and Native American Indian participants, it is hard to draw reliable conclusions about the role of language in cognition from such specific research topics. It is more productive to widen the scope of research to broader and more wide-ranging grammatical topics such as motion events, spatial language and mass/count distinctions, to name a few.

Comprehension of instructions in different languages

Another issue when conducting cross-linguistic research is to ensure that all language groups tested interpret the instructions for the task similarly, especially when the instructions are in different languages. For example, if participants are required to sort *'the same objects into a group'*, is the word *'same'* translated so that it carries a similar meaning for both language groups? It is important that the results in a study stem from linguistic differences rather than a misrepresentation or mistranslation of the instructions. The use of a baseline condition can provide some efficacy in limiting potential translation discrepancies, as it indicates that both groups are interpreting the instructions similarly.

Same stimuli for all participants

A final point is that the same stimuli be used for both language groups. Lucy (1992b) conducted a comparative study examining the grammatical usage of pluralisation in the

Yucatec Mayan language and in American English. His stimuli consisted of line drawings of scenes with animals, artefacts and substances, for a memory and a sorting task. Unfortunately, the stimuli had to be altered during testing because some of the images were unfamiliar to the Yucatec Mayans. Consequently, the Mayan participants responded to different stimuli than their English counterparts. Such inconsistencies in the design have the potential to confound results.

5.3 Previous cross-linguistic research on verbal morphology

A particularly salient characteristic across languages is that some events have a result, or an endpoint, or a goal (a 'telic' event characteristic), which is reliably accompanied by a corresponding linguistic marker, such as inflection (Comrie, 1976). Cross-linguistic research on verbal morphology concurs on two points: verbal forms vary considerably across languages; and they are learnt at an early age. Linguistic differences in what, when, and how verbs are inflected are found when comparing narratives produced by different language groups. For example, there have been several studies investigating cognitive processing of event structures in different languages such as English, Spanish, German and Turkish (Slobin, 1987; 1990). In particular, Slobin investigated the presence of event perspective, degree of agency and loci of control in verbal descriptions of picture sequences. Slobin concluded that the participants' event narratives were clearly guided by salient properties in their respective languages, and "they do not tend to compensate by additional means where the language is relatively under-elaborated, nor simplify where the language is relatively elaborated; and they come to adapt the structure of connected discourse to the strengths and limitations of grammatical means for encoding event characteristics" (Slobin, 1987; p. 443).

Evidence for the second point is substantiated by language acquisition research, which indicates that children understand morphological and lexical verb markers from an early age (Jones, 1991; also Slobin, 1990). For example, research in Russian confirms that from early years, children have an awareness of verb information (Vinnitskaya & Wexler, 2001; also in Hebrew, Ravid & Malenky, 2001). Gathercole, Sebastian and Soto (2000) explored the acquisition of a relatively complex verbal system such as Spanish. In English, Pinker (1999; also Marcus, Pinker, Ullman, Hollander, Rosen, & Xu, 1992) argued for a rule-based model of learning the English past tense (however, see Ramscar, 2002, for an alternate explanation).

A commonality in the research findings discussed in this section is there are variations in verbal morphology across languages, and children are sensitive to these patterns from an early age. The question of interest in the thesis is whether linguistic variations in verb expression influence the way people fundamentally think about events.

5.4 Characteristics of verb forms

Verbs are marked by three main grammatical classes—tense, aspect and modality.

Tense is the grammatical change to a verb form to illustrate the temporal nature of an action or idea. Aspect is the representation of event structures, which can be expressed by verb semantics. Modal verbs, such as *can*, *do*, *may*, *must*, *ought*, *should*, *would*, express distinctions of mood, for example, between possibility and actuality. There are other potential morphological markers on verbs, such as number and subjunctivity, however, tense, aspect and modality are potential morphological markers that are commonly considered together because they carry a semantic payload, which affects the

quality of the event. In English, tense is expressed by morphological changes to verb forms, however in other languages tense and aspect may be reflected by overt morphology instead.

Often times though, tense and aspect are conflated and it is difficult to distinguish between the two. The study in this chapter is primarily concerned with variations in language that arise from whether tense is encoded, and if it is, what types of events are coded more saliently than others. Due to the close relationship between tense and aspect, in this chapter, tense refers to morphological changes made to the verb, whereas aspect refers to lexical changes that do not alter the verb form.

Some researchers (e.g., Bybe, 1985; Shirai, Slobin & Weist, 1998; Smith, 1991) propose that despite linguistic differences, verbs can be classified into two broad categories: perfective (likely to be telic and bounded); and imperfective or progressive (likely to be atelic and nonbounded; e.g., in English, Bloom, Lifter & Hafitz, 1980; in Greek, Stephany, 1981; in Italian, Antinucci & Miller, 1976; in Japanese, Shirai, 1993; in Polish, Weist, Wysocka, Witkowska-Stadnick, Buczowska & Konieczna, 1984; and in Turkish, Aksu-Koc, 1988).

Vendler (1957) proposed four categories of verbs: activities (progressive, no inherent endpoint, e.g., *run, walk, swim*), accomplishments (perfective—successive phases with an inherent endpoint, e.g., *paint a house*), achievements (punctual and instantaneous, e.g., *recognise a friend*) and states (not successive and no inherent endpoint, e.g., *know, love, think*). Both activity and accomplishment verbs have successive phases. There are three semantic features of these categories: punctuality, telicity and dynamicity. Punctuality relates to instantaneous rather than durative events

(e.g., achievements); telic events have an inherent endpoint (e.g., accomplishments and achievements); and dynamic events are activities, accomplishments, and achievements. Vendler's verb categories and corresponding features are useful in understanding event constructions in other languages.

In the following section, there is a brief overview of verb forms—in particular, tense and aspect markers—in Tamil and Mandarin, the target populations in the study that follows. In the study, actions are only depicted in the third person singular, in either the progressive or completive form. However, for completeness, tense inflections for all pronouns and major aspectual markers in Tamil and Mandarin are reviewed in the following sections.

5.4.1 Verbs in Tamil

Based on changes in consonants when tense markers are added to the root, some scholars have classified Tamil verbs into thirteen separate classes; others have proposed just seven classes (e.g., Arden, 1969). Further, Tamil verbs can also be classified as 'strong' or 'weak' verbs, which sometimes correlate with transitivity and intransitivity, respectively. However, this debate is largely pedagogical, and it is appropriate to review Tamil verb forms without participating in this discussion. Basic tense structure (i.e., past, present and future tense) in Tamil is very similar to English (Arden, 1969; Stever, 1987; 1992). In order to mark tense distinctions, suffixes that mark information about the person committing the action are added to the root verb.² Although there are some irregularities in the past tense forms, tense inflection is simple. Following is an example of inflections for the verb *to eat/ saapi-du*.

² As in Spanish, verbs are number marked.

Table 5.1

Present, past and future tense inflections of the verb *to eat* in Tamil

Pronouns	Present — <i>am eating</i>	Past — <i>ate</i>	Future — <i>will eat</i>
English/Tamil			
I— <i>Naan</i>	(Naan) saape-da- <i>reaan</i>	(Naan) saape-te- <i>aan</i>	(Naan) saape-du- <i>vaan</i>
He— <i>Avan</i>	(Avan) saape-da- <i>raan</i>	(Avan) saape-ta- <i>an</i>	(Avan) saape-du- <i>vaan</i>
She— <i>Aval</i>	(Aval) saape-da- <i>raal</i>	(Aval) saape-ta- <i>al</i>	(Aval) saape-du- <i>vaal</i>
It— <i>Athu</i>	(Athu) saape-du- <i>thu</i>	(Athu) saape-tu- <i>chu</i>	(Athu) saape-du- <i>im</i>
We— <i>Naanga</i>	(Naagna) saape-da- <i>room</i>	(Naagna) saape- <i>toom</i>	Na(Naagna) aga saape- du- <i>voom</i>
They— <i>Avanga</i>	(Avanga) saape-du- <i>raanga</i>	(Avanga) saape-ta- <i>anga</i>	(Avanga) saape-du- <i>vaanga</i>

Note. Italicised verb parts indicate tense changes.

Discussing aspect in Tamil is a little more complex. Although Tamil does have auxiliary markers that provide semantic distinctions such as punctuality/durativity, telicity/atelic and dynamicity/stativity as outlined by Vendler, it is optional rather than obligatory to mark aspectual distinctions. Some scholars claim social reasons, such as politeness, shared perceptions, and the nature of truth propositions, for avoiding aspectual markers (e.g., Renganathan, 1996). It is important to note that the lack of an aspectual marker in a sentence indicates that it is unmarked rather than absent. For example, if a sentence is used without its completive marker (*vidu*), this does not imply that the action is incomplete, simply that the aspectual nature of the action is unmarked.

When aspectual markers are used, they highlight the speaker's commentary of an event, occurring most often in positive rather than negative declarative sentences, and both positive and negative imperatives. There are numerous aspectual markers. For example, *vidu* (mentioned in the previous paragraph) marks completion. Another aspectual marker *aahu* is also completive, but indicates an expected result; for example, an object falls to the ground. To mark continuity, *vaa* is used to convey a "series of connected events (or waves of occurrences) rather than as uninterrupted continuity" (Renganathan, 1996; chap. 3). When referring to an undesirable change of state, the aspectual marker *poo* is often coupled with verbs that inherently express a change of state, (Examples 1 to 3, Renganathan, 1996).

Example 1: *kaanju poo*: 'dry up, wither, fade'

Example 2: *kettu poo*: 'get spoiled, rotten'

Example 3: *odenji poo*: 'get broken'

One final example of aspectual markers in Tamil is *koo*, which provides several distinctions to a sentence. It communicates simultaneous action, when the action will be completed, and even if it was volitional or accidental. The availability of aspectual markers in Tamil and their occasional use should prohibit one from assuming that this optional grammatical form implies a deficiency in expressing the corresponding meaning. Rather, Tamil verbs share some similarities with English, for example, marked tense inflections and available aspectual forms.

5.4.2 Verbs in Mandarin

In most Western languages, past tense markers are used for resultative events, however Mandarin does not mark tense inflectionally. Instead, the tense of a Mandarin sentence

can be indicated by a temporal adverb often established in the beginning of a conversation. For example, *Tomorrow/yesterday/today, he learn the piano*. Authors of Mandarin grammar textbooks confirm that Mandarin has a simple verb structure (e.g., Chao, 1968; Newnham, 1971), which according to some linguists gives rise to difficulties when learning a more complex verb system as in English (Waggot, 2000). Often both Mandarin speakers and ESL teachers remark that the hardest part of English grammar for Mandarin speakers to learn is the tense structure.

In Mandarin, when describing the meaning of a verb, it is more common for an adverb to precede a verb than an aspect marker, and some aspect markers are also regarded as a temporal adverb (Li & Thompson, 1981; Yeh, 1992). Common grammatical aspect markers are *zai*, *-zhe*, *-ne*, *guo*, *-le*. The first three are progressive markers (see Li and Bowerman, 1998, for further discussion on these markers). The first marker *zai*, has been described more often as a preposition than an aspect marker. However, some researchers have recognised it as an indicator of an ongoing event or action (see Li, 1997). Although most aspect markers appear after the verbs that they are marking, some aspect markers, such as *zai*, appear in front of the verbs that they mark.³ The marker *zhe* indicates ongoing (i.e., progressive) events and replicates the function of the verb *to be + verb-ing* in English. This aspectual form is most compatible with stative verbs (in contrast with *zai*, which is incompatible with stative verbs). The next marker *ne*, is limited to colloquial use (Liu, 1997), and the marker—*guo*, is used for

³ In fact, some linguists argue whether *zai* really functions as an aspect marker because the prepositional function of *zai* can also appear before the verb.

experiences. The final marker, *-le*, marks perfective aspect and can have two functions:⁴ to indicate the completion of an action if the verb has a clear temporal boundary (e.g., the boy built a sandcastle); and to signal the termination of an event if it is a non-bounded verb (e.g., the man ran). It is important to recognise that *-le* is not equivalent to past tense inflections in English because Mandarin does not have to express tense changes; if they do, it is with temporal and contextual words. Here is an example of the different uses of aspect markers in Mandarin (from Chan, 1997):

Example 1. Akiu xi *-zhe* na jian dayi.

‘Akiu is/was washing that coat.’ (*zhe*—progressive aspect)

Example 2. Akiu xi *-guo* na jian dayi.

‘Akiu (at least once) washed that coat.’ (*guo*—experiential aspect)

Example 3. Akiu xi *-le* na jian dayi.

‘Akiu washed that coat.’ (*-le*—perfective aspect)

Examples 2 and 3 indicate that the action of washing has passed, whereas Example 1 is expressed during washing.

Lexical aspect in Mandarin has received very little attention. The most prominent work is by Tai (1984), who divided Mandarin verbs into the four categories suggested by Vendler. There are some fundamental differences in how Mandarin and English mark these categories. For example, although activity verbs are compatible with the progressive marker *zai* (Example 4), if they end in a result, this combination is not acceptable (Example 5; examples from Li & Bowerman, 1998; p. 315):

⁴ When appearing at the end of the sentence, *-le* is also used as a modal particle to denote a new state. A general rule to distinguish between the aspectual and modal use of the term is to note where it occurs in the sentence, as the aspect particle *-le* is found after the verb.

Example 4. Yuehan *zai* xue Shongwen

John is studying Mandarin (progressive)

Example 5. Yuehan *zai* xue-hui Shongwen

John is learning Mandarin (i.e., study-know, resultative)

The incompatibility of resultative verbs and progressive markers (*zai* and *zhe*) are also reflected in accomplishment and achievement verbs. This contrasts with the English pairing of accomplishment verbs with the progressive marker and emphasises the result rather than the action (Li, 1987).⁵ Instead, Mandarin describes these events with the perfective marker *-le*, and considers both event types as punctual, rather than durative.

Another difference between Mandarin and English is the apparent contradiction of conjoining an accomplishment sentence with the perfective marker *-le* and an assertion that the event is not complete (e.g., I wrote a letter yesterday, but I didn't finish writing it; adapted from Smith 1991, p. 107). However, Soh and Kuo (2001) argued this cross-linguistic difference in how the perfective form interacts with accomplishment situations relates to differences between Mandarin and English nominal systems, not verb differences. They argue that "English head nouns have count/mass and singular/plural distinctions, while Mandarin head nouns are mass" (section 4; see also Cheng & Sybesma, 1998; Chierchia 1998). Their analyses correspond with Smith's proposal that *-le* indicates completion in a telic/bounded event, but termination in an atelic/non-bounded event. However, when narrating past events, it is not necessary to

⁵ As a result, some researchers (e.g., Tai, 1984) have argued that Mandarin lacks accomplishment verbs (however, see Li, 1997, and Yang, 1995, for an alternative view).

use *-le* unless the completion of the action is being stressed and it is not used with verbs describing habitual actions or emotional states.

An expansion of Vendler's aspectual categories includes semelfactive and mixed telic-stative verb categories. The former category was proposed by Smith (1991), and the latter by Li (1990). Semelfactive verbs, such as *cough*, *tap* and *knock*, are similar to achievement verbs in that they are punctual, and are compatible with progressive markers because they represent a repeated event. In Mandarin, they are considered as non-resultative (like activity verbs) and are often paired with progressive markers such as *zai* and *ne* (Li & Bowerman, 1998). The second verb category, mixed telic-stative verbs, indicates "either the process of a telic action or the state resulting from that process, depending on their aspect marker" (Li & Bowerman, 1998, p. 316). The aspectual marker *le* also indicates that a stative verb (*to wear*) is the result of an earlier action (Example 6 from Li & Bowerman, 1998, p. 316):

Example 6. Ta chuan *-le* yi-jian xin yifu.

He is wearing (as a result of having put on) a new garment.

The above sentence contrasts with using the progressive *zhe* to indicate that he *is wearing* a new garment. Mixed telic-stative verbs represent an interaction between grammatical and lexical aspect.

The main difference between Mandarin and Tamil verb forms is Mandarin does not have explicit tense markers in the same way that English and Tamil have. In Tamil, tense changes are marked with suffixes added to the root verb. In Mandarin, tense changes are generally not marked explicitly. Instead, adverbs may be included to situate

the event within temporal parameters. Table 5.2 illustrates how the different language groups express the verb *to eat*.

Table 5.2

Present, past and future tense inflections of the verb *to eat* in English, Tamil and Mandarin

Verb— <i>To eat</i>	Present	Past	Future
English (3 rd person singular)	Eats	Ate	Will eat
Tamil (3 rd person male)	Saapeda rann	Saapeta an	Saapedu vaan
Mandarin	Chi'h	Chi'h	Chi'h

When discussing aspect, there are minor differences in usage between Tamil and Mandarin. In Tamil, although the use of aspect markers is optional, a variety of markers can be used to mark different aspectual notions. In Mandarin, although there is a debate on whether certain adverbs and prepositions are considered as aspect markers due to their positioning within a sentence, Mandarin linguists agree that certain verb changes are marked lexically. In particular, both Tamil and Mandarin include markers for completive (*vidu/aahu* and *-le*, respectively) and progressive forms (*vaa* and *zai*, respectively). To avoid any confusion that may arise from encoding aspectual difference, the actions represented in the study were limited to the above two forms. This also avoided any linguistic complexities that arise when expressing different action types (e.g., semelfactive verbs—*cough*, *knock*—in Mandarin are considered as non-resultative). To highlight further commonalities in verb forms between Tamil and

Mandarin, the actions depicted in the study were dynamic events that included a resultative state rather than stative ones (i.e., *to drop, to push, to hit*, rather than *to know, to think*).

5.5 Present Study

As research on verbs has confirmed a relationship between verb forms and a semantic understanding of action categories (e.g., Huttenlocher, Smiley & Charney, 1983), in this study we investigate whether grammatical differences in verbs between Tamil and Mandarin will affect speakers' conceptual representations of action categories. Tamil speakers are the control group because their tense inflections are similar to English. However, in Mandarin, verbs are seldom inflected, and speakers rely instead on previously established context or temporal parameters to situate a conversation.

There are two main reasons for the study. The first is to move beyond early research on isolated label differences and focus on a broader area such as the differences between grammatical patterns. Verb concepts provide a suitable testing ground for this, as there is evidence for the correlation between verbal morphology and event representation. The difference in verb expression in Tamil and Mandarin allows us to investigate whether grammatical differences correspond with cognitive structures. This more comprehensive outlook will allow more reliable conclusions to be drawn regarding the role of language in thinking.

The second motivation for the study is to minimise the interference of cultural and educational factors in cross-linguistic research on the role of language in cognition. In order to do so, both Tamil and Mandarin speakers were recruited from Malaysia, a

multi-cultural country where three dominant cultural groups reside amicably.⁶ A benefit of conducting testing in Malaysia is that although it is home to different language groups, the relatively small geographical area encourages a similar cultural environment. The Tamil and Mandarin volunteers reside in neighbouring villages, within a 10 to 15 mile radius of each other. Further, both groups also share a similar socio-economic status, and thus, the disparity in educational levels is minimised. This geographical proximity and cultural similarity reduces any culture-specific anomalies that may occur in cross-linguistic studies conducted in several countries. In the study, not only were participants recruited from the same country but from the same area as well.

The study consists of three experiments, exploring the effects of language on perceptual and conceptual processes by assessing similarity judgments and response latencies to picture pairs. The first experiment was a pilot study designed to confirm that different verb forms in the target populations induced differences in perceived similarity of picture pairs. Participants were instructed to access their language when performing the task in order to observe the direct influence of language on their verb concepts. Experiment 2 replicated this experiment, with a modified design. The instructions were implicit, and did not obligate the participants to access language when performing the task. A baseline condition was introduced and photographs replaced the line drawings stimuli. The first two experiments employed a similarity judgment task, and Experiment 3 extended these findings to assess forced-choice responses (a *same/different* decision task) and response latencies when presented with pairs of actions. This task contrasted

⁶ Malays are the third dominant cultural group.

off-line measures with on-line methods. Response latencies in Experiment 3 indicated how long participants spent deliberating over the picture pairs, possibly as a result of accessing corresponding verb patterns. Instead of relying on narratives and question-and-answer sessions that capture the explicit influence of language, the study compared Tamil and Mandarin speakers' similarity judgments of pictorial stimuli in order to observe the implicit influence of language.

5.5.1 Experiment 1(Pilot Study)⁷

This experiment verified the influence of the different verb structures on conceptual thinking in Tamil and Mandarin speakers.

Participants

The sample consisted of 98 monolingual Tamil and Mandarin speakers from Malaysia. Out of these, 55 were Mandarin speakers, comprising 37 11-12 year olds from the San Yuk Mandarin School in Malaysia, and 18 Mandarin speaking adults who were originally from China but were studying at a local college in Malaysia. Of the 43 monolingual Tamil speakers, 25 were 11-12 year old children from a local Tamil school in Malaysia, and 18 were Tamil-speaking adults from a small village in Malaysia. In addition to the volunteers, there were also four translators who assisted in giving the instructions in either Mandarin or Tamil to the different groups.

Materials

There were 22 sets of three drawings in this study; each triplet depicted the same animate agent in all three variants—Base, Action Change, and Theme Change (B, AC,

⁷ The pilot study was funded by a Small Projects Grant (2000), awarded by the University of Edinburgh Development Trust.

TC). The Base form (pic B) showed the agent in the process of committing an action, for example a pirate dropping a jug, or a nun pushing a ballerina. The Action Change form (pic AC) depicted the same action at the point of completion, for example, the pirate dropped the jug (i.e., the jug is on the ground); or the nun pushed the ballerina. The Theme Change form (pic TC) showed the same action as the base form, but the theme was changed, for example, the pirate drops a gun, rather than a jug; or the nun pushes a burglar instead of a ballerina. Of the 22 sets of pictures, 11 showed inanimate themes (e.g., book/jug) and 11 showed animate themes (e.g., ballerina/clown). All pictures were an artist's line drawings presented on a 7.5 cm x 10 cm (3" x 4") card with a white background (see Figure 5.1 and 5.2 for an illustration of the picture sets).

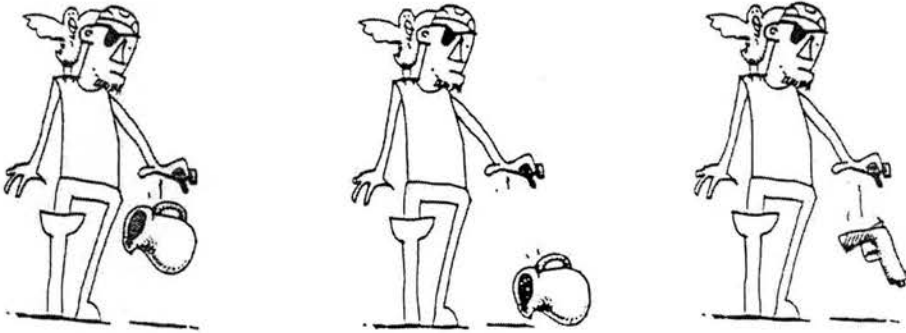
The picture stimuli were paired in the following combinations: 22 B-AC combinations; 22 B-TC combinations; and 11 filler combinations. The B-AC combination represented the same agent, performing the same action on an inanimate object, but at a different stage, for example, a pirate drops/dropped a jug. In the B-TC combination, the same agent, executed the same action, at the same point in time, on a different object/person, for example, a pirate drops a jug/gun. The final combination was a filler pair, which depicted different people, doing different actions, at the same point in time, for example, a picture of a painter selling a cup to a clown was paired with a picture of a cowboy punching a boxer (see Figure 5.3 for the different picture combinations).

In Mandarin, context elaborates a scenario in place of absent tense inflection. In the study, no context—verbal or pictorial—was provided and participants were forced to encode the events in the picture pairs in relation to each other, rather than a larger event

framework. The base picture served as a reference for the subsequent picture (either Action Change or Theme Change). The B-AC picture pairs reflected tense differences as the AC picture depicted the completion of the action in the Base picture. Tamil speakers, like English speakers, use past tense markers to express this difference, for example, the man *drops* the jug; the man *dropped* the jug. The Mandarin speakers however, are not obligated to express this difference grammatically. The B-TC picture pairs did not invoke any tense-aspectual forms because the TC picture showed the same action (at the same stage) and the same agent as the Base picture. The only difference was the theme—inanimate/animate—in the picture. The B-TC combination was a control to ensure that participants were focusing on the action, rather than the person performing the action. Thus, regardless of grammatical structure, participants should rate the actions in the B-TC pair as more similar than the B-AC pairs.

All pictures in the study depicted dynamic events that included a resultative state rather than stative ones (i.e., *to drop*, *to push*, *to hit*, rather than *to know*, *to think*), and the B-AC pictures represented punctual events. To accommodate the completive and progressive markers available in both Mandarin and Tamil, the action in the picture pairs was limited to these two forms—completed (B-AC) and progressive (B-TC).

In addition to the picture sets, each participant received a response sheet with a scale from 1 to 7, for 55 questions.

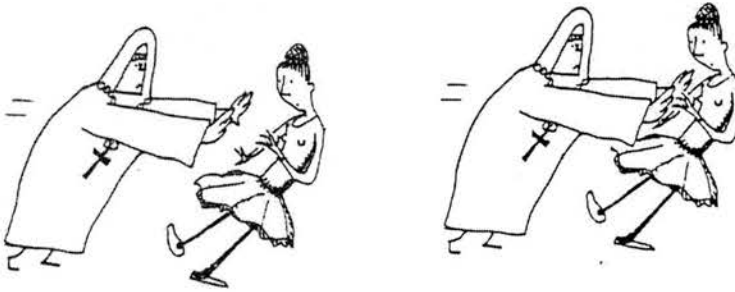


Base (B)

Action Change (AC)

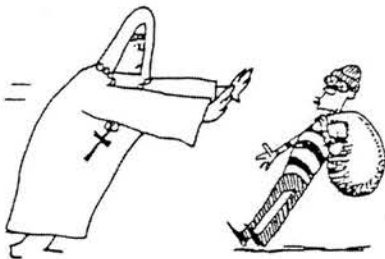
Theme Change (TC)

Figure 5.1. Picture sets of an agent with inanimate themes in three variants



Base (B)

Action Change (AC)

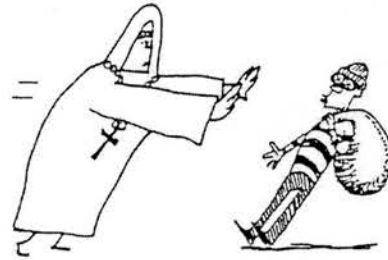


Theme Change (TC)

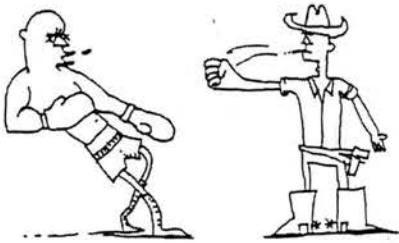
Figure 5.2. Picture sets of an agent with animate themes in three variants



B-AC combination: same agent, different tense, same theme



B-TC combination: same agent, same tense, different theme



Filler combination: different agent, same tense, different theme

Figure 5.3. Three different picture combination pairs

Procedure

Participants received 55 pairs of pictures in a randomised order and were instructed to judge whether the actions in the base and pair (AC or TC) were similar. A translator gave the following instructions to the participants: *Rate how similar you think these actions are, in your own language.* Participants used a scale of 1 (*not similar*) to 7 (*very similar*) to make their judgments, and were asked to circle the number on the response sheet that described the similarity of the pictures. A test stimulus was shown and participants were asked if they had any questions. The experiment was conducted in silence with no further instructions given to the participant.

Hypotheses

In order to assess whether linguistic structure plays a significant role in influencing our concepts, participants were asked to explicitly access their language when viewing the pictures. Because supporters of the linguistic relativity and the universalist hypotheses (and the variant positions in-between) readily agree that linguistic differences do exist, the debate centres over what drives these differences. Two possible predictions regarding the role of language in event concepts are outlined below.

Language-as-an-influence hypothesis (Hypothesis LI)

Supporters of this position suggest that the verb structure will influence participants' perception of different actions. Consequently, there will be a difference in how the Tamil and Mandarin speakers rate the picture pairs. The Tamil speakers, who have a similar verb structure to English speakers, will be sensitive to tense differences in the picture combinations, and will rate the actions in the B-TC picture combinations as

more similar than the B-AC combinations. However, for the Mandarin speakers, the lack of marked tense structure in Mandarin will influence them to perceive the actions pairs in both the B-AC and B-TC picture combinations as similar.

Language-as-a-reflection hypothesis (Hypothesis LR)

Advocates of this position argue that although both language groups express events differently, they share a common representation of them. Consequently, both Tamil and Mandarin speakers will exhibit similar response patterns to the B-AC and B-TC picture pairs. Although both language groups will rate the B-TC picture pairs as similar, the direction of similarity judgments of the B-AC picture pairs is unclear, for example, will B-AC pictures be considered as different, in line with English; or will they be judged as similar, corresponding to Mandarin? At present, the prediction is that similarity judgments for both groups will be in the same direction.

*Results*⁸

Analyses on the similarity ratings were conducted with participants (F_1 ; Language= between, Picture= within) and items (F_2 ; Language=within, as both language groups were shown all pictures; Picture=between, as the B-AC and B-TC pairs differed from each other) as random factors.

Eight participants failed to complete the questionnaire, 6 Mandarin children, and 2 Tamil adults, and their data were excluded from the following analyses. For the remaining 90 participants, the mean similarity ratings for both B-AC and B-TC picture combinations are presented in Figure 5.4. The Mandarin volunteers rated the B-AC and

⁸ Results from Experiment 1 were presented at the 27th International Congress of Psychology, 2000, and an Interdisciplinary Seminar, November 2000, Division of Informatics, University of Edinburgh.

B-TC picture pairs similarly. The mean similarity rating on a scale of 1 to 7 (with standard deviations in parentheses) was 5.6 (.8) for the B-AC pairs, and 5.5 (.8) for the B-TC pictures. The Tamil speakers however, rated the combinations differently; the mean rating for the B-AC pairs was 4.7 (1.3), and for the B-TC pairs, it was 3.7 (1.1).

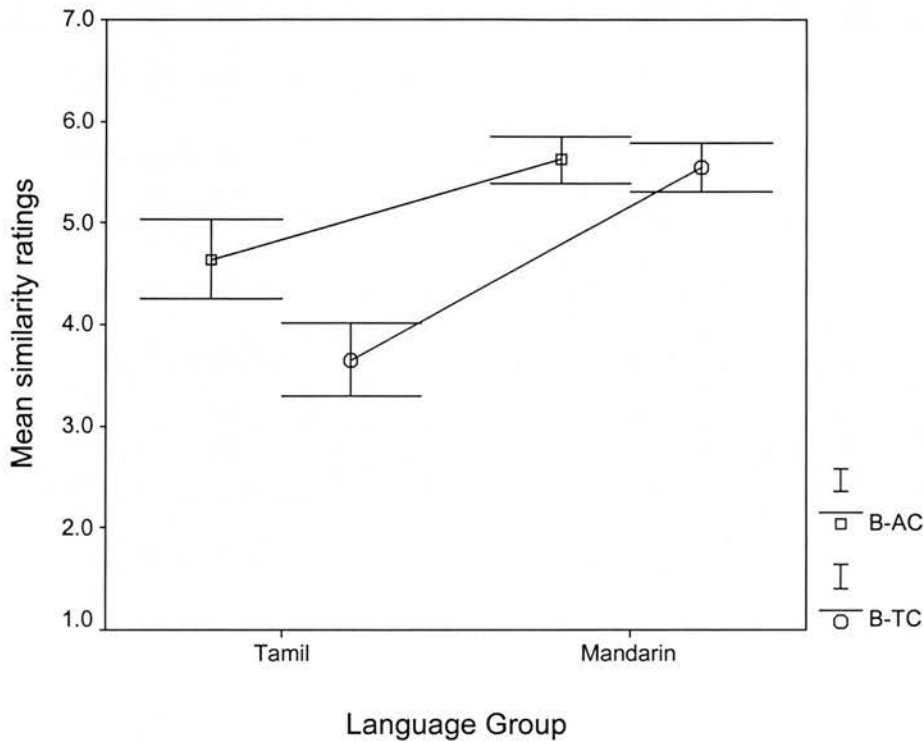


Figure 5.4. Mean ratings (1 = not similar; 7 = similar) for picture similarity for Action Change (B-AC) and Theme Change (B-TC) pairs, by linguistic group of participants

In a mixed two-way ANOVA, there was a significant difference between responses of the Tamil and Mandarin speakers; $F_1(1, 88) = 53.32, p < .001$; $F_2(1,42) = 241.20, p < .001$. There was also a significant main effect for similarity judgments of pictures pairs; $F_1(1, 88) = 41.35, p < .001$; $F_2(1,42) = 14.44, p < .001$. There was a

significant interaction between language group and picture type; $F_1(1, 88) = 30.87, p < .001$; $F_2(1,42) = 35.48, p < .001$.⁹

Scheffe's post hoc comparisons (at the alpha level of .05) indicated that the Tamil participants' ratings of the B-AC pairs and B-TC pairs were not significantly different; neither were the Mandarin participants' ratings of these two picture combinations. However, some researchers have argued that the Scheffe's test is an unnecessarily conservative analysis (e.g., Klockars & Hancock, 2000). To account for the potential of losing sensitivity of the data, paired sample t-tests with an adjusted alpha level ($p < .025$) were also conducted. The analyses confirmed differences between the Tamil participants' ratings of B-AC and B-TC combinations, but not the Mandarin participants' ratings of these combinations.

Discussion

The results confirm that the Mandarin and Tamil speakers rated the B-AC and B-TC picture pairs differently. In particular, the paired sample t-test indicated that the Tamil participants rated the B-AC pairs differently from the B-TC pairs, possibly the result of explicit tense markers in their language. This finding appears to support Hypothesis LI, that linguistic structure is playing an influential role on participants' conceptualisations of actions. However, this conclusion is a little premature as the Tamil participants' similarity judgments for the B-TC pictures were in the reverse direction of the prediction in Hypothesis LI. The Tamil participants should have rated the B-TC pictures

⁹ A separate ANOVA explored the relationship between Language, group, Picture type and Age group (11-12 year olds vs. adults). However, only the interactions between Language and Picture type ($p < .001$), and Language and Age group ($p = .002$) were significant, indicating that the different age groups used the similarity scales differently.

as more similar than the B-AC picture pairs because of the explicit linguistic distinction in verb forms, instead, they rated the B-TC picture pairs as less similar than the B-AC (compare means 3.75 and 4.77, respectively). Neither hypothesis LI nor LR provides an account for why the Tamil speakers judged the B-TC picture pairs as less similar than the B-AC pairs.

Further, the Tamil participants' ratings of the B-TC pictures were lower than the Mandarin participants' ratings (means of 3.75 versus 5.44, respectively). According to the Hypothesis LI, similarity ratings between the two language groups should only be different for the B-AC picture pairs, not the B-TC pictures. As the B-TC picture pairs were a control in the study, Tamil speakers should have produced comparable ratings for the B-TC pictures as the Mandarin participants did.

Although the Mandarin speakers' ratings for the B-AC and B-TC pairs were not significantly different (means of 5.6 versus 5.5, respectively), a null effect cannot be taken as support for Hypothesis LI. The absence of tense morphology might have influenced their similarity ratings, however, further research is needed before we can confirm that tense differences affect speakers' similarity judgments of the different actions.

In light of these inconclusive results, there are several concerns. As the purpose of this experiment was to establish the influence of different verb structures on conceptual thinking with respect to the target populations, the instructions were explicit, requiring the participants to access language when considering the picture pairs. However, there is no guarantee that participants did not code additional information in the pictures, potentially confounding the results. For example, Tamil speakers may have

focused on the theme that appeared in the picture pairs rather than the action.

Accordingly, they would have rated the B-TC pictures as less similar because of the different themes depicted in the Base and TC picture (e.g., in pic B, the pirate is dropping a book; in pic TC, he drops a jug). Consequently, the participants were not explicitly asked to access their language when performing the task in the following experiments.

Further, it is uncertain whether both language groups interpreted the instructions similarly. The B-TC pictures pairs were a control to ensure that participants understood the instructions, as both Tamil and Mandarin speakers should perceive the actions in the pairs as similar. However, the Tamil speakers' ratings for B-AC and B-TC pictures were in the opposite direction of what was expected. It is possible that in the translation, the Tamil participants might have interpreted the instructions differently to the Mandarin participants. Thus, to ensure that both language groups understood the instructions in the following two experiments, a baseline condition with object stimuli was included. In a review of cross-linguistic developmental research, Gentner and Boroditsky (2001) suggested that objects and actions are processed differently, regardless of linguistic variances. Objects are directly perceivable, whereas actions are relational. Supplying numerous cross-linguistic examples, they argued that "the denotations of concrete nouns tend to follow natural partitions—naturally preindividuated perceptual groupings" (p. 25). Malt et al. (1999), support the idea that objects are not strongly influenced by linguistic variances, as three different language groups—English, Spanish and Mandarin—perceived objects similarly, yet generated different names for the objects (see section 2.3.4 for a discussion of this study).

On the other hand, verbs are learned by “extracting relational elements” (p. 28), and interaction with people determines useful information to encode. Sera, Gathje and Pintado (1999; also Sera, Gathje, & Castillo, 1999) extended this premise and suggested that linguistic biases in English and Spanish speakers were more likely to influence event categories than object categories. Taken together, it appears that even if objects have different labels, they will be represented similarly. Event concepts, however, are more closely linked to interaction with people, and therefore, are more susceptible to linguistic influence. In the following two experiments, different types of cups are used for the baseline condition. Proponents of both the linguistic relativity position and the universalist position agree that such objects pairs should be perceived similarly; for those who argue that language does influence representations, the similar linguistic labels for cups would encourage similar representations; those who contend that people share universal representations would also agree that Tamil and Mandarin speakers’ representations of cups would be similar. Consequently, ‘drinking apparatus’ appears to be a suitable category for the baseline condition in the following experiments.

A final consideration is that the stimuli used in the experiment were simple line drawings and might have biased the results because they did not represent real individuals performing different actions. Although in previous research object recognition of line drawings and colour photographs was comparable (Biederman, 1987; Biederman & Ju, 1988), this finding has been refuted. According to Biederman (1987), objects are constructed from basic components known as ‘geons’, which are analogous to phonemes in the English language, and consist of blocks, cylinders, arcs and so on. For example, a cup is made up of an arc connected to a cylinder. An object is recognised

by its components, for example, a cup is recognised by an arc and a cylinder. This componential view of objects accounts for the similar strategies employed in recognising objects from line drawings and colour photographs. However, this theoretical assumption has not been supported. For example, Kimchi (1992) and Rensinck, O'Regan and Clark (1997) argued that people will more often process an object or a picture of a scene globally, rather than componentially.

A further proposal by Biederman was that in object recognition, edge information (e.g., curved vs. parallel edges) is more informative than surface information (e.g., colour; however see Joseph & Proffitt, 1996, for findings confirming the importance of colour information in object recognition). Although two-dimensional symmetry in the line drawings is meant to represent three-dimensional symmetry, it does not always portray this accurately. In fact, Sanoki, Bowyer, Heath and Sarkar (1998) argued that edge information only contributes to object recognition in line drawings when the object is presented in isolation, rather than in the context of other objects. When participants were presented with either line drawings or colour photographs of objects, recognition of objects in the colour photographs was significantly higher than those in the line drawings.

Although the focus of this study is not object recognition, we can apply Kimchi's, Rensick et al.'s and Sanoki et al.'s findings of perceptual process to the stimuli used in the study—people are more likely to process picture scenes globally and line drawings are a poor representation of real-world images. To promote a closer association between the pictures and participants' experiences of events, the stimuli in

the following experiments were coloured photographs of people performing actions, such as drinking and eating.

5.5.2 Experiment 2¹⁰

Although the findings of the pilot study are mixed, there is some evidence that the Mandarin speakers did not differ in their similarity ratings of the B-AC and B-TC picture pairs, which could be the result of their simple verb structure. In order to explore this possibility further, two follow-up experiments were conducted. There were several important modifications to the design. First, both experiments included an object baseline condition to verify that both language groups interpreted the instructions and respond to object categories similarly. Next, participants were not explicitly asked to access language during the task. In light of different processing strategies of line drawings and photographs discussed above, photographs were used as the stimuli. Experiment two replicated the pilot study with these modifications.

Participants

Participants were 56 Mandarin and Tamil native speakers from Malaysia—20 Tamil speakers were tested in the Sekolah Jenis Kebangsaan Tamil (local Tamil school), and 36 Mandarin speakers in the San Yuk Mandarin School. Participants were 11-12 year olds. For both language groups, their native language was also the dominant language used in their educational environment and home life. Members of neither group spoke English or had participated in the previous experiment.

¹⁰ Experiments 2 and 3 were funded by the Drever Trust Fund, Department of Psychology, University of Edinburgh.

Materials

Two types of stimuli were used in this experiment—object stimuli for a baseline condition and action stimuli for an experimental condition. Both types of stimuli were filmed using a Panasonic EZ1 mini television camera. The images were then fed into a Macintosh computer and recorded using an Apple Video Player to capture them as stills.¹¹ All images were taken in the same room with the same background and lighting conditions. For the baseline condition, objects were filmed on a solid blue background. For the experimental condition, actions were filmed against a brown wall. All images were then saved as ‘bitmap’ conversions, printed, laminated and mounted on 7.5 cm x 10 cm (3” x 4”) cards.

In the baseline condition, photographs of different mugs were the test items, with various other items as fillers. There were 9 pairs of test stimuli consisting of a Base picture and an Object Change picture. The Base form was a photograph of a mug, and the Object Change form depicted an alternation of the same mug, for example, the handle was broken. There were 11 filler stimuli of unrelated items, such as keys, a book, and a hammer. These items were only presented in their original condition. The object stimuli were paired in the following conditions: *same* condition—the Base form of a mug was presented with the corresponding Object Change form; *same type* condition—two different mugs were shown; and *different* condition—unrelated items were paired together, such as a book and a set of keys (see Figure 5.5).

¹¹ The photos were taken using a television camera instead of a digital camera to allow for flexibility in capturing the appropriate action sequences. For consistency, the objects for the baseline condition were also shot with a television camera.

In the experimental condition, there were 20 picture sets represented as triplets of Base, Action Change and Theme Change forms as in the original study.¹² The action stimuli were paired in the same manner as in Experiment 1 and are depicted in Figure 5.6: B-AC pairs (same agent, different tense, same theme), B-TC pairs (same agent, same tense, different theme) and filler pairs (different agent, same tense, different theme). Ten picture sets depicted agents with animate themes, and the other ten sets were illustrated with inanimate themes.

In addition to the picture sets, each participant received two response sheets with scales from 1 to 7. The first sheet had scales for 20 questions for the object stimuli, and the second 55 questions for the action stimuli.

Procedure

There were two conditions: a baseline condition and an experimental condition.

In the baseline condition, participants were shown 20 pairs of object stimuli—3 sample stimuli, 6 *same* pair stimuli, 6 *same type* pair stimuli, and 5 *different* pair stimuli.

Stimuli presentation was counterbalanced to minimise order effects. Participants received the following instructions through a translator: *Rate how similar you think these objects are.* They were instructed to circle a number between 1 (not similar) and 7 (very similar) on the response sheet to represent the similarity of the object pairs.

Participants were given a short break after completing the baseline condition. In the experimental condition, there were 55 pairs of action stimuli—3 sample stimuli, 20 B-AC pairs, 20 B-TC pairs and 12 filler pairs. Stimuli presentation was counterbalanced

¹² Because of the difficulty in photographing some of the actions depicted in the original picture set, for example, a girl falling from a tree, there were two less stimuli in experiments 2 and 3.

to minimise order effects. A translator instructed the participants to: *Rate how similar you think these actions are*. Participants were asked to circle a number between 1 (not similar) and 7 (very similar) on the response sheet to represent the similarity between the actions in the picture pairs.

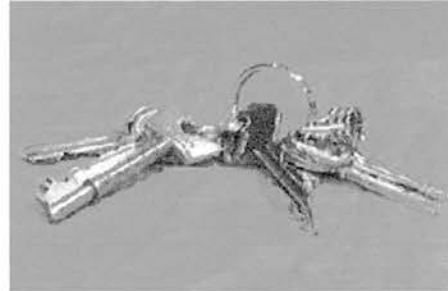
In both the baseline and experimental conditions, the first three were sample stimuli and responses to these are not included in the following analyses. After the sample stimuli were presented to the participants, they were asked if they had any questions. The experiment was conducted in silence, with no further instructions given to the participant.



Same combination: same object, different form



Same type combination: different object, same form



Different combination: different object, different form

Figure 5.5. Different picture combination pairs in the baseline condition



B-AC combination: same agent, different tense, same theme



B-TC combination: same agent, same tense, different theme



Filler combination: different agent, same tense, different theme

Figure 5.6. Different picture combination pairs in the experimental condition

Hypotheses

The design was modified to more accurately evaluate the relationship between different linguistic structures and conceptual patterns. In particular, the baseline condition ensures that both language groups comprehend the instructions, whereas the experimental condition assesses the influence of verb structure on perception of action categories in the target populations.

Baseline Condition

The use of object stimuli in the baseline condition is based on the argument that objects are perceptually grounded and not affected by labelling differences. Consequently, the predictions in hypotheses LI and LR (Language-as-an-influence; and Language-as-a-reflection, respectively) for the baseline condition are similar—both Tamil and Mandarin speakers should perceive and therefore, rate, the object pairs similarly. The objects were paired in such a way that certain pairs were similar (e.g., two mugs in the *same* and *same type* conditions), whereas others were not (e.g., a book and a hammer in the *different* condition). Picture pairs should be rated differently from each other, for example, the *same* pairs should be rated as highly similar (similarity ratings should be closer to 6 or 7), the *same type* pairs should be judged as moderately similar (ratings of 4 to 5), and *different* pairs should be rated as dissimilar (ratings of 1 or 2). However, the Tamil and Mandarin speakers should exhibit similar response patterns because they will encode the object pairs similarly. It is important to note that object labels are similar in the target populations.¹³

¹³ It is beyond the scope of this study to investigate whether perceptual judgements are independent from labelling (see Malt et al., 1999).

Experimental Condition

In the experimental condition, differences in expressing events can be explicated in one of two ways.

Language-as-an-influence hypothesis (Hypothesis LI)

Proponents of this hypothesis consider verbs as relational, rather than inherently perceptual, like object concepts, and as a result, linguistic structure plays a more important role in influencing how people represent actions. Tamil speakers' similarity judgments will reflect the marked tense structure, and the actions in the B-AC pictures will be rated as different, but the actions in the B-TC pictures as similar. The Mandarin speakers, who do not have a marked tense structure, will be influenced accordingly, and rate the actions in both the B-AC and B-TC picture pairs as similar.

Language-as-a-reflection hypothesis (Hypothesis LR)

While linguistic differences in verb expression are acknowledged, the premise of this hypothesis is that language does not influence cognitive structures. Despite verb differences, Tamil and Mandarin speakers share a similar representation of events and will exhibit a similar pattern of ratings for the B-AC and B-TC picture pairs.

Results

Similarity ratings of both the baseline and experimental conditions were analysed together, and the results are recorded in Appendix A. The following analyses were conducted with participants (F_1 , Language= between, Picture= within) and items (F_2 , Language=within, Picture=between) as random factors. Similarity judgments were the dependent measure.

Baseline Condition

Similarity scores for the three conditions for Picture type—*same, same type* and *different*—were averaged (with standard deviations in parentheses): Tamil participants: 4.3 (1.6); 3.4 (1.1); 2.2 (1); Mandarin participants: 5.3 (.9); 3.6 (1.3); 1.9 (1.4) for each of the picture conditions respectively (see Figure 5.7). The similarity judgment means appear to be comparable across the language condition.

A two-way mixed design ANOVA confirmed the hypothesis that Tamil and Mandarin participants responded similarly to the object pairs. There was no difference in ratings between the two language groups, $F_1(1,53) = 1.20, p = .27$; $F_2(1,14) = 2.97, p = .11$. Hence, the Mandarin speakers rated the object picture pairs similarly to the Tamil speakers. There was a main effect for the Picture type, $F_1(2,106) = 77.30, p < .001$; $F_2(2, 14) = 34.05, p < .001$. The interaction between the two factors was not significant, $F_1(2,106) = 2.30, p = .11$; $F_2(2,14) = 2.99, p = .08$. This finding suggests that although picture pairs were clearly rated as highly similar or dissimilar, both language groups perceived the pairs similarly. Post-hoc Sheffe's tests confirm the difference in similarity ratings between object pairs, as all factors were rated significantly different from each other (all pairwise comparisons were significant at $p < .05$). The difference between the object picture pairs is expected, as certain pairs were less similar than others. Both language groups exhibited similar response patterns to these picture pairs, confirming that they understood the task. These combinations were also significant in paired sample t-tests with criterion adjusted to $p < .0167$.

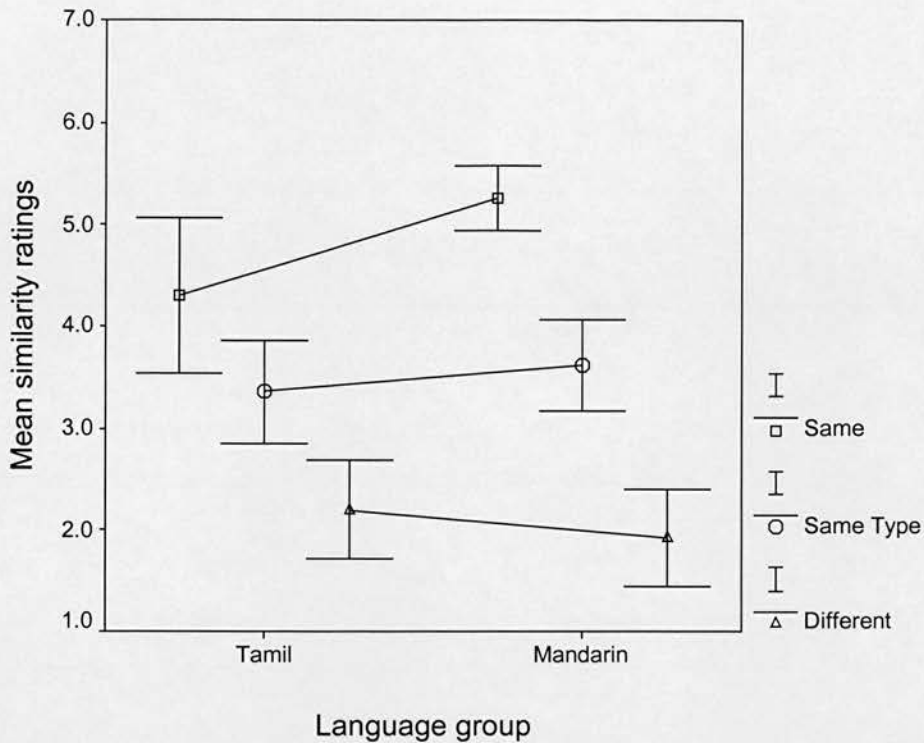


Figure 5.7. Mean ratings (1 = not similar; 7 = similar) for picture similarity for Object pairs (same, same type and different), by linguistic group of participants

Experimental Condition

In the experimental condition, the mean ratings for the B-AC pairs are slightly lower than for the B-TC pairs (with standard deviations in parentheses): B-AC—5.55 (.8) and 5.45 (.5); B-TC—5.7 (.7) and 5.8 (.6) by Tamil and Mandarin participants respectively (see Figure 5.8). There does not appear to be any difference in similarity judgments between the two language groups.

A two-way mixed design ANOVA indicated both language groups responded similarly to the picture pairs, $F_1(1,54) = 0.01, p = .92$; $F_2(1,38) = 0.04, p = .85$. The by-participants analyses show that the B-AC and B-TC picture pairs were rated differently,

$F_1(1,54) = 8.20, p = .01$, however this was not confirmed in the by-items analyses, $F_2(1,38) = 3.13, p = .09$. The interaction between the two factors was not significant, $F_1(1,54) = 1.65, p = .20; F_2(1,38) = 1.17, p = .20$.

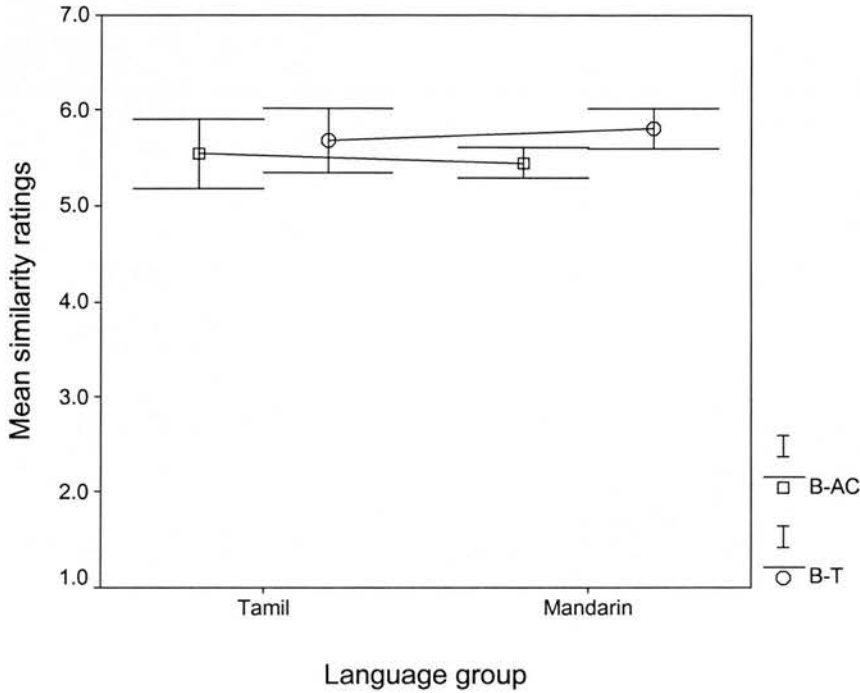


Figure 5.8. Mean ratings (1 = not similar; 7 = similar) for picture similarity for Action Change (B-AC) and Theme Change (B-TC) pairs, by linguistic group of participants

Discussion

Baseline condition

The predictions for the baseline condition were supported as the by-participants and by-items analyses confirm that there was no interaction between Language group and Picture type (see Table 5.3). This finding suggests that as there were no linguistic variances between the two language groups, both groups perceived differences in the

object pairs similarly. There was also no significant difference in the Tamil and Mandarin speakers' ratings of the objects. There was a main effect for picture type, which indicated that the actual similarity ratings for the object pairs (same/same-type/different) were significantly different. Post-hoc analyses further confirmed that the picture combinations were rated differently from each other. This result was expected as the picture pairs represented varying degrees of similarity between objects. Some object pairs were clearly similar, for example, two types of mugs, whereas others differed greatly, such as a set of keys and a book. The findings from the baseline condition support the hypothesis and also suggest that both language groups interpreted the instructions similarly.

Table 5.3

Summary of results from baseline and experimental conditions

Factors	By-Participants	By-Items
Baseline Condition		
Language group	X	X
Picture pairs	✓	✓
Interaction	X	X
Experimental Condition		
Language group	X	X
Picture pairs	✓	X
Interaction	X	X

Note. X = NS; ✓ = significant at the alpha level of .05.

Experimental condition

In the experimental condition, the results do not provide any support for the influence of language on cognition. Although the B-AC and B-TC picture pairs were rated differently in the by-participants analysis, the by-items did not confirm this. In general, linguistic variances did not appear to affect the similarity ratings, and both Tamil and Mandarin speakers produced a similar pattern of similarity ratings. Before we hastily accept Hypothesis LR—that despite verb differences, we share a universal representation of action concepts—it is important to remember that lack of evidence for one position does not automatically confirm the opposite premise.

It is worth noting that the anomaly in the Tamil speakers' responses in the pilot study was not repeated in this experiment. It is possible that the modifications to the methodology were effective in eliminating any confounds arising from misunderstanding of directions or coding of irrelevant information.

There are some concerns with this experiment. One particular issue is that the Mandarin speakers appear to interpret the similarity scales differently from the Tamil speakers. For example, they produced higher similarity ratings in Experiment 1 and in the baseline condition in Experiment 2, which might be an artefact of the task. Perhaps off-line measures, such as similarity ratings, are not an appropriate tool for examining global questions about the role of language because they cannot inform us of the more subtle influences of verb structure on action concepts.

Although similarity ratings provide some insight into the role of language in event concepts, other methodological frameworks might be more effective in assessing linguistic contribution. In light of this possibility, the following experiment investigated

on-line processes of a decision task measured by response latency. Decision tasks elicit a speeded response from a participant and are a common methodological tool in psycholinguistic research (see Gernsbacher, 1994, for a review of various studies). In particular, Experiment 3 employs a *same/different* judgment task (see Morrow, Bower, & Greenspan, 1990, for a similar methodology in research in narrative comprehension). The response latency is thought to be reflective of an explicit and inferred activation of the target information. For example, a faster response indicates quick activation of a verb concept, whereas a slower response might be the result of conflicting grammatical and perceptual information for action pictures. The pattern of response latencies allows a researcher to infer the nature of verb structure and its effect on the speaker (see Gernsbacher, 1990; Ratcliff & McKoon, 1981, for psycholinguistic research using response latencies in decision tasks). In Experiment 3, by comparing the speed of response to the B-TC pairs with the B-AC pairs, we can explore the influence of verb structure on event concepts.

Another possible confound in this experiment is that participants were tested in a classroom, in a group, rather than individually. There might be a residual peer pressure bias that interferes with the results. Hence, in the following experiment each participant was tested individually to eliminate such potential effects.

5.5.3 Experiment 3

Although the stimuli in the third experiment were the same set as used in experiment two, the design was different. In order to explore on-line processing of the action concepts, each pair in the B-AC and B-TC combinations was flashed simultaneously on a computer screen. Tamil and Mandarin participants were asked to press a button on the

keyboard indicating whether they believed the images to be *same* or *different*. This method allowed for an examination of how long participants would take to make a decision and provided an insight into their online processes that the previous similarity judgments did not. This experiment addressed the following questions: Will Tamil and Mandarin participants attend to similar aspects of the action stimuli, or would their responses correspond with variances in verb expressions? Would Mandarin participants take longer to notice differences in the same event because of an unmarked tense structure?

Participants

There were 60 participants, 30 Tamil speakers and 30 Mandarin speakers. Both language groups had roughly equal numbers of 11-12 years old and adult speakers. The Tamil children were attending the Sekolah Jenis Kebangsan Tamil (local Tamil school), and the Mandarin children were students at the San Yuk Mandarin School. The adults were residents of a small local community recruited from the same villages as participants from experiments 1 and 2. Both language groups resided in Malaysia, and their native language was the dominant language, used in school and at home. Members of neither group spoke English or had volunteered for the previous two experiments.

Materials

The materials used in this experiment were the same object and action stimuli used in Experiment 2. All pictures were presented on a 21 cm by 28 cm (8" x 11") coloured screen of a PowerBook Macintosh laptop, using Psyscope software (Cohen, MacWhinney, Flatt, & Provost, 1993).

Procedure

Each participant was tested individually. They were seated in front of a portable PowerBook Macintosh computer and asked to read the following instructions written in their language: “You will see two pictures. I would like you to look at these two pictures and tell me if you think these two pictures are the same type of object (action). If you think they are the same type of object (action), press the button that says ‘SAME’. If you think they are not the same type of object (action), press the button that says ‘DIFFERENT’. When you see an arrow like this: → you will see the next question. Thank you.”

The pictures in both the baseline and experimental conditions were paired in the same way as described in Experiment 2. The picture pairs were presented on a laptop computer in a randomised order. Participants were instructed to press a key indicating whether they considered the pictures as the *same* (key *P*) or *different* (key *Q*). The corresponding keys were on separate sides of the keyboard to minimise the probability of pressing the wrong key. Participants were allowed to use whichever hand they were most comfortable with, although most used both hands. The stimuli remained on the screen until either key *P* or *Q* was pressed.

In the baseline condition, participants were given three practice trials with object stimuli to ensure that they understood the task. Next, they responded to 17 object pairs in the test trials. After they completed the baseline condition, they had a short break. In the experimental condition, participants received three practice trials with action stimuli before responding to 52 action pairs in the test trials. The computer program recorded

the participants' responses (i.e., *same* or *different*) and response time (in milliseconds) to the picture pairs.

Hypotheses

Baseline Condition

The two predictions for this condition are the same for the language-as-an-influence and language-as-a-reflection positions (Hypotheses LI and LR respectively). The first prediction is that the Tamil and Mandarin speakers will produce similar responses to the different object pairs. Because some of the object pairs consist of noticeably different items, there should be a difference in how they are rated, for example, participants will be more likely to respond *same* to photos of two mugs in the *same* and *same type* condition than a book and a hammer in the *different* condition. However, the Mandarin speakers' responses to the object pairs will not differ from the Tamil speakers' responses. The second prediction is that since Tamil and Mandarin speakers should spend comparable amounts of time responding to the object pairs, as reflected by their response latencies.

Experimental Condition

As this experiment involves two tasks—similarity judgments of and response latencies to picture pairs, we can investigate the strength of linguistic influences in the experimental condition. The predictions are summarised in Table 5.4.

Table 5.4

Summary of predictions for Tamil and Mandarin speakers in the experimental condition

Hypotheses	Predictions	
	Similar Response Patterns (<i>same vs. different</i>)	Similar Response latencies (in msec)
Hypothesis LI ₁		X
Hypothesis LI ₂	X	
Hypothesis LR	X	X

Language-as-a-strong-influence hypothesis (Hypothesis LI₁)

Although proponents of this view adopt a milder position than Whorf's original premise that language determines thought, they nevertheless argue that linguistic patterns are the dominant conceptual patterns that influence cognition, often precluding alternative representations. There are two predictions according to this hypothesis. First, the Tamil and Mandarin speakers' responses will reflect the corresponding verb characteristics. Specifically, the explicitly marked verb structure in the Tamil language will direct speakers to consider the B-AC picture pairs as *different* and the B-TC pairs as the *same*. Because of the relatively simple verb structure in Mandarin, speakers will consider both B-AC and B-TC picture pairs as the *same*.

The second prediction is that the language groups will not differ in the amount of time they spend judging the similarity of the actions (measured by response latencies).

Since linguistic patterns have been ingrained during language learning, conceptual parameters are automatised and therefore, speakers do not need to explicitly access language while performing the task. Although language is influencing the Tamil and Mandarin speakers' conceptualisation of events, it does not directly mediate their responses during the task.

Language-as-a-weak-influence hypothesis (Hypothesis LI₂)

Proponents of this hypothesis argue that although Mandarin speakers express events differently from Tamil speakers, this does not preclude them from conceptualising them similarly (see Au's criticism of Bloom's research, 1983). As a result, the first prediction is that both Tamil and Mandarin speakers will produce similar response patterns to the action pairs.

Based on the premise that participants are accessing language when performing the task, the second prediction is that Tamil and Mandarin speakers will differ in how long they spend in decision-making. In particular, Mandarin speakers will take a longer time to respond to the B-AC action pairs (same action, different tense) because they might perceive of the actions as *different* compared to the B-TC pairs. However, if language is mediating their responses, the similar expressions for picture B and AC may cause a conflict between their perception and expression of the picture pairs and they will spend some time deliberating whether the picture pairs are indeed *same* or *different*. The Tamil speakers however, will not face such decision-making conflict, and will respond more quickly to the B-AC picture pairs compared to the Mandarin speakers.

Language-as-a-reflection hypothesis (Hypothesis LR)

Proponents of this view argue that linguistic differences when expressing events do not ultimately influence speakers' conceptual representations of them. Therefore, Tamil and Mandarin participants will produce similar response patterns in their similarity judgments, and their deliberation of the picture pairs will not be significantly different.

Results

A general analysis of combined responses for the baseline and experimental conditions can be found in Appendix B. For the baseline and experimental conditions, analyses were conducted with participants (F_1 ; Language= between, Picture= within) and items (F_2 ; Language=within, Picture=between) as random factors, on the following dependent measures: response latencies (measured in milliseconds), response index (based on the categorical choice of *same* and *different*), and response latencies by response patterns (*same* vs. *different*).

Baseline Condition

Response Latencies

The mean response latencies of the Tamil and Mandarin speakers suggest that they did not differ much in their response times for each object pair (see Table 5.5).

Table 5.5

Mean response latencies (in msec) for object pairs by language group

Language Group	Picture combinations		
	Same	Same type	Different
Tamil	2872 (1273)	3859 (3268)	3351 (1926)
Mandarin	3876 (2539)	3832 (2379)	3933 (2748)

Note. Standard deviations are in parentheses.

In a two-way mixed design ANOVA, by-participants analyses revealed no language effects, $F_1(1,58) = 0.9$; $p = .35$; there was however a small effect for language group in the by-items analyses; $F_2(1,14) = 5.4$, $p = .04$. There was no main effect in response times for the different pictures, $F_1(2,116) = 1.57$; $p = .22$; $F_2(2,14) = 0.39$, $p = .68$. There was also no interaction between language group and picture pairs, $F_1(2,116) = 1.82$; $p = .16$; $F_2(2,14) = 1.9$, $p = .18$. The non-significant interaction confirms that Tamil and Mandarin speakers spent comparable time deliberating their responses.

Response Patterns

In order to analyse the responses produced by the participants, a response index based on the separate totals for *same* and *different* responses, was calculated in order to compare responses for B-AC and B-TC pictures. For the B-AC picture pairs, the formula for the index was $B-AC \text{ same} / (B-AC \text{ same} + B-AC \text{ different})$. The same calculation was used for the B-TC pictures, with responses to the B-TC pairs. In the response index calculations, the closer the figure is to 1, the more *same* responses the participant produced. If the figure is closer to 0, the participant tended to produce more

different responses. The response index means suggest that although the Mandarin speakers were more likely to respond *same* to object pairs in the same and same type condition, responses in both language groups decreased monotonically across conditions (see Table 5.6):

Table 5.6

Mean response index (0 – 1) for object pairs by language group

Language	Picture combinations		
	Same	Same Type	Different
Tamil	.65 (.24)	.43 (.24)	.03 (.09)
Mandarin	.84 (.19)	.74 (.27)	.05 (.1)

Note. Standard deviations are in parentheses; scores closer to 1 indicate that the participant produced more *same* responses, and scores closer to 0, indicate more *different* responses.

A mixed two-way ANOVA was conducted with the response index as the dependent variable. There was a main effect for language groups; $F_1(1,58) = 20.8, p < .001$; $F_2(1,14) = 24, p < .001$. Although the difference in responses between language groups was not expected, it is important to remember that the patterns of responses are similar, for example, although Tamil volunteers produced less *same* responses to the *same* and *same type* picture pairs, responses of both language groups increased monotonically across conditions. There was also a significant difference between picture pairs; $F_1(2,116) = 308.96, p < .001$; $F_2(2,14) = 29.5, p < .001$. The interaction was reliable; $F_1(2,116) = 12.4, p < .001$; $F_2(2,14) = 5.5, p = .02$. Scheffe's post hoc analysis

yielded statistically significant differences ($p < .05$) between *same* and *different* picture pairs, and between *same type* and *different* picture pairs. Paired sample t-tests at an adjusted alpha level ($p < .0167$) confirmed the difference in similarity decisions between these picture combinations, in addition there the responses to the *same* and *same type* pictures were also significantly different.

Response Latencies by Response

Some researchers who measure reaction time in decision task have suggested that it takes longer to judge a false description than a true one (e.g., Clark & Chase, 1972; 1974). In light of the fact that there are different cognitive processes that underlie *same* and *different* responses (or *true/false* responses), response latencies when producing *same* and *different* responses for the three picture conditions—*same*, *same type* and *different* picture pairs—were analysed separately.

However, as some participants responded to all the stimuli in a condition as *same* or *different* (e.g., participant 2 responded to all same-type items as the *same*; participant 13 perceived all B-AC items as *different*), there were inevitably empty cells. In order to preserve a balanced design with minimal agitation to the observed variances, the following formula was used to estimate the missing cells means:

$$AB'_{ij} = A'_i + B'_j - G' \quad (\text{Winer, 1971, p. 488})$$

Missing cell means = Subject mean (or Item mean) + Condition mean — Grand mean

The mean response times by responses are presented in Table 5.7. The Mandarin speakers' mean response latencies are slightly higher than the Tamil speakers' response times. The higher RT can be explained when looking at the raw data for items. For

example, a few Mandarin speakers responded *same* to some of the object pairs in the *different* category and spent a long time deliberating over this choice. This response is unexpected as the object pairs in the *different* category were clearly different, for example, a hammer and a book. Their longer response times suggests that they may have been searching for any commonality between the object pictures in order to judge them as the *same* (in the above example, a commonality might be that they are both kept in the house).

Table 5.7

Mean response latencies (in msec) by participants' responses for object pairs

Language	Picture combinations					
	Same		Same Type		Different	
	<i>Same</i>	<i>Different</i>	<i>Same</i>	<i>Different</i>	<i>Same</i>	<i>Different</i>
Tamil	3484 (2185)	4408 (5330)	3327 (1987)	3243 (1921)	6797 (2393)	2869 (1284)
Mandarin	4033 (2567)	4153 (2549)	4339 (3702)	3558 (2435)	7647 (2618)	3708 (2304)

Note. Standard deviations are in parentheses.

In the first analysis, comparing *same* responses across the three picture conditions, there was no main effect for Language group in the by-participants analyses, $F_1(1,58) = 1.7, p = .19$; however, there was a significant difference in the Tamil and Mandarin speakers' responses in the by-items analyses, $F_2(1,14) = 9.2, p = .009$. In the by-participants analyses, there was a main effect for Picture type, $F_1(2,116) = 116.5, p < .001$; but not in the by-items analyses, $F_2(2,14) = 0.93, p = .42$. The interaction between the two factors was not significant, $F_1(2,116) = 0.41, p = .67$; $F_2(2,14) = 2.3, p = .13$,

indicating that both language groups spent similar amounts of time when judging the picture pairs as the *same*.

In the second analysis, with *different* responses, there was no main effect for Language group, $F_1(1,58) = 0.23$, $p = .63$; $F_2(1,14) = 0.13$, $p = .73$. In the by-participants analyses, there was a significant main effect for Picture type, $F_1(2,116) = 4.2$, $p = .02$; but it was not confirmed in the by-items analyses, $F_2(2,14) = 1.6$, $p = .23$. The interaction between the two factors was not significant, $F_1(2,116) = 1.07$, $p = .35$; $F_2(2,14) = 1.3$, $p = .31$, confirming that the length of time both language groups spent deliberating over the object pairs when they judged them to be *different* was comparable. Overall, the findings from the *same* and *different* responses are expected.

Experimental condition

Responses Latencies

The mean response latencies for the Tamil and Mandarin participants are presented in Table 5.8. The Mandarin speakers took longer than the Tamil speakers to respond to both picture conditions. Moreover, the Mandarin speakers took twice as long to respond to the B-AC pairs compared to the B-TC pairs (a 1182 vs. a 566 msec difference from Tamil speakers' response times).

Table 5.8

Mean response latencies (in msec) for action pairs by language group

Language	Picture combinations ¹⁴	
	B-AC	B-TC
Tamil	3336 (1205)	3235 (1244)
Mandarin	4518 (2762)	3801 (1876)

Note. Standard deviations are in parentheses.

Analyses from a two-way mixed design ANOVA indicated that response latencies between Tamil and Mandarin speakers differed significantly, $F_1(1,58) = 3.7$, $p = .05$; $F_2(1,38) = 46.15$, $p < .001$. There was also a significant difference for response times of the picture pairs; $F_1(1,58) = 5.56$, $p = .02$; $F_2(1,38) = 5.77$, $p = .02$. In the by-participants analyses, the interaction between the two factors narrowly missed significance; $F_1(1,58) = 3.2$, $p = .07$; there was a reliable interaction in the by-items analyses, $F_2(1,38) = 5.78$, $p = .02$.

Response Patterns

Summarised below are the mean responses (calculated by the response index described above) of the Tamil and Mandarin speakers (Table 5.9). Scores closer to 1 signify more *same* responses, whereas scores nearer 0 denote more *different* responses. The response index means suggest that both language groups exhibited similar response patterns to

¹⁴ Out of interest, the Tamil speakers' mean response time for the random pictures was 3090 msec, and for the Chinese it was 3418 msec, which are faster than responses to the control picture condition: B-TC. The faster response times for random pictures suggest that both language groups understood the instructions to judge the similarity of the actions in the picture pairs.

the picture pairs. It appears that both language groups judged the B-AC pairs to as *different* compared to the B-TC pairs.

Table 5.9

Mean response index (0 – 1) for action pairs by language group

Language	Picture combinations	
	B-AC	B-TC
Tamil	0.71 (.25)	0.81 (.23)
Mandarin	0.64 (.23)	0.84 (.14)

Note. Standard deviations are in parentheses; scores closer to 1 indicate that the participant produced more *same* responses, and scores closer to 0, indicate more *different* responses

A two-way mixed design ANOVA indicated no main effect for Language groups, $F_1(1,58) = 0.27, p = .70$; $F_2(1,38) = 0.63, p = .40$. There was a main effect for Picture pairs, $F_1(1,58) = 23.9, p < .001$; $F_2(1,38) = 6.8, p = .01$. In the by-participants analyses, the interaction between variables was not significant, $F_1(1,58) = 2.7, p = .11$; however it was significant in the by-items analyses, $F_2(1,38) = 5.7, p = .02$.

Response Latencies by Response

From the response latency means (see Table 5.10), the Tamil speakers response times appear to be stable across picture conditions and responses. The Mandarin volunteers however, seemed to take considerably longer when responding *different*, particularly in the B-AC picture condition.

Table 5.10. Mean response latencies (in msec) by participants' responses for action pairs

Picture combinations				
B-AC			B-TC	
Responses				
Language	<i>Same</i>	<i>Different</i>	<i>Same</i>	<i>Different</i>
Tamil	3354 (1213)	3828 (2471)	3298 (1303)	3398 (1853)
Mandarin	4260 (2698)	5250 (3522)	3722 (1814)	4005 (2335)

Note. Standard deviations are in parentheses.

The Tamil and Mandarin speakers' response latencies were analysed separately according to responses produced. First, for the *same* response, analyses from a two-way mixed design ANOVA indicated no main effect for language groups in the by-participants analyses, $F_1(1,58) = 2.3$, $p = .14$; however, in the by-items analyses, the language groups differed significantly, $F_2(1,38) = 22.6$, $p < .001$. There was no main effect for picture pairs, $F_1(1,58) = 2.4$, $p = .13$; $F_2(1,38) = 2.9$, $p = .10$. The interaction between variables was not significant either; $F_1(1,58) = 1.6$, $p = .22$; $F_2(1,38) = 3.3$, $p = .07$.

For the *different* responses, the difference in response times between language groups was nearly significant in the by-participants analyses, $F_1(1,58) = 3.3$, $p = .07$; and was reliable in the by-items analyses, $F_2(1,38) = 19.3$, $p < .001$. In the by-participants analyses, there was a main effect for picture pair, $F_1(1,58) = 4.7$, $p = .03$; however, this was not confirmed in the by-items analyses, $F_2(1,38) = 0.001$, $p = .98$. The

interaction was not significant, $F_1(1,58) = 1.12, p = .30$; ; $F_2(1,38) = 0.04, p = .84$. Scheffe' s post hoc tests indicated that none of the comparisons were significant, however paired sample t-tests confirmed that the Mandarin speakers took longer when responding different to B-AC picture pairs compared to the B-TC pairs ($p = .04$). The Tamil speakers response times were not differ significantly for the B-AC or B-TC picture pairs. Although the paired sample t-test was not significant at the adjusted criterion of $p < .025$, it is important to remember that the question of interest here is whether there were within-group differences in the response latencies when responding *different* to the picture pairs. In this instance, there is weak evidence that the Mandarin speakers' response times to the B-AC pairs were significantly longer than to the B-TC pairs.

Discussion

The investigation of similarity judgments and response latencies in this experiment provided a useful measure of the extent of linguistic influence on conceptual thinking in the Tamil and Mandarin participants. The results from the baseline condition are first discussed, followed by findings from the experimental condition.

Table 5.11

Summary of Tamil and Mandarin speakers' results from the baseline condition

Dependent measures	Factors	By-Participants	By-Items
Response latencies	Language group	X	✓
	Picture pairs	X	X
	Interaction	X	X
Response Index	Language group	✓	✓
	Picture pairs	✓	✓
	Interaction	✓	✓
RT by response: <i>same</i>	Language group	X	✓
	Picture pairs	✓	✓
	Interaction	X	X
RT by response: <i>diff</i>	Language group	X	X
	Picture pairs	✓	✓
	Interaction	X	X

Note. X = NS result; ✓ = significant result

Baseline condition

The results for the baseline condition are summarised in Table 5.11. Overall, the findings are in-line with the prediction that both language groups will yield a similar pattern of results.

First, analyses on the response latencies confirm the hypothesis that Tamil and Mandarin participants will take a similar amount of time when producing their similarity judgments for the object stimuli. There was no interaction between Language group and

Picture type, nor main effects for Picture type. Although there was a small language effect in the by-items analysis, this was not supported in the by-participants results and it is appropriate to conclude that there is no language effect on response latencies.

Secondly, when comparing the Tamil and Mandarin participants' responses (using an index calculation), there was a significant interaction between Language group and Picture type, and significant main effects, confirming that the language groups differed in their responses to the picture pairs. The post-hoc analyses indicate that responses to all picture combinations were significantly different from each other. From the mean responses (see Table 5.6), the Mandarin speakers appear to have judged the *same* and *same type* object pairs as *same* more frequently than the Tamil speakers. One suggestion is that the Mandarin participants have a natural bias towards judging picture pairs as *same*, for example, in experiment 1, and in the baseline condition in experiment 2, they also produced higher similarity ratings than Tamil speakers. The increased frequency of *same* responses could be a task artefact, rather than language-specific responses. In light of this possibility, it is more productive to look at on-line processes such as response latencies in this experiment. Although differences between language groups in interpreting similarity tasks are expected, it is important to note that the Tamil and Mandarin speakers' response patterns to the object pairs were similar, in that the responses increased monotonically across object conditions.

Finally, when analysing the response latencies by response patterns, there was no interaction between Language group and Picture type in both the *same* and *different* responses. This finding suggests that the Tamil and Mandarin speakers took similar amounts of time in deliberating over their responses to the object pairs. Although there

was a significant main effect for Language group in the by-items for *same* responses, however, this was not confirmed in the by-participants analysis. Main effects for Picture type in both the *same* and *different* responses in the by-participants analyses were also not confirmed in the by-items analyses.

Experimental condition

Table 5.12

Summary of Tamil and Mandarin speakers' results from the experimental condition

Dependent measures	Factors	By-Participants	By-Items
Response latencies	Language group	✓	✓
	Picture pairs	✓	✓
	Interaction	✓	✓
Response Index	Language group	X	X
	Picture pairs	✓	✓
	Interaction	X	✓
RT by response: <i>same</i>	Language group	X	✓
	Picture pairs	X	X
	Interaction	X	X
RT by response: <i>diff</i>	Language group	✓	✓
	Picture pairs	✓	X
	Interaction	X	X

Note. X= NS result; ✓=significant result

The results for the experimental condition are summarised in Table 5.12. When examining the mean response times of the Tamil and Mandarin volunteers, the Mandarin speakers took longer when responding to the B-AC pictures. The significant interaction between Language group and Picture pair, as well as significant main effects confirms that verb differences affect the processing time of event concepts. This finding provides some support for Hypothesis LI₂, as the difference in verb structure between the two language groups appeared to affect their decision-making time.

Next, when the responses (based on an index calculation) were analysed, the Mandarin speakers produced slightly more *different* responses to the B-AC pictures, however this difference was not significant. Overall, the Mandarin speakers' responses were comparable to the Tamil speakers and both language groups exhibited similar response patterns. The response means indicate that Tamil and Mandarin speakers produced more *different* responses to the B-AC pictures than the B-TC pictures. In light of this, it is difficult to argue for strong support for Hypothesis LI₁, as the different verb structures did not appear to influence how the Tamil and Mandarin speakers judged the action combinations.

Finally, when the results were analysed separately by responses, both Tamil and Mandarin speakers appeared to spend comparable amounts of time in deciding whether picture pairs were the *same*. However, when responding to action pairs they considered as *different*, there was a numerical difference between the Mandarin and Tamil participants (compare the difference in mean response latencies: a 1422 msec difference for the B-AC pictures; and a 607 msec difference for the B-TC pictures). In particular, the paired sample t-test confirms that the Mandarin speakers spent a longer time

deliberating over the B-AC picture sets when producing a *different* response. This result provides weak support for the predictions in Hypothesis LI₂ that the Tamil and Mandarin speakers will differ in their decision-making time in the B-AC pairs because Mandarin are not obligated to express tense differences, whereas Tamils are. If language was mediating participants' responses, then the unmarked verb structure in Mandarin might have influenced them to deliberate whether actions performed by the same actor at different stages where indeed *different*. Although they finally identified the B-AC pairs as dissimilar from each other, it took them longer to overcome their grammatical bias to judge the action pictures as similar.

The results in the experimental condition do not support Hypothesis LR, as tense morphology influenced representations of event concepts. In particular, Tamil and Mandarin speakers differed in how long they spent judging the actions in the picture pairs as *same* or *different*. Thus, while representations of more perceptually grounded concepts, such as objects, are perhaps universal, other concepts such as events, are affected by grammatical differences.

5.6 Summary and General Discussion

The purpose of this chapter was to extend the exploration of the original question regarding the relationship between language and conceptual understanding to a cross-linguistic environment. As the previous chapter confirmed that language plays a role in influencing conceptual representations, this chapter investigated the influence of different grammatical structures on cognition. In particular, the study explored the effect of different verb structures on event concepts in Tamil and Mandarin speakers.

There are unavoidably potential confounds when conducting cross-linguistic research. Although it is unrealistic to anticipate that all extraneous variables can be eliminated in a study, it is possible to minimise the interference of such factors on the findings. In section 5.2, we outlined some methodological concerns that accompany cross-linguistic research. First, where possible, volunteers should be from similar cultural and educational backgrounds. This recruitment policy allows the researcher to interpret experimental results in light of linguistic differences, rather than potential cultural confounds. Next, the language difference in question should be reflective of a pattern of thinking, rather than an individual vocabulary difference. Although early cross-linguistic researchers were zealous in highlighting differences between languages, these differences contributed very little to the question of the role of language in cognition because they were not representative of broad thinking patterns. The next methodological concern is that when administering the tasks, instructions should be clear and every effort made to ensure that they are interpreted similarly across language groups. The introduction of a baseline may be useful in this matter. Finally, the same stimuli should be used for all language groups tested.

The next section of this chapter reviewed previous cross-linguistic research on verbal morphology. Some general characteristics of verb forms were highlighted, followed by a short review of Tamil and Mandarin verbs, the language groups under investigation. A principal difference in verb expressions between these two groups is that Tamil verbs, like English, are inflected to indicate tense differences, however Mandarin verbs are not and speakers are not obligated to express tense differences.

Three experiments investigated the influence of the different verb structures in Tamil and Mandarin on representation of action concepts. The first experiment was a pilot study, designed to investigate whether the different forms of verb expression influenced the speakers' similarity judgments of two different picture pairs: B-AC (same agent, different tense, same theme) pairs and B-TC (same agent, same tense, different theme). An example of a B-AC picture is a man dropping a book (Base) paired with a picture of the same man having dropped the book (Action Change). In the B-TC combination, we see a man dropping a book (Base) paired with a man dropping a jug (Theme Change). In order to estimate if the different verb forms were affecting their conceptual representation of these events, participants were instructed to explicitly access their language when viewing the picture pairs (i.e., they were asked if in their own language, they considered the pairs as similar or not).

With respect to the question: do linguistic differences engender cognitive differences, the results from experiment 1 are mixed. The Mandarin speakers showed no difference in their similarity judgments between the B-AC and B-TC picture sets, whereas the Tamil speakers did. However, support for the Language-as-an-influence hypothesis (Hypothesis LI) is severely mitigated as the similarity judgments of the Tamil speakers were in the wrong direction—they rated the B-TC pairs as less similar than the B-AC pairs (3.75 and 4.77 respectively). It is possible that explicit linguistic encoding of the picture pairs confounded the result as they may have coded additional and irrelevant information; or it could be that the different language groups interpreted the directions differently. In light of these concerns, several methodological changes were made. In particular, participants were not directed to access language while

performing the task, the stimuli were changed from line drawings to photographs of actions, and a baseline condition was introduced to ensure that participants understood the instructions.

Experiment 2 was a replication of the pilot study, with the aforementioned modifications. In the baseline condition, both language groups exhibited similar response patterns. This is expected as the object stimuli are coded similarly in both languages. Further, the similar response patterns confirmed that both language groups interpreted the instructions similarly. In the experimental condition, the results indicated that both language groups produced comparable similarity judgments: B-AC—5.55 and 5.45; B-TC—5.7 and 5.8 by Tamil and Mandarin participants respectively. Not only were the picture pairs rated similarly to each other, the Tamil speakers' ratings were also similar to the Mandarin speakers' ratings. This finding suggests that the verb differences in Tamil and Mandarin did not influence their action concepts. Although a null effect does not provide support for the universal hypothesis (Hypothesis LR), it is possible that language differences do not play a strong role in cognitive processes. However, it is oversimplistic to relegate the role of language to opposing positions (an influence or a reflection; hypotheses LI and LR), and we may be overlooking more subtle influences on cognitive processes. Comparing on-line processes of a decision task is a valuable way to assess whether explicit tense morphology results in faster activation of certain event concepts. Thus, in experiment 3 we investigated participants' responses as well as their response times to the picture pairs.

In experiment 3, results from the baseline condition confirmed the prediction that both language groups will not differ in the length of time spent in processing the

object stimuli. Although the Mandarin speakers produced more *same* responses than the Tamil speakers, this pattern of results is consistent with those in experiments 1 and 2 as they also produced higher similarity ratings of the picture pairs. The higher frequency of *same* responses confirms the value of using on-line measures to investigate the role of language in cognition.

The experimental condition investigated the strength of linguistic influence on action concepts. First, the similar response patterns between the Tamil and Mandarin speakers suggest that language does not play a strong role in influencing our concepts (Hypothesis LI₁). If it did, the differences in verb inflections would have led the participants to perceive the actions in the pictures differently, for example, the Mandarin speakers should have judged the B-AC pairs as the *same* rather than *different*. Instead their responses to both picture pairs were comparable to the Tamil speakers. When examining the response latencies however, the findings indicated that the language groups differed in the time spent deliberating over their responses (Hypothesis LI₂). Although both language groups spent equal time processing pictures depicting thematic changes (B-TC picture pairs), their response latencies differed for the B-AC pictures. In particular, the Mandarin speakers spent more time when judging the B-AC picture pairs as *different*. This difference in response times is arguably a result of the different language structures, since the Mandarin speakers don't have an explicit tense structure in their language, as do the Tamil speakers, they took longer to identify images reflecting tense changes in actions. Because language was mediating their responses, there was a conflict between their immediate perception of the events in the photographs and how they classified them linguistically. The result is that although they finally

determined that the actions in the B-AC picture pairs were different, it took them a longer time to overcome their grammatical bias.

As discussed above, the significant difference in both responses and response latencies in the Tamil and Mandarin participants could be a result of language mediating their responses. This possible explanation of the difference in both dependent variables needs further exploration. At present, the results provide some support for the habitual use premise (section 2.3.2), as the presence of an explicit verb code in Tamil allowed them to process verb concepts more quickly than Mandarin participants. Although the simple verb structure in Mandarin did not preclude them from representing action changes (i.e., drop, dropped), they took longer to process these concepts compared to the Tamil participants.

In general, the findings reveal some interesting effects of the role of language in representations. The influence of language can be viewed on a continuum, and perhaps exerts varying strengths of influence on difference conceptual representations (see section 2.3). For example, perceptual processes are a primary skill, evident at birth (indeed many researchers have investigated perceptual patterns of non-linguistic infants and primates, see Bornstein, 1981; 1987) and it may be harder for linguistic patterns to affect them. Thus, the more directly a concept is linked to perception, the less effect language has, resulting in a universal representation of that particular concept. This explanation could account for why some concepts such as colour categories and object concepts, are considered as universal (however, see Roberson et al. 2000). On the other hand, relational concepts are more socially defined, and thus language has a greater influence. Since relational terms such as verbs are learnt, through communicating with

people, language has a greater propensity to influence thinking. However, it is important to remember that this influence does not preclude a particular language group from thinking in an alternate pattern (e.g., Miura and Okamoto, 1989).

When reviewing the results from all the experiments in this study, we can make the following suggestions in light of the continuum presented in Chapter 2 (section 2.3; see Table 5.13).

Table 5.13

Summary of conclusions from the study

	Linguistic Determinism	Linguistic Relativity (Habitual use)	Thinking for Speaking	Perception + Language	Universal concepts
Experiment					
Exp 1		?			
Exp 2					?
Exp 3	X	✓	?	?	

Note. ✓ indicates positions supported by the data; ? indicates positions possibly supported by the data; X indicates positions not supported by the data.

The results from the first experiment intimated that language may play a role in cognition, as Mandarin speakers did not differ in their similarity judgments of the B-AC and B-TC picture pairs. However, the Tamil speakers results are a little less clear—their similarity judgments were in the opposite direction of the prediction. Although this response pattern was not repeated in the subsequent two experiments, no clear conclusions are drawn from this experiment. Rather, it served as a pilot for further

exploration on generating a methodological sound study when comparing language effects in event concepts. In experiment 2, the null effects hint at the possibility that language differences do not engender cognitive differences and the data suggests that Mandarin speakers are likely to use tense-markers, despite their optionality.

The results in experiment 3 allow us to surmise two things. First, verb differences did not affect the actual responses produced by the Tamil and Mandarin speakers. This result corresponds with the similar pattern of similarity ratings produced in experiment 2, and suggests that language does not play a strong role in influencing conceptual representations. However, the Tamil and Mandarin speakers produced different response times, in particular, the Mandarin speakers spent longer deliberating over the B-AC picture pairs when responding to them as *different*. This could be because considering tense in Mandarin is not 'automatic' and requires extra work, possibly because it is not intrinsic to the verb. This finding suggests that language is being accessed to make similarity judgements, but further study is required in order to explore whether language affects perception of similarity as well.

Although language appears to play some role, albeit a weak one, in how concepts are represented, we can further explore its influence. For example, the study did not directly investigate whether language intervenes during the processing of picture pairs. The difference between the influence of linguistic structure on representations while speaking but not otherwise, or if grammatical patterns exert any influence on representations even when language is not accessed as a result of pre-set conceptual parameters, requires further study before making further claims regarding the role of language in cognition. Although experiments 2 and 3 did not require the participants to

explicitly access language when performing the task, as the pilot study did, there is no assurance that their responses were language-mediated (although the results suggest that language was indeed mediating their responses). A future study examining this distinction would require an additional group of Tamil and Mandarin participants to articulate nonsense sounds that are phonologically compatible with both languages during the task in order to load their verbal memory (see Gennari, et al., 2002, for a similar strategy). The use of articulatory suppression would prohibit participants from effectively accessing language, allowing a detailed comparison of findings from participants who are allowed to access language with those who are not. This particular design would provide insight to whether event concepts are pre-set during the language-learning stage with no further interference from language, or if the role of language is more dynamic, providing constant input to the conceptual and perceptual processes.

A second area of further investigation is the premise that some concepts are more perceptually grounded and thus, less sensitive to the influence of linguistic differences. Recently, Munnich et al. (2001) proposed the possibility that some basic spatial concepts can be resistant to linguistic variation, but this suggestion has not been investigated with object and event categories (Gentner and Boroditsky, 2001). Although experiments 2 and 3 used object stimuli as a baseline, both Tamil and Mandarin speakers encode the stimuli similarly. One possible way to explore the claim that object concepts are less sensitive to linguistic influences is to ask various language groups that

have label differences for objects to perform a sorting task or similarity judgment task on a selection of objects.¹⁵

The study is primarily concerned with the question of linguistic influence on cognition: Do speakers of a language that does not have explicit tense morphology conceptualise events differently from those who do? Overall, the findings from the study confirm the premise that grammatical patterns have the potential to affect conceptual representations. Although this influence does not preclude speakers from thinking in an alternative pattern, it does bias them in a particular direction.

¹⁵ Although Malt et al.'s (1999) results indicated a dissociation between categorisation and labelling of containers, the stimuli were not pre-selected based on differences in labels across the language groups. In the interest of a methodologically sound framework, it would be preferable to first establish labelling differences for the object stimuli and then test participants' responses to them.

CHAPTER SIX

SUMMARY AND DISCUSSION

6.1 Review of the language-thought debate

This thesis addressed the language-thought debate. Previously, researchers in this area have adopted mutually exclusive positions—that language either has an influence or does not. The premise of the former position is known as linguistic determinism and is supported by research demonstrating corresponding links between differences in linguistic structures and behavioural patterns. The latter position is known as cognitive determinism and is based on the proposal that language reflects pre-existing distinctions between concepts.

Given the diversity of research findings in cross-linguistic work, it is more productive to view the role of language on a continuum of influence rather than represented as the dichotomous positions outlined in the paragraph above. In this thesis, we proposed a restructuring of the language-thought debate and investigated both strong and subtle linguistic effects. Following is a review of the proposals of each position listed on the continuum in Figure 2.1 (see also Table 6.1). The first position is linguistic determinism, and is based on the proposal that language directs thinking. This premise is supported by early work by Whorf (1956), who observed lexical differences and recorded comprehensive case studies outlining linguistic differences in concepts such as space, time and matter, between Native American

Indian languages and European languages. Whorf argued that language constrains the coding and interpretation of experiences, thereby determining thinking and actions of speakers. A weaker proposal, known as linguistic relativity, is that language does not determine conceptual representation, however it plays some role in thinking. Cross-linguistic studies such as Miura and Okamoto (1989) illustrate that language differences can affect thinking, however they do not necessarily preclude alternative ways of thinking. Further, language structures can also affect how quickly concepts are processed, for example, having a specific lexical entry for a concept might speed up the activation of that concept (see Hunt and Agnoli, 1991). In the next position, thinking for speaking, Slobin (1987; 1996) claimed that because people are sensitive to individual grammatical patterns, while speaking, thoughts are confined to particular linguistic parameters.

Supporters of the next position suggest that perception and language have a shared influence on cognition. Linguistic effects are most marked when there are weak universal or perceptual tendencies, whereas they are less evident when concepts are considered as bootstrapped by perception (Gentner & Boroditsky, 2001; Imai & Gentner, 1997; Munnich, Landau, & Doshier, 2001). The premise of the final position, cognitive determinism, is that language is a reflection of experiences. This position is supported by early work on colour categorisation (e.g., Berlin & Kay, 1969; Rosch Heider, 1972; Rosch Heider & Olivier, 1972) and more recently, by theories on embodied cognition (e.g., Lakoff & Johnson, 1999).

In the language-thought debate, the influence of language on cognition has focused on vocabulary differences and grammatical patterns. The construct of 'thought' is measured by language-explicit responses, such as narratives or a

question and answer session; and language-implicit responses, such as sorting tasks, similarity judgements and memory tasks.

The first step before re-evaluating the role of language in cognition is to ascertain the effect of task demands on behavioural responses before we can be assured that the behavioural responses are an accurate indication of cognitive processes rather than a result of the task. The study in chapter three confirmed that task demands in an experimental condition play a vital role in conceptual representations and it is imperative to keep the task constant in order to obtain an accurate assessment of the role of language in cognition.

6.2 Relevance of findings to the language-thought debate

Strong and subtle linguistic effects from the findings in this thesis are discussed in light of this division of linguistic influence on cognition (see Table 6.1). The study in chapter four investigated whether concepts are affected by the context (linguistic or embodied) they're used in when the task is invariant. Spatial perspective is an important cognitive domain across languages and various cross-linguistic studies have explored whether differences between relative terms (i.e., *left/right*) and absolute descriptors (i.e., *east/west*) result in corresponding differences in behavioural patterns (e.g., Brown & Levinson, 2000; Munnich et al., 2001; Pederson et al., 1998). We focused on a monolingual English population in order to eliminate the potential cultural interference. Although we could not investigate the relative versus absolute distinction in spatial perspective as English relies more on relative terms, we examined the influence of language and experience in deictic spatial and temporal terms.

Deictic labels, such as *front/back* to discuss spatial motion or *ahead/behind* to refer to temporal motion, are often understood in the context of two schemas of motion—Ego-Moving and Object/Time-Moving. These two motion schemas are evident in both spatial and temporal domains and previous research has confirmed that these two separate motion systems are psychologically real and distinct (e.g., Gentner & Imai, 1992; and McGlone & Harding, 1998). Motion terms can be ambiguous and we investigated whether a linguistic context or an experiential context would direct the representation of motion in spatio-temporal concepts.

Participants were exposed to a virtual environment representing one motion system (e.g., experiments 1 and 2 depicted an Ego-Moving environment; and experiments 3 and 4 depicted an Object-Moving environment). While interacting with the virtual environment, one group of participants received a linguistic prime representing the opposite spatial motion from the environment (e.g., in experiments 1 and 2, there was an Object-Moving linguistic prime; and experiments 3 and 4, there was an Ego-Moving linguistic prime). Another group of participants responded to a non-spatial question about the virtual environment. The findings demonstrated that although experiencing a virtual environment was effective in influencing the participant's motion perspective, linguistically representing an alternative schema of motion was able to override the spatial experience. The linguistic label activated a particular motion schema, and maintained its level of activation throughout the participant's experience in the virtual environment. This continued activation suppressed the influence of the virtual environment and affected participants' responses to the ambiguous target tasks. The results indicated that language is not subservient to experiences, but is able to exert some influence on cognition

People have both Ego-Moving and Object-Moving representations of motion and the study confirmed that lexically activating one of these motion systems has a direct influence on thinking. This study provides support for Slobin's premise of 'thinking for speaking' as verbalising a particular motion schema influenced participants' concept of motion. In this instance, it appears that subtle linguistic effects occur everyday.

Given that language exerts subtle influences on thinking, the study in chapter five explored stronger linguistic effects. For example, does habitually speaking about something affect how people fundamentally think about it? We investigated whether grammatical differences in verbs between Tamil and Mandarin affected speakers' conceptual representations of action categories. The main difference between Mandarin and Tamil verb forms is Mandarin does not have explicit tense markers in the same way that English and Tamil have. In Tamil, tense changes are marked with suffixes added to the root verb. In Mandarin, tense changes are generally not marked explicitly. Instead, adverbs can be included to situate the event within temporal parameters.

Tamil and Mandarin speakers were asked to judge the similarity of pairs of action pictures in order to assess whether their grammatical biases would influence their representations of actions. As the results from Experiment 1 appear to be confounded by several other factors, they will not be considered in the discussion of the contribution of language to thinking patterns (see *Discussion* in section 5.4.1 for further detail). In Experiment 2, there was no difference in similarity judgments between Tamil and Mandarin speakers and it is possible that language was exerting a subtle rather than a strong effect on cognition.

In Experiment 3, the Tamil and Mandarin speakers' response patterns and response latencies for the different picture pairs were examined. The pattern of findings in the experimental condition from Experiment 3 confirmed the results in Experiment 2—there was no significant difference in the responses between Tamil and Mandarin speakers. The similarity in response judgments suggests that language does not play a strong role in event concepts, and Mandarin speakers don't perceive a difference in actions despite tense optionality. However, when examining the response latencies, which are considered as an indication of how quickly the target information is activated, the Mandarin speakers took longer when responding *different*, particularly to the B-AC picture pairs. This difference is possibly the result of the conflict between their unmarked verb structure and perceptual input. Although the results suggest that language was mediating participants' responses, we did not investigate whether language was exercising an immediate influence while the participants were performing the task (the thinking for speaking), or if linguistic parameters were preset during the language-learning stages (linguistic relativity position). The proposed study in section 5.5 with the use of articulatory suppression while performing the task in the experimental condition would discriminate between these two positions. The results from Experiment 3 indicate that language plays a subtle role in thinking, a finding consistent with the results of the virtual reality study in chapter four.

A cautionary note is that the findings on the role of language from one research area may not be generalisable to other areas of conceptual representation. For example, confirmation of the role of language in spatial perspectives does not imply linguistic influence in other conceptual representations, such as object

concepts. However, it is clear that the findings from this thesis suggest that the extreme positions on the continuum are not viable expressions of the role of language in cognition. Further study should be restricted to the remaining three possible positions represented on the continuum. For example, we can explore the premise that some concepts are more easily influenced by language than others (Perception + Language position).

Table 6.1

Overview of findings from this thesis regarding the role of language in cognition

	Linguistic Determinism	Linguistic Relativity (Habitual use)	Thinking for Speaking	Perception + Language	Universal Concepts
Experiment					
Virtual Reality			✓		X
Cross-linguistic	X				
Exp 2					
Cross-linguistic	X	?	?		
Exp 3					

Note. ✓ indicates positions supported by the data; ? indicates positions possibly supported by the data; X indicates positions not supported by the data.

6.3 Related issues on conceptual representation

Although the studies in this thesis were restricted to exploring the role of language in cognition, we address a few general questions relating to conceptual representations with respects to linguistic influence. The premise of conceptual representation in this

thesis is that a concept consists of different features, rather than a unitary representation. Further some of these features are extracted under certain contextual conditions, and are sensitive to task demands as the study in chapter three demonstrates. Given that language plays some role in thinking, albeit, a subtle one, we ask the following questions:

1. Are concepts hardwired?

Although this question was not directly examined by this thesis, we can make some suggestions. If concepts are hardwired, it is likely that they would be relatively unaffected by external factors. However, the patterns of findings from this thesis demonstrate that certain concepts are susceptible to both linguistic and experiential influence, such as certain aspects of spatial concepts. The linguistic patterns of certain frequently accessed concepts, such as event concepts, also appear to affect people's representations of them. In light of this evidence, and other cross-linguistic work on spatial perspectives, event concepts, and even colour concepts, there is some consensus that at least certain concepts are affected by linguistic structures. Consequently, it seems unlikely that concepts are hardwired and unaffected by external factors.

2. Do people have individuated concepts?

Current research has indicated that although people still rely (in varying degrees) on defining and characteristic features, definition-based and prototype-based views are not viable. Instead, a growing amount of researchers have argued against the notion of canonical concepts and have integrated the role of context in conceptual representation (e.g., Ramscar & Yarlett, in press). Fieldwork by Braisby (2000) confirmed that people rely on different contexts to guide their conceptual judgments.

In scenarios with genetically modified foods, shoppers at a local grocery store deferred to external factors, such as contextual use of the food, over defining and prototypical features when asked to categorise these novel foods.

The notion of contextual value in conceptual representations is furthered by models of co-occurrence (i.e., how closely words appear in a semantic space; Landauer and Dumais, 1997; McDonald and Ramscar, 2001).¹ For example, on hearing the word *value*, semantically related words, such as *worth*, are activated as well (McDonald and Ramscar's example). This semantic association in processing implies that meaning of subsequent words is accessed more quickly and speakers rely on the linguistic environment to direct conversation and make predictions about the semantic content of words. People are sensitive to "statistical regularities in the linguistic environment... (which) explain(s) how language learners accomplish tasks from segmenting speech to bootstrapping word meaning" (McDonald and Ramscar, p. 611). Empirical work by McDonald and Ramscar revealed that people rely on co-occurrence of words when determining semantic content, especially with low-frequency words. The low-frequency word *samovar*, was presented in one of two contexts—a kettle-biased or an urn-biased context. The kettle-biased context included phrases such as 'Joe boiled water in the *samovar* for tea; (it) was blackened from years of use'. The urn-biased context included the following phrases: 'it was the first earthenware *samovar* that he had seen'. Participants' interpretation of the meaning of *samovar* was contingent on the context it was presented: properties associated with either kettle or urn were used to surmise the meaning of *samovar*.

¹ Models differ in their operationalisation of semantic space; some models define an optimum 'context window' by ± 2 and ± 10 words (e.g., Patel, Bullinaria & Levy, 1998).

Landauer and Dumais' model (1997) known as Latent Semantic Analysis (LSA) is a computational model of context-driven semantic processing, which uses a statistical process to produce meaning from a string of initially meaningless words. By determining how frequently words co-occur, LSA is able to infer semantic content, and has produced adult scores in vocabulary tests, and passed multiple-choice tests at a tertiary level. The authors claim that these achievements demonstrate the efficiency and effectiveness of context-dependent associations.

In context models for language, the closer and more frequently words appear together, the stronger the association between them. A recent model, known as the associate-scan model proposed by Barsalou (1999, Wu & Barsalou, under review; and Solomon and Barsalou, under review) applied a similar principal to people's perceptual experiences. Their findings indicated that when constructing a perceptual simulation of an object, people also encoded additional visual information in the surrounding context of the object.

Both accounts of context-driven decisions share a similar premise: conceptual representations are influenced by contextual environment. Although Landauer and Dumais's model (1997) and Barsalou and colleagues' model (e.g., Barsalou 1999, Wu & Barsalou, under review; and Solomon and Barsalou, under review) differ in the definition of a 'contextual environment' (the former position is based on the premise that learning in their model can occur without prior experiences, whereas the latter model relies on associated perceptual experiences), both models emphasise the importance of context over individuated concepts.

These context models challenge more traditional categorisation models, such as definition-based and prototype-based views. People may not have individuated

concepts per se and may rely more on contextual situations in category decision-making. However, the claim that the linguistic environment assists in the formulation of concepts may be overstated in light of the findings from this thesis. Although language plays a role in conceptual representations, the data presented here suggest that it only exerts a subtle effect on how people think. It is possible that linguistic context is only one factor in the formulation of conceptual representations, and other factors, such as perception and experience also contribute to representations.

The primary goal of this thesis was to explore the roles of language and experience in conceptual representations. In light of mixed results in previous cross-linguistic studies, we suggested a reformulation of the language-thought debate to accommodate varying influences of language on cognition. Based on this restructuring of linguistic influences, we explored both strong and subtle effects of language. In summary, the findings from this thesis have demonstrated that linguistic determinism and cognitive determinism are not tractable positions, and it is more productive to pursue the investigation of subtle linguistic effects in cognition.

APPENDIX A

Similarity ratings of both the baseline and experimental conditions in Chapter 5, Experiment 2

A general analysis on the similarity ratings from the baseline and experimental condition was conducted on three factors: F_1 =Language group as the between-group variable, and the Stimuli type (Object/Action) and Similarity type (in the object stimuli, same-pair objects are similar, and in the action stimuli, B-TC pairs are similar/in the object stimuli, same-type-pair objects are dissimilar, and in the action stimuli, B-AC pairs are dissimilar) as the two within group factors. In the by-items analyses, Stimuli type and Similarity type were between-condition variables, as the picture pairs are considerably different from each other; and Language group was the within-condition factor, as both language groups rated all stimuli.

A three-way mixed design ANOVA yielded the following results: there was a small effect for the between-subject variable of Language group, $F_1(1,53) = 3.09$, $p = .08$; in the by-items analyses, the effect was bigger, $F_2(1, 48) = 9.75$, $p = .003$. There was a main effect in how participants rated the object and action stimuli, $F_1(1,53) = 64.78$, $p < .001$; $F_2(1, 48) = 28.9$, $p < .001$. There was also a significant difference in ratings between the similar and dissimilar pairs of pictures, $F_1(1,53) = 92.65$, $p < .001$; $F_2(1, 48) = 84.1$, $p < .001$. The results revealed a significant interaction between Language group and Stimuli type was reliable, $F_1(1, 53) = 5.7$, $p = .02$; $F_2(1, 48) = 8.79$, $p = .005$. This finding suggests that linguistic patterns affected how participants rated

different stimuli. There was a modest interaction between Language group and the Similarity ratings in the by-participants analyses, $F_1(1,53) = 3.58, p = .06$; however, this was not confirmed in the by-items analyses, $F_2(1,48) = 2.8, p = .10$. The interaction between the two types of Stimuli and Similarity type was also significant, $F_1(1,53) = 28.66, p < .001$; $F_2(1,48) = 14.78, p < .001$, which indicates that the type of picture pairs influenced the similarity ratings. There was however, no 3-way interaction between the factors, $F_1(1,53) = 1.54, p = .22$; $F_2(1,48) = 0.31, p = .58$.

APPENDIX B

Similarity ratings of both the baseline and experimental conditions in Chapter 5, Experiment 3

Analyses were conducted with participants (F_1 ; Language group = between, Stimuli type and Similarity type = within) and items (F_2 ; Language group = within, Stimuli type and Similarity type = between) as random factors. Response latencies were the dependent measure.

In a three-way mixed design ANOVA, by-participants analyses indicate no main effects for Language group, $F_1(1,58) = 2.3$, $p = .14$; however there was a main effect in the by-items analyses, $F_2(1,76) = 7.4$, $p = .008$. There was no main effect for Stimuli type (object and action stimuli), $F_1(1,58) = 0.04$, $p = .80$; $F_2(1,76) = 0.48$, $p = .49$. The by-participants analyses indicate no main effect for Similarity type, $F_1(1,58) = 0.01$, $p = .91$, however there was a significant difference in the by-items analyses, $F_2(3,76) = 0.31$, $p = .03$. The interaction between Language group and Stimuli type was significant, $F_1(1,58) = 4.2$, $p = .04$; $F_2(1,76) = 7.8$, $p = .007$, suggesting that the different language patterns influenced the decision-time when responding to object and action stimuli. No interaction was observed between Language Group and Similarity type, $F_1(1,58) = 0.78$, $p = .38$; $F_2(3,76) = 0.57$, $p = .63$; nor between Stimuli type by Similarity type, $F_1(1,58) = 2.3$, $p = .14$; $F_2(3,76) = 0.87$, $p = .78$. The 3-way interaction was not significant in the by-participants analyses, $F_1(1,58) = 0.006$, $p = .94$, however, it was significant in the by-items analyses, $F_2(3,76) = 2.9$, $p = .04$.

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