# The Salience of the Hues: Colour Cognition from an Indigenous Australian Perspective

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy


John Lenarcic

School of Business IT and Logistics
College of Business
RMIT University


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## Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole of in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and, there has been no editorial work, paid or unpaid, carried out by a third party on this thesis.

John Lenarcic

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# Abstract

Does natural language determine the way we think? If the so-called Sapir-Whorf hypothesis of linguistics were true then colour categorization would be an entirely arbitrary process dependant entirely on the language that we speak. For a while in academic circles this was the received wisdom: The fact that English had 11 colour terms and Dugum Dani (from Papua New Guinea) had only two was a factor attributed to the language in use.

In 1969, Brent Berlin and Paul Kay ushered in the paradigm shift of Basic Colour Terms, a theory that defined the structure and evolution of colour terms in cultures (Berlin and Kay, 1969). According to this theory there was a neurophysiological basis for colour categorization, which implied that all human beings had the potential to see the same colours but naming the categories was an evolutionary process tied into the technological sophistication of a society. Language in other words played little or no part in colour perception. The initial theory was highly controversial with the demand growing for verification of the initial findings.

To address the contentious issues surrounding Berlin and Kay's theory, a project entitled the World Colour Survey was initiated with the goal of determining colour categorization patterns within 110 pre-literate cultures across the globe. This project has spanned more than 30 years with a definitive publication of the results still in the works. The current PhD project, which has been in progress since the dawn of time, involves an independent analysis and interpretation of the indigenous Australian component of the World Colour Survey raw data on colour categorization. It is both an exercise in secondary analysis as a research method and a tangential meditation on the ambiguity of knowledge that can be derived from extant data sets.

# Acknowledgements

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It takes a village to raise a child, so they say and it probably takes an academic department to nurture a PhD. Therefore, boundless appreciation is offered to the entire RMIT School of Business Information Technology for their collective part in what you now hold in your hand.

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# CHAPTER 1

# 1 Introduction

## *1.1 Aim*

*The aim of this study is to explore the World Colour Survey within the context of the indigenous Australian component in order to seek out and comment on any colour categorization patterns that may be present and determine whether or not they align with the Berlin and Kay (1969) framework of basic colour term theory.*

This thesis will document an independent analysis and interpretation that is limited to the indigenous Australian section of the World Colour Survey raw data devoted to colour naming which is available to the public online. The collected data that deals with the mapping of focal colours elicited from informants will be not be examined. Rather than broadly examining all of the 110 language groups in the World Colour Survey data set and arriving at a general finding that could be sanitised of any statistical noise that might be deemed extraneous, the research outlined here seeks to drill down into the five language cohorts of the World Colour Survey that represent the Australian continent, namely Kriol, Kuku-Yalanji, Martu Wangka, Murinh-Patha and Warlpiri.

Cross-cultural psychological studies dealing with indigenous Australian populations are sparsely represented in academic literature and little work has been done in the area of colour categorization. In fact, the survival of many indigenous languages is endangered in a large part due to the encroachment of Western culture (Dalby, 2003) and this would preclude such studies from ever being carried out again. So, the World Colour Survey data set is akin to a time capsule that can be probed almost in an archaeological fashion to gauge colour naming behaviour amongst the designated indigenous Australians who participated in an era of the recent past.

The administrators of the World Colour Survey project have generously made the data set available online for public use. This act is in itself an implicit example of the new “Science 2.0” movement, a term that describes the new customs of scientists who post raw experimental data, emerging theories, first-hand news of breakthroughs and rough copy versions of papers on the Internet for open access (Waldrop, 2008). This trend towards open distribution of raw empirical data may initiate a Web-fuelled resurgence in the research practice known as secondary analysis. This is defined as being any supplementary investigation of an extant data-set which produces discussions, suppositions, or knowledge that is extra to, or seen in an alternate viewpoint from, those offered in any initial publications on the data compilation and its results (Hakim, 1982). Now these initial publications referred to in the description of secondary analysis would normally be the product of the individuals who collected the raw data in the first place. In the case of the World Colour Survey, while there are some preliminary papers outlining the study's findings that members of the principal investigation team have produced, such as Regier and Kay (2003) and Regier, Kay and Cook (2005), publication of a long-advertised final monograph deliberating their overall conclusions is still being held in limbo at the time of this writing..

The origins of the World Colour Survey itself can be traced back over 30 years, so as an example of cross-cultural psychology it has become a historical artefact. The raw data as it stands can probably never be replicated in a similar manner by new field work, given the deterioration of indigenous Australian languages (Nettle and Romaine, 2000), not to mention the overpowering influence of Western culture on potential informants in the guise of English. This is a serious limitation of the work but then one has to take the available World Colour Survey raw data at face value, almost as a possibly flawed treasure. It is the intention of the research presented in this thesis to treat the indigenous Australian component of the World Colour Survey data set as a kind of bygone entity that documents the qualitative responses of the informants with regards to what colour categories they thought were presented to them.

Rather than supporting the existing theory by Berlin and Kay (1969), a reading of the World Colour Survey raw data using a statistical technique to examine the level of diversity may in fact reveal errors and inconsistencies that could lead to counterintuitive insights. Or the exploratory process may simply show that this particular section of the World Colour Survey raw data that is available online is still in a mess with no discernible patterns of interest embedded therein. Either of these findings would make a statement on the status of the World Colour Survey data set as is: Is it proof positive of an influential theory of colour categorization or is a source of continuing ambiguity? This is an overarching research question addressed in this work.

## 1.2 Motivation

The pages that follow document independent research that offers a novel secondary analysis of the indigenous Australian component of the World Colour Survey. The World Colour Survey is a global field experiment to verify the theory of basic colour terms originally advanced in Berlin and Kay (1969). The work of Berlin and Kay (1969) advocated that universal colour categories existed with a possible neurophysiological basis that enabled them to transcend the influence of natural language, thus making them pan-cultural in nature. The research presented in this thesis is deemed to be original, first and foremost, because it segments the indigenous Australian component of the World Colour Survey data set, which is available to the public online. At a secondary level the novelty of the research is exhibited in its examination of the data using diversity metrics primarily employed in ecological modelling.

Thirty years after the project began, the chief investigators of the World Colour Survey have not, as of the time of writing this, published their findings in a final report, even though said monograph has long been advertised as coming soon. Few analyses, independent or otherwise, of the World Colour Survey data set currently are in print and those that do span all the 110 language groups that were covered in the study will be discussed. These may have found statistically-relevant patterns in the data en masse but these configurations do not reveal anything special about what may be present in the data belonging to isolated groups of languages on a continent such as Australia. It is a case of not being able to see the forest for the trees. As the proverb implies, at times attention to detail can distract one from the situation as a whole. The big picture here is the level of diversity in the World Colour Survey data.

Even a casual inspection of the Kriol, Kuku-Yalanji, Martu Wangka, Murinh-Patha and Warlpiri World Colour Survey data sets discloses a high level of diversity in the codes that represent colour categories elicited from informants. The research outlined in this thesis will approach the World Colour Survey data set as if it were analogous to a natural closed ecosystem, home to various living species. Instead of gauging biodiversity, though, the diversity of colour categories will be considered instead, with the different terms elicited from indigenous subjects being the analogue of species. In tandem with this diversity analysis of the indigenous Australian World Colour Survey data set will be a more linguistic approach to probing the data and teasing out any meaning therein. The significance of colour to indigenous Australian culture and speculations otherwise will be addressed at a peripheral level during the course of the journey.

Colour is more than just a quality of experience. Apart from its practical applications to those who paint in the fine arts, it is an idiosyncratic scholarly pastime unto itself that over the centuries has fascinated the likes of physicists, chemists, philosophers, psychologists, linguists, anthropologists, neurologists, art historians, authors and even the odd politician, namely 19th century British Prime Minister, Sir William Gladstone (Riley, 1995; Ball, 2001).

Chromatic experience is something that most of the population take for granted. Yet colour is the canvas of existence in the visual sense. Those of us who are not colour blind in some form or another cannot avoid being exposed to the full extent of the spectrum. It is perhaps the confounding simplicity of colour that has made it an intellectual pursuit for many.

Here is an example to illustrate one facet of colour’s perplexing characteristics: When a tomato is illuminated by white light, red light is reflected and it appears to be of that colour. However, when that same tomato is bathed in blue light, it still appears to be red. This is due to the phenomenon of colour constancy (Morgan, 1997). Our perceptual systems strive to provide stability in automatic behaviour patterns (e.g. to maintain consistency in object recognition) and in the process subvert what we would expect to be true through common sense.

We may assume and wrongly so that blue light should make all objects in its path blue in appearance but our brains ensure that a different perceptual strategy is in play. In fact it was Sir Isaac Newton who famously proclaimed that rays of light are not coloured in themselves but have the propensity to evoke the sensation of colours in the observer (Gleick, 2003). The wavelength interpretation of colour is merely one perspective of the phenomenon, one that is subject to perceptual variability. It can be assumed that colour is a quality that can be objectively measured in terms of its wavelength, ranging from 400 nanometres for ‘violet’ to 700 nanometres for ‘red.’ Subjectively, however, the phenomenon of metamerism complicates matters in this respect, since there exist colours that when matched appear to be the same to the naked eye yet possess different spectral distributions when physically measured (Berns et al, 2000).

It is worth noting here that the aforementioned use of the word ‘violet’ has also evoked consternation in some, given its place in the names of spectral colours (‘red,’ ‘orange,’ ‘yellow,’ ‘green,’ ‘blue,’ ‘indigo’ and ‘violet.’) The concern is mainly with regard to the inclusion of ‘indigo’ by Sir Isaac Newton in the list of spectral colour names, since the latter would seem to refer to the same colour as ‘violet,’ at least in ordinary discourse. McLaren (1985), in fact, speculates that Newton’s inclusion of ‘indigo’ in the colour spectrum was an attempt to develop an analogy with the musical scale. But is ‘violet’ the same as ‘purple’? The mundane vagueness of language in categorization can be both a source of power and confusion as will be revealed in this work.

The real world is inherently ambiguous and our perceptions of it are of a probabilistic nature. It is considered that in order to operate with consistency in an environment the autonomic need for predictive interpretation of the objects that we experience has emerged. This processing is postulated to be undertaken by the brain, which actually means the entire neural-perceptual system. Indeed, some would even argue that *“color is in the brain, not in the world”* (Frith, 2007, p. 134). If this is true then it would be a case of the brain generating value-added knowledge to enhance human functionality. This is an important point with regard to how we classify our environment: The act of colour categorization could very well be dependent on the malleable properties of human diversity at a perceptual level.

Research indicates that as the brain develops to physical maturity it requires sensory stimulation to reach an optimal state (Wexler, 2006). The neuronal networks that govern thought and behaviour are formed within this organ over time via connections that are shaped by external stimuli. Over time the accrued routines, opinions and values of a set of people become a shared definition for their general behaviour as a whole and another means of describing a collective lifestyle. This cluster of social actions and modes of conduct becomes known as culture and its emergence provides a rich constellation of sensory stimuli via linguistic or aesthetic channels. By changing the cultural environment, each generation shapes the brains of the next. By early adulthood, the neuroplasticity of the brain is greatly reduced, and this leads to a fundamental shift in the relationship between the individual and the environment: during the first part of life, the brain and mind shape themselves to the major recurring features of their environment; by early adulthood, the individual attempts to make the environment conform to the established internal structures of the brain and mind.

In his exposition on how the human brain shapes culture and vice versa, Wexler (2006) explored the social implications of the close and changing neurobiological relationship between the individual and the environment, with particular attention to the difficulties individuals faced in adulthood when the environment changes beyond their ability to maintain the fit between existing internal structure and external reality. Humans as a community generate culture and then culture loops back to physically affect its host source and so forth. It is claimed by Wexler (2006) that we can differentiate between a myriad of just-noticeable differences in colour yet most cultures choose to only label a distinct few.

The subjective nature of colour is part of the very essence of human consciousness, yet it is something that is more often than not glossed over in discourses on the latter. It has been mooted that perception does not exclusively depend on either raw sensory data or on high-level computational mechanisms such as categorization (Corr, 2006). There is significant integration of modules within the human perceptual system that all work together in a synchronized manner. Perceptions and bodily actions align, intersect and interfere with each other within sensorimotor systems to produce the emergent psychological nature of sensation. Colour cognition is one aspect of this maze of complexity.

There is a distinction between the sensation of colour and its perception. Sensation involves being able to recognize just-noticeable differences in chromatic appearance. Perception, on the other hand, has been argued to be intertwined with the processes of reasoning itself (e.g. Arnheim, 1969). The ability to segment the environment into categories and assign names to these requires thought which later may evoke further meanings. These possibly multi-dimensional meanings can become what is dubbed tacit knowledge, namely that which is by its very nature intuitive in kind and not readily amenable to overt codification. An understanding of colour as a knowledge base in its own right, rather than a mere quality of experience, rests on the supposition that such insight is primarily derived via implication and not through any reductionist form of measurement. It is this holistic nature of colour that may make it difficult to convey its description to others, especially in cross-cultural matters, as will be revealed in this thesis.

The degree to which colour is still a matter of confusion to many is illustrated in the following recent quote.

> *"Color cannot be assigned a dimension, size, or number. If we wish to say something about color, therefore, we must rely on impressions formed under varying temporal and spatial conditions affecting both the observer and the observed. Modern color reproductions would seem to facilitate communication on the subject, but the problem remains the same: the perception of color is based on personal impressions of a rather haphazard nature"* (Pleij, 2004, p. 9).

Now, the author of the aforementioned text on medieval interpretations of colour appears to be completely oblivious of the existence of colour order systems, such as the widely accepted Munsell system (Nickerson, 1976), which broadly organise chromatic relationships in a spatial manner via the three dimensions of hue, lightness and saturation, or their respective equivalents depending on what system is being used. However, Pleij (2004) does make an interesting point in highlighting the role of personal impressions in colour discrimination.

The term "impression" is suggestive of a feeling that is explicated by thought. Colour is a quality that engages both the cognitive and emotional sides of our being. The cognitive act of classification permits us to label something as being "red" but this colour also evokes the emotions with the suggestion that it is "warm", a category that is oriented to feeling. Language can be used to describe experience but linguistic constraints have been advanced as being factors than can affect the process of thought itself. In linguistic scholarship this notion is referred to as the Sapir-Whorf hypothesis, whose variants are that natural language either determines the way we think (i.e., linguistic determinism) or merely influences cognitive processes (i.e. linguistic relativity). Essentially the Sapir-Whorf hypothesis states that there is a systematic relationship between a language's grammatical structure and the world view of a speaker of that language (Koerner, 1992).

This thesis will address these intersecting themes from the perspective of colour nomenclature. If the Sapir-Whorf hypothesis were true in its extreme guise (i.e. "language determines thought") then colour categorization should be an entirely arbitrary process dependant entirely on the language that we speak. For a while in academic circles this was the received wisdom: The fact that English had 11 colour terms and Dugum Dani (from Papua New Guinea) only two was a factor attributed by some to the natural language in use that enabled classification to take place (Heider-Rosch, 1972b).

In 1969, Brent Berlin and Paul Kay (Berlin and Kay, 1969) ushered in the paradigm shift of basic colour terms, a theory that defined the structure and evolution of colour terms in cultures (Berlin and Kay, 1969). According to this theory there was a neurophysiologic basis for colour categorization, which implied that all human beings had the potential to see the same colours but naming the categories was an evolutionary process tied into the technological sophistication of a society. Language in other words played no significant part in colour perception. In terms of anthropological thought, it was an attempt at offering a causal explanation for an observed phenomenon, rather than adopting the standard practice of detached interpretative description.

The initial theory was highly controversial with the demand growing for verification of the initial findings. To address this conflict an interdisciplinary project entitled the World Colour Survey was conducted under the aegis of Berkeley's Institute of Cognitive Studies with the goal of determining colour categorization patterns within 110 pre-literate cultures across the globe (Kay, Berlin, Maffi and Merrifield, 1997). This project has spanned more than 30 years with a definitive publication of the results still in the works. (The text "World Colour Survey," said to be published by the Center for the Study of Language and Information at Stanford University and co-authored by Paul Kay, Brent Berlin, Luisa Maffi and William R. Merrifield, is listed as being available for purchase on Amazon.com and has been so for over a year, yet a search of the Library of Congress catalogue, as of January 2009, returns no hits on this book. Yet both editions of Berlin and Kay (1969), the original 1969 version and the 1999 reprinting, are listed in the Library of Congress collection. The latter is a deposit library, meaning that any copyrighted work that is published in the United States must be deposited there. So, the "World Colour Survey" monograph must not have been published as yet.)

## *1.3 Approach*

Diversity in colour categorization was a hallmark of the pre-Berlin and Kay (1969) era when it was consider entirely arbitrary on a pan-cultural basis. However in the post-Berlin and Kay (1969) age, variability in colour naming at an individual level is still present in studies such as the World Colour Survey. Amongst these subject groups, numbering 20 - 25 on average, the level of agreement was not high, particularly amongst the indigenous Australian cohorts who are the focus of this thesis. When presented with a single Munsell colour chip, variability in denotations of the same stimulus was prevalent amongst subjects in the study. This statistical noise is something that could be exploited from an analytical point of view by seeking inspiration from other areas of knowledge.

For example, simulated annealing is a commonly employed optimization technique employed for combinatorial (and other problems) in numerate disciplines such as econometrics. This mathematical procedure takes advantage of the similarity between the way in which a metal cools and solidifies into a crystalline structure possessing a minimum energy level (i.e. the annealing process) and the pursuit of a minimum in a more general system (Kirkpatrick, et al, 1983).

In a similar vein – but from a biological rather than a physical science perspective –the methodological approach employed in the research outlined in this work will adopt the metaphor of species diversity in a natural environment as a frame of reference for at least partially determining the basicness of a colour term. Biological systems can be interpreted structurally via a hierarchy of ascending complexity: molecules, cells, organisms, populations, communities and ecosystems. The notion of species diversity is a trait exclusive to the community level of biological association. From an ecological perspective, higher species diversity is commonly taken to point toward a more intricate and robust community because a larger assortment of species allows for more interactions between classes, consequently resulting in greater system stability and offering an indication of favourable environmental conditions (Ziegler, 2007). A variety of diversity indices can be calculated to compare ecological communities.

Species diversity has two parts. Richness refers to the number of species found in a community and evenness refers to the relative abundance of each species (Magurran, 2004). A community is said to have high species diversity if many nearly equally abundant species are present. If a community has only a few species or if only a few species are very abundant, then species diversity is low. Consider a community with 100 individuals distributed among 10 species. It should make sense that if there are 10 individuals in each of the 10 species in the community it is more diverse than if there are 91 individuals in one species and one individual in each of the other nine species. Figuratively speaking, if one can consider a Munsell chip to be a chromatic "ecosystem" (or, more appropriately, a lexical system), then the possible names that can denote the chip would take on the role of different species that inhabit this conceptual domain. Imagine the World Colour Survey colour chart as a global set of 330 of these schemas. The foci (or basic colour terms) in this abstract universe would then correspond to those lexical systems in which the species diversity index is at a minimum because that would imply a greater level of agreement in nomenclature and a reduced number of alternate colour terms.

## 1.4 Contribution

The publication in 1969 of Paul Kay and Brent Berlin's theory of Basic Colour Terms initiated a storm of academic controversy. This paradigm ran counter to the then-established principle of arbitrary language variation. Berlin and Kay's multilingual investigation of colour nomenclature suggested that a pan-cultural, near universal pattern existed in the categorization of colours that were designated abstract names in each language of the study at the time. The subsequent debate was a catalyst in reforming the opinions of anthropologists, linguists, and biologists alike. Disputes about the theory abound in the literature since its inception. Criticisms levelled at the original theory eventually precipitated the World Colour Survey in an effort to validate the findings. The raw data of the World Colour Survey has only recently become available online, thus providing an open-source forum for independent analysis Examination of the World Colour Survey raw data set to date has focussed on statistical analyses of the entire corpus. This thesis will present an analysis and interpretation of the indigenous Australian component of the World Colour Survey raw data in isolation.

## 1.5 Outline of the Thesis

This thesis is comprised of six chapters, a references section and five appendices of graphical representations of data. Chapter One is an introduction to this work and outlines the motivation of the research, methodological approach and research questions and objectives.

Chapter Two is a literature survey that provides both an overview of the pertinent literature dealing with the convoluted research domain of colour categorization from its 19th century origins to the seminal work of Berlin and Kay (1969) and their supporters and opponents and on to the present day flurry of scholarly activity culminating in the wake of the World Colour Survey and peripheral ventures. This chapter also contains an abridgment of germane issues related to indigenous Australian language and culture. The latter is included because this work deals with an analysis of the indigenous Australian component of the World Colour Survey.

Chapter Three describes how the appropriate research methodology that was undertaken to analyse the indigenous Australian component of the World Colour Survey was arrived at. Since this work entails a secondary analysis of an existing data set with the intention of seeking out likely patterns or otherwise therein, content analysis as a practice is discussed at first. The preliminary view of treating the World Colour Survey data set as a text, variable in nature, led to an investigation of the analysis of diversity as such and this is expressed chiefly from an ecological vantage. Using ecological modelling of natural environments as a source of insight, colour terms elicited from World Colour Survey informants denoting individual colour stimulus chips were conjectured to be analogous to biological species. Therefore an examination of what makes up a species is included in this chapter, along with the problems associated with species differentiation from a categorization perspective. Speculation that natural language itself is a species is also suggested in support of the research methodology adopted.

Chapter Four describes the analysis of the indigenous Australian component of the World Colour Survey as depicted in this research. It commences with a description of a reference point for the analyses that will follow, this being the results of a study by Sturges and Whitfield (1995) that determined English focal colours. Next, each of the analyses for the indigenous Australian cohorts in the World Colour Survey is detailed according to a standard format. The language groups in question are Kriol, Kuku-Yalanji, Martu Wangka, Murinh-Patha and Warlpiri.

Chapter Five features a discussion on the outcome of the analyses offering a broad range of arguments to understand the nature of the results and Chapter Six offers a summary of this work in a final conclusion.

# CHAPTER 2

# 2 Literature Survey

## 2.1 Introduction

The chapter provides both an overview of the pertinent literature dealing with the labyrinthine research area of colour categorization, as well as a synopsis of relevant issues concerned with indigenous Australian language and culture. The latter is important because this work deals with an analysis of the indigenous Australian component of the World Colour Survey.

The chapter opens with early work by 19th century British Prime Minister William Ewart Gladstone, whose peripheral speculations on the deficiency in colour perception by the Ancient Greeks arguably sparked generations of later research in cross-cultural colour categorization (Gladstone, 1858). This work dealt with issues of how language and culture could affect the segmentation of the colour spectrum. In fact, colour categorization was eventually to become a leading test-bed to gauge the validity of the so-called Sapir-Whorf hypothesis in linguistics - namely that language influences thought - and this is covered next in the chapter.

Also allied to colour categorization is the work by Eleanor Rosch on prototype theory and the notion of what constitutes a salient category (Rosch, 1973a, 1973b, 1988). Following on from this, an overview is presented in this chapter of the now dominant Berlin and Kay paradigm of basic colour terms is described, along with their notion of the evolutionary sequence of colours in cultural development. The neurophysiological significance of this theory is also noted, with its idea of universal colour categories that are in opposition to the Whorfian view of linguistic influence (Whorf, 1956). The theory of Berlin and Kay (1969) proved to be controversial and criticisms of it both early and ongoing are featured in the chapter.

To counter growing academic dissension with basic colour terms as a concept, the World Colour Survey was initiated as a global cross-cultural experiment in colour categorization to validate the original theory in a more complete manner (Cook et al, 2005). A synopsis of this ongoing academic debate is outlined within this chapter. From the earliest release of its often anomalous findings, the World Colour Survey was to be equally contentious in academic circles, spawning at least one new theory to explain the irregularities observed. The most prominent one, namely vantage theory (MacLaury, 1997), is described in this chapter as one approach to modelling colour categorization that has generic transferability to other domains but one that adds an extra layer of explanatory complexity.

Neo-Whorfian challenges to the Berlin and Kay (1969) paradigm have surfaced recently and these are described in overviews of the work by researchers such as Ian Davies and Debi Roberson, an example being Davidoff, Davies and Roberson (1999). Recent analyses of the World Colour Survey data set, made available online for public use, are also covered in this chapter. One series of research related to these analyses links back to the original opinion of Gladstone in the 19th century that the Ancient Greeks were colour deficient with an inability to perceive 'blue' (Gladstone, 1858). Analyses of the World Colour Survey, such as those by Lindsey and Brown (2002), have been used to offer a possible cause for colour categorization anomalies observed in informants from equatorial regions.

The section of this chapter that deals with indigenous Australian language and culture begins with a commentary on linguistic sophistication levels, followed by a discussion of the problems of classifying languages within the continent. The ambiguity of indigenous Australian languages is explored as well as their diverse richness, especially in communication styles. The semantics and classification practices of indigenous Australian languages are also featured. Particular mention is made of Western Desert languages because one of these, Martu Wangka, is part of the indigenous Australian component of the World Colour Survey, the other language groups being Kriol, Kuku-Yalanji, Murinh-Patha and Warlpiri. Aboriginal sign languages are also discussed as a parallel dialect. Some coverage is assigned to Aboriginal art and the chapter closes with an exposition on existing research from cross-cultural psychology dealing with indigenous Australia.

## 2.2 In the Cradle of Biological Determinism: 19th Century Theories of Colour Terminology and its Evolution

The Oxford University Gazette of 21 May 1998 featured a report of the University Church commemoration service marking the centenary of the death of William Ewart Gladstone, four-time British Prime Minister, Liberal statesman, amateur philologist and classics scholar. Wheatcroft (1997) noted that the utter duration and extent of his public life make him virtually peerless in the history of British politics, with Winston Churchill, another intellectual British Prime Minister, perhaps being the only comparison. Gladstone's prowess as a charismatic orator led the well-known contemporary journalist W. T. Stead to depict him as being a "kind of secular pope" (Crosby, 1997).

In a 1998 memorial service to honour this 19th century politician and polymath, Gladstone, who obtained a degree in Classics and Mathematics from Oxford in 1831, was acclaimed for his outstanding "moral non-*conformism*" (Crosby, 1997). Indeed, it was probably this non-conformist streak in his personality that partially fuelled Gladstone's initiation of the debate on the cultural differences in colour perception and in color vocabulary. Sloane (1989) goes so far as to call Gladstone the "grandfather" of this still-raging controversy. Hickerson (1983) considered his writings in this domain as being a pioneering though flawed study in ethnolinguistics that offer a unique synthesis of the cognitive abilities of a particular race in a cultural setting (in this case, the ancient Greeks), primarily derived from investigating their indigenous lexicon.

Crosby (1997) labelled Gladstone as *being* a "Victorian workaholic". Wheatcroft (1997) commented that during his lifetime Gladstone recorded that he had read in the order of 20,000 books in at least six languages. His reading interests covered a panoply of genres, as Jenkins (1995) described with astonishment, including theology, politics, history, science, poetry, fiction, as well as all the leading controversial publications of the time. Gladstone was the recipient of literally thousands of complimentary books from publishers, as well as authors, owing to his reputation as an avid bibliophile (Glasgow, 1998).

Among other myriad pursuits between political ministries, he actively maintained his intellectual preoccupation with classical studies and in 1858 released an imposing three-volume book on the life and work of the epic poet Homer. Gladstone was an individual whose strong religious beliefs influenced his political activities and even tainted his scholarly interests. For example, in his Homeric analysis, Gladstone postulated that the ancient Greek poet had in fact received divine revelation akin to the Judaic prophets (Crosby, 1997). According to Jenkins (1995), who believed that Gladstone used Homer to promote a religious cause, the critical response to *"Studies in Homer and the Homeric Age"* was predominantly unfavourable from a scholarly perspective. What proved to be a revelation to some anthropologists, though, was Gladstone's radical supposition that the ancient Greeks as a race possessed defective colour vision, existing essentially at a premature stage of development. Basing his argument on Homer's idiosyncratic use of colour terms, Gladstone (1858, p. 458) offered the following justification:

> *"Among the signs of the immaturity which I have mentioned, the following are found in the poems of Homer:*
>
> *I. The paucity of his colours.*
>
> *II. The use of the same word to denote not only different hues or tints of the same colour, but colours which, according to us, are essentially different.*
>
> *III. The description of the same object under epithets of colour fundamentally disagreeing one from the other.*
>
> *IV. The vast predominance of the most crude and elemental forms of colour, black and white, over every other, and the decided tendency to treat other colours as simply intermediate modes between these extremes.*
>
> *V. The slight use of colour in Homer, as compared with other elements of beauty, for the purpose of poetic effect, and its absence in certain cases where we might confidently expect to find it."*

It is interesting to observe that while Gladstone's activities in the arena of Homeric scholarship are well reported his reflections on the degree of incipience of ancient

Greek colour perception receive little or no attention in mainstream biographies on the politician (e.g. Shannon, 1982; Matthew, 1986a; Bebbington, 1993; Matthew, 1995; Jenkins, 1995; and Crosby, 1997.) Even Gladstone's comprehensive *Diaries* contain scant detail on his colour-related interests. According to Matthew (1978), diary entries indicated that Gladstone worked on the colour section of his *"Studies in Homer and the Homeric Age"*, with a modicum of self-confessed diligence, on the 4th, 5th, 6th and 8th of February 1858, completing the section on the latter date. The characteristically terse diary entry for Monday, February 8, 1858 was as follows: *"Worked on Homer: finished 'Colour': which has been stiff."* In fact, this last section was one of the final parts he worked on before declaring his Homeric manuscript to be finished on Wednesday, February 10, 1858, a little under three years after he started out on this academic odyssey.

Gladstone (1858, p. 457) prefaced his manifesto on *"Homer's Perceptions and Use of Colour"* with the chauvinistic remark: *"That our own country has some special aptitude in this respect, we may judge from the comparatively advantageous position, which the British painters have always held as colourists among other contemporary schools."* Hickerson (1983) pointed out that Gladstone was probably the first author to employ a set of English colour terms to serve as a de facto standard against which to evaluate another alien system of colour nomenclature: An Anglocentric habit which has persisted to this day and is the subject of criticism in some circles (e.g. Saunders and van Brakel, 1997).

In his literary dissection of the ancient Greek texts, Gladstone (1858) singled out colour epithets that Homer appeared to have used inconsistently. Hickerson (1983) noted that the ancient Greek colour term *porphureos* (with the provisional English gloss being *violet*) was the first one that Gladstone (1858, p. 461) indicated as exhibiting *"a startling amount of obvious discrepancy"* in the list of referents to which it was applied. These referents included blood, dark clouds, waves, and disturbed river and ocean waters; garments and carpets; the rainbow; in compounded forms assigned to wool and woollen textiles; and, metaphorically, death, and the brooding mind. Using English equivalents, the aforementioned ancient Greek colour category was used to describe such diverse qualities as *"the redness of blood"*; *"the purple proper, as of the sea"* (Gladstone, 1858, pp. 461-462); and *"the grey and leaden colour of a dark cloud when* *about to burst in storm, and of a river when disturbed"* (Gladstone, 1858, p. 462) as well as possibly designating *"tawny"* or *"brown"* shades.

In a contemporary historical essay by a physicist dealing with the nature of light, Park (1997) wrote that Homer describes the sea as being either purple, white or wine-like but never blue. The poet's works also feature cattle as being wine-like in hue and wine as being, on occasion, black. In a rare use of the colour blue, Homer employed it in the *Iliad* to describe the deceased Hector's hair. In the *Odyssey*, Homer referred to fresh meat or fish as being yellow-green in appearance, *yet* talked about "green wood" in a manner akin to its contemporary meaning. The *Odyssey* also included the emotion of fear being given the adjective "green". Park (1997) then indicated that the 5th century B.C. ancient Greek playwright Euripides also used colour in a counter-intuitive fashion: In *Medea*, green tears flowed down the woman's cheeks, while in *Hecuba*, the daughter of Queen Hecuba, Polyxena, apparently has blood that is yellow-green in colour.

Gladstone (1858) was also troubled by the fact that Homer never used the appropriate equivalent of blue to describe the sky, choosing such alternative equivalents as *"starry", "broad", "great", "iron"* and *"copper"* in different instances. He stated, with a touch of irony:

> *"So again with wine-coloured oxen, smutty thunderbolts, violet-coloured sheep, and many more, it is surely conclusive against taking them for descriptions of prismatic colours or their compounds, that they would be bad descriptions in their several kinds. We must then seek for the basis of Homer's system with respect to colour in something outside our own"* (Gladstone, 1858, p. 487).

Sceptical of accepting the traditional belief that Homer was blind, Gladstone (1858) chose not to use this avenue to rationalize the odd deployment of color names. In a similar vein, he rejected the notion of some sort of blanket poetic license being at play in Homeric colour epithets, claiming that such a practice would have led to confusion by readers comfortable with a fixed standard for colour. Ultimately, Gladstone (1858, p. 488) made the pronouncement:

> *"I conclude, then, that the organ of colour and its impressions were but partially developed among the Greeks of the heroic age. In lieu of this,*

> *Homer seems to have had, firstly some crude conceptions of colour derived from the elements; secondly and principally, a system in lieu of colour, founded upon light and upon darkness, its opposite or negative.”*

He also noted that the alleged phenomenon of colour term confusion was still present during the later era of Aristotle. Gladstone’s source for the latter observation was the 1849 text “*Aristoteles über die Farben*” by Carl von Prantl (Matthew, 1978). Aristotle held that the three primary colours (or hues) were red, green and blue, a notion that he apparently inherited from Anaximenes (Miller, 1993).

### 2.2.1 Colour Term Usage in the Hellenistic Era

Platnauer (1921, p. 162) agreed with Gladstone on the matter of defective colour term usage amongst the ancient Greeks, with the suggestion “*that they felt little interest in the qualitative differences of decomposed and partially absorbed light.*” He believed that “*it is lustre or superficial effect that struck the Greeks and not what we call colour or tint,*” adding that “*this is more or less natural in a country where the light is brilliant.*” Osborne (1968) presumed that the ancient Greeks appreciated “gaudy” colours and were chiefly impressed by chromatic “brilliance” (i.e. “a factor of saturation combined with luminosity”) rather than differences of hue. He judged the ancient Greek colour vocabulary to be “jejune”, relatively sparse in number and oddly applied compared to the European practice of modern times.

In a comprehensive review of colour term usage in ancient Greek poetry, Irwin (1974) offered a hypothesis to explain the literary disinterest in adopting a blue-green vocabulary. The suggestion is given, with reference to the Munsell colour order system (Nickerson, 1976), that for a race whose idea of colour is still at an embryonic stage, hue is most prominent in colours of high value and chroma. Consequently, those colours that by virtue of their spatial position are low in value (i.e. “dark” colours) are more probably to be denoted in terms of their value rather than hue. Hence, the hues of reds and yellows were more compelling to the ancient Greeks than those of blues and greens.

Gladstone’s startling assumption that the ancient Greeks were afflicted with dyschromatopsia, essentially using differences in brightness as primary visual cues rather than hues, consequently implied that colour vision as a well-developed sense would have been a relatively recent acquisition when judged against the time scale of human evolution (Gladstone, 1858). Of course, one could also speculate that the trait of colour-blindness (or some more debilitating form of colour vision disorder) was a genetic abnormality endemic to the ancient Greeks as a race. Indeed, philosophers such as Wittgenstein (1977) have entertained the possibility in the abstract sense by devising thought experiments imagining the problems that would be faced by a tribe of colour-blind people. One immediate problem would be a lack of colour concepts that could be shared by other cultures. If they could speak English, they would have access to all the English colour words but they probably would have learned to use them in a different fashion. If they were fluent in a foreign language then translation would be a difficulty. However, Maxwell-Stuart (1981) voiced what is probably the intuitively obvious opinion of the masses when he states that the discovery of an entire ethnic group being affected by flawed vision would be an astonishing occurrence.

### 2.2.2 The Island of the Colour Blind

The proposition that such an affliction could have an ethnological origin is not an entirely preposterous notion in the light of contemporary medical evidence. For example, Sacks (1996) documented the existence of a totally colour-blind community on the tiny atoll of Pingelap situated among the Pacific Islands where a remarkably high proportion of the population has suffered the debilitating effects of congenital achromatopsia. Hussels and Morton (1972) also noted that high myopia accompanies the incidence of congenital achromatopsia amongst the indigenous population. Cassin and Solomon (1990) indicated that reduced visual acuity is symptomatic of this type of achromatopsia which is also referred to as rod monochromacy.

Brody *et al* (1970) recorded that between 4% and 10% of the Pingelapese people are monochromats from infancy. In comparison, Pokorny *et al* (1979) cited the normally observed incidence of complete achromatopsia with reduced visual acuity in a general population to be about 1 in 30,000 (i.e. 0.003%), while the prevalence of complete achromatopsia with normal visual acuity (also known as cone monochromacy) is an even rarer disorder (about 1 in $10^8$ of the population.) It is postulated that the genetic defect responsible for this condition reached a high frequency after a typhoon devastated the atoll around 1775, sharply reducing the population and isolating the remaining survivors. In other words, over a time span of just two centuries the ability to perceive colour has vanished for a significant percentage of the inhabitants.

### 2.2.3 Homer and Environmental Factors in Colour Vision within Populations

Rutherford (1996, p. 9) had this to say about Homer as a historical figure: *"We do not know who Homer was, and ancient biographies, largely fanciful in the manner of the genre, are no help; the fact that there was even speculation as to the origin of the name proves that antiquity was no wiser than we are about the man behind it."* Magnusson (1990) wrote that Homer lived during the 8th century B.C. and that "*the tradition that he was blind may have little basis in fact.*" Homer may have recited his poems to his pupils, the so-called "*Homeridae*", who then recited them to others or committed them to writing, perhaps with changes added in the process. Then again Homer may have committed his verses to writing himself. The Greek island of Chios (or Khios) in the Aegean Sea is one suggestion for the birthplace of Homer (Bridgwater and Kurtz, 1969).

If one of the Greek islands were in actual fact the place of origin of Homer, it would not be out of the question to speculate that his blindness of ancient lore may have its roots in the same genetic defect that has befallen the Pingelapese in more modern times (Sacks, 1996). Homer may have been a member of an isolated community of monochromats or he may have been individually stricken in this manner. In the latter hypothetical scenario, it could be that the Homeridae were instrumental in transmitting their master's anomalous colour descriptions.

Referencing a study of individual differences in colour vision undertaken by Pickford (1951), Kalmus (1965) observed that the latter found a colour normal girl who used irregular colour descriptions apparently under the influence of her 'blue'-deficient sister. Ozgen and Davies (2002) who found that training could improve an individual's capacity to distinguish similar hues of a single colour. In the case commented on by Kalmus (1965), the colour normal girl had effectively been implicitly "trained" to use abnormal colour imagery by her 'blue'-deficient sister.

It must be mentioned, though, that the incidence of achromatopsia amongst modern Greeks is exceedingly rare. In a colour vision study involving 29,985 Greeks aged between 13 and 17 years old, Koliopoulos *et al* (1976) observed that of the 21,231 males examined, 1,678 had some form of dyschromatopsia but only two of these were monochromats. Of the 8,754 females surveyed, only 37 had a detectable colour vision disturbance and none of them were monochromats. The findings closely matched the prevalence rate for dyschromatopsia found from other studies at the time focusing on European male populations.

In yet another hypothetical scenario, either Homer or his followers could have been victims of the rare neurological disorder known as synaesthesia (Cytowic, 1989). The strange use of colour terms in the epic poems could then be attributed to the writer's complication in differentiating between different sensory inputs. Birch *et al* (1979) indicated that trauma to the brain or visual pathway could result in loss or degradation of colour perception. One type of colour vision defect of cerebral origin is colour agnosia, a condition distinguished by the total or partial incapacity to name colours or to choose them by name alone, or to associate correct colour names with common objects. Pinckers *et al* (1979) noted that colour agnosia does not necessarily prevent those afflicted from experiencing normal colorimetric performance and chromatic discrimination. Evidence suggests that colour agnosia is predominantly a defect of either categorization or association abilities.

Acquired colour vision defects can be due to vascular lesions of the cerebral cortex, concussion damage or specific lesions induced by tumours. A stroke, for example, is described as being one cause of unilateral colour vision loss in a particular individual. Critchley (1965), cited in Birch *et al* (1979), reported the case of a stroke victim with a transient visual aberration who claimed all objects were *"covered with gold paint."* Technically described as being *xanthopsia*, the latter condition is a type of chromatopsia, or perversion of colour vision, in which white visual stimuli appear yellow.

Chromatopsia resulting as a side-effect of a cortical defect is sometimes called coloropsia. Such chromatopsias are temporary afflictions and come in other manifestations as well: *ianthinopsia*, if white is perceived as purple or violet, *cyanopsia*, if white is perceived as blue, *chloropsia*, if white is perceived as green and *erythropsia*, if white is perceived as red (Pinckers *et al*, 1979). Perseveration is another bizarre symptom of some acquired colour vision defects. This is characterized by the sensation of an especially bright colour persisting for a period of time while permeating through the whole environment after only a brief visual inspection. The bright colour of a garment, for example, may seem to spread out over the wearer's face and arms.

### 2.2.4 Critiques of Gladstone's Views

Dismissing Gladstone's position, Gage (1993) indicated that Hellenistic art and architecture possessed a rich tradition of polychromy (i.e. colours deployed in solid patches or in textures and patterns, according to Baines (1985)). This contention was ostensibly supported by archaeological evidence described as early as 1817. The surfaces of Greek sculptures were often painted in strong, schematic colours for highlighting purposes. Blue, a colour to which it was assumed the ancient Greeks had a perceptual immunity, was vividly present in early Greek paintings. Walch and Hope (1995) suggested that the relatively restricted palette of Greek ceramics may have contributed to the defective colour vision controversy. Technical difficulties in production gave earth tones precedence over stronger hues such as blues, greens and yellows.

Gage (1993), however, stated that Gladstone did admit to a contradiction between the surviving samples of ancient pigments and the literary representation of colours. As Gladstone(1858, p. 495) said: *"The explanation, I suppose, is, that those, who had to make practical use of colour, did not wait for the construction of a philosophy, but added to their apparatus from time to time all substances which, having come within their knowledge, were found to produce results satisfactory and improving to the eye."* This possibly implies that the "*organ of colour*" referred to by Gladstone (1858, p. 488) was one that processed linguistic rather than visual data. In his study of ancient Egyptian colour terminology, Baines (1985) advanced the notion that in exploring and ordering colour, individuals discriminate sequentially between foci and built mental models of escalating complexity, which may vary in different media.

Gage (1993) cited the work of a "R. Hochegger" as being a premier critic of Gladstone due to his initiative in comparing language and artifacts via an interdisciplinary approach. Hochegger's 1884 treatise is claimed to be "*Die Geschichtliche Entwicklung des Farbsinnes*" (sic). Skard (1946) also referred to "R. Hochegger" but indicated that the title of the author's 1884 text was "*Die geschichtliche Entwickelung des Farbensinnes. Eine psyhologische Studie zur Entwickelungsgeschichte des Menschen*" published in Innsbruck, the original version stated as being a dissertation. In actual fact, "*Die Geschichtliche Entwickelung des Farbensinnes*" was an 1877 text authored by Hugo Magnus, who was an ally, rather than an opponent, of Gladstone's stance (Bellmer, 1999). MacLaury (1997) in his extensive bibliography devoted to colour ethnography includes Magnus but does not cite Hochegger.

### 2.2.5 The Legacy of Gladstone's Musings on Colour Categorization

Gladstone's literary excursion into Homer's perceptual abilities ushered in a new epistemology of vision research whose practitioners were devoted to the forensic analysis of colour term evolution via a philological approach. Maxwell-Stuart (1981), however, was of the opinion that Gladstone repeated the arguments of Goethe, featured in his 1810 work *Zur Farbenlehre*, who maintained the belief that the colour terms of the ancient Greeks were derived from contrasts between light and darkness (Goethe, 1970). Park (1997) remarked that Goethe was probably the first scholar to observe Homer's reticence at referring to anything as being blue. Interestingly, Irwin (1974) suggested that Goethe's thoughts on this matter may have been influenced by the writings of the English chemist John Dalton, who in 1798 became the first scholar to publish an account of the affliction known as color blindness or Daltonism.

Gladstone may have been inspired by Goethe's reflections on colour (Goethe, 1970) in his initial commentary on Ancient Greek colour perception (Gladstone, 1858) but there is no clear evidence to suggest this. *Zur Farbenlehre* is certainly conspicuous by its absence from Gladstone's lifetime reading list featured in his *Diaries*, but several of Goethe's fictional works are catalogued (Matthew, 1994). It is worth noting that while *Principia Mathematica* is on Gladstone's voluminous reading list, Sir Isaac Newton's other equally famous treatise on the nature of light and colour, *Opticks*, is not present even though it is quoted from in Gladstone (1877). Gladstone (1877) also briefly referred to Goethe's thoughts on colour, the source being Sir Charles Lock Eastlake's 1840 translation of *Zur Farbenlehre* (re-titled *Goethe's Theory of Colours*) (Goethe, 1970).

Matthew (1994) recorded "Sir Charles Loch Eastlake (1793-1865)" (sic) on Gladstone's lifetime "*dramatis personae*" list, indicating that the two did meet. Eastlake was an English historical painter and Fellow of the Royal Society, who from 1850 was president of the Royal Academy and from 1855 was director of the National Gallery. Eastlake shared Gladstone's passion for the classics. Monkhouse (1973) indicated that whilst undertaking his artistic training, Eastlake often read classic works by Virgil and Homer in their original language for several hours per day to serve as a source of aesthetic inspiration. In 1818, Eastlake embarked upon a sojourn to Greece, spending more than three months in Athens pursuing his interests in oil painting.

Miller (1987) noted that Eastlake was fascinated with the application of colour theory to the arts and also maintained an interest in optics, having been a founder of the Royal Photographic Society in 1853. In retrospect, Miller (1987) believed that Eastlake's translation of *Die Farbenlehre* (sic) often modified or excluded the context in which the phenomena in question were presented, thus conveying the meaning underpinning Goethe's original use of language and symbolism in a distorted fashion. Following this line of reasoning one could question whether or not Goethe's earliest thoughts on the colour perception of ancient Greeks were actually faithfully transmitted in the English language translation (Goethe, 1970).

The German scholar Lazarus Geiger was one of the more prominent exponents of the Gladstone tradition. Geiger(1880), focusing on the *Rig Veda* (from India), the *Zend Avesta* (the books of the Parsees), the *Edda* hymns, the *Koran* and sundry ancient Chinese works, reached the conclusion that ancient peoples had a problem with distinguishing the colour blue, as well as suffering possible perceptual difficulties with the colours green and yellow. Geiger, of course, had his critics. In one study of colour word usage in the Rig Veda, the following conclusions were drawn:

> *"1st, Non-mention of the colors green and blue is not proved for the Rig Veda literature; 2d, That the sky is not called blue nor the fields green rests on reasons which have nothing to do with the development of the*

> *retina; 3d, We cannot admit that either color words or color perception of those who composed the Rig Veda were inexact or imperfect, for the cause of the apparently inexact employment of words lies in the variable and uncertain color of the objects to which the color terms are applied. The theory of the development of the color sense rests, from a literary point of view, in great part on negative data. From the standpoint of physiology it has no support”* (sic) (Hopkins, 1883, p. 191)

Berlin and Kay (1969) credited Geiger as being the first person to postulate a universal sequence in the acquisition of basic colour terms. Apart from Gladstone’s ideas, Charles Darwin’s seminal 1859 work *On the Origin of the Species* may have also provided Geiger with the impetus to develop his own theory of evolution. Presented at a meeting of German naturalists in 1867, documented in Geiger (1880) and discussed in Berlin and Kay (1969), he proposed a six-stage evolutionary sequence:

- stage one being a linguistically unique blend of ‘black’ and ‘red’;
- stage two being the formation of a distinct ‘black’ and a distinct ‘red’;
- stage three being ‘black’, ‘red’ and the addition of ‘yellow’, with possible expansion into ‘green’;
- stage four being the previous set with the addition of ‘white’, which is purported to be derived from ‘red’;
- stage five being the previous set with the addition of ‘green’, developed out of ‘yellow’; and
- stage six being the previous set with the addition of ‘blue’.

Commenting on the evolutionary sequence of colour terms, Geiger (1880) speculated that it may have mirrored the order of the colour spectrum, with an awareness of yellow being present before that of green. With this in mind, Heinrich (1978) noted that, except for the anomalous placement of white, the Geiger sequence represents a progression from the long to short spectral wavelengths.

One can interpret from Gladstone’s Homeric tract (Gladstone, 1858) a pioneering advocacy of the biologically-based evolution of colour terminology. Heinrich (1978) believed that the apex of this school of thought was achieved by the aforementioned Hugo Magnus, who he referred to as “an ophthalmologist from Jena”. Berlin and Kay

(1969) described Magnus as being "an eminent ophthalmologist of Jena." Sloan (1989) called him "an ophthalmologist and classical scholar from Breslau", while yet another source, Matthew (1986b), indicated that he was a "German anatomist and classicist". Magnus was also a supporter of evolutionary development in colour nomenclature, along the lines of Geiger, with blue postulated as being at the apogee of the sequence.

The work of Magnus (1877) apparently made a significant impression on Gladstone himself. According to his *Diaries* (Matthew, 1986b), Gladstone personally wrote to Magnus on the 17th of May 1877 and read Magnus (1877) on the 17th, 18th, 21st, 22nd, 23rd and 24th of May 1877, finishing the book on the latter date. Gladstone's diary entry for Thursday, May 24, 1877 stated the following: *"Finished Magnus on the Sense of Colour. Most interesting."* Spurred on by the flurry of colour perception theories emanating from Germany at the time, Gladstone decided to recapitulate his earlier thoughts on the matter in the form of an article entitled "The Colour Sense", published in 1877 in the popular journal, *The Nineteenth Century* (Gladstone, 1877). His *Diaries* indicated that Gladstone composed the article between the 30th of August and the 7th of September in 1877 (Matthew, 1986b). Gladstone (1877) synthesized the author's ideas from nearly two decades earlier with those of other scholars from both the literary and scientific spheres.

Viewed from another perspective, Gladstone's writings on Homeric colour perception could be interpreted as exhibiting an implicit argument supporting human evolution in the Darwinian mould: The "primitive" colour sense of the Ancient Greeks evolved over the centuries to become the "refined" chromatic impressions experienced by 19th century Englishmen. Alter (1999) observed that Charles Darwin's colleagues felt compelled to issue a remarkable number of commentaries concerning a correspondence they noticed between the transmutation of biological species and the evolution of natural languages. In the latter treatise - which surprisingly ignores Gladstone's scholarly efforts in this regard - it is claimed that some of the leading scientific writers of the period used the power of illustrative metaphor and analogy to expound and shed new light on Darwin's theories.

Interestingly, Alter (1999) pointed out that Darwin himself devoted only a small portion of his writings to the discussion of language. Since philological scholarship was in vogue in the 19th century, with its emphasis on linguistic and literary change over time, one way they did so was by drawing attention to the observation of etymological patterns as well as discussing structural similarities detected among certain groups of languages. In its own modest way, Gladstone's scholarship in linking colour perception to language was a harbinger of academic efforts in the early part of the 20th century that explored the connection between language and thought, culminating in the emergence of the Sapir-Whorf hypothesis, which is the subject of the section that follows.

## *2.3 The Sapir-Whorf Hypothesis*

### 2.3.1 Preamble

This section deals with conceptual work that has investigated the relationship between language and thought and whether the latter influences (or determines) the former. In linguistic research, this notion has been dubbed the Sapir-Whorf hypothesis and is named after its' two chief co-developers, Edward Sapir and Benjamin Lee Whorf (Koerner, 1992; Whorf, 1956). Thought is something that is part of human nature, while language can be construed as a process enabling communication that emerges through nurture. In the discussion that ensues, the nature-nurture dichotomy will also be revealed to be one that has challenged those with an interest in colour perception.

### 2.3.2 Goethe on Colour through Nurture

The mechanics of visual perception is complex and still largely poorly understood being the domain of a number of competing theories that offer a variety of explanations (Gordon, 2004). Indeed, this domain has long been a fertile ground for a clash of ideas. One of the earliest arguments was raised by German author and playwright Johann Wolfgang von Goethe (1749-1832) who, as an amateur scientist, famously dabbled in colour theory. In retaliation to what he considered to be an overly analytic treatment of colour by Sir Isaac Newton, Goethe published his own "Theory of Colours" in 1810 (Sepper, 1988). Goethe's theory was more descriptive than predictive and addressed colour as being the by-product of the dynamic interaction between darkness and light. As such it approached colour from the perspective of human experience.

### 2.3.3 The Hering-Helmholtz Controversy as a Nature vs. Nurture Argument

Yet another dispute was evoked by the question of how is it that we can see as consistently as we are able to. In the 19th century, two leading German scientists in the area of physiological optics, Herman von Helmholtz and Ewald Hering, began an ongoing debate whose ramifications still echo today (Turner, 1994). Essentially the controversy revolved around the notion of nature versus nurture in human development regarding visual perception. Hering was of the belief that perception is an inborn trait, whereas Helmholtz assumed that its development is rooted in experience and their arguments entailed all aspects of perception including that of light and colour (Turner, 1994). Low-level physiological mechanisms were the drivers that actively determined what humans see according to Hering, while the Helmholtz view was that high-level unconscious processes were at work to infer from experience what humans can perceive (Turner, 1994).

### 2.3.4 Linguistic Relativity

An analogous academic debate was to rage in the 20th century and partially dominate the discourse of both anthropology and linguistics (Koerner, 1992). This controversy also dealt with the nature versus nurture issue, but this time the focus was on the relationship between language and thought. The mechanisms of cognition are physiological in nature and therefore inborn by definition, but thought in action is also an empirical process of communication that requires the use of a language to represent and convey concepts. Given that language is the medium by which thought can be expressed to others it is conceivable that one could consider the possibility of it applying constraints to the process of cognition.

Relativity in the philosophical sense refers to the notion that there exists no metric to gauge truth or morality in an objective capacity. Subjective interpretation of reality dominates with this doctrine and whatever can be conceived of is open to personal bias. The concept of linguistic relativity (also known as the Sapir-Whorf hypothesis) suggests that natural languages influence the way their speakers think (Whorf, 1956; Boroditsky, 2003). Sapir (1929) believed that language reflects the nature of ‘social reality,’ since the system of cultural patterns that constitute any society is catalogued in the vernacular which expresses that society. The worldview held by speakers of a language is shaped by how it can be encapsulated with the grammatical categories in use. Linguistic relativity is in fact a "weak" interpretation of the Sapir-Whorf hypothesis (Whorf, 1956) given that it advances that language only influences how speakers may think in it. The "strong" interpretation of the hypothesis is denoted as linguistic determinism, namely that the antecedent conditions afforded by grammatical categories lead to inevitable patterns of thought: Language determines thought.

### 2.3.5 Evaluating the Validity of Linguistic Relativity

Testing the validity of the Sapir-Whorf hypothesis is a challenging proposition. One approach is at the lexical level in the domain of colour categorization. Given that colour is a phenomenon that is governed to a uniform degree by the laws of physics, the adoption of it as a psychological stimulus to study naming behaviour was considered a suitable choice to gauge the relationship between language and thought: "Language" here being the use of words to denote colour categories, these being the product of "thought" (Berlin and Kay, 1969). It has been observed that natural languages vary considerably in their differentiation of the colour domain. Some, like that spoken by the Dugum-Dani in Papua New Guinea, have only two colour terms in their lexicon, namely *mili*, meaning 'dark/cool,' and *mola,* meaning 'light/warm' (Heider-Rosch, 1971, 1972a, 1972b). Others like English have a full complement of 11 colour terms. Thus it would be reasonable on this basis to assume that disparate languages could affect their speaker's ability to perceive colours. Colour as a test-bed for linguistic relativity was also deemed to be suitable because its appearance to an observer should be dictated by the physical properties of the stimulus (e.g. a Munsell colour chip) and the neurophysiological system that perceives it.

Carroll (2004) noted that research in colour cognition to test linguistic relativity has essentially adopted two strategies. Codability as a concept is one of these, in which the length of verbal expressions chosen to signify colours, coupled with the frequency and ease of use, are taken as a combined metric to gauge the salience of the stimulus (Brown and Lenneberg, 1954). Given a language, it was posited that the number of available words of optimum codability for denoting colours might be influential in the capacity for their recognition. Indeed, Brown and Lenneberg (1954) cited tests undertaken with

Zuni Indian subjects who referred to ‘orange’ and ‘yellow’ with the same term and later confused these two colours more often in recognition tasks than English subjects. The conclusion drawn was that the more codable a colour was, the easier it was to recall it from memory (Lenneberg and Roberts, 1956). This was considered to offer tacit support for the linguistic relativity hypothesis since codability was deemed to be a linguistic property.

Examining the Sapir-Whorf hypothesis from a cognitive psychology perspective, Hunt and Agnoli (1991) argued that lexical differences between languages could influence how users of these words structure similar experiences in which these terms may play a part in denoting. Direct effects in this regards are evident in the acts of discrimination that a person must perform when selecting or comprehending a suitable word from their lexicon. Hunt and Agnoli (1991) also noted that linguistic factors imposing indirect influences on the cognitive experience could be observed in polysemous words, which are those terms in a language that have multiple meanings. When all meanings of such a word are triggered and a correct meaning, or most appropriate one, is sought, then a selection usually is established with reference to context. Those words that are more polysemous in a language should exert a greater indirect influence on thought.

Cross-linguistic studies were another means of testing the Sapir-Whorf hypothesis in both its strong and weak forms. Berlin and Kay (1969) was such a study, one that investigated the effects of colour terms in various languages, with the World Colour Survey being the next iteration. While Berlin and Kay (1969) was seen by some as effectively debunking the Sapir-Whorf hypothesis with its finding that basic colour terms had a neurophysiological grounding and were in fact a universal phenomenon, there were numerous critics of the theory. However, one of the architects of the theory, namely Paul Kay, co-wrote a paper that, paradoxically, was almost sympathetic to the notion of linguistic relativity and this is discussed in the next section.

## 2.4 A Seminal Evaluation of the Sapir-Whorf Hypothesis

“*What is the Sapir-Whorf hypothesis?*” is the rhetorical question that is the title of Kay and Kempton (1984). Such an opening would seem to suggest that a definitive account of the Sapir-Whorf hypothesis was to be presented. In actual fact, the paper offered a reinterpretation of the controversial hypothesis based on two deceptively simple experiments to gauge whether natural language affected colour perception.

Kay and Kempton (1984) treated the near poetic exposition of some of the writings of Sapir and Whorf (Sapir, 1921; Whorf, 1956) as being as major source of confusion to scholars seeking a clearer definition of their fundamental linguistic insights. Referencing an interpretation from Brown (1976), they stated that Whorf (1956) advanced what seemed to be two chief hypotheses:

I. Differences in the structure of language systems will, in broad terms, be matched by nonlinguistic cognitive variances, of a vague nature, in the native speakers of the languages being compared.
II. The structure of a language either strongly influences or wholly determines the world-view of native speakers of that language.

As a consequence of I and II above, Kay and Kempton (1984) observed that a third Whorfian hypothesis could be derived:

III. The semantic systems of divergent languages change without constraint.

Kay and Kempton (1984) performed two simple experiments to essentially gauge whether the lexical categories of a language palpably influence non-linguistic perceptions of its speakers to a non-trivial degree.

The first experiment was based on the hypothesis that English speakers would have a tendency to distort the psychological distance (or discrimination distance) between blues and greens because the language itself makes that distinction in lexical terms. On the other hand, speakers of an alternative language which used the same word for blue and green would not make this distinction. One such language is Tarahumara, a Uto-Aztecan dialect of northern Mexico, which possessed the basic color term *siyóname*, meaning “green or blue”. Tarahumara had no separate terms that denoted ‘blue’ and ‘green.’ The experimental subjects consisted of five English speakers and four Tarahumara speakers. These numbers would seem too small a sample size to produce any statistically significant outcomes.

As experimental stimuli, Kay and Kempton (1984) employed a set of eight Munsell colour chips of varying shades of greenish blue and blueish green. The selection of these colours as stimuli could be considered a reminder of the possible inherent confusion by some in perceiving blue, an observation originally noted by Gladstone (1858) in the 19th century with respect to the Ancient Greeks. The chips in the Kay and Kempton (1984) experiment represented two levels of brightness (Munsell chips with values of 5 and 6). The chromas (i.e. saturation) of two chips in the set were inexplicably of a higher level than the rest, though. Chroma levels should have been held constant to minimise perceptual bias towards more saturated colours.

The colour chips were arranged in order from green to blue, with each chip having the same discrimination distance from those on either side of it. Discrimination distance was measured in terms of just noticeable differences and is defined as being the smallest physical difference that can be detected by the human eye. Details of the exact computational method for determining discrimination distances were not provided in Kay and Kempton (1984) but a reference to Wyszecki and Stiles (1967) was given for tabular data used. Hue distances among colour chips used in all of the experiments were presented as relative distances that were proportional to the normalised just noticeable difference between adjacent chips on either side of the English blue/green lexical category boundary. Kay and Kempton (1984) emphasized that although the discrimination distance norms were empirically derived from only English speaking subjects, the absence of similar discrimination data from Tarahumara speakers was deemed to be of no great concern since the only subjects found in the experiment to deviate from these norms were also only the English speakers.

For experimental purposes, Kay and Kempton (1984) defined the “boundary” between lexical colour categories not in absolute terms but as the equilibrium point of two overlapping gradient categories. In other words, the blue-green lexical category boundary was taken as being that wavelength of light at which an equal blend of green and blue was noticed.

In one of the experiments in Kay and Kempton (1984), subjects were displayed triads of colours chips in the ‘blue-green’ range and were then instructed to select the odd one out. English subjects displayed a predisposition towards classifying colours according to the terms ‘blue’ and ‘green, while Tarahumara subjects did not. The sharp linguistic distinction between ‘blue’ and ‘green’ in English appeared to actually heighten the subjective perceptual difference between colours for subjects in the study, in particular, for those that lay on the category boundaries. The experiment was then repeated with some changes: The colour chips were displayed in such as way that only two at a time could be viewed and subjects were instructed to compare the degree of difference in levels of ‘blue’ or ‘green’ between the pairs of chips. The Whorfian effect noted in English subjects during the first experiment vanished and their perceptual judgments agreed with Tarahumara informants. The tentative conclusion drawn was that the perception of colours was found to dependent on the terms employed to refer to them.

In justifying the concept of discrimination distances as being the “real” scale for use in their experimental work, Kay and Kempton (1984) claimed that the just noticeable difference scale measured the psychophysical colour response directly because it was a variable function of the light wavelength. However, Ratner (1991), in discussing the ramifications of Kay and Kempton (1984) relevant to the domain of social psychology, made the point that there was an important distinction between perceiving just noticeable differences among stimuli and perceiving the stimuli’s quality: The former was reliant upon the physiological constraint of the human eye’s capacity to merely discriminate colour whereas the latter was a higher-level psychological process tinged with a possible cultural-linguistic bias.

## 2.5 Rosch and Prototype Theory

In a series of experiments in the 1970s, Eleanor Rosch demonstrated that when people label an everyday object or experience, they rely less on abstract definitions than on a comparison with what they regard as the best representative of the category designated by that word (Heider-Rosch, 1972a, 1972b). Rosch also showed that the Dugum Dani tribe of New Guinea could still perceive the existence of colours even though their language lacked words for colours except black and white (Heider-Rosch, 1972b). This ran counter to the notion that language determined thought to the extent that people could not understand a concept for which their language had no word. Rosch extended her conclusions to universal statements about language, claiming that people in different cultures tended to categorize objects in similar ways (Heider-Rosch, 1972a). She argued that basic objects had a psychological import that transcended cultural differences and shaped people’s mental representations of them and her work formed the foundation of what is known as prototype theory.

Prototype theory is an approach to graded classification in cognitive science with a view that categories are populated with members of differing salience with some being more central than others. Rather than a static, definition-based model of categorization where attributes and/or behaviours delineate class membership, prototype theory contends that these attributes and/or behaviours often vary for a class. Their unequal status leads to supposition of graded categories with some members being more central than others. This is analogous to the concept of a cline in population genetics where there is a gradual change in the characteristics of a species over a geographical area that is often attributed to environmental heterogeneity.

The body of research attributed to Rosch (1973a, 1973b, 1988) suggested that categorization was a key component underpinning human cognitive abilities and was explicable through prototype theory. We think about things that are or can become categories be they ideas or more tangible objects. Rosch’s theory of prototypes (Rosch, 1973a, 1973b, 1988) looked at category membership and the notion that exemplars exist within kinds. A crucial principle established by the empirical findings of Rosch (1973a, 1973b, 1988) was that people place less emphasis on abstract definitions when they classify a mundane entity or skill. Instead, they seek out the pre-eminent interpretation of an appropriate category. Consider, for example, a chicken or an ostrich: Both are members of the conceptual category “bird”, however a robin maybe a much better prototype in terms of salience, particularly to Europeans. To an Australian, a prototypical “bird” may be a magpie and so forth. The term prototype has been defined in Eleanor Rosch's study "Natural Categories" (Rosch, 1973a) and was first defined as a stimulus, which takes a salient position in the formation of a category as it is the first stimulus to be associated with that category. Later, she redefined it as the most central member of a category.

In the domain of colour, Rosch (1973a) identified that non-arbitrary, semantic categories were built upon the foundation of perceptually salient "natural prototypes." This was determined by teaching a cohort of indigenous Dugum Dani speakers in Papua

New Guinea two different sets of categories: One set reflected a framework that presumed that natural prototypes were central tendencies of the categories in question. The other set violated this construct such that the prototypes were distorted to be at the periphery of boundaries. The indigenous speakers were part of a culture initially devoid of concepts for hue, or even geometric-forms for that matter. The hypothetical "natural" categories were found to be learnt with greater alacrity than the "distorted" categories. The learning of natural prototype stimuli was found to be more rapid even when not central within a category and these were more often selected as the most typical examples of the category when compared to other stimuli.

Rosch (1975) examined the mental representations invoked by colour names, concluding that the cognitive interpretation of colour categories encompassed information used in encoding physical color stimuli and that this representation reflected the prototype-like structure of color categories. This provided tacit support to the notion of basic colour terms (Berlin and Kay, 1969). These basic color categories seem to be ordered so that they consist of a universal focal area with variable borders. The focal area should be immediately salient whereas the boundary was subject to ambiguity (e.g. “Is it blue or green? Or is it greenish-blue or vice-versa?) Mervis, *et al* (1975) outlined that recognition of foci for colour categories emerged much earlier in individuals and reached a stable definitive state more rapidly than the capacity to classify boundary colours, the latter possibly due to their fuzzy nature in a stochastic sense. This research also found that focal judgments in colour naming were always more consistent than name selections for boundary colours.

Categories could be pancultural but common sense would dictate that prototypes were often subject to cultural or geographical constraints. However, Rosch (1973a, 1973b, 1988) did contend that categorization of basic objects transcended cultural differences and idiosyncratic mental representations of them. What was important, according to Rosch (1973a, 1973b, 1988), was that there most likely existed a universal tendency to evoke category exemplars when engaged in cognition, perhaps as an innate strategy to manage complexity. Rosch’s findings led her to believe that people engaged with an intrinsic hierarchical model of subordinate, basic and superordinate categories, arranged in a manner such that a modicum of cognitive effort resulted in optimal information (Rosch, 1973a, 1973b, 1988). For example, the term “furniture” represents a superordinate category, with "chair" being a basic category and "recliner" being a subordinate category in this possible hierarchy. In terms of "colour" as a basic category, one could speculate then as to what superordinate category it belongs to.

Lucy and Shweder (1979) asserted that the focal colours used by Rosch (Heider-Rosch, 1972a) as experimental stimuli were deliberately more salient than the nonfocal colours in the study, thus enabling them to be more readily discriminated in a perceptual sense. The notion of focality may be something that is an intrinsic attribute of an individual colour, but the propensity for discrimination is something that is a relative property in contrast to other surrounding colours. In their research, Lucy and Shweder (1979) managed the experimental regime to account for discriminability and uncovered no variations between focal and nonfocal colours in a short-term memory recognition task undertaken by subjects, albeit discrepancies were observed in long-term recall. In experiments that revisited the work of Brown and Lenneberg (1954) on the role of ease of naming in colour salience and communication, Agrillo and Roberson (2009) also concluded that focal colours were not intrinsically easier to remember.

## *2.6 The Berlin and Kay Paradigm: What is a Basic Colour Term?*

As discussed in the previous section, the work of Eleanor Rosch on prototype theory (Rosch, 1973a, 1973b, 1988) using focal colours as an example lent credence to the notion that these constructs in cognition were an innate mechanism that facilitated human categorization abilities. Brent Berlin and Paul Kay's landmark work on basic colour terms (Berlin and Kay 1969) was a study dealing with 98 languages in which they uncovered strong cross-cultural evidence for universals in colour naming, suggesting a neurophysiological basis for colour classification that ran counter to the then prevailing cultural relativistic view.

The notion that colour terms were arbitrary and dependent upon natural languages, once firmly entrenched even in linguistics textbooks (e.g., Gleason 1961) was rapidly swept aside by a paradigm shift of epic proportions. According to Berlin and Kay (1969), the physical continuum of the colour spectrum was no longer considered to be arbitrarily segmented into a hotchpotch of names. Instead, it was posited that a basic set of up to eleven colour categories existed – namely, white, black, red, yellow, green, blue, brown, purple, pink, orange and grey – and that these followed a common order of development across different cultures.

Berlin and Kay (1969) established seven criteria for a word to be a basic colour term in their original 1969 exposition of the theory. These consisted of four hurdle requirements and four subsidiary conditions to deal with any ambiguous factors. The first four principles were as follows:

i. A basic colour term must be monolexemic in form. This indicates that the meaning of the word is not obvious from its component parts. For example, 'reddish' is not monolexemic. In a sense, basic colour terms are intended to represent semantic atoms of language with respect to chromatic denotation;
ii. A basic colour term must not be a word whose range of meaning is included in another word. For example, the English word 'scarlet' is a specific term that means 'red' but the latter is the more general term for that colour. Hence, 'scarlet' is not a basic colour term;
iii. A basic colour term must not be constrained in use to any limited class of objects. For example, 'brunette' is word that is solely used to denote hair colour;
iv. A basic colour term must be psychologically salient. This can be decomposed into three component characteristics:
    a) If informants of a study are asked to catalogue words with colour meaning in their native language then those that are basic colour terms should elevate to the top of the list;
    b) There should be consistency in how a basic colour term is referenced that spans both informants and circumstances of application; and
    c) The term should occur in the idiosyncratic language variants used by specific individuals in a community of speakers. For example, 'wann' would not be a basic colour term, given that it is an archaic Anglo-Saxon word used to denote the gloss of a raven's plumage or the sheen of dark chain-mail armour (Biggam, 1997).

If a word is deemed to have passed these first four criteria then it can be accorded basic colour term status, but if it is doubtful then the subsidiary conditions must be addressed.

The reasons underpinning this were not too clear, as noted by Crawford (1982). The ancillary criteria to aid in the discrimination of a questionable term are as follows:

i. It should have potential distributions in the language similar in form to the candidate basic colour term. For example, ‘greenish’ is a valid English word, based on the basic colour term ‘green,’ but ‘beigeish’ is not;
ii. It must not be the name of an object that is of that colour, such as ‘gold’ for example. Note that the English term ‘orange’ is not excluded on the basis of this subsidiary criterion because it passed the first four primary conditions;
iii. It must not be a recent loanword from another language;
iv. It should not be morphologically complex, especially if lexemic standing is not easy to establish. This could mean that composite words are excluded.

Streamlined for simplicity and excised of much of the inherent contradictions in his opinion, Crawford (1982, p. 342) distilled the essence of the definition by Berlin and Kay (1969) in the following passage:

> *“A basic color term occurs in the idiolects of all informants. It has stability of reference across informants and across occasions of use. Its signification is not included in that of any other color term. Its application is not restricted to a narrow class of objects.”*

## 2.7 The Evolutionary Sequence of Basic Colour Terms

The primary finding of Berlin and Kay (1969) is that words that refer to basic colour terms in all known languages are derived from a group of eleven universal perceptual categories. However, a subsidiary conclusion advanced the notion that this common set of colour categories becomes fixed in the development of a particular language following a somewhat preset order. If a language permits fewer than the full complement of eleven colour categories, then detailed natural constraints appear to exist as to which categories may be encoded. These were initially observed by Berlin and Kay (1969) to be divided into seven stages as follows:

i. All languages have words that represent ‘white’ and ‘black’. (Stage 1 terms, as they also are referred to, can also refer to all colours that are considered by speakers of a language to be ‘warm’ or ‘cool,’ this being a kind of synaesthesia-like equivalent of ‘light’ or ‘dark.’

ii. If a language has three colour terms in its lexicon, then one of these denotes ‘red,’ with the others representing ‘black’ and ‘white.’
iii. If a language has four colour terms in its lexicon, then one of these denotes either ‘green’ or ‘yellow’ but not both. The other words represent ‘black,’ ‘white’ and ‘red.’
iv. If a language has five colour terms in its lexicon, then words exist for both ‘green’ and ‘yellow.’ The other words represent ‘black,’ ‘white’ and ‘red.’
v. If a language has six colour terms in its lexicon, then it features a word for ‘blue,’ as well as terms for ‘black,’ ‘white,’ ‘red,’ ‘green’ and ‘yellow.’
vi. If a language has seven colour terms in its lexicon, then it has a word for ‘brown,’ as well as terms for ‘black,’ ‘white,’ ‘red,’ ‘green,’ ‘yellow’ and ‘blue.’
vii. If a language has eight or more colour terms in its lexicon, then it has a word for ‘purple,’ ‘pink,’ ‘orange,’ ‘grey,’ or a selected arrangement of these. The other existing colour terms would be those that represent ‘black,’ ‘white,’ ‘red,’ ‘green,’ ‘yellow,’ ‘blue’ and ‘brown.’

A set of eleven universal perceptual categories were posited from which could be drawn the referents known as basic colour terms. Berlin and Kay (1969) calculated that 22 combinations of the eleven basic colour terms were possible and that these appeared to emerge in societies according to the sequence of seven evolutionary stages listed above. They speculated that a partially fixed, chronological order was present in the lexical encoding of basic colour categories within languages.

Kay (1975) documented the first major revision of Berlin and Kay (1969) with respect to the evolution of basic colour terms. Ethnographic field data gathered from elaborate studies of the colour term systems of isolated speech communities in the intervening years between 1969 and 1975 made this change necessary (e.g. Berlin and Berlin, 1975; Dougherty, 1977; Hage and Hawkes, 1975; Heider-Rosch, 1972a,b). In the original hypothesis the basic colour terms of all natural languages encoded a subset of eleven fixed perceptual foci subject to a partially fixed temporal progression. A new interpretation of this evolutionary sequence was put forward to encompass the encoding of new foci, as well as to incorporate the subtle interaction of foci and boundaries of colour categories.

When discussing Stage I colour term systems it is imprecise to consider the two-term distinction to be a simple brightness contrast (i.e. ‘black’ and ‘white’ or ‘dark’ and ‘light’.) It would be better to think of such a chromatic dichotomy as contrasting all dark and cool hues in opposition to all light and warm hues. The foci within these broad categories may be variable across members of speech communities and across languages. This component of the revision to Berlin and Kay (1969) only affected the meaning of part of the original evolutionary sequence but not its ordering.

Controversy surrounding the encoding of ‘green’ and ‘blue’ warranted a change in the ordering of the evolutionary sequence. Originally ‘green’ was specified before ‘blue’ but field data provided counter-examples (i.e. the ‘blue’ focus being encoded before or simultaneously with the green focus.) Kay (1975) suggested that the influential element in the sequence at Stage III was neither the focus green nor the focus ‘blue’ but the composite category GRUE. The use of capitalization in Kay (1975) was a convention to indicate a composite colour category. Basic colour term status may be granted to the category GRUE either before or after the ‘yellow’ focus is encoded. However, GRUE was never broken up into ‘green’ and ‘blue’ and labelled with two basic colour terms until after the ‘yellow’ focus is encoded. The aforementioned revision to Berlin and Kay (1969) is succinctly presented in Figure 1.

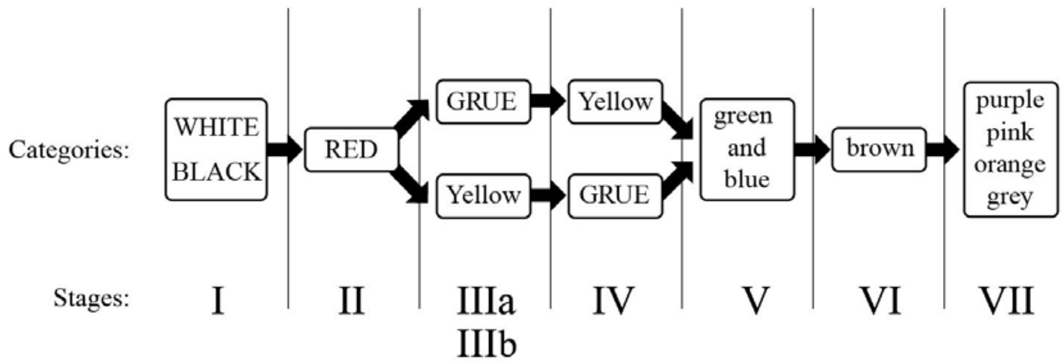


**Figure 1 - Revision to basic colour term evolution hierarchy (Kay, 1975, p. 260)**

Figure 1 can be deciphered as follows: Stage I is made up of two basic categories: WHITE, which includes ‘white’, all very light colours, all ‘warm’ colours, and BLACK which includes ‘black’, some very dark ‘brown’ and ‘purple’ colours and all but the lightest ‘blue’ and ‘green’ colours. (WHITE may have its focus in either ‘white’, ‘red’ or ‘pink’, while BLACK probably has a variable focus in ‘black’ and dark ‘green’ and 'blue' colours.) RED is designated by a basic colour term at stage II and includes all 'warm' colours with the focus in English focal 'red'. This description of stage II is no different to the one put forward in Berlin and Kay (1969) except that RED can be thought of as evolving solely from WHITE rather than having emerged partly from WHITE and partly from BLACK. Stage III bifurcates to allow either the 'yellow' focus or the category GRUE to be accorded a basic colour term (IIIb and IIIa, respectively). In the case of GRUE, the focus may be either in 'blue' or 'green' or in both, but it is deemed highly unlikely to be in any singular focus that would be dubbed 'blue-green' in the colloquial sense.

Progression from a stage IIIa system to a stage IV system yields the addition of 'yellow', while the transition from IIIb to IV results in the inclusion of GRUE instead. All stage IV colour term systems contain WHITE, BLACK, RED, GRUE and yellow, with foci as outlined for stage III. GRUE decomposes into 'green' and 'blue' at stage V. Stages VI and VII also remain consistent with the original Berlin and Kay (1969) conception, except for the possibility of post-1969 field data providing further justification for the contention that grey may appear as a wild card term in earlier stages.

The remainder of Kay (1975) dealt with the relationship of basic colour term evolution to more general research issues in linguistic variation and language change. (i.e. the "synchronic variability and diachronic change" part of the paper.) "Synchronic" and "diachronic" are linguistic terms that have their origins in de Saussure (1916/1959). "Synchronic" refers to any method of linguistic study that deals with the state of a particular language in a descriptive manner at any one instance in either the past or the present. On the other hand, "diachronic" refers to any procedure of linguistics concerned with the historical development of a language over time.

According to Kay (1975), empirical evidence indicated that linguistic change had its beginning in synchronic variation or, in other words, the apparent heterogeneity of speech communities. Following on from this it was noted that a general postulate is believed to exist that diachronic change implies synchronic variation. A range of predictions about synchronic variability in basic colour term systems were advanced which were derived from the interplay of the latter general postulate with the knowledge of the aftermath of linguistic change in basic colour lexicons as manifested in the evolutionary sequence. For example, the foremost broad conjecture that could be made was that some primitive colour systems would be nearly stable in the diachronic sense and show insignificant synchronic heterogeneity while others in the process of change would display substantial inter-speaker variation. Empirical observations were discussed in Kay (1975) that offered tacit support for this prognosis as well as the others outlined.

Motivated both by preliminary findings from the World Colour Survey as well as vision science research into colour appearance, Kay and Maffi (1999) refined the model of colour term evolution on two fronts. One being the adoption of a language-based principle based on words being formed via the act of partitioning in any categorization process. The second front is based on colour appearance research and suggests that the above linguistic partitioning principle is driven by an observer's predisposition to distinguish 'black' from 'white' as well as 'warm' colours (e.g. 'red' and 'yellow') from 'cool' ones ('green' and 'blue').

The primacy of 'red' in human perception was also another colour appearance factor that serves as a mechanism in the amended model of colour term evolution presented by Kay and Maffi (1999). This work was intended to be a rejoinder to those who embraced the "Emergence Hypothesis" of colour terms, as dubbed by Kay and Maffi (1999). According to this hypothesis, not all natural languages automatically have a small set of words each being referents to colour concepts that collectively segment perceptual colour space. In this line of reasoning, as exemplified by Lucy (1997), Saunders and van Brakel (1997) and Levinson (2000) for example, colour terms emerged within a given society subject to linguistic and/or cultural constraints.

## 2.8 The Linguistic Impact of Basic Colour Terms

Common sense would dictate that cognitive processing of colour stimuli is a universally similar phenomenon since all human beings share a common physiology.

In their paper entitled, "*The Linguistic Significance of the Meanings of Basic Colour terms*," Kay and McDaniel (1978) reiterated the notion advanced in Berlin and Kay (1969) that all natural languages shared a universal system of colour categorisation. It was a significant work in this research area because they presented arguments, based on neurophysiological aspects of human colour perception, to justify why speakers of the English language segment the visual spectrum in the systematic manner that they do. In fact Kay and McDaniel (1978) went so far as to claim that the lexical categorisation of colour could be viewed as a sign of the existence of biologically based semantic universals in the general linguistic sense. Effectively, such a supposition would have invalidated the extreme version of the Sapir-Whorf Hypothesis (Whorf, 1956) pertaining to colour term semantics.

Kay and McDaniel (1978) suggested that the elementary building blocks that constituted linguistic structures, the so-called ultimate semantic primes, were not discrete entities with Boolean properties but were, in fact, best represented by a fuzzy continuum. Following this line of thought, it was proposed that colour categories, like the neurophysiological mechanisms that detected them, were continuous functions that should be described using a non-discrete formalism, such as fuzzy set theory (Zadeh, 1965).

Following this line of reasoning, each basic colour category can be represented as a fuzzy set where each member is selected from the global set of all possible colours that can be perceived. Each perceived colour can then be assigned a value between zero and unity to specify the degree of membership in a particular basic category. The value of unity would signify category foci (i.e. those that are most salient) and zero would represent category boundaries, the range between being a declining continuum of membership values associated with successive perceived colours. Kay and McDaniel (1978) stated that the positions of the basic category foci and their absolute boundaries were universally fixed in the perceptual colour space.

Kay and McDaniel (1978) purported that the fuzzy membership functions that characterised the semantic frameworks of the universal basic colour categories red, yellow, green and blue could be determined straight from the neural response functions that constitute the code for these colours at a physiological level using the opponent process model of colour vision (Hering, 1920/1964; DeValois et al, 1966).

In the opponent process model of colour vision as reported by Hurvich and Jameson (1957) there exist opponent response cells in the neural pathways between the retina and brain which vary their firing rate in response to specific wavelengths of light. These cells are present in two different kinds of pair-wise arrangements having an antagonistic relationship to each other: one pair reacts to yellow and blue wavelengths, while the other reacts to red and green wavelengths. The relative magnitudes of the firing states of these two cell pairs then govern the type of hue that is perceived. Maximal firing states for each condition corresponding to either red, yellow, green or blue wavelengths impinging on the visual system give rise to the four fundamental colours. There are also non-opponent cells whose function it is to carry information about the brightness of light. Hence, black and white are determined by the firing rate of these non-opponent cells.

Neural response categories for colours and their semantic equivalents are both apparently non-discrete and naturally represented as fuzzy sets. According to Kay and McDaniel (1978), the creation of all basic colour categories was attributed to fuzzy-logical operations acting on the human visual system's six fundamental response categories (i.e. those corresponding to neural states for black, white, red, yellow, green and blue.) Semantic categories resulting from the identity operation of fuzzy logic equate to black, white, red, yellow, green and blue and are referred to as primary basic colour categories.

Composite colour categories, such as those found in Stage I systems on the evolutionary scale of colour terms (i.e. dark-cool and light-warm), are hypothesised as being the by-product of the fuzzy union of primary basic colour categories. Other examples of semantic categories based on this fuzzy-logical operation are warm and cool (aka grue). Grue, in other words, is the category corresponding to the fuzzy set "green OR blue" (Kay and McDaniel, 1978). (OR, in this instance, denotes the fuzzy union operation.)

Fuzzy intersection between primary basic colour categories offers an explanation for the genesis of the remaining later-stage basic colour terms (i.e. brown, purple, pink, orange and grey.) These later-stage basic colour categories based on fuzzy intersection are also called derived basic colour categories. For example, the category corresponding to the fuzzy set "red AND blue" is called purple. (AND, in this case, denotes the fuzzy intersection operation.) Kay and McDaniel (1978) noted that while the foci of the primary and composite categories have a relationship with physiological unique hue points, the foci of the derived categories did not share this characteristic.

Kay and McDaniel (1978) pointed out that where Berlin and Kay (1969) postulated the existence of 11 universal basic colour categories of a single logical type, there are in fact at least 15 basic colour categories of 3 logical types. These were deemed to be marked by the relations which their semantic structures pertained to the human visual system's fundamental neural response categories for colour.

A re-interpretation of basic colour term evolution from Stages I-V was advanced by Kay and McDaniel (1978) that looked at the expansion of the colour lexicon not as the successive encoding of foci, but as the consecutive demarcation of previously existing basic colour categories. At Stage VI and beyond, discrimination amongst colour categories proceeded through the encoding of intersections of the primaries. The concept of fuzzy partition, an extension of fuzzy set theory (Zadeh, 1965), was put forward by Kay and McDaniel (1978)as a means of formalising the discussion of the evolutionary sequence of colour terms.

In this framework, each colour category could be considered to be a fuzzy subset (i.e. is fuzzily contained in) of the set of all colour sensations. Colour terms "partition" the universe of colour sensations and their evolution from stage to stage involves a gradual change from a coarser to a finer partition. From a fuzzy partition viewpoint, Stages I-V could be thought of as a continuous refinement of partitions of the colour domain. The creation of a new partition separately classified everything specified individually in the old partition, and in addition uniquely designated at least two members that were classified the same in the old partition.

Kay and McDaniel (1978) also claimed that derived categories do not refine the partition of colour space. This was said to follow from the contention that primary basic colour categories contracted with the emergence of derived categories, and the ensuing fact that no colour sensation could belong to a derived category if it did not already fit in to a primary category. For these reasons derived categories were deemed to be essentially less significant than primary categories.

## 2.9 Early Criticisms of the Berlin and Kay Paradigm

With the advent of Berlin and Kay (1969), the belief that colour terms were arbitrary and dependent upon natural languages, once ingrained even in introductory linguistics textbooks such as Gleason (1961), was rapidly overturned. To Berlin and Kay (1969) the physical continuum of colour space was no longer divided into a random assortment of names with no underlying pattern. Instead, it was asserted that a basic set of up to eleven colour categories existed –white, black, red, yellow, green, blue, brown, purple, pink, orange and grey – and that these conformed to a common order of evolution across different cultures.

At first, Berlin and Kay's insights into colour categorization were well received by the academic community at large, but an increasing number of commentators began to challenge the empirical validity of their theory, noting that their work lacked sufficient attention to detail in both data gathering and interpretation (Durbin, 1972, Saunders and Van Brakel, 1997). It was claimed that the findings of Berlin and Kay (1969) were based primarily on output from colour naming tasks with bilingual university students in the San Francisco Bay area, whose first spoken language was English. Informant numbers for most of the language groups surveyed were very small indeed, in some instances only one. Also, the colour lexicons for some of the languages were decided upon by consulting ethnographic literature and dictionaries, making it more of an exercise in philology rather than psychology.

The theory outlined in Berlin and Kay (1969), therefore, was not constructed from quality field data assembled from monolingual subjects nor, ideally, from preliterate ethnic communities. Such societies would have been free from the cultural interference that knowledge of English or any other Western European language could introduce. Also, the empirical data obtained by Berlin and Kay (1969) were elicited from a questionable set of colour stimuli that may have biased the informants' answers. The set consisted of only the most saturated colour chips in the reference collection constructed by the US-based Munsell Company (Nickerson, 1976), rather than a representative sample of all of the available chips in the latter collection. The logic behind this tactic appeared to be that the most highly saturated chips would be more salient to observers – in itself an interesting and somewhat ethnocentric presumption.

## 2.10 The Birth of the World Colour Survey

Cross-cultural psychological experiments undertaken in primitive and unfamiliar surroundings are likely to be fraught with conceptual ambiguities as well as being handicapped by technical pitfalls (Ratner and Hui, 2003). One immediate ideological hindrance to be addressed by the experimenter in the field is the enduring emic versus etic controversy (Headland *et al*, 1990; Pike, 1967). While this emanates from anthropological scholarship, the notion should be transferable to cross-cultural psychologists engaged in field research. The emic position deals with the primary viewpoint that the ideal goal of the anthropologist is one that is faithful to the insider's perspective of reality within the culture under scrutiny. In other words, the field researcher seeks to become part of the culture being studied. The etic position, though, would hold that the outsider's point of view is of principal importance as it describes the culture as others perceive it. In this view, the field researcher acts as an impartial observer from afar. The most suitable standpoint to adopt for a psychologist in the field is a dilemma that must be addressed.

Initiated in 1898, the aim of the Cambridge Anthropological Expedition to the Torres Straits islands was to study indigenous sensory capacities (Herle and Rouse, 1998). The validity of data obtained from cross-cultural psychological experiments has been in question since E. B. Titchener's damning 1916 critique of the Cambridge Anthropological Expedition to the Torres Straits islands (Cole, 1996; Titchener, 1916). Culture was not under experimental control, indigenous subjects were not randomly assigned with respect to it and the experiments themselves were not amenable to replication due to the variable nature of physical environments in the wild. A subject's interpretation of an experimental task would almost certainly be dependent on culture thus influencing performance. It is worth noting that interpreter bias, as well as unintended experimenter expectancy bias (or the "*self-fulfilling prophecy*" phenomenon), have both been known to confound the progress of behavioural research even in controlled, laboratory-based studies where the observer and subject come from the same cultural background (Rosnow and Rosenthal, 1997).

The World Colour Survey (Cook *et al*, 2005), under the aegis of Berkeley's Institute of Cognitive Studies, was an interdisciplinary project based on the Basic Colour Term work of Berlin and Kay (1969). Their original treatise documented what they perceived to be strong cross-cultural evidence for universals in colour naming behaviour, thus implying a physiological foundation for colour classification. This argument represented a genuine paradigm shift away from the long dominant cultural relativistic position. In terms of anthropological thought, it was an early attempt at offering a causal explanation for an observed phenomenon, rather than adopting the standard practice of detached interpretative description (Strauss and Quinn, 1997).

The World Colour Survey was initiated in 1976 as a more ambitious project which would overcome some of the original weaknesses (Kay, Berlin, Maffi and Merrifield, 1997). The goal of this new interdisciplinary project was to verify the initial Berlin and Kay (1969) hypothesis by gathering data on how colours are named in 110 preliterate indigenous cultures around the world, in order to identify both universals and variations across languages. An emphasis on monolingual speakers this time around was considered to be a priority when assembling cohorts of subjects.

Straddling the disciplines of linguistics, anthropology, psychology and biology, the World Colour Survey was arguably one of the most ambitious field experiments ever undertaken; yet the whole venture is uncharacteristically low key for what is essentially another example of "big" science in action, similar in scope to the Human Genome project (Everson, 1997). Over a quarter of a century has passed since the project's conception and it has been completed but the long advertised monograph outlining the findings of the World Colour Survey in a manner similar to that of the original Berlin and Kay (1969) one is still in limbo. (At the time of writing this work, www.amazon.com was listing the text as being available for pre-order.)

For some unknown reason the set of colour stimuli used in the World Colour Survey consisted of the same maximally saturated samples as that used in the original 1969 Basic Colour Terms study (Berlin and Kay, 1969). Once more an appropriately sampled (i.e. larger, more comprehensive) set of Munsell colour chips, as delineated by Sturges and Whitfield (1997), was not used as naming stimuli. This is not an insignificant practical issue, as the possible effects on naming behaviour due to variations in saturation were ignored.

In reverse, one could also offer a cogent argument to suggest an alternative experimental scenario in which only colour chips of the lowest possible saturation were employed to gauge a set of minimal criteria to elicit a name (i.e. a "just noticeable difference" approach in the grand tradition of psychophysics). Once again this kind of tactic would skew the experiment with a particular bias. The only technique beyond reproach would be to display the entire set of Munsell colour chips to each informant, but that would be far too time-consuming a task and induce perceptual fatigue in all but the hardiest viewer.

Despite such methodological weaknesses, attempts have been made to tie the new empirical evidence obtained in the World Colour Survey to established theories of the evolution of colour perception and cognition. The project should have been a catalyst to transform the classic theory of basic colour terms from its beleaguered original state to one of elegant clarity. Instead, the ambiguities that have surfaced in the World Colour Survey data have compelled the researchers to shore up their original ideas with complex amendments (Kay and Berlin, 1997).

The work has been discussed in a general manner by the principal researchers in two journal articles and a chapter in a recent anthology devoted to human colour categories (Kay et al, 1991; Kay and Berlin, 1997; Kay et al 1997). Detailed interim reports documenting milestones in the project's lengthy history were practically non-existent, until the full World Colour Survey dataset was made freely available online for public use in 2003 (Cook et al, 2003). Prior to this publication of raw data, the only comprehensive 'report' to ever be made available to the public was a set of 28 microfiches available for purchase (Kay et al, 1991), consisting of over 1500 pages of annotated data.

This microfiche set was published by the Summer Institute of Linguistics (now referred to as SIL, International), a Texas-based international linguistics centre that provided fieldworkers for the project. It is commendable that such a vast amount of observational data was initially presented for open inspection in this way, as usually only digested or processed forms are released even in other less ambitious experimental endeavours. However, this set of data was withdrawn from circulation by the World Colour Survey team, with claims that it contained numerous though unspecified transcription errors. It is equally commendable that the World Colour Survey raw data was made available again via online means in 2003. Presumably this new incarnation contains data with these errors minimised.

The methodology of the World Colour Survey itself involved an average of 24 native speakers of each of 110 languages without a documented form of writing who were required to perform two tasks:

i. Informants had to name each of 330 Munsell colour chips, presented to them in a constant, random order, and
ii. Informants were exposed to a palette of these chips and requested to select their best examples ('foci') of the major colour terms that were elicited in the previous naming task.

The fine details of the instructions presented to World Colour Survey fieldworkers were featured in Berlin, Kay and Merrifield (1976-1978), while the history of the World Colour Survey data set was outlined in Cook et al (2005).

## *2.11 Vantage Theory*

In his overview of vantage theory, Allan (1999) commented on the diversity of basic colour terms within speakers of the same language. This variety can also be present within the same generational cohort of the aforementioned grouping even within a minuscule population. Empirical observations suggested that variations existed in the apprehension of colour foci with individuals negating the perception of a focus in one hue and situating it in another. Vantage theory was conceived by MacLaury (1997) to deal with points of view in cognition and was initially established to address the anomalies noted in cross-cultural colour naming studies with Mesoamerican languages and other sources. At the core of the theory is the idea that discerning accents placed on individual perceptions can result in their modification.

Vantage theory advances the notion that fixed and mobile coordinates of reference are the foundation for categorization. In this regime, the process of colour classification necessitates the coalescence of fixed coordinates of brightness (a.k.a. “value” in the Munsell colour order system), saturation or hue with the mobile coordinates of jointly balanced degrees of attention with respect to how a viewer ascertains the similarity or difference between colour stimuli. These merge into coherent wholes to determine whether something belongs to a particular colour category. The following example illustrates how the category “red” can be constructed according to vantage theory.

The human classifier considers stimuli to gauge the best example of “red” and subconsciously notes other sensations as similar or different to the stimuli being perceived. If greater attention is allocated to similarity then more stimuli are included in the category and its extent increases. A greater awareness of difference between stimuli, leads to a fortification of category boundaries: Stimuli are considered to fall beyond the mental perimeter of a category or not. Vantages emerge from the coherent wholes that form from these fixed and mobile coordinates and multiple vantages can be involved in the classification of a category but only one is in focus at a time. New coordinates can be focused against a background of old coordinates and this is referred to a “zooming in.”

Now, in some languages, distinct categories for ‘red’ and ‘yellow’ do not exist. Tzeltal, a Mayan language spoken in Chiapas, Mexico is one example of such a language (MacLaury, 1997). But according to Vantage Theory a “warm” category, a coherent whole made up of two types of vantage one being dominant and the other recessive. Two distinct Tzeltal words refer to this category with the dominant term being focussed in ‘yellow’ and the recessive term focussed in ‘red’. In the dominant vantage, similarity is stronger (appears at more levels, which augments its value) and comes before difference. In the recessive vantage, difference is the stronger coordinate. As a result, that vantage's boundaries (margins) are established first and then whatever comes within those boundaries is seen as similar to the focal point. Due to the different arrangement of coordinates, the same mechanism of vantage construction yields different entailments.

The basis for coming up with this account were some 900 interviews conducted in Mesoamerica with speakers of 116 languages (plus many others elsewhere) with the help of the Munsell colour array. In this way MacLaury (1997) identified three types of relationship between vantages: near synonymy, coextension and inclusion, plus the relationship of complementation obtaining between the dominant vantages of distinct categories. The relationships were found synchronically in world's languages but also followed a diachronic sequence in that order. The process has to do with progressively greater differentiation of categories along with greater emphasis placed on difference at the expense of similarity. The relationships are idealized segments of a continuum. The most intriguing of the four is coextension.

The investigations of MacLaury (1997) into basic color term systems have led him to develop a theory of cognitive points of view, "vantages," involving alternating attention to similarities and dissimilarities among cognitive categories. The interpretation of the evolution of basic color term systems that MacLaury (1997) outlined is formulated largely within the vocabulary of vantage theory. Vantage theory makes broad claims in the field of cognitive psychology (MacLaury 1997; Taylor and MacLaury 1995), which are beyond the scope of the present work.

## *2.12 The Neo-Whorfian Challenge to the Berlin and Kay Paradigm*

It would almost be an understatement to indicate that linguist Ian Davies and his cluster of co-researchers at the University of Surrey and associated institutions are prolific in colour categorisation research. His outcomes and that of his colleagues have to date displayed a sympathetic inclination towards the possibility of Whorfian influences in chromatic nomenclature, even though the findings of his research output often align with the broad position of Berlin and Kay (1969). This section will examine a selection of research from Davies and his collaborators. General criticisms that could be laid at the endeavours of Davies and his collaborators are that colour stimuli used in fieldwork on the whole were not standard, in particular properly sampled sets of Munsell colours were not employed.

Categorical perception was explored in Ozgen and Davies (2002) and Pilling *et al* (2003) with a view to determining whether it was changeable by studying improvements in discrimination at the boundaries of colour categories. Pilling *et al* (2003) concluded that the perception of colour categories may be dependent on the assignation of verbal labels but that verbal interference does not automatically prevent it. In other words, perception can be influenced by categorisation and training enhances the effect, enabling people to become more receptive to color differences that span boundaries.

Ozgen and Davies (2002) reported that training could augment a person's ability to differentiate between similar hues of a single colour, such as being able to distinguish between a 'bluish green' and 'yellowish green.' Training was also found to make subjects able to divide an existing basic colour category into two new ones and eventually perceive these in a natural manner. Rather than being innate, categorical perception in the colour domain was found to be an acquired process. This work in part replicated the findings of Roberson and Davidoff (2000) that the process of colour categorisation was mediated by verbal labels and not by perceptual mechanisms.

Davies and Corbett (1998) noted that it was the contention of Kay and McDaniel (1978) that the Berlin and Kay (1969) linguistic colour universals were established on the notion of a universal perceptual physiology. Based on this supposition, speakers of languages with comparatively fewer basic colour terms should have perceptual configurations equivalent to the "absent" linguistic categories, referred to as the "nascent categories hypothesis". In addition, speakers of languages possessing the full set of terms for the 11 universal categories should still preserve the perceptual composition that generated the evolutionary path manifested in the original hierarchy – a premise denoted as the "recapitulation hypothesis".

These corresponding hypotheses were evaluated in a cross-cultural study by comparing speakers of English, Russian, and Setswana, the latter being prevalent in Southern Africa, also documented in Davies (1998). These languages have been observed to contain 11, 12 and 5 basic colour terms respectively. A colour-grouping task was administered to determine whether cluster selection revealed variations in the chromatic lexicons of the three languages. Subjects were asked to sort a typical set of 65 colours into N groups (where N ranged from 2 to 12) based on their perceptual similarity. The assumption was tested that degrees of agreement over which individual colours to group together should peak when N was equivalent to the number of basic color terms in the target language. Additional consideration was given to possible linguistic influences on color grouping in the 'green-blue' region of color space.

Setswana speakers in the latter study used a single term for this 'green-blue' region (*botala*), whereas English uses two terms ('green' and 'blue') and Russian uses three terms to denote this range: *zelenyi* for 'green', *sinij* for 'dark blue' and *goluboj* for 'light blue'. A remarkable characteristic of the results was the clear resemblance of the colour groups chosen across the three language examples. On top of this observation, there were minor but consistent disparities in grouping allied with linguistic differences. In particular, maximum levels of consensus arose at lower values of N for Setswana speakers than for the other two languages and they were more likely to sort 'green' with 'blue' than speakers of the other languages.

The confounding nature of categorization observed by Davies and Corbett (1998) was reminiscent of the supposition advanced by Gladstone (1858) that the Ancient Greeks had difficulty in perceiving 'blue.' Categorization in the 'green-blue' region was also deemed to be problematic in the work of Kay and Kempton (1984). On the other hand, Russian speakers were as liable to form separate 'light blue' and 'dark blue' groups as speakers of the other two languages. The fact that Russian was observed to have 12 basic colour terms runs counter to the maximum amount of 11 posited by Berlin and Kay (1969). It was originally assumed that Hungarian also possessed 12 basic colour terms, with *piros* and *vörös* both denoting 'red,' but this has been challenged (Uusküla and Sutrop, 2007).

Davies, Sowden, Jerrett, Jerrett and Corbett (1998a) described a cross-cultural study comparing speakers of Setswana and English as a test of the Sapir-Whorf hypothesis (Whorf, 1956). A preferential selection task using colour triads was applied to speakers of the two languages. Subjects were instructed to choose which of the three colours were least like the other two. Two types of stimulus structures were devised: control triads, designed so that any linguistic pressures should ideally lead to the same choices amongst subject, and experimental triads, geared in a way that the manipulative effect of language should supposedly lead to different choices by the two groups. Universalist doctrine would posit that the choices of the two samples should be essentially the same for all triads, while the relativist viewpoint forecasted that selections should be the same for the control triads, but differ for the experimental triads.

A surprising outcome of the study by Davies *et al* (1998a) was that choices invoked by the two cohorts were closely related for both varieties of triads, thus offering tacit support for universalism. Nevertheless, there were also small but reliable discrepancies associated with the linguistic differences, thus also supporting the prevalence of Whorfian effects, albeit of a “weak” nature. By and large, the authors concluded that a tension existed between the competing forces of universalism and relativism within this aspect of human cognition, namely the former was a strong influence on colour choice while the latter could moderate the process through cultural factors such as language.

The results as described in Davies and Corbett (1998) are consistent with the existence of universal perceptual processes tempered at the boundaries by linguistic or cultural influences and prove to be a closer fit to the version of Basic Colour Term theory as expounded in Kay, Berlin and Merrifield (1991a) rather than earlier incarnations. In the Kay *et al* (1991b) analysis the emphasis was on visual physiology and the role it played in the evolutionary development of basic colour vocabularies, constraining the possible composite categories to a small number of those theoretically possible due to neural responses. Even though there were still inconsistencies, Davies and Corbett (1998) concluded that there was support for the universalist's position – namely, that there were compelling pan-cultural similarities in colour grouping despite linguistic differences - but the Berlin and Kay (1969) framework may not sum up the full scope of colour-category universalism.

Davies, Corbett, McGurk and MacDermid (1998b) reported on a study of the acquisition of colour terms by Russian children with the dual purpose of testing the original Berlin and Kay (1969) theory of color universals using acquisition order as a gauge of the extent to which a term is basic or not, as well as confirming the observation that the two ‘blue’ terms of Russian were genuinely basic. This implied that there were two separate colour foci for ‘blue.’ Experiments were conducted with two hundred children, aged from three to six-years-old, who were tested on three tasks - colour term listing, colour term production and colour term comprehension.

Outcomes of the study by Davies *et al* (1998b) revealed an acceptable level of concordance with the Berlin and Kay (1969) colour term acquisition scheme, but the data also provided some evidence for the weaker claim that primary terms tend to be learned before derived (or composite) terms. The data also offered further support to the notion that Russian has an extra term for blue. However, differentiation between the two blue terms - *goluboj* (or 'light blue') and *sinij* (or 'dark blue') – was problematic to a greater degree than any other colour term pair, even by the older five- to six-year-old cohort in the study.

The study of Turkish color terms conducted by Ozgen and Davies (1998) was initiated with four primary motives:

i. to ascertain the array of basic colour terms for this language;
ii. to compare this derived list with the Berlin and Kay (1969) set of universals;
iii. to investigate if Turkish is inconsistent with the original theory by having two basic terms for 'blue' (cf. Russian denotations for this hue); and,
iv. to outline the possible cognitive side-effects of the two 'blue' terms, if Turkish is an exception to the Berlin and Kay (1969) hypothesis.

A mix of Turkish-speaking children and adults performed a task to list colour terms and a subset of these two samples was then engaged in the colour naming exercise. In the naming task, subjects were instructed to identify 65 typical colour tiles. Indicators of salience and consensus resulting from these two undertakings come together to imply that Turkish has 12 basic colour terms. The experimental elicitation of these terms in association with the glosses provided by dictionaries and Turkish-speaking consultants provide evidence that 11 of these words are Turkish exemplars of the Berlin and Kay (1969) universal colour categories.

The 12th Turkish colour term observed by Ozgen and Davies (1998) – *lacivert* or 'dark blue' - was positioned between the Berlin and Kay (1969) foci for 'blue' and 'purple' and its scope was co-extensive with the 'dark blue' term of Russian, *sinij*. Then again, in a third stage of the analysis, the greater part of informants held that *lacivert* ('dark blue') was a kind of *mavi* (or 'blue'), thus violating one of Berlin and Kay (1969) norms for a basic colour term, namely non-inclusion. Ozgen and Davies (1998) concluded that the paradoxical situation could possibly exist where a colour term was used widely and particularly in a consensual manner while at the same time being acknowledged as a subset of another term. Whatever the exact status of the dual 'blue' terms, however, evidence was uncovered using colour grouping, similarity judgments and same-different tasks that the cognitive depiction of the blue region of colour space for Turkish speakers may indicate the salience of the two 'blue' terms. This once again is an indication of anomalous colour categorization behaviour with respect to 'blue,' as was noted by other researchers (Gladstone, 1858; Kay and Kempton, 1984).

Davies, Roling, Corbett, Xoagub and Xoagub (1997) described a study of color terms in Damara, a language spoken in Namibia within southern Africa. The primary aim was to seek a validation of Berlin and Kay (1969)'s theory of colour term universals, but this time on a member of a new language family, since Damara was an emergent Khoisan dialect at the time. Also of concern in the study was the level to which the catalogue of Damara colour terms was influenced by bordering languages, as well as the impact of recent social and political transformations in the region and their alleviation in the categorization process.

The data gathered by Davies *et al* (1997) implied that Damara's 11 colour terms – which consisted of 8 fundamental and 3 loan terms – were congruent with the Berlin and Kay (1969) position. The list of terms in the language was found to be in a state of flux with the presence of borrowed words appearing to exist only as a substitute for the corresponding "absent" Berlin and Kay (1969) universals. The study also observed that the colonial situation and bilingualism have seemingly influenced the age of colour term acquisition in the indigenous population, among other peripheral effects.

Davies, Corbett, Mtenje and Sowden (1995b) outlined an inventory of colour terms used by those conversant in Chichewa, a Bantu dialect spoken in Central Africa. The study involved two samples of Chichewa speakers - a rural band of 40 subjects varying in age from 18 to 82 and a group of 43 university students. These cohorts were instructed to undertake three tasks:

i. free naming of all potential colour terms salient to each individual;
ii. a colour vision test; and,
iii. a colour naming exercise.

Experimental analysis discovered five basic colour distinctions in Chichewa: ‘white’, ‘black’, ‘red’, ‘yellow’ and ‘blue/green’. The outcomes were found to be consistent with the original Berlin and Kay (1969) theory in this instance.

Laws, Davies and Andrews (1995a) featured an examination of linguistic structure and non-linguistic cognition by contrasting Russian and English speakers' behaviour on tasks related to the perception of the ‘blue’ region of colour space. In the first experiment of this study, five Russian subjects were envisaged to psychologically extend distances between pairs of colours from dissimilar lexical categories and to similarly contract distances between pairs from comparable lexical categories. In the second experimental exercise, eight Russian and six English subjects were forecast to augment the apparent resemblance between pairs of colours from the same lexical category and minimize perceived similarity of pairs from contrasting categories. In the third experiment with nine speakers each of Russian and English it was expected that the Russian cohort would divide light and dark ‘blue’ colours more often than the English group. The results of the first three tasks initiated a fourth experiment with 30 English speakers that confirmed that these subjects could learn to make a distinction in the ‘blue’ region of colour space along a ‘light-dark’ aspect more unhesitatingly than in the analogous ‘green’ region.

Davies, Corbett and Bayo Margalef (1995a) classified Catalan, a language spoken in northeastern Spain, as being a typical stage VII category language with eleven basic colour terms, largely in compliance with the essential doctrine of the original Berlin and Kay (1969) theory. The investigation involved 10 adult speakers, aged between 17 and 50, as well as 40 children in the 11-12-age range. Deviations from the standard Berlin and Kay (1969) position were observed, though: It was noted was that Catalan possesses more than one salient term for the ‘blue’ region (cf. Russian) and that the ‘purple’ region of colour space for Catalan has a focus of terms unusually dislocated from the position of the Berlin and Kay (1969) "universal" focus for this area. The authors conjectured that the latter inconsistency may be associated with the approach to which the Catalan language apportions the ‘blue’ region of colour space.

Laws, Davies, Corbett, Jerrett and Jerrett (1995b) described an experimental analysis of the colour terms used by 390 Setswana speakers, ranging in age from 4 to 85, who were residing in Botswana, a country in southern Africa. Setswana is part of the Bantu family of African languages and the study paid particular attention to factors of age and place of residence, contrasting the effects of urban versus rural living. The outcomes of this report were largely consistent with the original Berlin and Kay (1969) theory but noteworthy trends were documented that indicated a shift from traditional indigenous colour terms toward an embracing of English ones. Among the young subjects especially, there were additional signs of a drift away from colour terms with bovine connotations, representing the interference effects of encroaching urban development.

There is an emerging body of research that suggests that language does in fact influence perception but only in a dominant way in the right half of the visual field, and to a much negligible extent, in the left half (Gilbert, Regier, Kay and Ivry, 2006; Drivonikou, Kay, Regier, Ivry, Gilbert and Franklin, 2007; Gilbert, Regier, Kay and Ivry, 2008). At a functional level the administration of language occurs primarily in the left hemisphere of the brain, which takes delivery of visual information that is channelled from the right visual field. Linguistic categories, such as those formed in colour naming, appear to have an effect on that which is perceived in the right visual field. Studies of this phenomenon have indicated that linguistic differences can accentuate perceptual difference. For example, if linguistic categories exist for ‘blue’ and ‘green,’ as they do in English, then the perceptual distinction between these two colours would appear to be heightened. Others who learn these categories would then supposedly inherit this perceptual tendency as well, subject to normal physiological conditions. The corollary of this would be that speakers of a language that did not have words for ‘blue’ and ‘green’ would have a reduced capacity to distinguish between these two colours at a perceptual level and, of course, not have the terms to name them.

To determine whether these newfound Whorfian effects in the brain could be detected via neuroimaging techniques, Tan, Chan, Kay, Khong, Yip and Luke (2008) employed functional magnetic resonance imaging to demonstrate that brain regions arbitrating language processes are seen to participate in the guise of neural networks that are activated by perceptual decisions. In the experiment subjects who were native Mandarin speakers of Chinese ethnic extraction were asked to perform a perceptual discrimination task on simple-to-name and difficult-to-name coloured squares, all while having their brain activity scanned. A key finding was that, in comparison with difficult-to-name coloured squares, perceptual discrimination of simple-to-name colours evoked stronger activation in the left region of the brain responsible for word-finding processes. This observation indicates that the language processing areas of the brain are directly take part in visual perceptual decisions and it was concluded that this study provided neuroimaging evidence for the Sapir-Whorf hypothesis.

However it may be that these lateralization effects change as humans develop from birth given that Franklin, Drivonikou, Bevis, Davies, Kay and Regier (2008) have observed that prelinguistic categorical perception of colour stimuli in infants is situated in the right hemisphere of the brain with it obtaining its information from the left visual field.

## 2.13 Recent Analyses of the World Colour Survey

This section will outline recent investigations of the World Colour Survey data set (Kay and Regier, 2003; Regier, Kay and Cook, 2005a; Regier, Kay and Cook, 2005b; Lindsey and Brown, 2006). These all share a common feature, namely that their analyses of the entire World Colour Survey data set of 110 language groups reveal support for the Berlin and Kay (1969) position. They also share commonality in a lack of clarity with their exposition of the statistical methodologies used to carry out these examinations.

A “cleaned up” version of the World Colour Survey data set was made available online to the general public (Cook, Kay and Regier, 2003) and soon after the first analysis co-authored by the principal investigator (Kay and Regier, 2003) was published. This examined the data from colour naming evaluation component of the study. Kay and Regier (2003) initially addressed the possibility that the original phenomenon of colour term universality could have been an artefact of a human predisposition to perceive non-random clustering in a random distribution of items on a surface (Clarke, 1946). The latter paper by Clarke (1946) debunked the belief during the Second World War that German bombs were targeting London in clusters with a significant number deliberately aimed at the more destitute areas of the city. The statistical analysis indicated that bombing was uniform and the clustering hypothesis was the product of being deluded by intuition.

The entire World Colour Survey data set was analysed by Kay and Regier (2003) with a Monte Carlo technique to determine whether clustering across the 110 languages was more than would be expected by chance aggregations. The description of the process involved in these tests was opaque to interpretation. Their findings, though, indicated significantly less dispersion of colour terms than would be expected by chance, indicating that there exists an inclination towards natural clustering of terms across the entire set of languages. In other words they claim that there was obvious cross-linguistic statistical evidence for named color categories to accumulate at certain special points in perceptual colour space. Perceptual colour space refers to the representational structure signifying relational aspects of human colour perceptions.

Based on a statistical comparison with the original Berlin and Kay (1969) data, the additional conclusion drawn by Kay and Regier (2003) was that these special points in perceptual colour space were similar for the unwritten languages of technologically unsophisticated communities and the written languages of industrialized societies. These special points in perceptual colour space have a propensity to be situated more often than not at those colours named ‘red’, ‘yellow’, ‘green’, ‘blue’, ‘purple’, ‘brown’, ‘orange’, ‘pink’, ‘black’, ‘white’, and ‘gray’ in English, these being the so-called Basic Colour Terms. Thus the World Colour Survey data set, when viewed as a conglomerate, appeared to justify the position that strong universal tendencies in colour naming exist across languages regardless of the technological complexity of their parent culture. The original research outlined in this thesis, however, will offer an analysis that is more directed, with a focus on the indigenous Australian component of the World Colour Survey data set subjected to scrutiny in isolation.

The languages examined by Kay and Regier (2003) were found to vary considerably in the number of major colour terms that they contained and they also varied significantly in the location within colour space of the boundaries between terms. Examined as a statistical aggregate, though, Kay and Regier (2003) found that specifically favoured points in colour space appeared to exist to which the colour naming systems of the world’s languages were secured. Statistical analysis of the color naming data of the World Colour Survey resulted in three conclusions:

i. There are apparent cross-linguistic statistical inclinations for named color categories cluster at specifically favoured positions in perceptual colour space;
ii. These favoured positions in colour space are shared to a certain extent by speakers of languages without a form of writing from communities lacking an industrial base and by speakers of written languages of more developed societies; and
iii. These privileged points tended to lie near, although not always at, those colours named ‘red’, ‘yellow’, ‘green’, ‘blue’, ‘purple’, ‘brown’, ‘orange’, ‘pink’, ‘black’, ‘white’ and ‘gray’ in English.

Regier *et al* (2005a) examined the focus data of the World Colour Survey rather than the naming data. Naming data referred to the native language responses uttered by World Colour Survey subjects upon being presented colour stimuli individually, one after the other. As well as naming isolated chips, the colour stimulus array was presented to speakers who were then asked to indicate the chip (or range of chips) in the array that denoted the best example (or focus) of each colour term in the language. This was referred to as the focal data of the World Colour Survey. In this thesis the naming data of the indigenous Australian component of the World Colour Survey data set was examined. The focal data was not subjected to any scrutiny in order to limit the scope of the research to naming patterns.

Regier *et al* (2005a) concluded that best-example choices for color terms in these languages cluster near the prototypes for English ‘white’, ‘black’, ‘red’, ‘green’, ‘yellow’, and ‘blue', these being the so-called Hering primaries. Best-example colour choices from the array were also found to cluster more tightly across the 110 languages in the World Colour Survey data set than do the centres of category extensions, these being ranges of colours deemed to belong to a category. The latter was taken as support in the paper that universal foci are a possible source of universal tendencies in colour naming behaviour. This was seen to validate the original Berlin and Kay (1969) notion of universals in the mapping of focal colours. Regier *et al* (2005) claimed that their evidence provided a rebuttal to the claims of Roberson, Davies and Davidoff (2000) who suggested that colour categories were not structured around universal foci but were instead determined by naming distinctions made at category boundaries, which vary across languages. The latter was based on research originally reported in Davidoff *et al*

(1999) and was based on colour categorization studies with a “stone-age tribe” discovered in Papua New Guinea who have had little contact with Western culture and spoke a language known as Berinmo.

Lindsey and Brown (2006) analysed the entire World Colour Survey colour naming data set using k-means cluster and concordance analyses. Concordance with respect to this study appeared to refer to a means of gauging the level of agreement in colour terms used in the World Colour Survey data set. The authors offered their definition by way of an example: Imagine that there is a cohort of 25 English speakers in a colour naming exercise using the World Colour Survey stimuli. 15 of these denote a specific World Colour Survey chip as being ‘red’, 5 are observed to use the term ‘scarlet’ for the exact same chip and the remaining 5 call it ‘crimson’. The formula for concordance, as deployed by Lindsey and Brown (2006), then takes the aforementioned three values and determines their maximum, this being 15. The later value is then divided by the number of subjects (i.e. 25), returning a concordance value of 0.6 for that chip.

The mean concordance for a particular World Colour Survey colour chip was computed by Lindsey and Brown (2006) by averaging it out over the 110 language groups in the entire data set. Something called the “grand mean concordance” was then derived from the average concordance across all chips. Essentially what they are determining then under the rubric of concordance is “level of agreement,” which has an inverse relationship to the notion of diversity. As we shall see, this thesis also contains an analysis of the World Colour Survey colour naming data but one which is tightly focused on only a group of seemingly related natural languages, namely those from indigenous Australia. The analysis will examine the data in terms of diversity rather than concordance.

The concordance analysis employed by Lindsey and Brown (2006) indicated that the statistical properties of colour naming by World Colour Survey informants exposed collective restraints on how cultures segregate colour space using words. Cluster analysis in this study used the technique of Pearson correlation as a similarity metric so that each informant’s patterns of colour naming could be analysed rather than proxies for these individual archetypes. Cluster analysis was also limited to chromatic colours (leaving out ‘black’, ‘white’ and ‘gray’). Findings from this study suggested that World

Colour Survey clusters are compatible with familiar English colour categories (or amalgamations of these) over a significant extent of cluster numbers.

According to Lindsey and Brown (2006), the mean colour naming patterns as espoused by the clusters all bore an obvious semblance to single or composite English patterns. The compositions of the k-means clusters spread out in a hierarchical manner that was evocative of the Berlin and Kay (1969) progression of colour term evolution. Gap statistical analysis revealed that the optimum number of World Colour Survey chromatic colour categories is 8, these being equivalent to ‘red’, ‘pink’, ‘blue’, ‘green’, ‘brown’, ‘purple’, ‘yellow’ or ‘orange’ and ‘grue’ (this being a composite category that is either ‘green’ or ‘blue’).

The concordance investigation of the entire World Colour Survey colour naming data set by Lindsey and Brown (2006) demonstrated that the greatest average statistically significant concordance was found in small regions that are related to five of the six Hering color-opponent primary colours, namely red, yellow, and green, black and white. Concordance analysis in the Lindsey and Brown (2006) study exhibited the presence of two key “fault lines” of low concordance in the World Colour Survey colour chart. These sections of statistically significant low concordance overlapped with the boundaries associated with the English composite colour categories of ‘warm’ and ‘cool’. (‘Blue’ or ‘green’ are considered ‘cool’ colours, while ‘red’ or ‘yellow’ are deemed to be ‘warm’ colours.) Lindsey and Brown (2006) believed that their analyses offered substantiation for a correlation between the World Colour Survey languages and English in terms of the systems that dictate how colour space is lexically segmented.

In his analysis of the World Colour Survey, Bimler (2006) used a metric called a boundary density to determine the level of consensus in his analysis, which was computed for all language sub-groups in the World Colour Survey as well as in general comparisons between language families that are present. The analysis technique concentrated on the averaged location of boundaries within the stimulus set of the World Colour Survey with the intention of uncovering the system of colour categories inherent to each language. In this approach immediately adjacent pairs of World Colour Survey colour stimulus chips were examined to determine the number of members within a particular language group who named each of them. The number of informants within a language group who gave a different name to each chip in a pair was then tabulated, this being deemed to represent a category boundary between the two. The boundary density metric was then defined as the ratio of the latter to the former. This served as a quantitative index of inter-language similarity that was employed to compare average boundaries.

The boundary density metrics were calculated for all World Colour Survey language groups apparently but were not all reproduced in the paper by Bimler (2006), except for a few representative examples. A combined mapping of boundary densities for all World Colour Survey languages was also calculated, which highlighted so-called “islands of stability” (i.e., a sign of clustering) that resembled the equivalent positioning of cross-cultural colour foci from the World Colour Survey data set as featured in Cook et al (2005).

In addition, Bimler (2006) computed an index of similarity between pairs of languages within the World Colour Survey. Multidimensional scaling was then applied to inter-language similarities in order to see relationship patterns within language families. Evaluating the correspondences among color naming patterns led to the formation of a “language space” in which languages were grouped into clusters according to linguistic families, meaning those showing descent from common ancestors. Bimler (2006) implied that each language’s digressions from the cross-cultural consensus about color categories appeared to be systematic and non-random in nature, thus offering tacit support for the Berlin and Kay (1969) position. However, he did admit that there were poor levels of agreement regarding the colour lexicon within individual languages.

In Regier, Kay and Khetarpal (2007a; 2007b) the argument was advanced that the colour naming behaviour observed across natural languages in studies such the World Colour Survey was a sign that optimal or near-optimal subset of an unevenly formed perceptual colour space were characteristic of human beings. The contention was formulated via a well-formedness metric that denoted the scope of any particular categorical partition of colour space which accentuated perceptual similarity within colour categories and curtails it across categories. The theory was proposed that the colour naming systems associated with global languages were in fact closely aligned with maxima in well-formedness or close to this, these being optimal colour naming systems in the conceptual sense.

Simulations were devised by Regier *et al* (2007a; 2007b) to model these optimal colour naming systems and their output was compared with selected language cohorts from the World Colour Survey data set. The study purported that across the 110 language groups of the World Colour Survey, colour naming displayed a propensity to be partially influenced by so-called well-formedness. But the simulations also indicated that innateness was not solely the driving factor with linguistic convention also exerting some capacity for manipulation due to the presence of a number of comparable but diverse partitions that were more or less equally well-formed. In terms of the tensions between nature and nurture in colour naming, a midway stance was not discounted by this research. While it offered support to the existing idea of universal tendencies in color naming, the research by Regier *et al* (2007a; 2007b) also allowed for some observed cross-language variation that could satisfy those who believe that categories are delineated at their perimeters by linguistic convention.

Regier *et al* (2007a; 2007b) noted that while colour foci were subject to universal constraints, there was a possibility that a boundless range of these best examples of colour exist. From the perspective of being perceptually salient, all colours have the capacity to be “focal” to a varying degree, resulting in an uneven chromatic landscape. The concession was made that language-specific adjustment could perturb the emergence of a perceptually optimal segmentation of colour space, thus altering universal tendencies of colour categorization for that language. This work supported the earlier proposal by Jameson and D’Andrade (1997) that was argued along similar lines.

With tangential reference to the World Colour Survey, Webster and Kay (2007) surveyed the nature of focal colours from both a psychophysical and linguistic vantage to discuss why individual and population differences exist. Psychophysics approached colour appearance by assuming that stimuli used in perception studies were shared by all human observers, the rationale being that they all should have a common physiology. The results from these studies were then used to determine underlying visual mechanisms in processing. The linguistic approach to colour appearance examined the notion that there are related colour categories that span natural languages. Webster and

Kay (2007) stated that significant variation in focal colours was presented at the individual level, probably due to physiological factors. This was also true at the language level but the variation in focal colours was considered to be less. These large individual differences were not deemed to interfere with supposed cross-linguistic universals in colour naming behaviour.

Webster and Kay (2007) attempted to explain away the influential factor of individual differences to the World Colour Survey study through a brief recourse to the Central Limit Theorem of statistics. But they conceded that, with respect to focal colours, it was highly unlikely that the individual languages of the World Colour Survey were extracted from a uniform population, thus suggesting an element of possible bias. Webster and Kay (2007) also stated that the large variation of focus positioning within individual languages in the World Colour Survey data set had no bearing on either possible linguistic differences in focal colour categorization or on potential universal predilections for focus positioning across languages.

Webster and Kay (2007) also admitted that the analysis of the World Colour Survey data reported in Regier and Kay (2003) indicated that different language groups do vary in the average focal choices for adjacent terms. They followed on to conclude that the presence of these differences within groups would carry some influence on potential universal tendencies in colour naming and that the mapping of basic colour terms was not a simple process of identifying strict equivalences across all languages due to contextual effects in colour naming. The analyses to date by the World Colour Survey researchers have not probed the possible reasons for the observed interlingual variation to identify whether environmental, cultural or physiological factors are at play. Webster and Kay (2007) are comfortable, though, with the diversity observed. An interpretation of the diversity to be observed in the indigenous Australian component of the World Colour Survey data set, observed in isolation, is the focus of the independent research to be outlined in this thesis.

Even though physical colour characteristics can fluctuate in varying environments thus possibly wreaking havoc with consistent perception due to adaptation processes, Webster and Kay (2007) believed that these contextual factors are still constrained enough to allow for colour foci for different populations to remain strongly clustered in colour space based on the current statistical analyses of the World Colour Survey data set. They surmise that the factors that gave rise to individual differences in perception must also exhibit strong universal tendencies themselves.

Kuehni (2007) also subjected the entire data set of the World Color Survey to an analysis with regard to individual focal choices. A total of 46 major color terms were observed to be employed by a minimum of 60% of speakers in a given language. While 24 of these terms could be expressed as equivalents of corresponding English colour terms, 22 could not be determined in a likewise fashion. The analysis revealed that the most prevalent color term with regards to usage was the equivalent of ‘red’ and that this was closely followed by ‘white’ and ‘black’.

Kuehni (2007) found that there were 73 different arrangements of major color terms amongst the entire set of 110 languages that comprised the World Colour Survey. The six Hering primary colours (‘white’, ‘black’, ‘red’, ‘green’, ‘yellow’ and ‘blue') were observed to be present, preferentially but not constantly, in the lexicons of languages with six or more key colour terms and it was assumed that this was the case because the Hering primaries were closely related to the mechanisms of the colour vision system. They signified the top six categories with respect to common convention across all 110 languages surveyed. Kuehni (2007) conceded that his analysis of the World Colour Survey indicated that the practical application of major color terms was a complex practice, evidently influenced by cultural factors.

### 2.13.1 The Effect of Sunlight on Colour Naming in Equatorial Regions as Revealed in Analyses of the World Colour Survey Data Set

Reminiscent of the original contention in the 19th century by Gladstone (1858) that the Ancient Greeks were colour deficient with the possibility of not being able to perceive the colour ‘blue’, Lindsey and Brown (2002) advanced new thoughts on this position citing the phototoxic effects of prolonged exposure of sunlight on the eye, which was dubbed the brunescence hypothesis. They proposed that discrepancies in colour naming may be the result of disparities in lens pigmentation and retinal impairment due to variable exposure to high levels of sunlight. Lindsey and Brown (2002) remarked that natural languages that do not have unique word for ‘blue’ in their lexicon have a propensity to be spoken in regions of the world where extreme levels of ultraviolet light are an environmental norm. The corollary being that the phototoxic consequences of ultraviolet irradiation could possibly induce diminished short-wavelength acuity to the extent where the colour 'blue' would in fact leave the observer's perception of the spectrum and with this become expunged from the colour lexicon.

In a sense the arguments in Lindsey and Brown (2002) are an extension of those put forward earlier by Bornstein (1973) who suggested that differential sensitivity to colours in the short wavelength band of the spectrum can be attributed to the emergence of a yellow ocular pigment in observers resident in certain geographic areas that strongly influences their colour naming behaviour as a consequence. Also, in arguing the case for a psychophysiological basis of universal colour terms, Ratliff (1976) suggested that a general weakness in perceiving short-wavelength stimuli is prevalent in human vision at a physiological level. This could possibly be a factor in the difficulty to perceive 'blue' in some cultures, as well as the tendency to confuse the latter colour with 'green.'

Lindsey and Brown (2002) referred to the World Colour Survey data set in their deliberations, so it would seem that their theory was an attempt to deal with the anomalous differences in colour naming between languages and perhaps then reconcile this with the original Basic Colour Term theory; much like MacLaury (1997) did with his formulation of Vantage Theory. However, Webster and Kay (2007) noted the Lindsey and Brown (2002) theory does not inform the question of variability with a particular language group. The arguments advanced by Lindsey and Brown (2002) stimulated much debate, primarily on the ground that cross-language colour naming patterns were detected in studies that obviated the conjectured detrimental effects of ultraviolet light in an environment (Regier & Kay, 2004; Lazar-Meyn, 2004). These bursts of criticism evoked a rebuttal as described in Lindsey and Brown (2004). Hardy, Frederick, Kay and Werner (2005) demonstrated that older and younger observers do not differ in how blue they rate spectral stimuli, despite their large differences in lens density.

A recent study casts further doubt on this explanation of the absence of 'blue' terms in equatorial languages and, in any case, shows it is unlikely to provide a plausible explanation for individual differences within a population. As we have noted these differences are at most weakly related to lens density. In a direct test, Hardy *et al* (2004) show that older and younger observers do not differ in how blue they rate spectral stimuli, despite their large differences in lens density. Hardy *et al* (2004) also show that lens density itself – which they measured directly – appears unrelated to the degree to which spectral stimuli are rated as blue.

## *2.14 Indigenous Australian Languages and Culture*

### 2.14.1 The Complexity of Australian Aboriginal Languages

The ancient Greeks used "barbarian" as a blanket term of exclusion to categorize all those who did not speak their native language. Implicit in this highly pejorative appellation was the spurious idea that these foreign languages were "primitive" by comparison. According to Voltaire, as translated by Wardhaugh (1999, p. 40): *"A primitive language or a primitive alphabet has no more existed than a primitive oak or a primitive grass."* Even so, the notion that Australian Aboriginal languages are "primitive" is still a common misconception amongst those who are not scholars of linguistics. Indeed, anecdotal evidence would suggest that many contemporary white Australians believe that there is only one Aboriginal language with a paucity of words and no grammar (Dixon, 1980; Evans, 1998). In actual fact, there were about 200 different languages spoken by the various tribes of Australian Aborigines, all but two or three of which belong to the one language family: the "Australian family". Evans (1998) quoted a figure of 250 and possibly even 600 different dialects, depending on the classification criteria used.

Blake (1991) noted that when the first British settlement was established in 1788 at Port Jackson, in what is now New South Wales, Australia was populated with approximately 300,000 Aborigines, divided into roughly 600 tribes with an average of 500 members each. Unfortunately, of the estimated 200 to 250 distinct languages spoken in 1788, more than half were extinct by 1991, with only about fifty of those existing languages having 100 or more speakers (Blake, 1991). Yallop (1982) noted that when a language is on the verge of extinction it is notoriously problematic to determine the exact number of existing indigenous speakers. Aboriginal elders over the age of 50, for example, may exhibit a tendency to use their traditional language rather than English while children may understand the language as a passive listener but not as an active speaker. Of course, there may be a transitional linguistic group who are effectively bilingual in their native tongue and English. Yallop (1982) believed that such a cohort of bilinguals may, intentionally or not, offer vague answers to questions about the languages they speak.

In yet another educated guess, Yallop(1982) quoted a range from 150 to 650 for the total number of different indigenous Australian languages that once existed subject to the proviso that in some regions of the continent bordering tribes conversed in very similar tongues that could have been either dialects of a single language or separate though related languages. Aborigines did not establish nation-states or geographic principalities with which linguistic classifications could be associated. Socially-based groupings other than the typical tribal structure were acknowledged by many Aborigines, though.

Yallop (1982) related that in regions of Cape York in Queensland the indigenous inhabitants were considered to be members of one of two “moieties”, known as “white cockatoo” and “black cockatoo.” Blake (1991) defined the term “moiety” as meaning half and indicates that sub-sections within moieties were colloquially referred to as “skins.” This social division spread across tribal and linguistic boundaries and dictated such goings on as suitable behaviour and intermarriage between members of different tribes. In parallel with these moieties, Cape York aborigines, as well as some indigenous people in other regions of Australia, also accepted the existence of separate clans within tribes. Since some clans spoke using dialects that were not the same, it was clearly likely that a child’s father and mother would speak different dialects. Given the prevalence of intermarriage among clans these dialects were highly malleable in nature and subject to either convergence or coalescence.

Yallop (1982) wrote that Aborigines in general gave the impression of not being too protective about their linguistic identity. Speakers appeared to have borrowed without restraint from other languages and were often not concerned about naming languages. For example, different clans with one mutual language might have a unique name for each clan but not one for their common tongue. Similarly, disparate indigenous neighbours might refer to the same tribe and its associated language by varied names.

Other anomalies abound in terms of language differences. Yallop (1982) claimed that if indigenous languages were compared using the techniques of lexicostatistics it was observed that the proportions of shared vocabulary varied greatly. Adjacent dialects or languages may share only a paltry slice of a basic vocabulary or as much as 80% or more. Blake (1991) admitted that the names of Australian Aboriginal tribes, and consequently their associated languages, were quite perplexing. A diverse range of spellings and dual appellations for the same tribe or language were described as being commonplace for a number of reasons, one of which being transcription errors by both amateur and professional linguists.

### 2.14.2 The Problems of Classifying Indigenous Australian Languages

Vocabulary-based classification of languages is a contentious issue, hinging as it does on the debatable notion of a universal basic lexicon. This would also imply the existence of a universal set of basic concepts. In this respect, Yallop (1982) highlighted a glaring problem being the lack of some indigenous words in certain domains. For example, Australian aboriginal languages commonly possess no verb meaning "to count" and no noun that is the equivalent of "year". There are also subtle differences in the meaning of words that on first translation appear to be equivalent. In another example, Australian aboriginal languages appear to be devoid of a generic term for "fruit". The closest matching word actually translates to English as "vegetable food" and is a category that includes edible roots and leaves as well as berries and other fruits. In some cases what displays itself as a unitary concept to speakers of other languages is actually denoted by more than one word. For example, there may be two indigenous terms referring to the single English equivalent of "string", differentiating on the basis of constituent materials, namely animal sinew and human hair.

O'Grady (1960), as cited by Yallop (1982), determined that no less than 69 words out of a frequently used 200-word list of basic items were inappropriate for lexicostatistics use in Australia. The sheer diversity of the indigenous vocabulary is a serious impediment to any kind of analysis. In some global language families, cognates, or slightly related vocabulary items, are present that span an entire language family. For example, a typical set of cognates are the Indo-European words for the concept of "mother", all differ in spelling yet many are similar in form (e.g. *Mutter* in German, *mati* in Slovenian, *madre* in Spanish and *mère* in French.) Only about 50 nouns, verbs and adjectives exist in Australian Aboriginal languages which share a resemblance in form but none to the degree that merit their being classified as cognates across the whole body of land. In discussing lexical similarity and diversity, Yallop (1982) mentioned that synonyms are prevalent in indigenous Australian languages, even in the commonplace vocabularies of casual speakers.

Even though it is conjectured that the various Australian Aboriginal dialects evolved over the course of thousands of years from some single ancestor language of unknown origin (i.e. "*proto-Australian*"), the forces of linguistic diversity took hold, resulting in an assortment of modern vernaculars in which any two can possibly be as different as Bengali and Scots Gaelic, for example. The languages are distinguished by complex grammars, with each having a vocabulary of at least 10,000 words made up of nouns, verbs, adjectives and so forth. Yallop (1993) acknowledged that the words of Australian Aboriginal languages were remarkably different. Some words were found to be pseudo-universals in form (i.e. cognates), such as the lexical equivalents for the term "hand" or the compound term "you and I", but in other cases diversity often reigns supreme.

### 2.14.3 Ambiguity in Indigenous Australian Languages

Collectively speaking, ambiguity is a hallmark of indigenous Australian vocabularies. Yallop (1982) noted that the term *mil*, or a similar form such as *miyil*, meant "eye" over a vast expanse of country including Central Australia, Queensland and New South Wales. Some other Australian Aboriginal languages have equivalent words that are more different in form but are still classed as being cognates (such as the term *el* used in Kunjen, Cape York.) However, Yallop (1982) stated that a considerable variety of languages were left in which the equivalent word for "eye" cannot in all fairness be accepted as being related in form to *mil*. For example, the word for "eye" in the Maung dialect, spoken in the region north-east from Darwin, is *wun* while in some of the Arandic languages of Central Australia the comparable terms are *atnnga* or *alknga*. The Arandic languages as a group share many distinguishing pronunciation and grammar traits yet beneath the surface they are actually diverse in vocabulary. Yallop (1982) observed that the rate of vocabulary replacement amongst indigenous Australian languages was relatively high in comparison to other global languages, offering the suggestion that the restrictive effects of Aboriginal word taboos was a possible causative factor. This custom of self-imposed censorship will be addressed in greater detail later in this section.

Geographically adjacent languages that may have similarities in pronunciation and grammar are shown to differ in completely general words. According to Yallop (1993), the equivalent word for "dog" in Arrernte, a language spoken near Alice Springs in the Northern Territory, is *kngulya*. To the west of the resident Arrernte-speaking population the corresponding word in the Western Desert languages spoken there is *tjitutja* or *papa*. To the northwest of the Arrernte-speaking population, the Warlpiri word for "dog" is *maliki*. Yallop (1993) noted that even in the closely related languages to the east and northeast of Arrernte, the word for "dog" is *aringka* or *alika*.

Dixon (1980) observed that the lexicon size in a typical Australian Aboriginal language was comparable to that possessed by the average citizen in any so called "civilized" country. Special purpose supplementary vocabularies used for ceremonial communication and inter-familial intercourse also bolster the lexical content of Australian Aboriginal languages. Incidentally, word inflections in many Aboriginal languages are described as being suggestive of Latin and Ancient Greek, made resonant with a pleasant sound similar to Italian in aural form (Dixon, 1980).

### 2.14.4 The Diverse Richness of Indigenous Australian Languages

Walsh (1993) used Warlpiri and Murrinh-Patha to exemplify the diverse richness of indigenous languages. Warlpiri, a language spoken to the northwest of Alice Springs in the Northern Territory, can be compared to Latin in the way its speakers indicate different functions of nouns. On the other hand, Murrinh-Patha, a language spoken on the coast south of Darwin in the Northern Territory, resembles Turkish in that a single word can hold many clearly discernible fragments of meaning. Upon translation to English, a Murrinh-Patha word can almost appear to be a complete sentence in itself. For example, the single word *manhipurlnu*, used in parent-to-child talk, is the semantic equivalent of "I'm going to wash you" or "I will wash you". Walsh (1993) noted that Murrinh-Patha has evolved into a de facto lingua franca for the indigenous communities at Wadeye (formerly Port Keats) on the west coast of the Northern Territory, its origin being traced back to around 1935 when missionaries united monolingual speakers of many diverse languages for scholastic reasons. By 1993 Murrinh-Patha was the linguistic medium employed for the local bilingual education program.

Blake (1991) stated that a language in general was made up of words that refer to whatever the speakers of that language are compelled to talk about. Alternatively, Romaine (1994) remarked that a beneficial mode of thinking about differences in languages was to view them as varying in what is inescapable to express when using them rather than in what is possible to express when using them. Contemporary Western civilization spawned the computer revolution and in doing so it became unavoidable to create a new vocabulary to converse about the new technologies and differentiate between them. On the other hand, Aborigines living in the centre of Australia are immersed in a world of kangaroos, emus, lizards, birds, rather than silicon chips. Consequently, words for different kinds of indigenous flora and fauna are in abundance in Aboriginal languages. Yallop (1982) noted that different species of the larger marsupials (e.g. “wallaroo”, “rock wallaby”, “red kangaroo”, etc.) and different kinds of spider, frog, lizard and snake are routinely distinguished by a unique single name for each variety instead of the English pattern of using compound words such as “brown snake” or “tiger snake”. Likewise, the botanical novices amidst Australians of Western European descent would probably view the different species of trees and other plants that decorate the landscapes as being alike and label them as “gum trees” or “wattle trees”, while indigenous Australians would more likely have a distinct name for each species.

Yallop (1982) pointed out that there were particular broad affinities of lexical organization from a semantic viewpoint in indigenous languages even though the form of words was subject to variation. Concrete nouns for human beings and body parts, topographical features and camp objects and implements are pervasive words. Most body parts are unambiguously signified with an almost clinical level of precision in comparison to the English language. In English, for example, the word “stomach” as a noun is a rather fuzzy term in customary usage. One can refer to “a tattoo on the stomach” or “a pain in the stomach” or “a very large stomach” and so on. (Incidentally, it can also be used as a verb, meaning “to endure” or “to tolerate”.)

When referring to a comparable anatomical vicinity in indigenous languages, Yallop (1982) noted that distinct terms are said to be in everyday use for the actual stomach as an organ, the intestines and the outer surface of the abdomen, not to mention the other principal internal organs as well such as kidneys and liver. Judged on the attention to detail in creating words that differentiate between these anatomical components, it would appear on face value that indigenous Australian cognition is not plagued with categorization deficits. The anatomy of larger animals, such as the kangaroo, is lexically mapped out with equal rigour. Yallop (1982) surmised that this could be the result of indigenous customs born out of necessity that promote frugal apportionment of meat as a foodstuff: an instance of "environment influencing language" rather than "language influencing thought" perhaps?

### 2.14.5 Classification Practices in Indigenous Australian Languages

The indigenous passion for classification also extends to descriptions of individuals by sex, age and responsibility that is separate to their already intricate system of kinship terminology. For example, Yallop (1982) listed some of the indigenous terms that are found for identifying types of Aboriginal persons that were also, by implication, not used to describe non-Aboriginals: "boy (not yet sexually mature)", "boy reaching puberty", "initiand" (sic) (i.e. presumably one who is currently being initiated), "recent initiate", "man (i.e. adult initiated male)" and "man with greying hair (i.e. man reaching senior status)". It would seem that these words are "information-rich", containing almost the equivalent of a short English sentence full of meaning in one aggregate chunk.

For a nomadic people with an affinity for the land, it is no surprise that indigenous Australians have a relatively large vocabulary to refer to topographic features, climatic conditions and the general implements and artifacts of camp life. Yallop (1982) remarked that terms exist for obvious environmental entities such as "sky", "earth", "sun", "moon", "fire", "water", etc., along with words for different types of sand and ochre, for features such as "gully", "floodplain", "swamp", "cliff", "cave", and for different seasons and weather conditions such as "windy season", "dry season", "heavy rain", "frost". Of course, whether or not a particular word is present would depend on the Aboriginal tribe's specific physical environment.

According to Yallop (1982), indigenous Australian lexicons included various adjectives describing size, dimension, shape and texture, featuring equivalent terms for “big”, “small”, “long”, “short”, “straight”, “crooked”, “rough”, “smooth”, “wet” and “dry”. Referring to colour terms, Yallop (1982) emphasized that these types of words were not uniform in number across indigenous Australian languages. He remarked that some indigenous dialects had three or four terms used as colour adjectives, these being the equivalents of ‘green’, ‘yellow’, ‘brown, brownish red’, ‘orange, light red’, in addition to ‘black’ and ‘white’, while other words referred to luminosity or texture rather than hue.

It is interesting to note that Yallop (1982) referred to colour terms only as “adjectives” rather than considering whether Australian Aborigines could use them as nouns. To use a colour term as a noun would imply that one has an appreciation of colour as an independent, disembodied concept and not something that exists only as a quality of some object. The existence of indigenous terms for ‘brown, brownish red’ and ‘orange, light red’ suggest that these words indecisively categorize subsets or “mini-continua” of the colour spectrum because they reflect the matching chromatic ambiguity of the speaker’s environment. Sunsets and outback landscapes would be amenable to description with these kinds of adjectives but would not the colour of freshly-spilt blood warrant the creation of a more specific term for ‘red’? In fact, indigenous words denoting ‘red’ are not an extinct lexical species as will be seen later on in this treatise. However, referents indicating colour as an abstraction appear to be a non-existent lexical entity to at least some Australian Aborigines with Yallop(1982) noting that the language Anindilyakwa, for example, possessed no genuine colour terms but did have *akulyutata* meaning “bright, shining, of a bright colour” and *amurritjungwa* meaning “drab, dull, dark”.

Many indigenous Australian terms were adopted by European languages and used to denote species of flora and fauna that were alien to the new settlers. One prominent example is “kangaroo”, a term derived from Guugu Yimidhirr spoken in the vicinity of Cooktown in northern Queensland. Many geographic place names such as Canberra or Prahran are derived from indigenous languages but a precise etymology can be problematic. For example, Walsh (1993) wrote that the place name Canberra was said to have interpretations as wildly divergent as “breasts” and “meeting place”! Poor correspondence between the sound system of English and certain Aboriginal languages can contribute to mispronunciation by Western European tongues and misinterpretation by Western European ears.

Indigenous vocabularies are often recognized as being modest in size though functionally sufficient for environmental designations as previously mentioned in this section. For this reason Blake (1991) noted that a near complete vocabulary knowledge was a common characteristic of Australian Aboriginal language speakers. English speakers, on the other hand, would typically know only a somewhat small portion of all possible existing words, since the latter would also include scientific, technical, trade-specific and other esoteric terms.

The “Macquarie Aboriginal Naming Book” (1996) was published by the Macquarie Library of Macquarie University in New South Wales, Australia (hereafter MANB) as part of their ongoing Australian Dictionary project and is, in fact, extracted from the larger “Macquarie Aboriginal Words”, a dictionary of words from 17 indigenous Australian languages, both living and dead. No editor or author was credited to this synthesized text, which is sub-titled “*An Australian Guide to Naming your Home or Boat.*” The introduction to this guide commented that many Australians had borrowed words from Aboriginal and Torres Strait Islander languages rather than adopting terms of European origin since the latter more accurately reflected the unique character of the landscape.

### 2.14.6 The Semantics of Indigenous Australian Languages

Dixon (1980) noted that the semantics of Australian Aboriginal languages were rich in complexity with distinctions made that link directly to physical and social aspects of life in an indigenous community. These languages are imbued with descriptive powers to a certain degree as they possess a rich unrestricted class of adjectives with hundreds of members comprising such qualities as value, age, dimension, posture, speed, physical attributes of people and inanimate objects, and also mental attitudes and states. In an analysis of word classes in Australian Aboriginal languages, Dixon(1980) included colour terms within the “adjective” class rather than the “noun” one, implying that colours were probably not considered to be either concrete or abstract entities. It was claimed that there were often only two, and probably never more than four, basic colour terms in the Australian Aboriginal languages that had been surveyed. Common nouns denoting things were observed to facilitate other colour descriptions. For example, the verbal designations for objects such as the "sun" or "red clay" have been employed to specify dissimilar shades of 'red' in Australian Aboriginal languages with only two colour terms.

Nathan (1996) stated that most colour names in indigenous Australian languages were secondary colour terms that principally designated items in the speaker's physical environment, such as charcoal, ochres and plants, for example. Nathan (1996) used Yolnu (sic) to illustrate this point. This dialect was spoken at the time by around 6000 people in north-eastern Arnhem Land in the Northern Territory. Yallop (1982) quoted a figure of "more than 3000" for the population of speakers of this linguistic grouping. The *miny'tji* were an important set of symbols in Yolnu (sic) art and ceremonial rituals. The *miny'tji* were essentially the equivalent of colour terms and the word itself means both "colours" and "an artistic work such as a painting." It was said that for Yolnu (sic) artists the deed of painting was a means of delineating their identity, wisdom and spirituality. Two basic (or primary) colour terms and 10 distinct secondary colour terms were found to make up the *miny'tji*. Each of these terms had both a colour-related meaning and a cultural association.

Davis (1982) offered a different perspective on Yolnu (sic), focusing on a qualitative exposition of a colour naming study undertaken amongst so-called Yolngu (sic) speakers at Milingimbi in the Crocodile Islands, east of Darwin in the Northern Territory. The term Yolngu (sic) was apparently derived from "yolnu" (sic) which Davis (1982) stated as meaning "Aboriginal person" or "man". The differences in spelling could possibly be due to typographical problems in faithfully depicting unique orthographic conventions for the language. It is claimed that the designation Yolngu (sic) was used as either the appellation for north-eastern Arnhem Land people or as a general reference term for any Aborigines. However, the Northeastern Arnhem Land people themselves are referred to by many aliases in the literature, such as "Murngin" (sic), "Walamba" (sic) and "Miwait" (sic) for example, without these classifications being locally adopted.

While commenting on classification difficulties in analysing languages of this region, Yallop (1982) used the terms “Murngic” (sic) and “Wulamba” (sic) when describing local dialects, with “Yuulngu” (sic) being the collective title. According to Yallop (1982), there were many clans amongst the north-eastern Arnhem Land people. Couplings between clans could then result in a common-place situation where a child was essentially bilingual from birth because their father and mother spoke two different languages. Running in parallel to this, select clans might achieve social dominance with the offshoot being that their dialects acquired prestige, thus encouraging the members of other clans to adopt this tongue and become multilingual in the process.

According to Davis (1982), Yolngu (sic) speakers encoded 5 basic colour terms: *watharr* (‘white’), *mol* (‘black’), *miku* (‘red’), *buthalak* (‘yellow’) and *mulkuminy* (‘green’). Interestingly, the physical colour which was encoded by the term *buthalak* (‘yellow’) actually had a focal point of higher colour value (i.e. brightness) than the equivalent focal point of the English colour term “yellow”. Another disparity between English and Aboriginal colour concepts concerned the Yolngu colour term *mol*. Most often translated as ‘black’, *mol* not only encompasses such objects as the “blackest” charcoal but also ripening uncultivated grapes which English speakers would generally name as “purple” in appearance.

The theory posited by Davis (1982) is that Yolngu (sic) pre-teenagers discriminate colours primarily according to their brightness. The terms *watharr* and *mol* were known by most young children up to five years of age but were used to differentiate between light and dark colours respectively. When the children encoded the term *miku*, it was used to refer to dark colours as well but not those as dark as black. Similarly, when they encoded *buthalak* it was used to refer to light colours but not those as light as white. Incidentally, Yolngu (sic) elders preserved these four colour terms and employed them to judge comparative brightness. Yolngu (sic) teenagers began to discriminate colours via a more hue-based categorization process. The emphasis was on recognition of focal colours. The term *mulkuminy* was also encoded at this relatively late stage. Yolngu (sic) adults encoded additional colour names by differentiating between “shades” of the five basic terms (in other words, a saturation-based categorization process.) For example, the terms *lirrgi* (“black charcoal”), *dungulmirr* (“soil black with humus”) and *wuluymun* ("ripe wild grapes") were all viewed as being "shades" of black, with *lirrgi* as the focal black colour.

Davis (1982) recounted the handicaps encountered by Yolngu (sic) children learning English colour terms in a classroom situation, pointing out that Aboriginal children encode colour terms later than European children. The children more often than not memorized this supplementary colour encoding system using trial and error rather than any other pre-established logical sequence. These newly acquired colour terms often received very little application beyond those originally discovered during the initial indoctrination process. Problems were seen to exist because Aboriginal children did not first encode vernacular colour terms covering brightness and hue before attempting to match English and indigenous colour terms and concepts.

Davis (1982) described test results in which most Aboriginal pre-school children from an experimental cohort derived from the Milingimbi indigenous population knew the English colour terms 'red', 'yellow', 'green' and 'blue' but could not consistently identify the correct colour range for the associated terms on a set ISCC-NBS colour charts. The children were apparently aware of the differences in English colour terms only from a lexical perspective instead of a conceptual one. When tested for the range of indigenous colour terms, the children identified all corresponding colour chips in terms of *watharr* ('white' or 'light') and *mol* ('black' or 'dark'). Hue-based matching of vernacular colour terms with associated correct physical colour ranges was an ability that had not yet matured in this group. Of course, all these observations and subsequent explanations rested on data obtained using ISCC-NBS colour charts as a visual catalyst, a set of stimuli that are an artifact of Western scientific culture with no physical analogue in Aboriginal society.

According to Dixon (1980), the frequently occurring terms in the Aboriginal colour lexicon are 'black' and 'white', the others being 'red' and 'green'. Conversely, the MANB also listed some Aboriginal equivalents for 'blue', 'grey' and 'yellow', as well as corresponding names for such colour-related terms such as 'charcoal', 'dark', 'dark-coloured' and 'light-coloured'. Only one of the 17 languages featured in the MANB had a comparable term for 'grey', this being the word *yulirn* belonging to the Murrinh-Patha dialect. Also unique amongst the set of 17 languages in the MANB was the word *ngalpa*, apparently an abstract term for the quality "colour" included in Paakantyi, a "dead" language that was spoken in western New South Wales, around the Darling River.

Dixon (1980) offered Dyirbal and Warlpiri as examples of languages said to have two colour terms, while Diyari was advanced as one that had four. On the latter, Dixon (1980) was contradicted by the MANB which referred to three colour terms for Diyari, namely *maru* ('black'), *warrhu* ('white') and *marrhalyi* ('red'). Diyari, spoken in northern South Australia, east of Lake Eyre, was in a moribund state, if not already extinct. The MANB stated that in 1994 there were only two people still alive who could speak Diyari fluently. With regard to "dead" languages, the MANB listed two 'red' terms (*karrokarro* and *taltarni*) and two 'white' terms (*ngarro* and *perkanna*) as being part of the Kaurna vocabulary, a dialect once spoken in the Adelaide Plains area of south-eastern South Australia,

### 2.14.7 Western Desert Aboriginal Languages

As a broad linguistic category, the Western Desert aboriginal languages constitute a large family of dialects that ranges from Port Augusta in South Australia in the east to Western Australia's Kimberly and Port Hedland in the west (Thieberger, 1996). However, the classification "Western Desert Language" is not a term used by the indigenous speakers themselves. Like the term "Scandinavian Language" is used to label Danish and Norwegian, it is a blanket linguistic designation that groups closely related forms of speech, albeit forms that are distributed over a vast area exceeding a million square kilometres in the Northern Territory, South Australia and Western Australia (Walsh, 1993). Yallop (1982) notes that the Western Desert language belongs to the Pama-Nyungan linguistic family and is one of the four largest languages in Australia, the others being Warlpiri, Mabuyag and Aranda. The latter three languages are also Pama-Nyugan.

Blake (1991) cited Pitjantjatjara as being the most familiar dialect of the Western Desert language family. Of all the Australian Aboriginal languages, Lynch (1998) claimed that the Western Desert language group had the largest number of speakers, consisting of an estimated 6000 at one time. According to Marsh (1992), Martu Wangka is one of the names used to describe the language spoken by the indigenous populace in the Jigalong area of Western Australia. Martu Wangka is one of the indigenous Australian languages that were examined in the World Colour Survey. The two principal dialects of this language are identified as being Manyjilyjarra (sic) and Kartujarra (sic). Warnman and Putiljarra are parochial Aboriginal dialects which could also make a possible constructive addition to the Jigalong linguistic mix. Yallop (1992) did not refer to the Jigalong dialect of the Western Desert language as Martu Wangka, noting that the language spoken in the region is actually a combination of different dialects owing to the transitory nature of the inhabitants. Yallop (1992) cited the primary constituent dialects of the Jigalong region as being Mantjiltjara (sic) and Kartutjara (sic).

History has shown that European researchers have experienced difficulties in clearly distinguishing Western Desert languages with Thieberger (1993) listing the plethora of language names and spelling variations that have been assigned to the native vernacular spoken in the vicinity of Jigalong: Jindi, Maduwongga, Mandjildjara, Mandjiltjara, Manyjilyjarra, Mardo, Marduwangga, Martu Wangka, Martu-wangka, Matuntara, Matutjara and Martuwangga. Dixon (1980) used yet another spelling variation, namely the term “Mantjiltjara”. Blake (1991) highlighted the confounding nature of Australian tribal names and their associated language labels, noting that most names appear with more than one spelling and that in certain situations two or more quite distinct names have been used for the same tribe or language. Such discrepancies were often due to errors in classification made by linguistically naive Western observers. Common mistakes included applying names for sections of a tribe to the whole ethnic group or using a tribe’s self-referential designation in addition to a bordering tribe’s appellation for them.

### 2.14.8 Indigenous Australian Communication Styles

No overt mention was made in the current online World Colour Survey data set of any cross cultural communication problems surfacing during the study that the field investigators might have had to have dealt with. Based on his research and observations in northern Australia, Walsh (1997) described various difficulties observed whilst interacting in Aboriginal settings. One such obstacle is the apparently common phenomenon known as the “delayed” reaction: For example, English-speaking linguists eliciting simple information such as environmental details from Aboriginal subjects might expect a near immediate response to their query. In actuality, a decidedly non-immediate answer is the norm rather the exception, with possibly no explicit linkage to the original question after the time lag. Aboriginal styles of communication are communal rather than dyadic in nature, with talk being broadcast *en masse* rather than directed to a specific person. Face-to-face contact is not a priority and relatively long periods of silence can freely punctuate verbal interactions.

Walsh (1997) considered the Aboriginal pattern of discourse to be one in which the communication channel was switched on and left open continuously, with group members having the option of engaging or not engaging in interaction at any time. Talk was a non-dyadic, continuous, free-flowing entity as opposed to the English dyadic style of social intercourse which was essentially a succession of discontinuous chunks of speech dominated by time. Instead of using the general term “English” as a group designation for certain non-Aborigines, Walsh (1991) used the more specific composite term “Anglo White Middle Class” (or AWMC). Based on empirical observations of the behaviour of Murrinh-Patha speakers around Wadeye on the west coast of the Northern Territory, it was the conjecture of Walsh (1991) that the Aboriginal style of social interaction was a naturally evolved management strategy for dealing with a lack of personal privacy in remote geographic locations where there was no built environment to segregate individuals. The continually active communication channels that were invariably established in the typically remote Aboriginal district constituted a virtual environment in which direct participation was a listener’s prerogative. Opting out of the on-going stream of conversation was thus an implicit sign that privacy was requested.

Because of their fundamentally dyadic and non-continuous nature, modern communication technologies such as the two-way radio and the telephone are problematic for some Aboriginal people. Walsh (1991) noted that the characteristic Aboriginal telephone user would attempt to shift the conversation towards being continuous, replete with long pauses that would be irritating to the average AWMC person accustomed to more immediate verbal responses. Conference telephones of the time are cited as being a preferred means of communication for those Aboriginal people with access to them. Walsh (1991) observed that for the non-dyadic and continuous Aboriginal communicator broadcast radio and/or television are often turned on and left on in conjunction with verbal communication channels, the former serving as a kind of background noise to be tapped for information if and when the need arose for participants in conversation. The written form was a somewhat modern innovation for many isolated Aboriginal communities and there was still a paucity of indigenous literature. Walsh (1991) classed written representations of language as being yet another manifestation of the dyadic and non-continuous bias in AWMC communication.

In terms of their behaviour when questioned, Walsh (1997) offered the generalization that Aboriginal society fosters the “indirect” approach where group members talk around the point. Walsh (1991) remarked that Aboriginal people are often handicapped in educational situations because AWMC teachers have a tendency to direct questions at individual students expecting a reasonably prompt reply. Of course, the typical Aboriginal response could often be the simple exercise of an indigenous person’s right not to reply and consequently be misinterpreted by an AWMC teacher as being a sign of shyness or a form of surly behaviour. AWMC scholastic customs encourage individual students to speak up but also discourage them from speaking if anyone else is talking in an official capacity. This standard classroom protocol could be puzzling to novice Aboriginal students. Communication styles such as these could be difficult to accommodate for in any psychological study of indigenous peoples, particularly if subject response times were an important factor.

Observed from an AWMC viewpoint, Walsh (1991) classified the researcher-consultant system of interchange as essentially dyadic and non-continuous but openly questioned the mechanics of the relationship as it would be viewed from an Aboriginal outlook. Several challenging unanswered questions were advanced by the author, first and foremost being whether or not the research undertaken was in effect an AWMC activity rather than an indigenous Australian one. Also, if indigenous Australians were to be trained as researchers using AWMC methods then the possibility could exist that an alternate manner of discourse would emerge in their practice of research. If this would be the case then the relationship between researcher and informant could possibly differ from that envisaged in the methodological framework of an AWMC researcher, thus rendering potential findings difficult to compare with others.

Walsh (1991) offered the proviso that the classification framework developed for conversational styles was not as categorically clear-cut as it may appear and was subject to interference by a variety of factors. For example, the common incidence of multilingualism in remote Aboriginal communities could impinge upon on customs of discourse. Impositions on the transfer of knowledge in some Aboriginal societies based on gender, age and other specifications could also affect interaction protocols. Walsh (1991) noted that access to knowledge in Aboriginal societies was not habitually open but was instead progressive and a sign of the attainment of a certain degree of personal prestige within a group. Ideologically speaking, knowledge was treated as intellectual property to which particular people could claim ownership.

Walsh (1991) cited Michaels (1985) who labelled Aboriginal communities as being "information societies", denoting cultures in which the sharing of information was subject to rigid control and rationing by artificial restrictions. Literate cultures offer protection of intellectual property via publicly accepted and externally dictated legal sanctions in the form of copyright. In the "information economy" implemented in an Aboriginal setting ownership of knowledge was safeguarded via cautious revelation by those with dominion over it. This is another instance of a possible imposition that would need to be addressed in communication with speakers of an Australian Aboriginal language. No doubt this would leave more than a little impression on interactions between AWMC researchers and indigenous consultants.

Grammatically speaking, Yallop (1993) noted that Australian Aboriginal languages and English differ significantly in terms of the structure of questions. Apparently, in most indigenous languages words like "who?" and "what?" in fact have an indefinite meaning. This implies that "who?" could be understood as being "someone or other, I don't know who" and that "what?" could be understood as being "something or other, I don't know what." In other words, a speaker of an indigenous language might seem to be asking:

*Who bought the cigarettes and gave them to Allan?*

when a more meaningful translation into English could possibly be the more oblique:

*Someone bought the cigarettes and gave them to Allan.*

Australian Aboriginal grammar, in effect, dictates that speakers do not really ask questions that seek specific information but instead utter statements that reveal gaps in personal knowledge to be filled in by other people. For example, in the English-style of direct questioning, expecting straight answers, an exchange might go as follows:

- Speaker A: *Who drank all the Scotch?*
- Speaker B: *Allan did.*

The more indirect Australian Aboriginal style of interaction would produce something like the following exchange:

- Speaker A: *Someone drank all the Scotch?*
- Speaker B: *Yes, Allan drank it.*

Yallop (1993) noted that Australian Aboriginal languages make far less use of direct questioning than English, the preference being an open, indirect style of interaction allowing others to add information instead of verbally compelling them to provide it. Information is a commodity that is, in an Aboriginal sense, regarded as something to be shared rather than pursued, something to be obtained by invitation and not extracted on demand. Thus, to an indigenous speaker the near ubiquitous English-style of direct questioning might appear to be too demanding and possibly even downright aggressive. Questions asked by adult speakers who quite obviously know the answer to the question beforehand would also possibly seem strange to indigenous speakers.

Imagine that an anthropologist of English origin is on a field expedition and asks an indigenous speaker of an Australian Aboriginal language to name the colour of a particular Munsell chip, for example. The question advanced might be the translated equivalent of the following:

*What is the colour of this object?*

A better strategy might be to translate the following:

*Something is the colour of this object.*

For a ‘red’ Munsell colour chip, say, the appropriate indigenous response could then possibly be similar to the ensuing retorts:

*Blood is the colour of this object.*

*The colour of blood is <indigenous term for “red”>.*

However, the key problem to be addressed is what action should be taken if the Australian Aboriginal language under consideration has no comparable word for the abstract concept of "colour". This is a similar situation that would have been encountered by field workers administering the World Colour Survey to indigenous Australians. The other dilemma for the researcher would have been the act of properly referring to something as culturally alien to an indigenous Australian as a Munsell colour chip in an indirect manner so as to not influence a response That is, a response in reaction to a specific perceptual stimulus rather than one that is a by-product of cultural politeness conventions in deference to an interlocutor perceived to be superior in some way.

### 2.14.9 Aboriginal Taboos

In discussing Aboriginal taboos, Blake (1991) noted that some indigenous customs restricted the discussion of certain sacred myths and religious rituals with those uninitiated in these matters. Also forbidden, but in varying degrees from tribe to tribe, was the commonplace usage of the name of a recently deceased individual. Remaining in force for several years duration or less, the prohibition was observed in some cases only by close kin. Kinship systems in Aboriginal societies were notoriously complex and serve as a means of classifying social relationships based on either on direct blood ties or family roles in the community. These kinship systems dictated social behaviour, governing privileges, duties and selection of appropriate marriage partners. Special forms of language existed known as "mother-in-law languages" designed for use in the presence of kin who are taboo.

In some instances, the taboo applied to words that sounded similar to the recently deceased person. If this custom was practiced by English speakers, for example, the death of a John Brown would effectively expunge the colour term "Brown" from the vocabulary of Mr. Brown's relatives for a lengthy period of time. Blake (1991) offered an example recorded at the Warburton Ranges mission by Douglas (1964) where an Australian Aboriginal named *ngayunya* died. In the spoken language of the indigenous people of the area, *ngayunya* was also the equivalent word for "me", hence a lexical substitute for "me" had to be found. An equivalent word was adopted from the regional mother-in-law language. It is considered by some critics that this process advanced the spread of synonyms for the same referent.

It has been observed that Aboriginal people who are reasonably fluent in English apparently use it in a fundamentally different way (Eades, 1983; 1988). In other words, at a superficial level it may resemble standard Australian English but it is presented in a communal and continuous mode rather than a dyadic and contained manner. Eades (1988) writes that language in general is inseparable from context, being in fact a dynamic entity that both mirrors and invents aspects of context. Even though English may be the language of choice by many contemporary Aboriginal people, the context of conversation itself has crucial Aboriginal cultural and social aspects which give rise to a uniquely Aboriginal set of semantics. Of fundamental importance in Aboriginal culture is the paramount role of social relationships, especially between relatives who may in fact be far more distant than is the public norm in European societies, say.

### 2.14.10 Indigenous Australian sign languages

Presumably, the colour terms elicited from the World Colour Survey indigenous Australian cohorts were derived from spoken responses to verbal interrogation by the field worker. Kendon (1988) noted that some Australian Aborigines had developed a codified gesture system or sign language to use as an adjunct to spoken language. In some cases this indigenous sign language was employed as an alternative to speech for use during intervals of mourning or in conjunction with customarily silent male initiation rituals. The colour terms of the spoken version of Warlpiri as used in the Lajamanu (Hooker Creek) region of the Northern Territory form part of the existing World Colour Survey data-set to be critically assessed later in this text. Incidentally, Blake (1991) wrote that the Warlpiri have had their name denoted by over a dozen different spellings, signifying yet another example of the confusion involved in identifying indigenous languages that exist in an unwritten form. Blake (1991) used the term “Walbiri” whilst noting that the generally accepted convention for scholastic use is “Warlpiri”.

The Warlpiri of Warrabri in Central Australia was documented as possessing an indigenous sign language. According to the illustrated dictionary of Walpiri (sic) hand signs produced by Wright (1980), there are distinct equivalents for the colour terms 'black', 'blue', 'red', 'white' and 'yellow'. There appears to be no sign for the abstract concept of "colour" but there are two different signs for "dark" and one for "light" (in reference to "fire" or "day"). The issue here is whether these colour terms were a salient property of the sign language or the speaker. Since the World Colour Survey methodology meant that only verbal responses to colour stimuli were elicited from informants, sign language variants of colour terms could have been overlooked.

Wright (1980) indicated that a term also existed in the Walpiri (sic) corpus of signs for "ochre". The second edition of the Oxford English Dictionary (Simpson and Weiner, 1989, p. 688) defined "ochre" as being "*a native earth, or class of earths, consisting of a mixture of hydrated oxide of iron with varying proportions of clay in a state of impalpable subdivision; varying in colour from light yellow to deep orange or brown.*" It is also noted that "*the ochres are extensively used as pigments; particular kinds are known as brown, red, white, yellow, Oxford ochre, etc.*" When adopted as a colour referent in English usage, it was indicated that "ochre" is "*a pale brownish yellow.*"

Only three Walpiri (sic) informants and one interpreter were used in the compilation of the dictionary of signs by Wright (1980). One of the more respected informants in the trio functioned as an arbiter to confirm or reject signs being translated. The project was delayed when this particular arbiter entered a period of mourning and could no longer communicate with the dictionary compiler due to cultural constraints. Wright (1980) noted that Walpiri (sic) sign language was in an advanced state of decay at the time with few fluent communicators. Various tribes at Warrabri were described as having different signing systems and the Walpiri (sic) signs of Yuendumu and Hooker Creek were identified as varying considerably from that of the Warrabri assortment.

According to Hale (1995), *spoken* Warlpiri had equivalent colour terms for 'black' (*maru*), 'green' (*wajirrki wajirrki*), 'red' (*yalyu yalyu*), 'white' (*kardirri* and *yarltiri*) and 'yellow' (*karntawarra karntawarra*). The equivalent spoken term for "ochre" was the single form of the latter, namely *karntawarra*, presumably signifying the kind that is yellowish in colour. More specifically, the equivalent Warlpiri term for "red ochre" was sub-divided into two categories. The "dark" variety is *karrku*, while the "light" type was denoted by the term *yurlpa*. It is interesting to note that the Warlpiri word for "black" was the same as the previously mentioned Diyari word (i.e. *maru*). In spoken Warlpiri, *munga* and *wuulypari* are two words that mean “darkness”, while *parrangka* means “light” or “day”. Hale (1995) gave no indication of any spoken Warlpiri term for ‘blue’, which is intriguing considering Wright(1980) catalogues an equivalent Walpiri(sic) hand sign representing this colour.

Historically, the Western Desert was a region where interaction via sign language has been prevalent, mainly by indigenous males, and is possibly still in contemporary use. It was not specifically indicated whether or not the Martu Wangka use sign language. Martu Wangka, a Western Desert dialect, was one of the indigenous Australian languages surveyed in the World Colour Survey. Apart from its function in initiation rituals, Miller (1978) listed different contexts in which Western Desert sign language was practiced, such as communication over distances, dual-channel communication (i.e. speech and sign simultaneously) and as a means of visually punctuating or highlighting parts of speech. In one instance it was noted that Western Desert sign language was frequently utilized instead of speech by an asthmatic male.

If Western Desert sign language was used on occasion as a speech surrogate it would not be out of the question to suppose that a subset of signs may have evolved to denote colours. However, the role of Western Desert sign language in the categorization of colour has yet to be discussed in the relevant scholarly literature. Even though it is only a hypothetical argument at this stage, the implication that two sets of basic colour terms coexist - one for Western Desert sign language and the other for the indigenous spoken language dialect - would certainly add another level of complexity to any colour naming study.

### 2.14.11 Aboriginal Art

Bingham (2005) claimed that ‘red’, ‘white’, ‘yellow’ and ‘black’ are sacred colours in many Aboriginal cultures, primarily in their representative use in art and rituals. Yellow and red ochre-based pigments were said to be particularly prized and used in rock and ground art as well as in bark painting and bodily adornment for ceremonies, whereas white pigments were derived from pipe clay and black from charcoal sources. Contemporary interest in indigenous Australian art in part stems from the Western

Desert Movement, initiated in 1971. This particular style was chiefly attributed to the influence of Geoffrey Bardon, a teacher at the Papunya school, northwest of Alice Springs in Australia's Northern Territory (Bardon and Bardon, 2004: Bingham, 2005). The Western Desert Movement encouraged indigenous artisans to blend ancient and modern traditions, as well as employ updated artistic materials such as acrylic paints on canvas. This lead to the now familiar Western Desert paintings composed of patterned, geometric elements featuring circles, dots and lines, in a richer colour palette made possible by the use of new artistic materials as mentioned above.

### 2.14.12 Cross-cultural Psychology and Indigenous Australian People

The World Colour Survey was a contemporary example of a study in cross-cultural psychology that focused on indigenous Australians amongst other global ethnic groups. In the case of the World Colour Survey, its aim was to ascertain colour categorization behaviour in different ethnic cohorts and observe whether or not language was an influential factor in this matter. Early scholarly literature documenting similar studies in cross-cultural psychology amongst indigenous Australian people could seem confronting when considered with a contemporary mindset where research projects involving racial differences are not deemed to be suitable for academic endeavours. For example, some early researchers in the area assumed that indigenous Australians were literally another biological species:

> *"The Australian aborigine, in common with the examples of his native flora and fauna, represents a biological species which existed for a long period apart from world competition. He may be expected, therefore, to exhibit primitive features representing a survival of anatomical and mental characteristics of a former era in the evolution of the more culturally developed human races of the present day."* (Fry and Pulleine, 1931, p.153)

The antiquated position above rested on the acceptance of a biological construct known as 'race,' now generally discredited due to genetic evidence (Smedley and Smedley, 2005). The differences that were present amongst the peoples of the world were then more likely to be due to the effects of variations in language and culture. In this regard even Fry and Pulleine (1931) could offer a valid contribution to the issue of cross-cultural colour categorization. In their work they outlined the findings of tests of mental, motor and sensory abilities that were undertaken by members of the Iliaura people located north-east of Alice Springs in Australia's Northern Territory. These indigenous Australians have in more recent times been referred to as being speakers of the Alyawarra language (Yallop, 1977). Tests were also undertaken by speakers of the Aranda language, now referred to as Arrernte (Brooks, 1991), at the Hermansberg mission station in central Australia. From the perspective of colour nomenclature, Fry and Pulleine (1931) concluded that the Aranda (Arrernte) speakers had a word for 'blue' in their lexicons, based on results from the Hermansberg tests. However, subjects did use a word meaning "like fire smoke" to convey the comparative sense of a 'blue" quality (Fry and Pulliene, 1931). The latter suggests that there was no firm evidence that these indigenous Australians were using a word that represented 'blue' in an abstract sense akin to the definition of a basic colour term. Dixon (1980) noted that the most prevalent terms in the Aboriginal colour lexicon were 'black' and 'white' followed by 'red' and 'green', with no mention of 'blue'.

The Iliaura (Alyawarra) test subjects also compared colours to assorted objects or phenomena, such as hot ashes, different types of ochres and flowers, the sky and the sunset. It was noted that "royal blue" was likened to appearance of a dark night. The Illiaura (Alyawarra) test subjects referred to 'blue' either with no name, or as 'black.' Subjects also likened this colour in their denotation to either the sky or a dark night.
Fry and Pulliene (1931) determined that the Illiaura (Alyawarra) only had actual colour words for 'black,' 'white,' 'red,' 'yellow' and 'green.'

In her historical review of cross-cultural psychology in Australia, Turtle (1991) cited some still pertinent comments about indigenous Australians that were originally made in Porteus (1931). As a result of his field work administering intelligence tests to indigenous Australian subjects, Porteus (1931) concluded that their aptitude for tasks was fine attuned to their own unique environment. However, it was noted that limitations existed in the methodology of cross-cultural psychology when dealing with these people due to the constraints of Western observers interfacing with their culture. The use of timed tests was also deemed to be unsatisfactory with indigenous Australians who were not familiar with the demands of working against the clock. Since salience in perceptual or categorization tests is usually measured by reaction times which are recorded, this factor would obviously hamper research in this regard. Response latency time has been used as a partial metric to gauge salience in colour categorization studies (Sturges and Whitfield, 1995; 1997).

Something vaguely related to a colour categorization study among indigenous Australians was described in Davidson (1974) who outlined experimental work undertaken with the Murngin of Elcho Island, located of the coast of Northern Territory. This research examined the notion of particular cultural dimensionalities and stimulus codability as factors determining choice reaction time in two comparative groups of adolescent males, one indigenous Australian and the non-indigenous. These two groups were found to classify stimuli displayed to them according to a moiety dimension of dual organization and a colour dimension. The moiety dimension is part of the indigenous culture and reflects a complex system of governing social structure in most indigenous Australian cultures. It is an intricate form of categorization involving recursive genealogical naming practices.

Two broad moiety categories existed in the Murngin society described by Davidson (1974) and all animate or inanimate objects that are encountered can be placed into one of these. Even some colours are apparently subject to this dual organization. So a colour may have its own name and also belong to one of these moiety categories. If is true with one example of an indigenous Australian culture then it could also be prevalent in others. Such a characteristic could have a bearing in the outcome of a study like the World Colour Survey which is under consideration in this thesis. Yet it is not clear in the extant literature whether such a factor was considered by the World Colour Survey field investigators when they carried out their tests with informants.

A limitation of the study by Davidson (1974) was that only twenty stimuli were used for classification along a chromatic dimension, these being ten ‘red’ and ten ‘blue’ slides projected on a screen. Munsell coordinate figures were computed for these two stimuli but they were not Munsell surface colour chips. The latter have become standard stimulus materials for use in colour categorization research. It was not clear what unique names were assigned to the colour stimuli by the Murngin subjects. Davidson (1974, p. 210) made the remark that the Aboriginal subjects who classified the stimuli solely along the colour dimension were unable to name the blue stimulus but this factor was seen to "*not impede their responses to blue stimuli beyond the bounds set by responses to other stimuli.*" The slides presented to subjects also featured objects that could be classified along the two moiety dimensions. A deficiency by some indigenous peoples in being able to name the colour 'blue' is an observation that has been noted by Rivers (1905) with regard to his experiences amongst the Torres Strait Islanders during the 1898 Cambridge Anthropological Expedition (Rivers, 1901). Indeed, even earlier than this as previously noted, Gladstone (1858) was of the belief that the Ancient Greeks were colour deficient with respect to 'blue,' as noted earlier in this literature review.

Turtle (1991) noted that from the 1970s onwards cross-cultural psychology research in Australia shifted from an emphasis on measuring the mental abilities of Aborigines to one of observing their cognitive strategies and styles, particularly with respect to learning capabilities. For example, Seagrim and Lendon (1980) provided an in-depth description of a comparative study of cognitive development in Aborigines residing in Central Australia. Known as the Hermannsburg Project, it was a longitudinal study in cross-cultural psychology to compare the intellectual performances of Aranda and Loritja children brought up at the secluded Hermannburg Lutheran Mission Station with those of other Aboriginal children reared in different locales, both geographical and environmental.

Standard Piagetian tests, based on concepts that originally emanated from Piaget (1929), were predominantly employed by Seagrim and Lendon (1980) to measure prowess in classification of objects, reasoning about conservation of mass, conception of space and cognition of reciprocal relationships of "greater and less than" in dealing with an ordered series of lengths. Findings indicated that the Central Australian Aboriginal students were cognitively immature since they could not perform certain assigned tasks as well as their Anglo-Australian counterparts.

Seagrim and Lendon (1980) claimed that Australian Aborigines were members of a culture that is alien to Western observers. Solely hunter-gatherers in the ecological sense and living in virtual solitude free from almost all external cultural tensions for over 30,000 years, they represented a people virtually untainted by the influence of civilization with its technological infrastructure and bureaucratic customs. In justifying their cross-cultural approach to studying the nature and development of logical thinking in these people, Seagrim and Lendon (1980) cited the example of the New Guinea tribe called the Abelam, described by Forge (1970). Members of this tribe were not able to interpret photographs that were displayed to them, even when these contained images of people and places that were familiar to them.

Seagrim and Lendon (1980) suggested that such observations implied that Western European skills in this regard could be derived from overlooked learning processes rather than from intrinsic perceptual processes. In short, perception could in part be something that develops via learning as well as through natural mechanisms that have a neurophysiological basis. This was noticed by Ozgen and Davies (2002) who found that training could enhance a individual's aptitude to distinguish similar hues of a single colour, such as being able to discriminate between a 'bluish green' and 'yellowish green.'

In a return to cross-cultural research that dealt with mental abilities once again, Kearins (1981, 1986) documented experimental work undertaken with various groups of indigenous Australian adolescents to determine memory abilities for spatial location of objects. Indigenous adolescents were drawn from traditional backgrounds in the Western Desert region of Western Australia, as well as groups from more urban settings, such as metropolitan Perth. These were compared with Anglo-Australian adolescents. She found that the indigenous cohorts outperformed the Anglo-Australian subjects. The latter tended to use verbal strategies to solve problems, whereas the former relied more on visual approaches. Since this was also the case with indigenous subjects from non-traditional, urban settings, genetic differences were hinted at being a possible cause.

Adaptation to environmental conditions in the bush and desert regions of Australia at an ancestral level may have been the evolutionary driver in the reliance on visual strategies for problem solving observed amongst indigenous Australians by Kearins (1981, 1986). However, another explanation could be attributed to idiosyncratic child-rearing practices present in indigenous Australian culture in general that accentuate learning processes which optimise visual spatial memory in developing children. In the case of indigenous Australians living a traditional lifestyle, Kearins (1981) speculated that this spatial ability emerged due to its value for pathfinding in a desert environment. A biological basis for the heightened differences in visual acuity and visual memory of indigenous Australians has been advanced by Klekamp, Riedel, Harper and Kretschmann (1987; 1994), who asserted that Australian aboriginals possessed a larger visual cortex than non-indigenous persons.

## *2.15 Conclusion*

This chapter offered both an outline of the relevant scholarly literature documenting the convoluted research area of colour categorization, as well as a summary of significant matters dealing with indigenous Australian language and culture. The latter was deemed to be important considering that this thesis involves an analysis of the indigenous Australian component of the World Colour Survey.

The chapter commenced with a discussion of the amateur endeavours in classical scholarship by 19th century British Prime Minister William Ewart Gladstone, whose peripheral speculations on the deficiency in colour perception by the Ancient Greeks arguably sparked generations of later research in cross-cultural colour categorization (Gladstone, 1858). An analysis of the works by Homer led him to believe that the Ancient Greeks had problems in perceiving the colour 'blue'. In the 21$^{st}$ century, researchers were still debating variations of this reflection, advancing hypotheses as to why ethnic groups residing in equatorial regions also had deficiencies in the perception of 'blue' (Lindsey and Brown, 2002). These were outlined within this chapter.

The work of Gladstone (1858) stimulated academic debate on how language and culture could influence the segmentation of the colour spectrum. Colour categorization was soon to become a primary test-bed to ascertain the validity of the so-called Sapir-Whorf hypothesis in linguistics (Whorf, 1956) - namely that language either influences or determines thought - and this was covered next in this chapter. This hypothesis was one impetus for colour categorization research in the 20$^{th}$ century and beyond but the major inspiration for its continuing interest was Gladstone's seminal efforts in the 19$^{th}$ century, which were covered at length in the literature survey. The research presented in this thesis dealt primarily with cross-cultural aspects of colour categorization not linguistic relativity per se.

The body of research by Eleanor Rosch on prototype theory and the conceptualization of what makes up a salient category (Rosch, 1973a, 1973b, 1988) was outlined as it is closely related to colour categorization.. Following on from this, a description of the now dominant Berlin and Kay (1969) paradigm of basic colour terms was presented, along with their view of the evolutionary sequence of colours in cultural development.

The neurophysiological significance of this theory was also commented upon in this chapter, with its idea of universal colour categories that are in opposition to the Whorfian view of linguistic influence (Whorf, 1956). The theory of Berlin and Kay (1969) became a contentious idea, attracting criticism from an early stage that has been ongoing and this was discussed in this chapter.

To address growing academic evaluations that questioned the legitimacy of Basic Colour Terms as a concept, the World Colour Survey was initiated as a global cross-cultural experiment in colour categorization to validate the original theory in a more thorough manner (Cook et al, 2005). This was described in this chapter as well as the ongoing academic debate that it still entailed.

From the earliest release of its often anomalous findings, the World Colour Survey was to be equally contentious in academic circles, spawning at least one new theory to explain the irregularities observed. The most prominent one, namely vantage theory (MacLaury, 1997), was depicted in this chapter as one tactic to model colour categorization that has generic transferability to other domains but one that introduced an extra layer of explanatory complexity.

Neo-Whorfian challenges to the Berlin and Kay (1969) paradigm that have surfaced recently were commented upon and these were described in overviews of the work by researchers such as Ian Davies and Debi Roberson, an example being Davidoff, Davies and Roberson (1999). Recent analyses of the World Colour Survey data set, made available online for public use, were also reported on in this chapter (Kay and Regier, 2003; Regier *et al*, 2005; Lindsey and Brown, 2006). Their findings offered unanimous support for the original position of Berlin and Kay (1969).

However, the recent statistical analyses of the World Colour Survey data set that have been published approach it as an aggregate, comprised of 110 distinct language groups as it is. This thesis will document research that provides an analysis of the indigenous Australian component of the World Colour Survey in isolation. The statistical technique adopted in the analysis to be described in this work was deemed to be more intuitive in its simplicity than prior strategies that have been described in existing corroboration efforts.

This chapter concluded with brief overview of relevant topics concerning indigenous Australian language and culture. This section began with a commentary on linguistic sophistication levels, followed by a discussion of the problems of classifying languages within the continent. The ambiguity of indigenous Australian languages was explored as well as their diverse richness, especially in communication styles. The semantics and classification practices of indigenous Australian languages were also featured. Particular mention was made of Western Desert languages because one of these, Martu Wangka, was part of the indigenous Australian component of the World Colour Survey, the other language groups being Kriol, Kuku-Yalanji, Murinh-Patha and Warlpiri.

Aboriginal sign languages were also discussed as a parallel dialect to illustrate the complexity of communication styles and the scope for redundancy with regards to colour lexicons. Some coverage was assigned to Aboriginal art to point out Western European influences in its modern evolution and the chapter closed with an exposition on existing research from cross-cultural psychology dealing with indigenous Australia. The next chapter will outline the research methodology adopted in the original work described within this thesis.

# CHAPTER 3

# 3 Research Methodology

## 3.1 Introduction

This chapter details the rationale taken to determine the appropriate practical constructs to employ in the research methodology to analyse the indigenous Australian component of the World Colour Survey. Since this work involves secondary analysis of an extant data set with emphasis on understanding the nature of the possible patterns or otherwise therein, content analysis as a practice is initially discussed. The initial notion of treating the World Colour Survey data set as a text, diverse in composition, led to an exploration of the analysis of diversity per se and this is described primarily from an ecological perspective.

Using ecological modelling of natural environments as an inspiration, colour terms elicited from World Colour Survey informants denoting individual colour stimulus chips were considered to be akin to biological species in the metaphorical sense. Thus a discussion of what constitutes a species is included in this chapter to set the context for ecological modelling and its adoption as a methodology in this research. In addition, the problems associated with species differentiation from a categorization perspective will be discussed as these are analogous to the ambiguity that has been noted in colour classification. The idea that natural language itself is a species is also featured here.

The construct of the diversity index from ecological modelling is outlined and its deployment in research outside of biology is discussed, especially with regards to its use as a metric of changeability where categorical variables are involved. The Brillouin diversity index was selected for the analysis of the indigenous Australian component of the World Colour Survey and a description of this is given, along with a justification of its particular choice in comparison to others. This is followed by a brief description of the data gathering process of the World Colour Survey, including a discussion of its limitations, and a worked example of how diversity analysis was applied to the World Colour Survey data. An example is presented and annotated of how the results of the diversity analysis of the indigenous Australian component of the World Colour Survey are displayed in graphical form within this work. The chapter closes with some discussion of techniques reminiscent of diversity analysis that other colour categorization researchers have employed.

## 3.2 Secondary Analysis of Data

Secondary analysis of data is a research technique whereby data accumulated through some other primary level empirical investigation is applied to answer new research questions or is evaluated using alternative statistical methods (Hinds, Vogel & Clarke-Steffen, 1997; Coyer & Gallo, 2005). It differs from a replication study in that the researcher does not collect his or her own data to validate an existing theory. Herrnson (1995) notes that replication duplicates the whole of a prior experimental investigation together with independent data collection. The aim of replication is to increase the degree of certainty for a set of observed generalizations derived from a previous study.

According to Herrnson (1995), secondary analysis also differs from verification studies since the latter is primarily concerned with validating the reliability and robustness of prior research results using alternative statistical approaches or model designs. However, Herrnson (1995) did not indicate whether verification studies should be conditional on independent data collection or not. Also, there was distinction made between verification studies involving quantitative and qualitative research objectives. A verification study could be undertaken using an existing data set constructed by other researchers. Predominantly, secondary analysis of data sets has been a research method used by sociologists and economists in (Cherlin, 1991) but psychologists have advocated exercising it to foster greater interdisciplinary collaboration (Duncan, 1991).

Duncan (1991) noted that psychologists are trained to gather their own data, whereas researchers in other disciplines such as economics, demography and sociology hold data collected by other bodies, such as government authorities, in high regard. Indeed, Duncan (1991) argued that developmental psychology research could reap benefits in some cases through the secondary analysis of selected government statistical data. The "*Science 2.0*" movement is a recent scheme attempting to promote secondary analysis for other sciences (Waldrop, 2008). The blanket term "Science 2.0" describes the emerging practices of scientists who post raw experimental data, nascent theories, news of breakthroughs and preliminary versions of scholarly papers on the Internet for open access. The World Colour Survey data set is one example in this respect.

The research described in this thesis uses secondary analysis of a data set from another original study as its overarching methodology but it also involved verification of a prior study. The original study referred to in this case is the World Colour Survey, which in itself was initiated to validate the findings of Berlin & Kay (1969) regarding the theory of basic colour terms. The World Colour Survey can be viewed as being an act of verification. The research outlined in this thesis is the secondary analysis of the data set gathered from this verification study. This data set was applied to examine a new research question this being the examination of the World Colour Survey from the perspective of the indigenous Australian component in order to determine any colour categorization patterns or otherwise that may be present and ascertain whether or not they support the Berlin & Kay (1969) agenda of basic colour term theory. Based on this description of the research aim it would seem that the work here is a replication study of Berlin & Kay (1969), however this is not the case since no new data was gathered for this purpose. Instead what was carried out was a detailed scrutiny of a filtered component of the entire World Colour Survey data set, this being those gathered from indigenous Australian informants.

A restrained emphasis on an initial research question is characteristic of secondary data analysis being adopted as a methodology (McCall & Appelbaum, 1991). Research that involves data collection is designed to address a specific question or a closely aligned set of them. With secondary data analysis as a methodology more specific research questions are observed to emerge subject to exploration of the structural implications of the existing data set.

To undertake a replication study of even the indigenous Australian component of the World Colour Survey would have been a costly endeavour both in terms of time and money. The geographic distance between locations where speakers of the different language groups reside within the continent is one factor. Another is the assembly of cohorts that could form a suitable sample for field experiments. Such a task could be hampered by the diminished chances of finding monolinguals in an era of increased Western enculturation and indigenous language decay (Nettle & Romaine, 2000).

Lower costs due to no collection expenses and ease of access to data sources have been argued as some of the advantages of secondary data analysis (Hofferth, 2005). The blended approach of qualitative verification and secondary analysis was deemed to be the optimal strategy in the research described in this thesis.

Standard limitations apply when secondary analysis of data is used as a research methodology (Hinds, Vogel & Clarke-Steffen, 1997) and this would be true with regard to the work outlined in this thesis. Distance from the data is a major problem. The World Colour Survey data set was accumulated over a period of time many years ago and access to the field workers was not possible for this research, except for a brief personal e-mail communication in 2003 with Stephen Swartz, the field investigator responsible for the Warlpiri cohort. Certainty about the quality of the data is another problem. The original World Colour Survey data set was originally published as a microfiche set but withdrawn and subsequently posted online after the data was clarified and presented in a different format more amenable to analysis. The online World Colour Survey data set is a collection of codes assigned by field investigators that denote the various words informants used to name colour chips displayed to them. The data as such is then not immediately susceptible to measurement given that it consists of discrete idiosyncratic categories which are qualitative in that they were coded subject to the interpretation of the respective field investigators. Therefore the methodology employed in the research described in this thesis deals with the secondary analysis of a qualitative data set.

The emphasis in this research methodology chapter is not to labour upon the details of the field work that gathered the World Colour Survey set. Rather the primary focus is to describe how and why a novel statistical lens was deployed to interpret the portion of the World Colour Survey data set under consideration here. The approach here was inspired by ecological modelling, namely diversity analysis applied to the variability or otherwise of idiosyncratic colour categories. The next section will discuss content analysis in general in order to examine its similarity to diversity analysis.

## 3.3 Content Analysis

Content analysis is an investigative strategy employed to ascertain the incidence of particular words or concepts embedded inside texts or collections of texts (Krippendorff, 2004). The occurrences, meanings and associated connections between such words and concepts are quantified in the analysis process. Inference can then be made about the messages laden within the texts, the people who created these texts and their potential audiences, not to mention possible commentaries on their cultural and historical context as well.

Within the realm of content analysis, texts can be generally labelled as books, book chapters, essays, interviews, discussions, short stories, newspaper headlines and articles, historical documents, speeches, conversations, advertising, theatre, television programmes, informal conversation, journal papers, PhD theses or practically any example of where language is deployed with communicative intent (Budd, Thorp & Donohew, 1967; Weber, 1990; Burn & Parker, 2003; Franzosi, 2004). Content analysis has been applied to a wide range of subject matter in various cultural contexts, with examples as diverse as greeting cards (Kaur-Kasior, 1987), popular songs of the 1960s (Cole, 1971), verbal memories of psychiatric patients (Isaacs, 1984) and erotic videos (Garcia & Milano, 1990).

Content analysis is performed on any such text through the act of coding the text by fragmenting it into expedient multi-layered categories consisting of word, word sense, phrase, sentence or theme in a process of selective reduction. Then either conceptual analysis or relational analysis is deployed upon the coded text. With conceptual analysis a match is sought between patterns in the coded text and a predefined set of research questions, while relational analysis involves establishing meaningful connections between concepts uncovered (Neuendorf, 2002; Krippendorff & Bock, 2009)

The ubiquity of text is famously stated by Derrida (1976: p.158) in his cryptic aphorism "*Il n' y a pas de hors-texte*" ("There is nothing outside of the text."). The statement hints at the intensely speculative notion that everything can be construed as a text or at least represented as one. Does a text have to contain words or sentences? In the domain of genetics, for example, 97% of the DNA present in human cells appears to be meaningless padding - the so-called "junk" DNA - with its purpose still unknown to researchers (Flam, 1994). Employing statistical techniques adopted from linguistics, Mantegna, Buldyrev, Goldberger, Havlin, Peng, Simons and Stanley (1994) examined the sequences of nucleotide bases in junk DNA. Zipf's law in linguistics is an empirical observation that if one is provided with some corpus of natural language content, the frequency of any word present is inversely proportional to its level in the frequency chart that can be derived for words in that collection (Zipf, 1949). Some words will occur very often while others will be rare, with word length being an indicator of frequency in languages such as English (i.e. the longer the word the lower the frequency of incidence.)

This Zipf approach, that is normally used to search for patterns in linguistic texts, was applied by Mantegna *et al* (1994) in a statistical study of junk DNA base pair sequences. It was found that the non-coding regions of DNA (i.e. the "junk") exhibited Zipf-like patterns akin to a natural language to a greater degree than the coding regions (i.e. is which is known.) Borrowing from information theory, Mantegna *et al* (1994) then modified the method by Shannon (1948) of calculating superfluous content within a linguistic text with respect to an assessable entropy function. It was established that non-coding areas in eukaryote DNA (i.e. the "junk") exhibit a lower entropy and higher degree of redundancy than coding areas, sustaining the likelihood that non-coding regions of DNA may contain biological information of some form. The comparatively smaller entropy observed in the non-coding regions with respect to the coding areas suggests that the former has a higher degree of order, signifying that information may be present rather than biological data in disarray.

The inference can be made that lower entropy (i.e. less disorder) in the non-coding regions of DNA is correlated with lower diversity in these regions, especially given the higher levels of redundancy noticed. To clarify the latter consider a thought experiment: Imagine that a homogeneous system of things exists. If everything is the same in a system, as would be the condition in the case of low diversity, then uniform order would exist, meaning a state of low entropy. Removing things from this system would still mean that everything was the same. Thus content would be redundant to a greater degree here in comparison to another system with higher diversity. It would seem that the analysis of diversity within a system is a powerful tool that can reveal content details. The content details of the Warlpiri cohort of the World Colour Survey data set are comprised of codes that signify words that each informant used to name different colour chips. Variability in these codes exists but determining the signification of this requires the use of diversity analysis. In the original research described within this thesis, diversity analysis was adopted to seek out potential patterns or otherwise in the complexity of the indigenous Australian component of the World Colour Survey data set.

## 3.4 Analysis of Diversity

Berlin and Kay (1969) ushered in a paradigm shift in how colour categorization was viewed with an emphasis on shared commonality dictated in part by the constraints of neurophysiology. Diversity in the way humanity segmented the colour spectrum through language was a hallmark of the pre-Berlin and Kay (1969) era when it was considered entirely arbitrary on a pan-cultural basis. However in the post-Berlin and Kay (1969) age, variability in colour naming at an individual level was still present in studies such as the World Colour Survey (Cook *et al*, 2005). Amongst the informant groups that constituted this study, numbering 20 - 25 on average, the level of agreement was not high and the general strategy of the World Colour Survey was critiqued from an early stage, chiefly on postmodernist grounds (Saunders & van Brakel, 1995).

Opponents of the World Colour Survey supported the notion of a relativistic system of observation with less emphasis on absolutes and standards of objectivity. When presented with a single Munsell colour chip, variability in denotations of the same stimulus was prevalent amongst subjects in the study, as will be seen later in this work which will examine the indigenous Australian cohorts of the World Colour Survey data set. However, even if statistical noise is present in the World Colour Survey data set there could still be something there that could be exploited from an analytical point of view by seeking inspiration from other areas of knowledge.

For example, simulated annealing is a commonly employed optimization technique employed for combinatorial (and other problems) in numerate disciplines such as econometrics. This mathematical procedure takes advantage of the similarity between the way in which a metal cools and solidifies into a crystalline structure possessing a minimum energy level (i.e. the annealing process) and the pursuit of a minimum in a more general system (Kirkpatrick *et al*, 1983).

In metallurgy, annealing is a physical process in which the heating and controlled cooling of a material results in the material's crystalline structure increasing in size with the concurrent bonus of said crystals having their inherent defects reduced. The heat initiates atoms within the material to suffer perturbations from their initial positions originally signifying a local minimum of the internal energy within the material. The excited atoms drift randomly through states of higher energy until the slow cooling stage of annealing provides more opportunity to establish arrangements with lower internal energy than the original one (Laarhoven and Aarts, 1987).

The algorithmic process of simulated annealing as used in mathematical programming, in fact, treats the physical incarnation as a guiding metaphor to minimize a real function in a systematic manner: A current solution to an optimization problem is substituted by a random adjacent solution which is determined with a probability that rests on the difference between the corresponding function values and a global parameter (referred to as the "temperature") that slowly rises as the technique progresses (Chong and Żak, 2008).

In a similar vein – but from a biological rather than a physical science perspective – what if the metaphor of species diversity in a natural environment could be adopted as a frame of reference for at least partially determining the "basicness" of a colour term? Biological systems can be interpreted structurally via a hierarchy of ascending complexity: molecules, cells, organisms, populations, communities and ecosystems. The notion of species diversity is a trait exclusive to the community level of biological association.

From an ecological perspective, higher species diversity is commonly taken to point toward a more intricate and robust community because a larger assortment of species allows for more interactions between classes, consequently resulting in greater system stability and offering an indication of favourable environmental conditions. A variety of diversity indices can be calculated to compare ecological communities. In addition, pairs of communities can be compared using community similarity indices. Analysis of species diversity is a common practice in ecological modelling. To adapt this technique to the analysis of colour categorization first requires some discussion on the species concept itself in order to delineate the metaphorical alignment between the latter and colour terms per se.

## 3.5 What is a Species?

The ecological metaphor has been appropriated to create the interdisciplinary field of industrial ecology (Graedel, 1996; Ashton, 2009). This area of scholarly interest was inspired by the notion that industrial activity can be thought of as being similar to a biological ecosystem in the integration of processes and in the cyclical nature of resource expenditure. Ashton (2009), in fact, uses diversity analysis in his research within the domain of industrial ecology. To elaborate upon how this ecological metaphor was also applied in the diversity analysis of the indigenous Australian component of the World Colour Survey data set requires some exposition on a central concept in any ecosystem, namely the species.

In his discussion on species concepts and their identification in human evolution, Tattersall (1992: 341) opens with the following statement: *"Little is known about the process of speciation."*

Though much has transpired in the life sciences since this was written, this is arguably still true in the present era. What exactly is a species? Even though the term "species" (or its lexical equivalent in other languages) is used in everyday discourse in many walks of life and across various cultures, there appears to be no agreement in the scientific community as to a common definition of the concept. This is the so-called "species problem." For example, Chung (2004) notes that the literature contains in the vicinity of three to 22 descriptions of the species concept, all from differing vantages (e.g. biological, evolutionary, ecological and so forth.) There appears to be no single, universal notion of the species concept, only a constellation of perspectives. This poor level of agreement on the fundamental meaning of the idea is one reason why research into the origins and mechanisms of speciation has been hampered to some extent. Book-length treatments of speciation, for example, are few and far between with Coyne and Orr (2004) being a recent example to break the drought.

Some scholars contend that species are merely a human construct of categorization and not tangible phenomena of nature that exist as real entities. When considered entirely from an ontological viewpoint, entities are real things that possess a location in space and time with the concurrent properties of either being subject to external action or internal change (Hey, Waples, Arnold, Butlin and Harrison, 2003). Species taxa are categories which have an alternate existence to entities as outlined in the previous sentence. (In biological terminology, taxa are taxonomic units that denote an organism or a group thereof. These form a hierarchy with the order of ranking broadly being:

i. domain,
ii. kingdom,
iii. phylum,
iv. class,
v. order,
vi. family,
vii. genus, and
viii. species.

A genus consists of several common species, while a family is made up of a number of genera and so on.)

Species taxa have defining properties that exist even if the entity to which they assigned becomes extinct. Can a name exist without the object to which it refers? Given that it would have a historical connotation then the answer could be in the affirmative. But names emerge because they label things, real, virtual or historical. Is colour an entity then? It does not have a location in space and time of itself as it is a quality of a thing. Things have a location in space and time. Things also can be acted upon or change. But colour is an epiphenomenon of a thing’s existence. So, colour cannot exist independent of its relation to a thing as a quality of that thing. This would imply that colour is not an entity but a category instead. Length too is a quality of a thing and one could similarly argue that it is a category, albeit one that is effectively one-dimensional. Colour is a polyvalent category and not just in terms of its hue, value and chroma or its wavelength. It has many values, meanings and appeals that span the scientific, cultural and aesthetic domains.

Circumstantial evidence exists to suggest there is probably an innate human drive to categorize whatever is perceived to occur on a repetitive basis (Hey, 2001). The rage to order as instinct is then the reason why recurring examples of organisms are given a label. Species as categories is a way of construing organisms using representations but in a manner that is a side-effect of human cognition. This gives the appearance that species are discrete entities. However, Mayr (1996) contended that certain evolutionary processes make it difficult to delimit some species and arrange them in taxonomic hierarchies. Biological species can viewed as evolutionary populations. Evolution implies a continuum of change meaning that static representations that involve simple labels are not the best approach to understand these populations.

There is often a difference between named species and real evolutionary groups, as Hey (2001) indicated, a disparity that can handicap a deeper comprehension of biodiversity. (If these evolutionary groups are in a constant state of flux, perhaps only at a micro-level, then their very existence would be mired in diversity for better or worse.) To settle the species problem, Hey (2001) advocated that they be viewed as models, which by convention are treated as idealized interpretations of reality. A model-based understanding of species would supposedly inspire debate about the characteristics of both the demarcations of real evolutionary groups and their internal configurations.

Established methods for classifying biological species are subject to intermittent failure, as Sites and Marshall (2004) noted, or may not be harmonious with each other in terms of level of agreement. It was their contention that this is due to the inevitable effect of the numerous permutations of deterministic and stochastic processes linked to any natural speciation event. This may lead to fuzzy boundaries around species and concomitant problems in classification. Variability in the detection of species numbers using existing delimitation methods is a distinct possibility. Sites and Marshall (2004) alluded to examples from the scholarly literature of a type of salamander for which figures of one, two, seven or eleven species have been obtained using different methods of species categorization.

Some scholars have presented discussions that the species problem could be tolerated via recourse to the notion of cluster concepts as espoused by the philosopher Ludwig Wittgenstein (Pigliucci, 2003; de Queiroz, 2005). These are also referred to as ‘family resemblance'-type concepts, with the famous example being that of the 'game.' Wittgenstein described that most people could recognize that a particular activity was a game. However the task of providing a common, unambiguous definition for a game in terms of a single attribute or a collection of properties was a nearly impossible task. For example, both Australian-rules football and chess are classed as games but they do not appear to share any fixed set of properties that also distinguish them from activities that are not deemed to be games. In this case a non-reductionist form of categorization seems to be prevalent and it is this that may contribute to the semantic confusion of the species problem.

This discussion concerning the species problem is meant to initiate reflection upon the diversity of meanings that can be assigned to even a commonplace concept. But then it could be that the very ordinariness of a concept is what stimulates semantic diversity in its comprehension? Hey *et al* (2003) posited that if the species problem could be attributed to confusion about meanings in context then a solution was simply to communicate the concept with more care. If the species concept has a plethora of meanings then to communicate an interpretation of the concept suitable for the purposes of the research outlined in this thesis, a specific meaning in context has to be defined. Since ecological diversity is the overarching metaphor being employed as an explanatory tool in this research project, this will entail the usage of a species definition derived from the discipline of ecology.

Amidst the wide variety of meanings assigned to the species concept, a commonly cited definition in the ecological sense is presented by Van Valen (1976, p. 233):

> "*A species is a lineage (or a closely related set of lineages) which occupies an adaptive zone minimally different from that of any other lineage in its range and which evolves separately from all lineages outside its range.*"

This statement requires some dissection to clarify the explanation: A lineage is a clone or a group of organisms that are descended from a single parent. Another way of viewing a lineage is as a succession of populations exhibiting a hierarchical ancestral-descendent structure. A population is a group of individuals in which there is a predominant degree of genetic interchange due to reproductive behaviour by members of that population. Lineages are closely related if they share a common adaptive zone in which ancestral-descendent population sequences can flourish. An adaptive zone is an ecological niche, an environment of natural resources in which lineages can emerge. The adaptive zone for lineages may alter over the course of time but the lineages can still be related if the new modifications are shared across lineages rather than beginning discretely in each.

In the original research described in this thesis, the analysis of the indigenous Australian component of the World Colour Survey rested upon the analogy that a single Munsell stimulus chip could be likened to a chromatic "ecosystem" (or, more appropriately, a lexical system). The possible names that can refer to a single colour chip take on the role of different species that inhabit this conceptual domain. To use the parlance of Van Valen (1976), the possible names for a single colour chip could also be viewed as being analogous to lineages in the common adaptive zone that is constituted by that stimulus chip. Imagine the World Colour Survey colour chart as a global set of 330 of these schemas. The foci (or basic colour terms) in this abstract universe would then correspond to those lexical systems in which the species diversity index is at a minimum because that would imply a greater level of agreement in nomenclature and a reduced number of alternate colour terms.

## *3.6 Language as a Species*

In his discussion on the evolution of Creole vernaculars, Mufwene (2001) critiqued the "language-as-organism" metaphor often taken for granted in linguistic thought. According to this viewpoint languages appear to have a vitality of their own as if they were organisms. He considered this metaphor to be flawed, particularly for the reason that it did not sufficiently account for differential variations within a language due to such factors as internal rates of change and geographic effects. Mufwene (2001) advocated that the species concept was a more relevant metaphorical construct for a language. Language is a construct that serves to aggregate much like one interpretation of the species concept. As a paradigm it is summative in that it is an extrapolation from singular dialects that are considered to share a common ancestry as well as other similar structural attributes. Mufwene (2001) claimed that linguistic variety can be defined like a biological species by the capacity of its members to reproduce and spawn progeny of the same kind. In this way a language can be seen to be a population of dialects that facilitate meaningful communication between hosts of these dialects.

Individual speakers in a society who can communicate interact with each other and in so doing set off a chain of processes that modify internal representations of personal language systems, either by discarding elements that are no longer of use or by incorporating new features from another speaker. Linguistic features percolate through a community of speakers at a gradual rate with the consequences being major or minor alterations in the whole language.

## *3.7 The Diversity Index and its Applications*

In a review of hybrid speciation in the biological sense, Mallet (2007) commented that many scholars supported the belief that enduring divergence was a key condition of the species concept. Speciation can then be viewed as a process of continual deviation at least until the advent of extinction. Diversity then is the norm in contemplating the nature of species.

Species diversity has two parts. Richness refers to the number of species found in a community and evenness refers to the relative abundance of each species (Magurran, 2004). A community is said to have high species diversity if many nearly equally abundant species are present. If a community has only a few species or if only a few species are very abundant, then species diversity is low. Consider a community with 100 individuals distributed among 10 species. It should make sense that if there are 10 individuals in each of the 10 species in the community it is more diverse than if there are 91 individuals in one species and one individual in each of the other nine species.

The measurement of diversity is not something restricted solely to the domain of ecology. McDonald and Dimmick (2003) reviewed the concept of diversity for an audience of communication researchers, identifying its importance also to the domains of geography, urban planning, psychology, linguistics, sociology, economics and, of course, communication. They remarked that scholars at times dealt with the opposite of diversity when employing the term “concentration,” or they may have used the term “variety” in their work in the same context as diversity.

In a study of diversity in the popular music industry, Christianen (1995) refers to concentration from an economic perspective as being a metric to denote market structure: If a market is controlled by a small number of sellers, thus signifying low diversity, then a high level of concentration is deemed to exist.

Alexander (1996) claimed that an entropy index is a robust measure to determine product diversity. Entropy within thermodynamics is defined as being a metric to evaluate the degree of randomness or disorder within a closed system (Sonntag, Borgnakke and Van Wylen, 2003). However, in the case of the study by Alexander (1996) it was used as a measure of the uniformity in the products released by the popular music recording industry. In order words, Alexander (1996) used entropy as a diversity index to gauge the degree of similarity within a population of data. The latter study provides some support to the notion that there exists a nonlinear relationship between market concentration and product diversity in the popular music recording industry. This implies that product diversity is at its greatest when the industry is in a state of moderate concentration.

When market concentration is at extreme levels, either high or low, then product diversity is found to be reduced. In an earlier study within the same problem domain, Peterson and Berger (1975) presented findings that suggested an inverse relationship between diversity in musical forms and market concentration, with the latter leading the former. No specific diversity index borrowed from ecological modelling was mentioned in the study by Peterson and Berger (1975) indicating that the approach to gauging variability was novel in this case. Alexander (1996) also argued that the entropy index could be used to quantify diversity in other culture-based industries, such as book publishing or cinema production, whilst conceding that some products may not be amenable to formal measurement techniques.

Adopting the concept of diversity from biology, Huisman (2000) examined the nature of institutional diversity in the higher education sector. Here diversity was treated as being the variety of types of institution coupled with the dispersion of entities across these types. Three techniques to address diversity were outlined by Huisman (2000): cluster analysis, ordination techniques and diversity index calculations. All were deemed to be examples of data reduction methods where a loss of information coalesced into some sort of condensed metric.

Cluster analysis as used by Huisman (2000) converted the myriad variations between higher education institutions into distances which can be represented in diagrams called dendrograms. These were a visual means of depicting clusters of similar higher education institutions. Ordination was described as a process that collapsed the number of institutional characteristics to fewer dimensions and in the example documented in Huisman (2000) this involved principal components analysis. The calculation of a diversity index in this particular study of the higher education sector was the extreme case of reducing many institutional characteristics to a single measure. In the original research described in this thesis, the analysis of the indigenous Australian component of the World Colour Survey also sought to gain insight on the categorical underpinnings of the data through the characteristics that could be inferred from a set of single measures, namely the Brillouin diversity index values for each Munsell colour stimulus chip that was displayed to informants.

Huisman, Meek and Wood (2007) once again examined institutional diversity in higher education by implementing the biological metaphor as before, this time considering the phenomenon in a comparative analysis across 10 countries that was longitudinal in perspective. In their conceptual framework, if diversity possessed two constituents, namely the number of species in a community and the distribution of organisms across the species, then they redefined their terms of reference as follows: Huisman *et al* (2007) considered the term “higher education system” to be equivalent to “community” in their study, “organizational type” or “profile” equates to “species” and “higher education institution” corresponds to the term “organism.”

According to Huisman *et al* (2007), one higher education system was more diverse than another if it contained a greater variety of institutional types. The total number of types within a system was equivalent to the notion of abundance in biodiversity but the authors believed that the distribution of individual institutions across the types was also important in the analysis. Therefore, a diverse system would be comprised of a wide array of dissimilar institutional types with an even distribution of individual institutions across these types. In the limiting cases of this study, maximum system diversity occurred when all individual institutions could fit into different unique types, whereas minimum system diversity was the state where all institutions were of the same type.

Both the Simpson index and the Birnbaum index are calculated in the research outlined within Huisman *et al* (2007). The Simpson index was originally developed for use in ecological modelling (Simpson, 1949) but the Birnbaum index is one that was concocted as an indicator of diversity within the U.S. higher education sector (Birnbaum, 1983). To determine institutional types, Birnbaum (1983) used multi-valued variables such as control, size, sex of students, programme, degree level and minority enrolment, and to gauge diversity, he computed the number of types divided by the total number of institutions to deliver a ratio where the maximum is the asymptotic value of 1. In the original research described in this thesis, the analysis of the indigenous Australian component of the World Colour Survey employed the Brillouin diversity index for calculations of categorical variability (Brillouin, 1956; Pielou, 1977).

In research from the domain of evolutionary psychology, the global configuration of diversity in religions was examined by Fincher and Thornhill (2008) and a conjecture was made that these spiritual segregations between people may have assisted in limiting the spread of infectious diseases. Tropical geographic regions are home to far more numerous religions than are temperate areas according to the authors of this study. Boundaries between groups emerge as a result of this religious diversity that in effect splinter, fragment and diversify an original culture leading to a multiplicity of groups forming from a single origin. This process is known as associative sociality, meaning that a coalition of similar individuals can arise for mating purposes or other kinds of social contact (such as the sharing of food or the communal practice of religion).In their analysis, Fincher and Thornhill (2008) equated diversity of religions to “religion richness,” this simply being the number of religions per existing country or territory with an independent government. “Pathogen richness” was defined in similar manner and the aim was to identify an explicit correlation between religion diversity and infectious disease susceptibility all over the world. Diversity indices borrowed from ecological modelling were not employed in this study.

McDonald and Dimmick (2003) defined diversity as being a two-dimensional construct, citing Junge (1994) who proclaimed that the statistical connotation of a diversity index was essentially an abridged depiction of a population that possessed a kind of class structure. The act of being able to measure diversity is usually associated with the allotment of some quantity (e.g., number of species, occupations, etc.) into a number of distinct classes. The diversity index can then be considered two-dimensional in its characteristics given that it denotes both the number of classes in a population as well as the gradation of evenness of the population distribution within the known classes. This first dimension is categorical such as ethnic groups, types of business or kinds of terms assigned to denote an object like a colour chip, as in the case of this thesis. In other words, the first dimension of diversity involves discrete classification. The second dimension deals with the allotment of elements to those categories in terms of numeric quantity.

McDonald and Dimmick (2003) did admit that some research does treat diversity as a one-dimensional construct - citing Long (1979) in this case - whereby the stress was placed only on the number of categories within a distribution. This is simply counting the number of different classes within a population and in some research this is effective (e.g. Napoli, 1999). It is in cases such as this that the term “variety” may be deemed more appropriate than diversity. McDonald and Dimmick (2003) believed that the dual-concept notion of diversity outlined above offers a richer interpretation of how uniformly the categories are dispersed across a population.

In their overview of various diversity indices, McDonald and Dimmick (2003) nominated interpretability as being an important choice factor. Simpson’s diversity index (Simpson, 1949), they argued, can directly be construed as a probability, this being the chance that two constituents selected at random from a population come from the same category. Of course, this would have more validity given a large population. For example, Greenberg (1956) adopted a probabilistic approach in his idiosyncratic diversity index used to offer a quantitative measure of linguistic diversity related to geographic area. An “Index of Communication” was described, this being the probability that if two members of a population are selected at random, they will be conversant in one shared language as a minimum.

In work of Greenberg (1956), the overarching assumption was that there was a correlation between greater linguistic diversity and substandard inter-societal communication coupled with diminished levels of production in the economic sense. However, the relationship was later found to be more complex. Greenberg (1956) alluded that the link between diversity and extra-linguistic factors was something for the academic realms of sociology and anthropology to debate.

The diversity index chosen for the research described in this thesis, namely the Brillouin Index, was expressed in McDonald and Dimmick (2003) as being comprised of a logarithmic transformation of factorials that model the sample size and number of members in each of the observed classes. Stating the obvious, they went on to state that the factorials of the number of members in the classes are multiplied in the Brillouin formula, but they argued that this became computationally intractable when large numbers were involved.

Hence, McDonald and Dimmick (2003) excluded it from their later worked example illustrating the workings of various diversity indices on a common data set (this being thirty years worth of prime-time network radio programming from 1926 to 1956 in U.S. markets classified by program type). McDonald and Dimmick (2003) in their analysis focused on three aspects of their chosen diversity indices:

i. The interconnectedness between the diversity measures used,
ii. The responsiveness of each diversity measure in relation to the largest proportion present in the population as well as the number of observed categories themselves, and
iii. The responsiveness of each diversity measure in relation to variations in the largest proportion and to the number of categories

However, it is important to note that the Brillouin index is singled out by Pielou (1977) as an appropriate diversity index for measuring collections whose membership has been fully determined. The World Colour Survey colour naming data set is one example of a collection whose membership is fully determined, so the Brillouin diversity index was adopted for its analysis.

McDonald and Dimmick (2003) found that for specialized use, certain diversity measures may be more appropriate than others. An example cited by them refers to situations in which the diversity measures used must be especially sensitive to changes in the number of categories present in a population. This may be applicable when observing phenomena for which it is essential to note the interpretation of some categories, even when such categories are a comparatively small proportion of the whole.

Other circumstances noted by McDonald and Dimmick (2003) suggest the need for diversity measures that are more sensitive to the proportion in the largest category. For example, in measures of the concentration of revenues in firms within an industry, an analyst might desire a measure that gives more weight to the largest firms. Two measures that were considered to be the most flexible and about equally sensitive to the proportion in the largest category are Shannon's H diversity measure (Shannon & Weaver, 1949) and Simpson's D (Simpson, 1949). The sensitivity of the former measure may be more balanced when sample sizes are very small with estimate being less than 10.

If one can consider a Munsell chip to be a chromatic "ecosystem" (or, more appropriately, a lexical system) in itself, then the possible names that can denote the chip take on the role of different species that inhabit this conceptual domain. Imagine the World Colour Survey colour chart as a global set of 330 of these schemas. The foci (or basic colour terms) in this abstract universe would then correspond to those lexical systems in which the species diversity index is at a minimum because that would imply a greater level of agreement in nomenclature and a reduced number of alternate colour terms.

Allied to the notion of a diversity index is the somewhat more obscure Cultural Significance Index (CSI) advanced by Turner (1988). This index was developed to assist in the analysis of ethnobotanical data. Presented with a particular plant taxon, this index represents a combination of a broad range of likely uses of a plant, ranked according to the contribution of each separate application to survival in traditional cultures, together with estimates of intensity and exclusivity of use for each.

## 3.8 Other Examples of Methodologies Akin to Diversity Analysis in Colour Categorization Research

A study documented in Sturges and Whitfield (1997) classified the naming of basic colour terms by a cohort of English university students according to three dependent measures: consistency, consensus and response latency time. Consistency refers to the regularity of the same colour sample being given the same name by the same subject on different presentations of that sample. Consensus referred to level of agreement between subjects in their colour naming behaviour and this can be construed as the inverse of diversity within the context of the approach followed in this thesis for evaluating the indigenous Australian World Colour Survey data sets.

The metric of response latency time used by Sturges and Whitfield (1997) dealt with the time lapse between the onset of the colour chip stimulus and the utterance by the subject of the name assigned to this. This is a culturally inappropriate metric to be used in indigenous Australian behavioural studies given that direct questions are generally deemed to be impolite, an issue to be discussed in depth later in this thesis. No details concerning these measures are present in the indigenous Australian World Colour Survey data sets. It is interesting to note that in the Sturges and Whitfield (1997) study only 102 of the 446 colour chips presented to subjects were named with perfect consensus. Another way of stating this is that 102 of the 446 chips had zero diversity in colour naming.

In the Sturges and Whitfield (1997) study, 446 Munsell colour samples were displayed to 20 subjects one at a time in random order and these were then displayed again to the subjects in reverse sequence. An equal number of rest periods for the subjects were included in both directions of the experiment. In terms of the indigenous Australian component of the World Colour Survey data set it would appear that the luxury of forward and reverse orders in the presentation of colour samples was not undertaken. Details of rest periods were also not indicated. A maximum consensus criterion for the Sturges and Whitfield (1997) study is denoted as being 40, presumably meaning that in forward and reverse order all 20 subjects agreed on the names for 102 colour samples. The smallest possible consensus criterion is taken to be 21.

The usage of the term “consensus criterion” is perplexing in Sturges and Whitfield (1997): One would assume for a criterion of 20 that there was no consistency in colour naming, whereas with 21 there is at least one subject who agrees with someone else. It would not be “consensus criterion” in this case. Rather it would seem to function more as a consistency criterion. (The graph featured in Figure 2 of Sturges and Whitfield (1997) on page 310 actually is labelled on the horizontal axis as “consistency criterion,” yet this axis in the text of the paper is referred to as a set of criteria for defining consensus.) It is stated that as the so-called consensus criterion is relaxed by one an extra 14 colour samples are included. Following on from this a consensus criterion of 21 results in 91% of the colour samples being included (or 407 out of 446).

Davies and Corbett (1994) also employed statistical indicators of salience and consensus of use in their study of colour terms of the Bantu language Xhosa, being one of the official languages of South Africa. Informants were selected from Transkei, a rural area in the Eastern Cape of South Africa. The 44 subjects in the study were required to perform two activities:

i. a verbal elicitation exercise where they had to list as many colour terms as they know with the aim of seeking out candidates for basic terms and
ii. a colour naming task.

In the latter, the informants were displayed stimuli composed of a restricted set of only 63 colour tiles. These were not Munsell-based colour stimulus chips, as used in most conventional studies that attempt to verify Berlin and Kay (1969) such as Sturges and Whitfield (1997), but were proprietary colours from the Colour-Aid Corporation. It was argued that the reduced set of stimuli would diminish fatigue amongst informants in comparison to being compelled to view the 446 Munsell chips of a comprehensively sampled array. (However, the use of non-standard stimuli, as is the case here, makes it difficult to compare findings with other more regulated studies.) The results of their study indicated that Xhosa has basic colour terms for white, black, red, yellow and grue (a combination of green and blue), this being a finding aligned to Berlin and Kay (1969) theory.

What is interesting about the Davies and Corbett (1994) study is that they factored in the importance of colour term “dispersion” in their analysis of the data as well as the frequency of use by informants. By dispersion they mean that there should a clear level of agreement between speakers of a language as to the referents of the basic colour terms that are elicited. This consensus of use would be signalled by narrow concentrations of term utilization in the data rather than distribution that is highly diluted in extent. In other words, the latter implies a situation of high diversity where term use is not convergent and many different words are being applied to a supposedly common referent.

## *3.9 The Brillouin Index*

In terms of biological diversity, Magurran (2004) noted that when the random nature of a sample could not be assured it was advisable to use the Brillouin index. Given this characteristic, the latter information index should also be the choice if the members of the community under observation are known with every individual being accounted for (Pielou 1969; Pielou 1975). The Brillouin index (B) is calculated using the following formula:

$$B = (\ln N! - \sum \ln n_i!)/N$$

In the above equation, $n_i$ refers to the abundance of the *i*th species and N signifies the total abundance. The Brillouin index is employed to depict the diversity of a known collection that is not subject to the uncertainty of a sample randomly drawn from a larger population.

In the context of colour terms the Brillouin index is employed in a novel fashion within the scope of this research project to gauge the level of agreement for a particular category designation. Taking the basic colour category ‘red’ as an example: If there are 25 subjects who use the same linguistic term X to name a colour chip as being ‘red’ then the total number of chromatic species is one. There is only one word to denote ‘red’ in this case. Given the unanimous level of agreement on the naming of this colour chip it could be concluded that the word used is a possible candidate for a basic colour term for that natural language. The diversity of chromatic species is at a minimum in the scenario outlined and computation of the Brillouin index would lead to a value of one.

However, if out of the cohort of 25 subjects, 5 use the word X, 10 use Y and the remaining 10 name the ‘red’ colour chip Z, then three chromatic species exist namely X, Y and Z. Diversity has increased, precipitating an increase in the Brillouin index.

### 3.10 Diversity Analysis Applied to Colour Categorization Studies

To reiterate was has previously been stated, within the context of the research outlined in this work the metaphor of species diversity in a natural environment was adopted as a frame of reference for at least partially determining the “basicness” of a colour term.

Systems within the realm of biology can be considered to exist as a hierarchy of nested complexity: molecules, cells, organisms, populations, communities and ecosystems. For example, a community is made up of populations. In ecology, these populations are sets of interacting species that inhabit some shared environment

A species is a taxonomic collection of organisms that can interbreed. Species classification is via the identification of common attributes. The co-existence of species within an environment can lead to a stable ecosystem. This is where an appreciation of diversity as a concept is of value. The notion of species diversity is a characteristic uniquely attributed to the community level of biological association (Magurran, 2004). From an ecological perspective, higher species diversity is commonly taken to point toward a more intricate and robust community because a larger assortment of species allows for more interactions between classes, consequently resulting in greater system stability and offering an indication of favourable environmental conditions.

Diversity indices are used in ecology as a statistical means of computing the biodiversity of an ecosystem. They are a qualitative measure of the dispersion of a population of individuals that are relegated to a variety of categories. Quantitative variability is ascertained using statistical constructs such as variance and standard deviation, for example, but diversity indices represent a metric for qualitative variability (Pielou, 1969; Pielou, 1975; Pielou, 1977). A diversity index takes into account the proportionality of categories in the dispersion of members within a population rather than simply tabulating the variety of differences. A variety of diversity indices can be calculated to compare ecological communities.

The Brillouin index is adopted from the mathematical theory of information with the central rationale being to gauge how much of the latter is required to distinguish a community. If a community is composed of the same species then less information is required to denote it but if the community members were all different species then the maximum amount of information is required because a unique name is needed for each one. Species diversity has two parts. Richness refers to the number of species found in a community and evenness refers to the relative abundance of each species. A community is said to have high species diversity if many nearly equally abundant species are present. If a community has only a few species or if only a few species are very abundant, then species diversity is low.

Garland (1979) referred to the Brillouin index as a means to evaluate the degree of order (or otherwise) of a specific population scattered over a number of distinct classes. This definition related to the underlying notion of entropy that was the basis of diversity indices that have a justification in information theory. In the latter study, the Brillouin index was employed to address the problem of selecting materials for a subject collection in a university library. The index was used to determine the diversity (or relatedness) of a collection of library materials with "comprehensiveness" being a key factor. Bogaert, Farina and Ceulemans (2005) used the Brillouin index as metric of entropy to gauge human-induced landscape fragmentation via the measurement of diversity in isolated patches of nature. Entropy is a measure of the disorder of a closed thermodynamic system and it is analogous to a diversity index in some cases (Sonntag *et al*, 2003).

In a metaphorical sense, if one can envisage a single Munsell chip to be a chromatic "ecosystem" (or, more appropriately, a lexical system), then the possible names that can denote the chip take on the role of different species that inhabit this conceptual domain. Imagine the World Colour Survey colour chart as a global set of 330 of these schemas. The foci (or basic colour terms) in this abstract universe would then correspond to those lexical systems in which the species diversity index is at a minimum because that would imply a greater level of agreement in nomenclature and a reduced number of alternate colour terms.

For example, if colour chip no. 1 is presented to 25 subjects and term designations are elicited, several possibilities can ensue: If all 25 informants designate the chip with the same name then there is a unanimous level of agreement in colour naming. Another way of considering this is to conclude that the diversity of colour term "species" is zero: There is only one colour term "species" present in the given sample of 25 which is in a state of maximum homogeneity. In another sense, there is a 100% level of agreement amongst the 25 informants as to the name denoting the stimulus chip.

Diametrically opposed to this is the scenario where there is no level of agreement in nomenclature and all 25 informants offer idiosyncratic terms to denote the same chip. In effect, 25 different terms denote the same chip within this hypothetical sample that is in a peak state of heterogeneity. The diversity of colour term "species" here is at a maximum. A sliding scale of diversity would exist between these two extremes. The conjecture followed in this line of reasoning is that diversity minima in colour term "species" should correspond to focal colours given that these are the most psychologically salient.

## 3.11 Diversity Analysis Applied to World Colour Survey Data: A Worked Example

To illustrate the process undertaken in applying diversity analysis to the indigenous Australian World Colour Survey cohort, a worked example dealing with one language group (Martu Wangka) shall be presented. The data analysed was gathered by World Colour Survey field workers over 30 years ago, processed for several decades and recently made available online to the general public for secondary analysis.

As mentioned in the Literature Survey of this work and outlined in more detail by Cook et al (2003), the methodology of the World Colour Survey required that an average of 24 native speakers of each of 110 global languages without a documented form of writing were designated to perform two tasks:

i. Informants had to name each of 330 Munsell colour chips, presented to them in a constant, random order, and
ii. Informants were exposed to a palette of these chips and requested to select their best examples ('foci') of the major colour terms that were elicited in the previous naming task.

The results from these two tasks were collected and coded by field investigators and the entire World Colour Survey data set was eventually made available online for public use (Cook *et al*, 2003). The limitations of the World Colour Survey as an Anglocentric global field experiment have been discussed by Saunders and van Brakel (1995), but there are methodological flaws as well with the original data gathering. The colour stimuli employed were not a properly sampled selection of chips from the Munsell colour order system, as was the case in Sturges and Whitfield (1995). Only the most saturated Munsell colour chips (i.e. those with the highest chroma) were used as stimuli and this may have unduly influenced their apparent salience to informants.

Also, the informant backgrounds and field worker notes, previously available in the earlier microfiche version of the World Colour Survey data set (Kay *et al*, 1991b), were embargoed in the latest publicly-available online edition. This meant that knowledge of the languages spoken by the informants was only available through a secondary source, namely Hargrave (1982). The latter revealed that almost all indigenous Australian informants were multi-lingual, not monolingual as was the original intention in the design of the World Colour Survey. Colour terms elicited from multi-lingual informants being presented with stimuli could be difficult to associate with any one language with respect to their salience. These limitations would affect the outcome of any analysis of the indigenous Australian component of the World Colour Survey data set. In fact, it could also be argued that diversity analysis (or any kind of statistical method for that matter) is an Anglocentric process of sense-making that could reveal skewed findings.

In this work, diversity analysis was applied to the colour naming data of the World Colour Survey indigenous Australian cohort to seek out any patterns that may exist and determine whether or not they signify the presence of basic colour terms in the respective language groups under consideration, these being Kriol, Kuku-Yalanji, Martu Wangka, Murinh-Patha and Warlpiri.

There were 25 informants in the Martu Wangka cohort. The World Colour Survey files for this language group that were examined related to the naming of 330 colour chips that were individually presented to subjects. In this case, the term.txt file was the subject of scrutiny. This file contains the complete data for the World Colour Survey naming task in which terms were elicited in response to the display of colour chips across 110 language groups. The format of the term.txt file follows a standard pattern:

i. the World Colour Survey language number in the range from 1 to 110, with Martu Wangka being 64;
ii. the World Colour Survey speaker number;
iii. the World Colour Survey chip number in the range from 1 to 330 (which corresponds to a World Colour Survey grid coordinate with the help of information presented in chip.txt); and
iv. the term abbreviation, being a code representing the indigenous name that the associated chip elicited from an informant.

At the time of analysis there was no key provided as to the precise number and extent of term abbreviations in the Martu Wangku cohort. This was determined according to the following procedure: Based on the World Colour Survey language number, the Martu Wangka data was extracted from the term.txt file and imported into an Excel file. This Excel file was split into 14 different files containing the data for various colour chip ranges. For example, one mini-file contained the data for chips 1 to 25, another for chips 26 to 50 and so on. These were then printed off and the range and extent of term abbreviations were collated via manual inspection. A total of 44 distinct term abbreviations were uncovered for the Martu Wangka dataset and these are featured in Table 3.1 below.

**Table 3.1 - Distinct term abbreviations for the Martu Wangka data set**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A | B | C | D | F | G | H | I | J | JT | K |
| KG | KL | KP | KR | KX | KZ | L | LA | M | MU | N |
| NI | NT | O | P | PJ | PN | PY | Q | R | RR | S |
| T | U | V | W | WA | WR | X | Y | YA | Z | ZZ |

Also observed was a term abbreviation denoted by an asterisk (*). It was not specified as to what this coding referred by it was also included in the analysis, technically making it the 45th colour term abbreviation.

To determine which diversity index to apply en masse to the indigenous Australian component of the World Colour Survey, both the Simpson and Brillouin indices were computed for each of the 330 chips from the Martu Wangka dataset and a Spearman's rank correlation coefficient was determined for the latter pair. Spearman's rank correlation coefficient (or Spearman's rho) is a non-parametric statistical measure of the correlation between two variables. An Excel file containing two columns with Simpson and Brillouin indices computed for each of the 330 chips in the Martu Wangka dataset was input to SPSS and correlation coefficients were calculated. The correlations for Spearman (2-tailed), Kendall and Pearson correlation calculations were observed to be very high (being 0.989, 0.928 and 0.884 respectively). Based on this outcome it was determined that there was no need to 'equalise' the two sets of scores.

The two sets of measures (i.e. Simpson's and Brillouin indices) were deemed to be virtually equivalent for this exercise. It was decided then to compute only the Brillouin indices for the rest of the indigenous Australian component of the World Colour Survey. One reason for doing this is that the Brillouin index was developed for fully censussed data sets (i.e. finite communities) and each of the informant populations that recounted names for the 330 colour chips is a static collection with known members. Simpson's index of diversity, on the other hand, is best deployed for an indefinitely large community as it is a measure of concentration which, in fact, denotes the probability that, if two members are selected discretely and at random from a community containing a variety of species, they will belong to the same species. Since the informant populations per colour chip are fixed for each language group such a probabilistic measure of diversity would be inappropriate.

Table 3.2 features a worked example of how the Brillouin index was calculated for colour chip no. 1 with respect to the Martu Wangka dataset:

**Table 3.2 - Worked example of Brillouin index calculation for colour chip no. 1 with respect to the Martu Wangka World Colour Survey data set**

| Colour term abbreviation | n | ln(n!) |
|---|---|---|
| * | 1 | 0 |
| L | 1 | 0 |
| M | 15 | 27.9 |
| N | 5 | 4.8 |
| T | 1 | 0 |
| Y | 2 | 0.7 |
| sample size (N) | 25 | sum =33.4 |

In the above table, n refers to the number of individual entities belonging to each "species" (i.e. colour term abbreviation) and N is the total number of individual entities.

To conclude the calculation:

ln(N!) = ln(25!) = 58.0

and

ln(N!) – sum = 58.0 - 33.4 = 24.6.

Finally:

(ln(N!) - sum)/N = 24.6/25 = 0.984 (The Brillouin diversity index for colour chip no. 1)

The process was adopted in an Excel spreadsheet to compute the Brillouin indices for each of the sets of responses to the 330 colour chips presented to the Martu Wangka cohort of the World Colour Survey (as well as the other indigenous Australian constituents in the data set.) A total of 330 Brillouin indices were collected then per indigenous Australian language grouping and these were plotted as vertical bar charts in Excel to facilitate easy visual inspection of the outcomes. The bar charts for all indigenous Australian languages under scrutiny are featured in appendices within this thesis. A sample bar chart from the Kriol cohort is featured below in Figure 3.1. The vertical axis represents Brillouin diversity index figures and the horizontal axis denotes World Colour Survey colour chip numbers, which can be decoded into their equivalent coordinates on a chart of Munsell colour stimuli (Figure 3.2) using information from the World Colour Survey official website.

For example, World Colour Survey colour chip number 19 in the sample bar chart is E27 in the chart of Munsell colour stimuli shown in Figure 3.2 and this scored a Brillouin diversity index of zero. The 330 colour chips used in the World Colour Survey are shown in Figure 3.2. The chips on the left most side denote achromatic colours are range from A0 to J0. A more detailed version of this colour chart, featuring numeric figures for Value (i.e. brightness) and Chroma (i.e. saturation) of each chip is featured in Figure A.1 of Appendix 1. Appendix 2 also contains miscellaneous details regarding the World Colour Survey Munsell chart.

Visual inspection of the bar charts was undertaken to identify both clusters of diversity minima and maxima. The bar charts for all five World Colour Survey indigenous Australian cohorts, Kriol, Kuku-Yalanji, Martu-Wangka, Murinh-Patha and Warlpiri, are featured in Appendices 3 to 7. Each cohort features 14 individual barcharts. The first in each cohort is for Munsell colour chips 1 to 25, the second for chips 26 to 50 and so forth. These barcharts were split in this fashion to facilitate ease of manual inspection for diversity minima and maxima. Numbers from 1 to 330 were randomly assigned to Munsell colour chips that already are designated by two-dimensional chart coordinates.

For example, Munsell colour chip 1 is E29 in the chart of colour stimuli shown in Figure 3.2 and chip 330 is B22. Colour chips scoring Brillouin diversity index figures less than 0.4 in terms of the frequency of naming were arbitrarily taken to be of low diversity, while those achieving figures greater than 1.6 were deemed to be of high diversity. These were plotted on the World Colour Survey colour chart (i.e. Figure 3.2) and compared with a plot of focal colours taken from the landmark study by Sturges and Whitfield (1995), also displayed on a World Colour Survey chart (Figure 4.1).

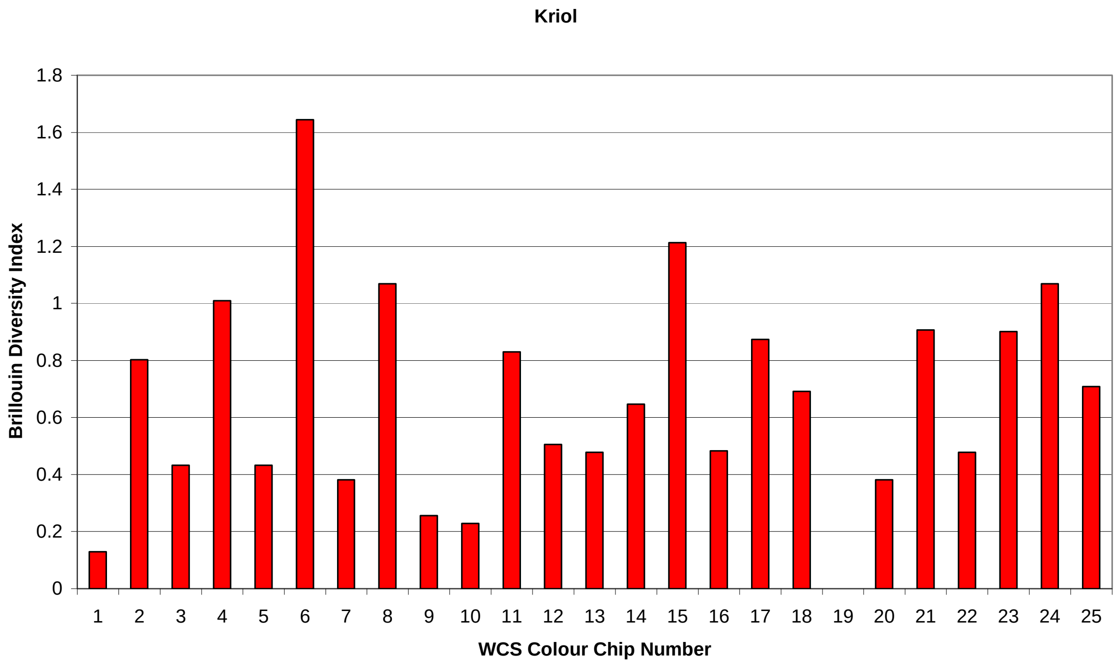


**Figure 3.1 - Sample bar chart used in World Colour Survey data analysis**

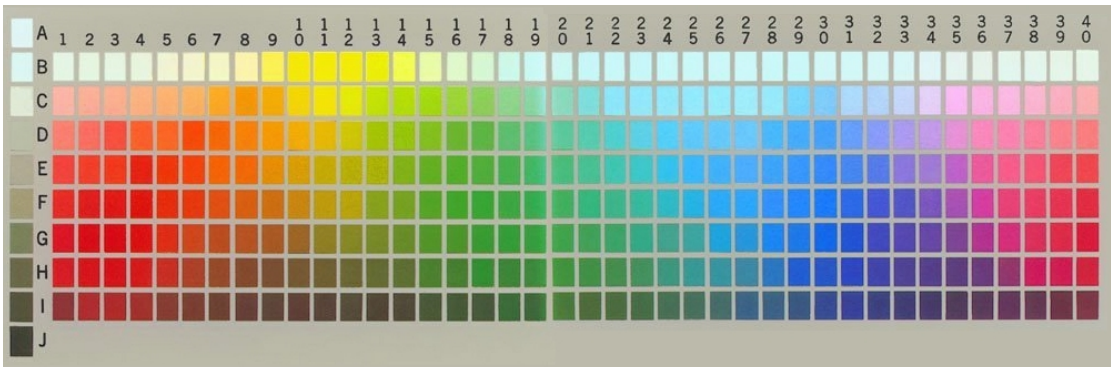


**Figure 3.2 - World Colour Survey Munsell colour stimuli**

## *3.12 Conclusion*

A research methodology can be broadly considered to be the rationale and concomitant philosophical suppositions underpinning the set of methods employed in a rigorous field of inquiry (Cresswell, 1998). Within this chapter the evolution of the research methodology employed in this work was unfolded, beginning with a general discussion of the nature of content analysis. This was followed by an overview of the analysis of diversity and how it could possibly be employed as a metric of categorization. High diversity within something like the World Colour Survey data set could indicate a certain level of confusion in whatever was elicited from informants, namely colour terms in this case. Conversely, a low level of diversity could insinuate a greater level of agreement and the possible presence of more stable categories within the World Colour Survey data set. This idea was put into practice by using a biological metaphor: Variable colour terms elicited from World Colour Survey informants that were assigned to a single stimulus chip were likened to different species within an ecosystem.

The Brillouin diversity index, borrowed from ecological modelling techniques, was outlined as the chosen analytical tool to use according to the latter manner on the indigenous Australian component of the World Colour Survey. A detailed exposition of ecological modelling and its metaphoric implication in other uses served as justification for the deployment of the Brillouin diversity index within the context of this research. This work represents research that is a secondary analysis of an extant data set, the collection of which was initiated as an attempt to validate the original Berlin and Kay (1969) theory and its subtle perturbations in the years since its formation. The aim is to use diversity analysis as a novel means of seeking out patterns in this regard or identify ambiguities in the process. A worked example using the Martu Wangka cohort of the indigenous Australian component of the World Colour Survey data set was delineated to illustrate how diversity analysis was to be employed in order to shed light on the content of the latter. Limitations in the World Colour Survey were also discussed in this section. The chapter concluded with a commentary on techniques similar to diversity analysis that were used by other colour categorization researchers.

# CHAPTER 4

# 4 Analysis

## *4.1 Introduction*

This chapter opens with a description of a reference point for the analyses that will follow, this being the previously mentioned determination of English focal colours by Sturges and Whitfield (1995). Next, each of the analyses for the indigenous Australian cohorts in the World Colour Survey data set is detailed according to a standard format. The language groups in question are Kriol, Kuku-Yalanji, Martu Wangka, Murinh-Patha and Warlpiri. Each cohort analysis section begins with a geographical and lexical background of the language group, including a breakdown of existing colour terms determined from print or web-based dictionaries, as well as any second-hand knowledge of the informants themselves. This is followed by a commentary on the World Colour Survey Dictionary File for that language group, this being the indigenous terms that were elicited from the informants by field workers. The next part of each analysis section features overviews of the diversity minima and maxima obtained for that language group with respect to the colour terms elicited in the World Colour Survey. Each individual analysis of the indigenous Australian cohorts concludes with a commentary on the findings. The chapter ends with a conclusion section in which commonalities and unique overall findings in the analyses are highlighted.

## *4.2 Sturges and Whitfield (1995)*

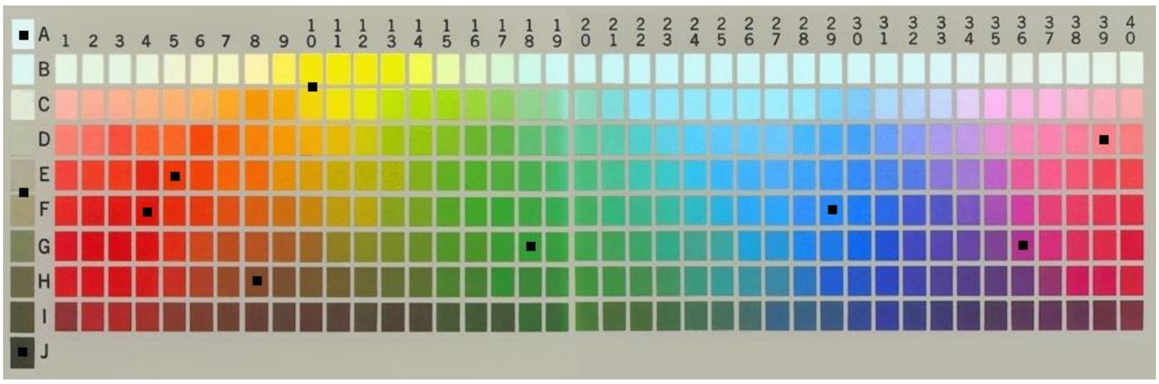


**Figure 4.1 - English focal colours (Sturges and Whitfield, 1995)**

Before presenting an analysis of the indigenous Australian component of the World Colour Survey colour naming data, reference is made to the set of English focal colours as determined by Sturges and Whitfield (1995) and these were mapped onto the World Colour Survey colour chart in Figure 4.1. The black markers in this figure constituted the averaged focal responses from English speakers that took part in the latter study and represent the 11 basic colour terms for the language. As mentioned previously, it was outlined in Sturges and Whitfield (1997) that consensus was one of the measures used in classifying the naming of basic colour terms by English speakers in this study. Consensus from this perspective means the level of agreement between subjects regarding their colour naming behaviour and as stated earlier this is considered to be the inverse of diversity within the context of the approach followed in this thesis for evaluating the indigenous Australian World Colour Survey data sets. In effect, Figure 4.1 displays 11 points of minimum diversity in colour naming for English speakers. These points will be used as markers for comparison in the analysis to follow.

## *4.3 Kriol*

### 4.3.1 Kriol - Geographical and Lexical Background

According to Hargrave (1982), there were 25 subjects in the Kriol cohort, 12 males and 13 females ranging in age from 18 to over 65. 12 of these test participants spoke one or more traditional indigenous Australian languages fluently but these were not outlined in detail by Hargrave (1982). Nine subjects spoke English fluently and 11 had limited abilities with the aforementioned language. The subjects were part of Ngukurr community situated in South East Arnhem Land on the north bank of the Roper River, inland from the Gulf of Carpentaria in Australia's Northern Territory.

As the name suggests, Kriol is an example of a Creole which is a stable language with a unique grammatical structure that has emerged as a native-spoken pidgin emanating from some parent dialect, which in this case is English (Hall, 1966, Bickerton, 2008). In a private communication with linguist Derek Bickerton, a leading researcher in Creole languages, (received via e-mail on November 19, 1998) the following comment was made with regard to colour terms in these languages: *"Common lexical items like basic color terms mostly survive the pidginization process so creoles tend to wind up with pretty much the same primary terms as their superstrate languages."* (Bickerton also doubted the validity of most Creole dictionaries, stating that *"if a color term didn't* *occur there, you couldn't be sure it didn't exist."* As can be seen in tables 4.1 and 4.2, the Kriol colour terms appear to have the same form as their English counterparts.

Table 4.1 features Kriol colour terms as derived from a 2004 draft-version of an online Kriol-English dictionary (Lee, 2004). Only the adjectival form of Kriol colour terms is displayed and only those used in the Ngukurr geographic region are included. A limitation of the indigenous Australian dictionaries cited in this thesis was that the number of linguistic informants used in the compilation process was extremely small and the methods involved were not explained in detail so as to gauge the accuracy of consensus.

**Table 4.1 - Colour terms from an online Kriol-English dictionary (Lee, 2004)**

| English | Kriol |
|---|---|
| black | blek |
| blue | blu |
| brown | braun |
| green | grin |
| grey | grei |
| light yellow | wait |
| orange | orinj |
| pink | bingk |
| purple | pepul |
| red | red |
| red and yellow | redyela |
| white | wait |
| yellow | yela/yelo |

In Table 4.1 the Kriol term *redyela* apparently referred to the composite colour 'red and yellow.' Also of interest in Lee (2004) was the use of the Kriol term *wait* for both 'white' and 'light yellow.'

### 4.3.2 Comments on the Kriol World Colour Survey Dictionary File

Hargrave (1982) noted that the Kriol informants used between 3 and 11 colour terms during the study. This maximum elicited amount of 11 is contradicted by the World Colour Survey Kriol dictionary file displayed in Table 4.2. This contains the final version of the World Colour Survey data for Kriol, so one would assume that it should be treated with a greater degree of legitimacy. The second column of the table features the field-worker's transcription of the Kriol colour term elicited, while the third column features the code or unique World Colour Survey term abbreviation denoting it for analysis. It is interesting to note that the Kriol colour term *bran* appears in Table 4.2 rather than *braun*. Both translate to the English 'brown' but the former is a term whose usage was observed to be prevalent amongst the Fitzroy Crossing community of Kriol speakers, according to Lee (2004). The World Colour Survey cohort of Kriol speakers supposedly were part of the Ngukurr community, where the lexicon contained the variant term *braun*. This could be attributed to a transcription error in the original dataset. There is also a coding inconsistency for terms 3 and 4 in the table as they both share the same abbreviation.

**Table 4.2 - World Colour Survey Kriol dictionary file**

| | **Elicited Kriol colour term** | **World Colour Survey Code** | | **Elicited Kriol colour term** | **World Colour Survey Code** |
|---|---|---|---|---|---|
| **1** | orinj | O | **15** | lait | L |
| **2** | pingk | P | **16** | silva | SI |
| **3** | pepul | PP | **17** | kalad | K |
| **4** | peipul | PP | **18** | djaklat | DJ |
| **5** | blu | BL | **19** | shaini | SH |
| **6** | grin | G | **20** | dakblu | B2 |
| **7** | blek | B | **21** | dakwan | DW |
| **8** | wait | W | **22** | dakgrin | DG |
| **9** | yela | Y | **23** | shaini | SH |
| **10** | red | R | **24** | grinblu | GB |
| **11** | bran | BR | **25** | laitblu | B3 |

| | | | | | |
|---|---|---|---|---|---|
| **12** | grei | GR | **26** | dakblek | DB |
| **13** | straberi | S | **27** | laitorinj | LO |
| **14** | dak | D | | | |

### 4.3.3 Kriol World Colour Survey Data - Diversity Minima

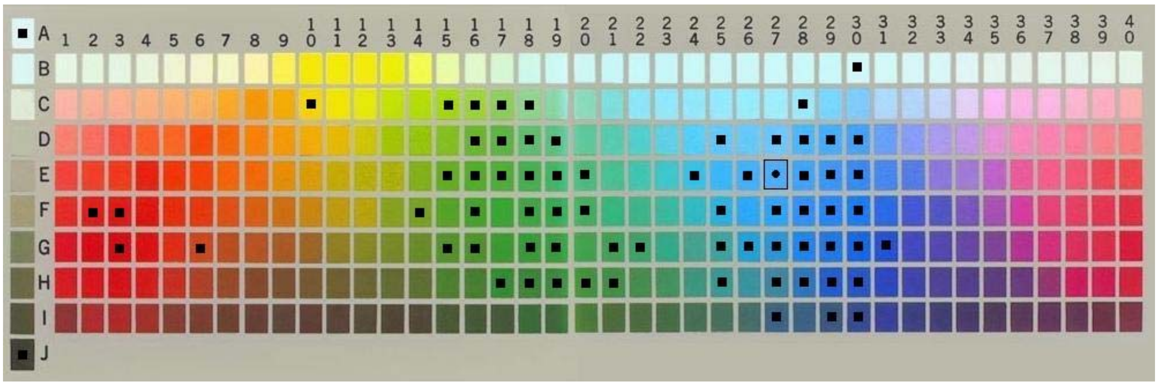


**Figure 4.2 - Kriol diversity minima**

Figure 4.2 displays minimum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index less than 0.4, constituting 70 out of the 330 colour chips. There is clustering of these points in the Green-Yellow / Green and Blue-Green / Blue / Blue-Purple hue bands on the World Colour Survey Munsell chart of Figure 4.2. Lesser clustering is also apparent in the Red hue band. The colour chip with the lowest diversity index in the selection above is E27. (Comparing this to the Sturges and Whitfield colour foci chart featured in Figure 4.1, the closest English focal colour to this chip is F29 this being prototypical 'blue.' As can be seen from Figure 4.2 above, F29 is a also a member of the cluster of low diversity points found in the Blue-Green / Blue / Blue-Purple hue bands).

Table 4.3 explicitly displays all the Brillouin minimum diversity index values shown in Figure 4.2 but this time as associated with the Kriol colour term codes as shown in Table 4.2 above. Only one World Colour Survey colour chip (E27 in Figure 4.2) had a diversity index of zero for the Kriol cohort. This was named with the Kriol colour term *grin* (represented in Table 4.2 by the World Colour Survey code G or by its English equivalent of *green*). All 25 subjects were unanimous in using the same word for this categorization so the diversity index was zero in this unique case. The hypothesis governing the research in this thesis states that if the diversity index is at a minimum for a colour chip then the name designating that would be a prime candidate for a focal colour of that language group and by implication also a basic colour term. However, since only one World Colour Survey colour chip obtained a Brillouin diversity index value of zero it would be imprudent to absolutely state that *grin* is a basic colour term for Kriol based on this limited dataset.

What can be seen from Table 4.3 is that Kriol codes G and BL have garnered the highest sum total frequencies for diversity index values that are less than 0.4. Kriol code G (*grin* or English equivalent *green*) has a sum total of 31, while BL (*blu* or English equivalent *blue*) has a sum total of 30. Based on the analysis of the World Colour Survey data it would seem that *green*, *blue*, *red*, *black*, *white*, *brown* and *yellow* were salient colours to the Kriol speakers in this cohort. No further judgement can be made as to whether any of these are basic colour terms based on this analysis given the small sample size and levels of diversity observed in their naming.

**Table 4.3 - Brillouin minimum diversity values for Kriol**

| **Brillouin diversity index** | **Frequency per recorded Kriol code** | | | | | | |
|---|---|---|---|---|---|---|---|
| ***(minimum values < 0.4)*** | **B** | **BL** | **BR** | **G** | **R** | **Y** | **W** |
| 0 | | | | 1 | | | |
| 0.128755 | 1 | 10 | | 4 | 1 | | |
| 0.228151 | | 2 | | | | | 1 |
| 0.255877 | | 10 | 1 | 16 | 1 | | |
| 0.309627 | | 1 | | | | | |
| 0.353571 | 1 | 4 | | 3 | 1 | | |
| 0.377816 | | | | | | | 1 |
| 0.381297 | | 3 | | 7 | | 1 | |

E27 in Figure 4.2 is the World Colour Survey colour chip with the minimum diversity in the Kriol cohort and this is more accurately specified by its coordinates in the Munsell system, which are:

7.5B 6.0/8

The colour chip is three-quarters of the way across in the blue hue band, with a value (i.e. brightness) of 6.0 out a possible 9.5 and a chroma (i.e. saturation) of 8 out of a possible 16. This can be translated into something with a more colloquial English meaning using the terminology from the ISCC-NBS colour name designation scheme (Kelly and Judd, 1976). Using this nomenclature the Munsell coordinate above is represented as: *brilliant greenish blue*.

Based on the available World Colour Survey data at the time, Hargrave(1982) noted the Kriol vernacular terms used by subjects in colour naming as well as their corresponding English glosses (i.e. equivalent terms). This is represented in Table 4.4, along with the number of Kriol subjects who used the colloquial term 5 or more times according to Hargrave (1982), who only featured those terms used by over half of the participants.

**Table 4.4 - Kriol colour terms from World Colour Survey study (Hargrave, 1982)**

| Kriol vernacular colour term | English gloss | No. of subjects who used Kriol term 5+ times |
|---|---|---|
| *red* | red | 24 |
| *blu* | blue | 24 |
| *grin* | green | 24 |
| *blek* | black | 23 |
| *yela* | yellow | 23 |
| *wait* | white | 22 |
| *bran* | brown | 22 |
| *pingk* | pink | 21 |
| *pepul* | purple | 21 |
| *orinj* | orange | 17 |
| *grei* | grey | 16 |

In her discussion of the Kriol component of the World Colour Survey results, Hargrave (1982) remarked that the data at the time signified that a process of cultural and linguistic flux was in place. It was apparent that there was a gradual incorporation of English colour terms into the Kriol lexicon but no evidence pointed towards a distinction between basic and non-basic colour terms. The full set of eleven BCTs was used by seven of the Kriol subjects, while eight participants used all except one. Hargrave (1982) speculated that future computer-based analyses of the World Colour Survey data could reveal significant variation between Kriol and English with respect to the extension of the eleven basic colour terms. An example of this is the case where *grin* in Kriol could extend as a label to hues that the majority of English speakers would designate as 'blue,' or the converse could apply.

### 4.3.4 Kriol World Colour Survey Data - Diversity Maxima

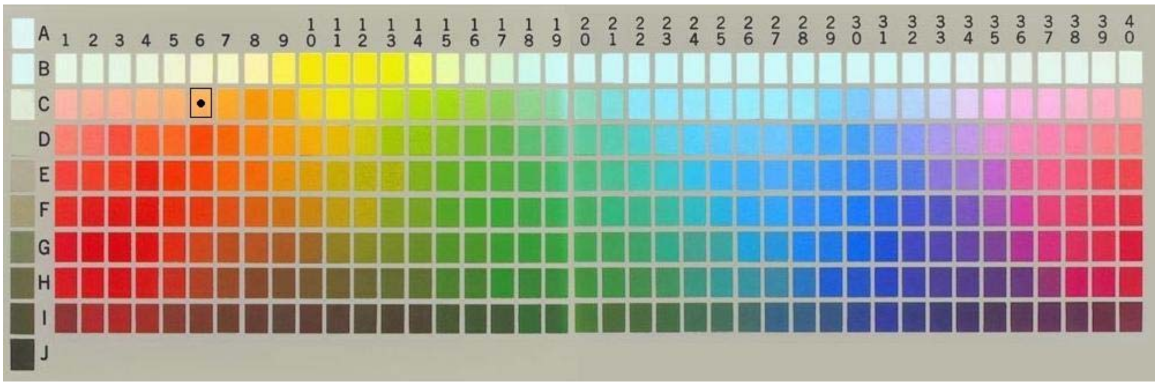


**Figure 4.3 - Kriol diversity maxima**

Figure 4.3 displays maximum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index greater than 1.6, constituting only 1 out of the 330 colour chips. The World Colour Survey colour chip with the maximum diversity value in the Kriol group is C26 in Figure 4.3. Its coordinates in the Munsell system are:

5YR 8.0/6

This colour chip is positioned midway in the yellow-red hue band, with a value (i.e. brightness) of 8.0 out a possible 9.5 and a chroma (i.e. saturation) of 6 out of a possible 16. If this is translated into its ISCC-NBS colour name designation, the result is the somewhat conflicted: *light yellowish pink / moderate yellowish pink / light orange*.

The reason for this constellation of names is that the colour chip under consideration falls at the nexus of three designations in the ISCC-NBS naming regime. This observation sheds some light as to why the Kriol subjects may have found colour chip C26 confusing to name.

### 4.3.5 Kriol World Colour Survey Data - Commentary

In the independent analysis of the World Colour Survey Kriol data for this thesis, a further contradiction was observed as it was found that 15 different term abbreviations were used, as well as one indeterminate (i.e. listed by an asterisk instead of a two-letter code.)According to the Kriol World Colour Survey dictionary file featured in Table 4.2, though, at least 27 different colour terms must have been observed to exist by the field-worker who collected the Kriol data. However, if one of these was deemed to be vague enough to only be denoted by an asterisk rather than a code designation, it raises the question of whether some of the others considered valid enough to warrant a code could also be the product of miscommunication. The duplication of a World Colour Survey code in Table 4.2 also challenges the integrity of the data sample.

Using the analysis method in this thesis, it is interesting to note from Table 4.3 then that both *blu* (‘blue’) and *grin* (‘green’) score the greatest minimum Brillouin diversity index values in the selection of colour terms elicited from the Kriol cohort. The version of the World Colour Survey dataset used in this thesis was presumably an amended update of the data that was subjected to partial scrutiny in Hargrave (1982). Personal comments that the Kriol subjects may have made and were noted by the World Colour Survey investigators are not available for perusal in the current online version of the World Colour Survey dataset. However, Hargrave (1982, p. 216) described that a female subject aged in her mid-fifties and a native speaker of Kriol remarked that *red*, *wait* and *blek* were the most important colours, while also making the comments that “*yela* is the head colour for *grin*, *blu*, *orinj*, [and] *bran*; *red* is the head colour for *pingk*, [and] *pepul*; *wait* is the head colour for *grei*”. This response would seem rather confusing.

## *4.4 Kuku-Yalanji*

### 4.4.1 Kuku-Yalanji - Geographical and Lexical Background

According to Hargrave (1982), there were 20 subjects in the Kuku-Yalanji cohort, 9 males and 11 females ranging in age from 30 to over 70. All test participants spoke

English to some extent, but only one member of the group was fluent in the language. A number of Kuku-Yalanji informants also spoke related dialects of their languages. The subjects were part of Wujal-Wujal community situated near the Bloomfield River in the Australian state of Queensland.

Table 4.5 features Kuku-Yalanji colour terms as obtained from a 1986 published version of a Kuku-Yalanji dictionary (Hershberger and Hershberger, 1986). Only the adjectival form of Kuku-Yalanji colour terms is displayed. The compilers of the dictionary remarked that at the time of publication in 1986, there were approximately 500 to 600 speakers of the language. These resided on the coast of south-eastern Cape York in Queensland, Australia, between Cooktown and Mossman, as well as inland regions reaching Chillagoe. The dictionary was comprised of words from the northern dialects of Kuku-Nyungkul, the Rossville/Shipton Flats dialect, Kuku-Yalanji, the China Camp/Daintree dialect and the Bloomfield dialect of Kuku-Jalanji.

The variety of dialects serving as the source material for the Kuku-Yalanji dictionary indicated a significant degree of linguistic diversity in this geographic locale of Australia. One would expect that inhabitants of this area would be multilingual in these dialects, so code switching would possibly be present in communicative behaviour. This would mean that individuals could use more than one language to express a concept, for example. In such a situation it would have been difficult to assign the linguistic point of origin concerning representation of thoughts or ideas to any one particular dialect. Once again it must be noted that a limitation of any indigenous Australian dictionary is that the number of linguistic informants used in the compilation process may be extremely small. The compilers of the Kuku-Yalanji dictionary acknowledged the contributions of many Kuku-Yalanji speakers from Wujal-Wujal near the Bloomfield River, as well as the indigenous population at Jajikal in Ayton, Queensland, but they did not explicitly note the number. However they did credit six major contributors by name.)

**Table 4.5 - Colour terms from a Kuku-Yalanji dictionary (Hershberger and Hershberger, 1986)**

| English | Kuku-Yalanji |
|---|---|
| black | ngumbu |
| green | kalki / kayal |
| red | jurrbil / marun-marun / mula-mula |
| white | bingaji |

As alluded to in the Hershbergers' dictionary, Table 4.5 only features Kuku-Yalanji colour terms, but there was an additional word included from the Kuku-Nyungkul dialect, *ngala-ngala*, this being the equivalent to the English term 'red.' The term *marun-marun* translates to the English 'bright red colour,' whereas *jurrbil* glosses to 'reddish colour.' (The diversity of terms for 'red' as observed in this dictionary could be a hint that this hue is of cultural significance to the Kuku-Yalanji.) The Kuku-Yalanji terms *kalki* and *kayal* may gloss to the English 'green' but according to the dictionary translation details it would appear that they refer more to things that are 'unripe' or 'raw.'

According to the Basic Colour Term theory of Berlin and Kay (1969), they would be have to be used in a more abstract sense as chromatic descriptors to be valid candidates for the status of basic colour term. The term *bingaji*, while translating to the English 'white,' also means 'light coloured.' This dual meaning could imply that the term was used as an extension for all colours deemed to be light in appearance. (Not listed in Table 4.5 is *ngungul-ngungul*, the Kuku-Yalanji equivalent to 'dark.')

### 4.4.2 Comments on the Kuku-Yalanji World Colour Survey Dictionary File

Hargrave (1982) noted that the colour terms used by Kuku-Yalanji informants five or more times in the study ranged in number between 3 and 9. This maximum elicited amount of 9 is contradicted by the World Colour Survey Kriol dictionary file displayed in Table 4.6. This contains the final version of the Kuku-Yalanji terms elicited in gathering the World Colour Survey data. The second column of the table features the field-worker's transcription of the Kuku-Yalanji colour term elicited, while the third column features the code or unique World Colour Survey term abbreviation denoting it for analysis.

**Table 4.6 - World Colour Survey Kuku-Yalanji dictionary file**

| | Elicited Kuku-Yalanji colour term | World Colour Survey Code |
|---|---|---|
| **1** | janbal | A |
| **2** | dayirr | D |
| **3** | ngumbu | G |
| **4** | bingaji | I |
| **5** | jurrbil | J |
| **6** | kayal | K |
| **7** | kulbul | L |
| **8** | ngala-ngala | N |
| **9** | burrkul | RK |
| **10** | wuba | U |
| **11** | wamumu | W |
| **12** | kabu-kabu | B |
| **13** | mirrbanka | M |
| **14** | mula-mula | O |
| **15** | kambal-kambal | Q |
| **16** | jiri | X |

Referring to the Kuku-Yalanji dictionary (Hershberger, 1986), *janbal* in Table 4.6 translates to both ‘blue quondong’ and ‘blue spotted fantail ray.’ A blue quondong is a tree found in the wet tropical regions of Queensland, Australia, and its fruit is of a deep blue colour, as depicted in Figure 4.4. It is conceivable then that some Kuku-Yalanji speakers could have used *janbal* (in its ‘blue quondong’ gloss) as a referent to things ‘blue’ in appearance.

**Figure 4.4 - The fruit of the blue quondong tree (Wet Tropics Authority, 2008)**

According to the Australian Museum Fish Site (2008), a blue-spotted fantail ray is a species of marine life that is found in shallow tropical waters from the central coast of Western Australia, around the tropical north of Australia, and south to the northern coast of New South Wales. This ray is distinguished by its orange colour and the vivid blue spots on its upper surface and is depicted in Figure 4.5. It is also plausible that some Kuku-Yalanji speakers could have used *janbal* (in its ‘blue-spotted fantail ray’ gloss) as a referent to things ‘blue’ in appearance. Since it is a word that refers to a living thing and not an abstraction, *janbal* would certainly not be a candidate for a basic colour term according to the theory of Berlin and Kay outlined in the literature survey.

**Figure 4.5 - Blue-spotted fantail ray (*Taeniura lymma*)**
**(Australian Museum Fish Site, 2008)**

In Table 4.6, the term *mirrbanka* is probably a miswritten version of *mirrbangku* (Hershberger and Hershberger, 1986). The Kuku-Yalanji word *mirrbangku* translates to 'pencil cedar.' According to the website of the Kumbartcho Sanctuary in Queensland, Australia (Kumbartcho Sanctuary, 2008), a pencil cedar is a tree that grows to about 20 metres in height and bears 'blue/purple' fruit in winter months. The natural habitat of this tree is sub-tropical rainforests. It is again likely that some Kuku-Yalanji speakers could have used *mirrbanka / mirrbangku* (in its 'pencil cedar' gloss) as a referent to things 'blue' or 'purple' in appearance. (The fruit appears to be the salient component of the botanical entity here, given that in their translation of *mirrbangku* Hershberger and Hershberger (1986) make the comment that the fruit of the pencil cedar is the shape of a date and very sweet.)

In Table 4.6, adopting the interpretations of Hershberger and Hershberger (1986), *dayirr* translated to the English 'clean,' 'clear,' or 'bright,' while *burrkul* is its counterpart, namely 'not clear,' 'not clean,' 'murky,' 'dirty,' or 'dusty.' This suggests that the informants from whom these were elicited may have confused the concept of surface colour with texture. The term *kulbul* can be interpreted as 'ripe.' Once again this could be a reference to surface texture coupled with hue if the colour chip being named was perhaps likened to the appearance of unspecified ripe fruit.

The word *wuba* in Table 4.6 translated to 'red ochre.' Red and yellow ochres are pigments that have generally been used to create rock art, cave paintings and bodily adornment for indigenous ceremonies in a variety of cultures across the world since prehistoric times. They are concocted from naturally occurring tinted clays and their red variety has been singled out to be of particular significance in human evolution due to the possible biological foundations of its salience to human beings (Wreschner, 1980). The Kuku-Yalanji people have used ochre as a natural pigment in bark painting, so a familiarity with colour in the aesthetic sense is part of their culture (Erbacher, 1991).

Erbacher (1991), in fact, described the various colours that manifest themselves in ochre: 'red', 'orange', 'yellow', 'brown', 'purple' and 'pink', with 'black' being a rare find. Charcoal mixed with clay was used for black pigments. These clays could also be stained with a variety of vegetable dyes or even blood in the process of crafting indigenous art. Apart from *wuba*, the Hershberger's Kuku-Yalanji dictionary (Hershberger, 1986) had another term for 'red ochre,' namely *murbuy*. Also, the term *makarra* referred to 'streaky yellow ochre,' while *makirr* translated to 'yellow ochre.' Yet there was no appearance of either of these terms in the World Colour Survey Kuku-Yalanji dictionary file displayed in Table 4.6, nor was there any word that translated to 'yellow' as an abstract quality.

The term *kabu-kabu* in Table 4.6 is most likely a misrepresentation of *kabu* which translates to 'rotten, bad or rotten smell,' according to Hershberger and Hershberger (1986). The insinuation here is that whoever used this term for colour naming probably was equating the look of a particular stimulus chip to the surface appearance of some form of decaying organic matter. The inclusion of the term *kambal-kambal* in the World Colour Survey Kuku-Yalanji dictionary file featured in Table 4.6 also suggests another case where an informant probably sought to a liken the surface appearance of a colour chip by name to a physical object with a similar textural and chromatic façade. According to Hershberger (1986), *kambal-kambal* translated to 'mud.' The Kuku-Yalanji term *jiri* meant 'sky' or 'heaven' (Hershberger and Hershberger, 1986). Given the absence of an equivalent term for 'blue' in the Kuku-Yalanji dictionary file displayed in Table 4.6, it is possible that *jiri* may have been used by some speakers to describe colours comparable to the blue tint of the sky. The term *wamumu* in Table 4.6 was not found in Hershberger and Hershberger (1986).

Apart from Hershberger and Hershberger (1986) there was only one other published Kuku-Yalanji dictionary, namely Oates (1992). The latter was derived from three primary sources: Hershberger and Hershberger (1986), a limited Gugu-Yalanji vocabulary culled from Oates and Oates (1964) and two hand-written word lists assembled by a Kuku-Yalanji speaker named Norman Baird. There were some differences between Oates (1992) and Hershberger and Hershberger (1986) with respect to colour-related terms that were listed, with the former dictionary having a dedicated, though modest, section for these. Most notably Oates (1992) featured the term *minin-minin* which translated to 'coloured.' This is surprising, since few indigenous Australian languages are believed to have a word that denotes the abstract concept of colour (Dixon, 1980). Hershberger and Hershberger (1986) featured a term which had a similar morphology, namely *mini-mini* and this translated to 'beautiful,' 'nice' or 'pretty.' It is conceivable that *minin-minin* from Oates (1992) was an updated, more specific interpretation of what was thought to be the term *mini-mini* given that both words relate to qualities of appearance.

Apart from *bingaji*, Oates (1992) also had *waki* as being a Kuku-Yalanj term meaning 'white' or 'light-coloured.' The term *mula-mula* translated to 'colour of blood' as well as 'red colour.' Oates (1992) also listed *ngala-ngala* as being used in Kuku-Yalanji to denote a 'mixed colour' that resembles orange and is created by mixing together white and red ochre as well as charcoal. This was listed in Hershberger and Hershberger (1986) as being a Kuku-Nyungkul word meaning 'red.' It was probable that *ngala-ngala* was used by Kuku-Yalanji speakers in some quarters as a loanword. It is interesting to note that the Oates (1992) section on colour-related Kuku-Yalanji terms also contained a descriptor that denoted qualities of surface texture, namely wurri-*wurri* which also appeared in Hershberger and Hershberger (1986). This word has the meaning 'spotted,' 'striped' or 'speckled.' Oates (1992) underscored this usage by the inclusion in the text of a drawing of a lizard with some of these characteristics and *wurri-wurri* serving as a caption to the rendering. Implicit here is the perceived notion that indigenous Australians have an interchangeable attitude to colour and texture.

### 4.4.3 Kuku-Yalanji World Colour Survey Data - Diversity Minima

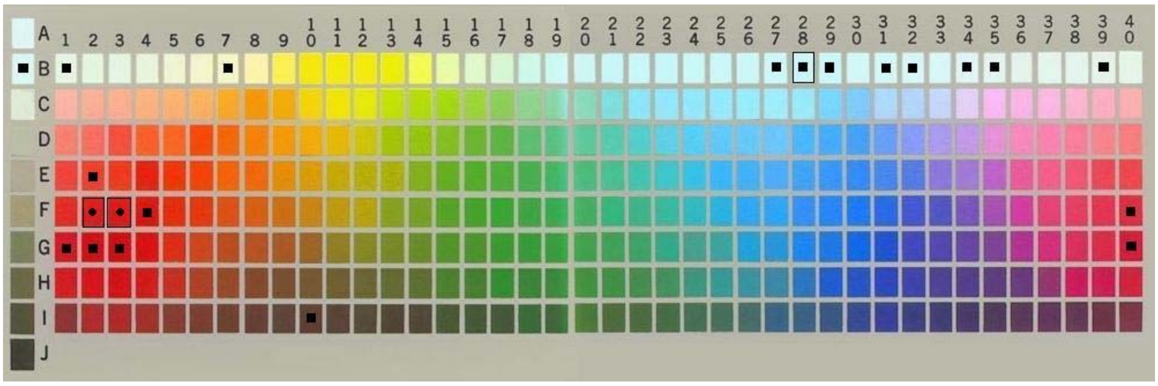


**Figure 4.6 - Kuku-Yalanji diversity minima**

Figure 4.6 displays minimum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index less than 0.4, constituting 21 out of the 330 colour chips. Minor clustering of these points is evident in the Red hue band of the World Colour Survey Munsell chart in Figure 4.6. There also appears to be an aggregation of points in the row of Munsell chips with coordinates that share a common high value (i.e. brightness) of 9.0 (out of 9.5). One could possibly speculate that this is a weak indicator of brightness being a salient quality in colour stimuli presented to Kuku-Yalanji subjects.

The colour chips with the equal lowest diversity index values in the selection above are B28, F2 and F3. (Comparing this to the Sturges and Whitfield colour foci chart featured in Figure 4.1, F2 and F3 are close to F4, this being the English focal colour ‘red.’ As can be seen from Figure 4.6 above, F4 is also a member of the cluster of low diversity points found in the Red hue band. The colour chip B0 in Figure 4.6 is adjacent to A0, which is the English focal colour ‘white’ in Figure 4.1. The colour chip I10 in Figure 4.6 is near H8, which is the English focal colour ‘brown’ in Figure 4.1. In addition, the diversity minima chips F40 and G40 in Figure 4.6 are in the vicinity of D39, the English focal colour ‘pink,’ and G36, the English focal colour ‘purple.’)

Table 4.7 explicitly displays all the Brillouin minimum diversity index values shown in Figure 4.6 but this time as associated with the Kuku-Yalanji colour term codes as shown in Table 4.6 above. No World Colour Survey colour chip had a diversity index of zero for the Kuku-Yalanji cohort. What can be seen from Table 4.7 is that Kuku-Yalanji codes I and N have garnered the highest sum total frequencies for diversity index values that are less than 0.4. Kuku-Yalanji code I (*bingaji* or English equivalent *white* or *light-coloured*) has a sum total of 11, while N (*ngala-ngala* or English equivalent *red*) has a sum total of 8. It is interesting to note that ngala-ngala is recognised as a Kuku-Nyungkul term rather than being part of the Kuku-Yalanji native lexicon. This could suggest the adoption of *ngala-ngala* as a loanword by Kuku-Yalanji speakers or it could be an artefact of the multilingual background of the subjects. The Kuku-Yalanji code G also makes a modest appearance in Table 4.7 and this corresponds to the term *ngumbu* (English equivalent *black*.) Based on the analysis of the World Colour Survey data it would seem that *white*, *red* and *black* are salient colours to Kuku-Yalanji speakers.

**Table 4.7 - Brillouin minimum diversity values for Kuku-Yalanji**

| **Brillouin diversity index *(minimum values < 0.4)*** | **Frequency per recorded Kuku-Yalanji code** | | |
|---|---|---|---|
| | **G** | **I** | **N** |
| 0.149787 | | 1 | 2 |
| 0.262351 | 2 | | 2 |
| 0.297009 | | 10 | 4 |

The colour chips with the lowest diversity indices for Kuku-Yalanji are B28, F2 and F3 and they can be more accurately specified by their coordinates in the Munsell colour order system. These are displayed in Table 4.8. The first column contains the World Colour Survey coordinate for the colour chip, with the second column featuring the equivalent Munsell coordinate. Column three contains the location of the chip in the relevant hue region of the World Colour Survey Munsell chart. Columns four and five contain the associated Value (i.e. brightness) and Chroma (i.e. saturation) figures respectively. The corresponding colloquial English colour name is the relevant ISCC-NBS designation as derived from Kelly and Judd (1976) and this is featured in column six of the table.

**Table 4.8 - Kuku-Yalanji: Munsell coordinates for minimum diversity World Colour Survey colour chips**

| World Colour Survey coordinate | Munsell coordinate | Hue region | Value (/9.5) | Chroma (/16) | ISCC-NBS colour name |
|---|---|---|---|---|---|
| B28 | 10B 9.0/2 | blue | 9.0 | 2 | *very pale blue* |
| F2 | 5R 5.0/14 | red | 5.0 | 14 | *vivid red* |
| F3 | 7.5R 5.0/14 | red | 5.0 | 14 | *vivid reddish orange* |

Based on the available World Colour Survey data at the time, Hargrave(1982) notes the Kuku-Yalanji vernacular terms used by subjects in colour naming as well as their corresponding English glosses (i.e. equivalent terms). This is represented in Table 4.9, along with the number of Kuku-Yalanji subjects who used the colloquial term 5 or more times according to Hargrave (1982), who only features those terms used by over half of the participants. The appearance of *bingaji*, *ngumbu* and *ngala-ngala* in Table 4.9 aligns with the finding above, using diversity index analysis, that these were most likely the salient colour terms for the Kuku-Yalanji cohort. It is not possible to ascertain whether these are candidates for basic colour term status given the small sample size involved and the high diversity observed in naming behaviour. However, the list in Hargrave (1982) had these three terms being used by all members of the cohort, whereas the current diversity index analysis indicates that such uniform consensus does not exist in the extant data.

**Table 4.9 - Kuku-Yalanji colour terms from World Colour Survey study (Hargrave, 1982)**

| Kuku-Yalanji vernacular colour term | English gloss | No. of subjects who used Kriol term 5+ times |
|---|---|---|
| *bingaji* | white or light | 20 |
| *ngumbu* | black or dark | 20 |
| *ngala-ngala* | red | 20 |
| *burrkul* | dirty or nondescript | 14 |
| *kayal* | green or unripe | 11 |

### 4.4.4 Kuku-Yalanji World Colour Survey Data - Diversity Maxima

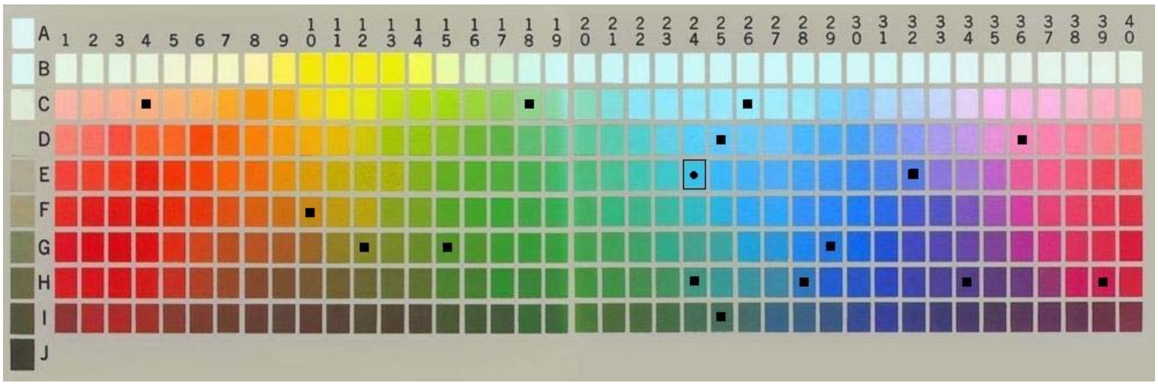


**Figure 4.7 - Kuku-Yalanji diversity maxima**

Figure 4.7 displays maximum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index greater than 1.6, constituting 16 out of the 330 colour chips. The World Colour Survey colour chip with the maximum diversity value in the Kuku-Yalanji group is E24 in Figure 4.7. Its coordinates in the Munsell system are:

10BG 6.0/8

This colour chip is positioned at the edge of the blue-green hue band, with a value (i.e. brightness) of 6.0 out a possible 9.5 and a chroma (i.e. saturation) of 8 out of a possible 16. If this is translated into its ISCC-NBS colour name designation, the result is: *brilliant bluish green*

Since it is conjectured in this thesis that high diversity in colour naming equates with an elevated level of confusion in the act, one can speculate that this may in part be due to the composite nature of the hue and the fact that both ‘blue’ and ‘green’ would have particular environmental significance to Kuku-Yalanji speakers. Hence a colour chip stimulus that is a blend of the two hues would probably elicit some degree of uncertainty amongst these subjects.

### 4.4.5 Kuku-Yalanji World Colour Survey Data - Commentary

Based on the preliminary analysis of the World Colour Survey data at the time, Hargrave (1982) concluded that Kuku-Yalanji speakers probably have three basic colour terms in their lexicon. This number would place them in Stage II of the Berlin and Kay (1969) colour term evolution sequence, whereby three categories exists namely 'white-light,' 'black-coal' and 'red-warm.' Hargrave goes on to delineate the latter two as 'macro-black' and 'macro-white,' (i.e. anything dark in appearance could fall under the former class whereas things that look the opposite could most likely be in the latter category.)

Two women in the Kuku-Yalanji cohort used only three colour terms in naming all the World Colour Survey chips, according to Hargrave (1982). These terms equated with 'white,' 'black' and 'red.' One of these female respondents, who was in her early thirties at the time, replied with the Kuku-Yalanji equivalent for 'none' whenever a stimulus chip was displayed that did not fall within the narrow range of the aforementioned three terms. The latter subject was the only one within the cohort noted as being fluent in English and Hargrave (1982) writes that the World Colour Survey investigators believed that she was too 'sophisticated' to offer a designation for a colour if there was no evident name for it. The World Colour Survey investigators for the Kuku-Yalanji cohort were Hank and Ruth Hershberger, the compilers of an early dictionary of the language (Hershberger and Hershberger, 1986).

Hargrave (1982) also notes the World Colour Survey investigators observed that several Kuku-Yalanji informants chose to name colour chips as being light or dark in comparison with the physical frame surrounding the chip itself or in contrast with the previously displayed chip. As noted in Table 4.9, the World Colour Survey investigators remarked that *bingaji* and *ngumbu* had interchangeable meanings: They were respectively being used to denote 'light' and 'dark' as well as 'white' and 'black.' As was noted earlier in this thesis, the diversity analysis of the Kuku-Yalanji World Colour Survey data hinted at brightness being a particularly salient quality in colour naming behaviour for this language group.

Hargrave (1982) pointed out that this finding of a dominant light vs. dark dichotomy in colour categorization is analogous to that of Jones and Meehan (1978), who concluded that Anbarra speakers (residing in the north-central region of Arnhem Land in Australia's Northern Territory) possessed only two colour terms that represented light and dark. There were four other colour-related terms used in Anbarra but these were names for mineral pigments and were limited in how they could be assigned in a descriptive fashion to objects. In other words, their capacity for abstraction was constrained. Similarly, Davis (1982) observed that Yolngu children at Milingimbi (also located in Arnhem Land) initially classified all colours as either *watharr* ('light') or *mol* ('dark'). As they matured, however, extra terms emerged, probably due to experiential learning, which served to complement the vocabulary of the aging speakers, thus refining the process of colour categorization by differentiation based on hue and saturation in addition to brightness.

The term *burrkul* appears in Table 4.9 with the English translations 'dirty' and 'nondescript.' Hargrave (1982) noted that the World Colour Survey investigators interpreted the latter extended meaning because some Kuku-Yalanji speakers were found to use the word as a wildcard to classify any colour chip that did not fit into the indigenous 'black,' 'white' or 'red' categories. The prediction was offered by Hargrave (1982) that the remaining word featured in Table 4.9, *kayal*, could be a future candidate for basic colour term status, either denoting 'green' or 'blue-green' (a.k.a. 'grue'), the latter being the case if Kuku-Yalanji conforms to the Berlin and Kay (1969) sequence of colour term evolution. The diversity index analysis of the current version of the Kuku-Yalanji World Colour Survey dataset does not support the forecast outlined in Hargrave (1982). As noted above the colour chip with the maximum diversity in naming amongst the Kuku-Yalanji speakers was found to be that which is designated by the English 'brilliant bluish green.' If diversity in naming is aligned with the level of confusion in identifying a colour, then, based on the existing World Colour Survey dataset, there appears to be minimal salience of 'blue-green' (a.k.a. 'grue') amongst the participants of the study.

It is also worth noting that in the Kuku-Yalanji dictionary assembled by Oates(1992) there appear excerpts from the word-list of indigenous speaker Norman Baird that highlight terms not recognised by contemporary speakers of the language. Included amongst the words fallen into disuse is *kayal*, which in Baird's earlier period of lexicographic observation, not specified by Oates (1992), was apparently used to denote 'green.' So, *kayal* as 'green' in Baird's time could have evolved to *kayal* as 'unripe' in the era of the World Colour Survey. Hargrave (1982) described that the World Colour Survey investigators noted that a number of informants seemed to mentally compare certain colour chips to either a fruit or a leaf in outward appearance and in so doing used the words *kayal* ('unripe') as well as *kulbul* ('ripe') to label various colours. In a closing remark on the Kuku-Yalanji, Hargrave (1982) did consider it to be noteworthy that the nine out of eleven subjects who used *kayal* chose to position it as being focused either in or bordering on the Berlin and Kay (1969) green focal area of the World Colour Survey colour chart when undertaking the focal colour mapping component of the study (which is not under explicit consideration in this thesis.)

In undertaking the diversity analysis of Kuku-Yalanji World Colour Survey naming data for this thesis it was found that no minima exist within the general vicinity of the focus point for 'green' as determined by Sturges and Whitfield (1995), on the other hand diversity maxima were observed in the 'green' focal area. Comparison with the Sturges and Whitfield (1995) focal colours is intended as a guide and it must be remembered that their findings applied to speakers of the English language. With regards to the latter, and referring to Figure 4.7, these were colour chips C18 (ISCC-NBS colour name designation of *very light green*), E24 (ISCC-NBS colour name designation of *brilliant bluish green*), G15 (ISCC-NBS colour name designation of *deep yellow green*) and H24 (ISCC-NBS colour name designation of *dark bluish green*). The high diversity index values recorded by these colour chips in the naming exercises suggests that a significant level of confusion existed in their categorization by informants. Based on the diversity analysis of the existing World Colour Survey colour naming exercise dataset there appears to be a poor level of agreement as to what should be a focal point for 'green' in Kuku-Yalanji.

There is also evidence that parallel forms of linguistic communication exist for the Kuku-Yalanji other than their native tongue, namely sign language and *biwul* (or 'Mother-in-law' language) (Erbacher, 1991). Sign language emerged as a communication tool to span a distance or to act as an alternate form of interaction when taboos existed on speech between certain parties. The silent mode of contact afforded by sign language was useful in hunting excursions as well as in situations where quietness and secrecy was at a premium. The 'mother-in-law' language *biwul* was used by males to communicate issues of spiritual significance and tribal lore with a mother-in-law. Given these ancillary dialects within Kuku-Yalanji culture, the relevant question concerning the research here is: *What, if any, are the unique colour terms of Kuku-Yalanji sign language and their extra 'mother-in-law' language?* Presumably the existing World Colour Survey data set for the Kuku-Yalanji focused on terms elicited from their standard language but it was not clear whether the investigators entertained all possibilities for colour terms, including those from supplementary idioms such as those mentioned.

## *4.5 Martu Wangka*

### 4.5.1 Martu Wangka - Geographical and Lexical Background

According to Hargrave (1982), there were 25 subjects in the Martu Wangka cohort, 12 males and 13 females ranging in age from 19 to over 70. Two very similar dialects belong to Martu Wangka, these being 'Mantjiltjarra' (spoken by 17 informants) and Kartujarra (spoken by 8 subjects). English was spoken by 17 of the informants to a minor degree and there was a smattering of other (unspecified) indigenous languages also used by some subjects. The Wangka Maya Pilbara Aboriginal Language Centre website (2008) referred to Martu Wangka as an indigenous Creole which fused parts of the 'Manyjilyjarra' and Kartujarra languages with components from the Warnman, Nyiyaparli and Putijarra languages. 'Manyjilyjarra' in the present sense is a refinement of the spelling of 'Mantjiltjarra' shown in Hargrave (1982). The bottom line was that these informants were multilingual and not monolingual as ideally required.

The Martu Wangka subjects were located at Jigalong in the Pilbara region of central Western Australia. Jigalong is an isolated community that abuts the geographic region known as the Western Desert of Australia (Tonkinson, 1978), positioned as it is on the western edge of the Gibson Desert. The 2006 Australian Census recorded the total population at Jigalong as being 278, of which 91.4% were indigenous persons (Australian Bureau of Statistics, 2008). This stands out in comparison with the figure of 2.3%, the percentage of indigenous persons in Australia at large in 2006. Table 4.10

features Martu Wangka colour terms obtained from a Martu Wangka-English dictionary compiled by Marsh (1992). The words under consideration here are all classed as being nominals meaning that they share features with nouns and adjectives. (A limitation of any indigenous Australian dictionary is that the number of linguistic informants used in the compilation process may be extremely small and is usually not indicated in these publications.) Incidentally, the word *miji*, according to Marsh (1992), translates to 'blood,' so the appearance of *miji-miji* as 'red' seems to highlight the prominence of this hue.

**Table 4.10 - Colour terms from a Martu Wangka dictionary (Marsh, 1992)**

| English | Martu Wangka |
|---|---|
| black | maru-maru / mungapuru |
| green | yukuri-yukuri |
| red | miji-miji |
| white | ngintarlpa /nyumpurlpa /piirl-piirlpa |

There are three Martu Wangka terms that mean 'white' in Marsh (1992). The word *piirl-piirlpa* denotes both 'white' and 'white soil' from a claypan. The latter is a naturally occurring cavity in the landscape made up of clay-like soil that retains water after rain. The word *nyumpurlpa* refers to the 'white (of gum trees)', while *ngintarlpa* translates to 'white (of a dog).' Thus all of these Martu Wangka words for 'white' have polymorphic meanings and do not have a single abstract interpretation of the hue, so in the strictest sense they should not be considered as basic colour terms in the Berlin and Kay (1969) style. Both *maru-maru* and *mungapuru* translate to 'black,' however the former term also has the meaning 'dark-coloured.'

The term *yukuri-yukuri* denotes 'green,' but *yukuri* translates as 'green grass.' The similarity between the two suggests that difficulties could arise from interpretation of vocal responses in determining whether the abstract or the object referent was being elicited by a colour stimulus. Also, the term *yukuri* has a similar meaning in Pintupi/Lurtija dialects spoken in the Western Desert (Hansen and Hansen, 1992). Marsh (1992) features two words *jurnpaly-jurnpalypa* and *kurtirl-kurtirlpa* which translate as 'colour term.' The former has the additional meaning of 'ash colour,' while the latter has the supplementary connotation of ‘black and white (of a dog).’ Thus *kurtirl-kurtirlpa* appears to be a colour descriptor that also takes into consideration surface patterning.

### 4.5.2 Comments on the Martu Wangka World Colour Survey Dictionary File

Hargrave (1982) notes that the colour terms used by Martu Wangka informants ranged from 2 to 12. This maximum elicited amount of 12 is contradicted by the World Colour Survey Martu Wangka dictionary file displayed in Table 4.11. This contains the final version of the Martu Wangka terms elicited in gathering the World Colour Survey data. The second column of the table features the field-worker’s transcription of the Martu Wangka colour term elicited, while the third column features the code or unique World Colour Survey term abbreviation denoting it for analysis. The Marsh (1992) colour terms displayed in Table 4.10 are all present in the dictionary file except for *nyumpurlpa*, one of the synonyms for ‘white.’ The word *piila-piila* in the dictionary file is most likely a misinterpretation of the other Martu Wangka alternate for ‘white,’ namely *piirl-piirlpa*.

The World Colour Survey Martu Wangka dictionary file contains terms which are not directly related to colour designations. According to Marsh (1992), the word *kalyu* has the meaning ‘water’ or ‘rain,’ but it is also noted that the use of it has been observed to denote the colour ‘light blue.’ This would not be a candidate for basic colour term status in the Berlin and Kay (1969) sense given that the word does not have a single abstract interpretation for the hue in question. As mentioned earlier, ochre plays an important ceremonial role in indigenous culture, so it is no surprise that the chromatic aspects of this mineral would serve to make words describing it more salient.

The term *karrku* in Table 4.11 translates to ‘red ochre,’ while *wira* has the meaning ‘white clay,’ another example of a natural pigment used in indigenous art. It is worth noting here that wira is also listed as being a Putijarra term that means both ‘white ochre’ and ‘yellow ochre’ (Wangka Maya Pilbara Aboriginal Language Centre, 2004). The latter is an indigenous dialect that has contributed to the content of Martu Wangka as a language. Marsh (1992) includes the synonyms *julkarrpa* and *pujurrpa*, which most likely are what the terms *juurlkarr* and *pujurr* in Table 4.11 should be and the misspelling is probably due to a transcription error in the processing of the World Colour Survey data.

In a similar vein, *munyjulpa* from Table 4.11 is probably a misinterpretation of *munyjulypa*, meaning ‘cooked’ or ‘done (as meat that has been cooked)’ or ‘ripe (as fruit)’ (Marsh, 1992). Once again this highlights the perceptual significance of texture as well as colour. Since both encompass issues of brightness, the terms *karrpu* (‘daytime’) and *karrpuminyarri* (‘really bright’) in Marsh (1992) would seem to bear a glancing similarity to *karrpu-wati* in Table 4.11. Also there is the word *karlka-karlka* which has an affinity to *karlka-karlkakaja* from Marsh (1992), meaning ‘big stones.’ The latter signifies a probable referent to the texture and colour of such geological formations, the word of which has possibly been subject to an error in transcription once again.

Environmental influences in colour naming behaviour are also evident with the inclusion in the World Colour Survey dictionary file of the terms *langa* (meaning ‘ground’ or ‘earth’), *warla* (meaning ‘lake’ or ‘large claypan’) and *ngarnka* (meaning ‘sky’), with all definitions being obtained once again from Marsh (1992). In a similar vein, the term *pana* in the World Colour Survey dictionary file is most likely the word *parna*, which means ‘ground,’ ‘earth,’ ‘dust,’ ‘sand’ or ‘country’ (Marsh, 1992). Hargrave (1982) notes that *parnaly-parnaly* is effectively a synonym for this term. From the point of view of natural ambience, the World Colour Survey dictionary file contains *puwalypa* (‘dull (not much light)’ or ‘dim (not much light)’) and *ruka-ruka* (‘evening/very late afternoon’). It may be that the Martu Wangka informants who used these to denote colour chips were adopting them as similes to describe a referent that had no obvious label in their own personal vocabulary.

Apart from such spurious entries ‘unknown’ and ‘unclear,’ the contents of the World Colour Survey Martu Wangka dictionary file featured in Table 4.11 were cross-checked with Marsh (1992) and it was found that several terms did not appear in the latter print dictionary of the language. These 33 anomalous Martu Wangka colour terms are listed in Table 4.12. Given that 63% of the terms in the World Colour Survey Martu Wangka dictionary file cannot be corroborated against entries from Marsh (1992) an explanation for these incongruous words must be sought. Jim and Marjorie Marsh were the World Colour Survey investigators for the Martu Wangka cohort, according to Hargrave (1982). Since the former was also the compiler of the Martu Wangka print dictionary referenced here (Marsh, 1992) one would hope to detect a minimum level of discrepancies in the World Colour Survey dictionary file.

Some of the anomalies in the World Colour Survey dictionary file could be due to residual transcription errors from the original data collected from Martu Wangka informants. For example, Marsh (1992) includes a term *juraly-juraly*, meaning ‘plant.’ (Seeds from this indigenous plant are edible after being ground and cooked in ashes. The colour of a stimulus chip could have been compared by an informant to the surface colour of this plant.) This term is close in form to the anomalous entry *jurnpaly-jurnpaly* in Table 4.12. Similarly, the anomalous term *munga-turrkatingu* from Table 4.12 could be a confused interpretation of a word related to *munga*. The term *munga* in Marsh (1992) translates to ‘night’ or ‘darkness’ and there are various Martu Wangka words of analogous meaning that include this in a prefix position, such as *mungapuru* which means ‘the colour black.’ Following this line of reasoning, the anomalous term *ngarntan ngarntan* in Table 4.12 could be a misinterpretation of *ngarnta* from Marsh (1992). The latter has the meaning ‘sick’ and there are several Martu Wangka words of analogous connotation that include this in a prefix position. One conjecture is that the informant using such a term could be comparing a stimulus colour chip to the pallor of a sick individual or the hue and texture of vomit.

Marsh (1992) included the terms *puyu* (meaning ‘smoke’) and *puyulyurru* (meaning ‘hot season’ or ‘heat haze’). The anomalous term *puyurr-puyurr* in Table 4.12 could be a misinterpretation related to either of the pervious words mentioned, given that both could be deployed to vaguely describe the appearance of a colour chip stimulus. The anomalous term *piila-piila* in Table 4.12 could be a misreading of the Marsh (1992) term *piirl-piirlpa* (‘white’) in Table 4.10. In her wordlist for Manyjilyjarra (a.k.a. Mantjiltjarra), Hanson (2008a) included *wira* and *pilya* which both translate to ‘white.’ This means that the spurious term *piila-piila* in Table 4.12 could also be a flawed depiction of *pilya* given that the latter dialect was used by 17 of the Martu Wangka informants according to Hargrave (1982).

However, the "Putijarra-English Wordlist" published by the Wangka Maya Pilbara Aboriginal Language Centre (2004) featured the term *piirlpiirl* (which translated to 'white'). Yet again it is also conceivable that *piila-piila* in Table 4.12 is a misinterpretation of this word, given that Putijarra is a dialect that has permeated Martu Wangka to some extent. With this in mind, it is also worth noting that the Putijarra terms *marumaru* ('black'), *ngintarlpa* ('white') and *yurkiri* ('green') mirror Martu Wangka terms from Marsh (1992) as featured in Table 4.10 and the associated World Colour Survey Dictionary File displayed in Table 4.11. The term *maru*, meaning 'black,' also appears in the Manyjilyjarra wordlist of Hanson (2008a) whereas *maru-maru* is the Martu Wangka equivalent according to Marsh (1992) and it is also found in the World Colour Survey Martu Wangka dictionary file. Putijarra, though, has a three additional colour words in its lexicon that are not found in Martu Wangka: i) *jirlpi* ('grey'), ii) *kalji* ('yellow') and iii) *parnayiparnayi* (brown'). Marsh (1992) notes that *jirlpi* in Martu Wangka refers to 'grey hair.'

**Table 4.11 - World Colour Survey Martu Wangka dictionary file**

| | **Elicited Martu Wangka colour term** | **World Colour Survey Code** | | **Elicited Martu Wangka colour term** | **World Colour Survey Code** |
|---|---|---|---|---|---|
| **1** | jupirr-jupirr | J | **27** | mungapuru | MU |
| **2** | jurnpaly-jurnpaly | R | **28** | mungarr | MU |
| **3** | jurturr-juturr | JT | **29** | munyjulpa | B |
| **4** | juurlkarr | S | **30** | ngarnka | N |
| **5** | kalyu | KL | **31** | ngarntan ngarntan | NT |
| **6** | karawangarlpa | KG | **32** | ngintarlpa | NI |
| **7** | karlka-karlka | KX | **33** | pana | PN |
| **8** | karntawarra | K | **34** | parrjunu | PJ |
| **9** | karranjiyal | V | **35** | parnaly-parnaly | A |
| **10** | karrku | Q | **36** | piila-piila | P |
| **11** | karrpu-wati | KZ | **37** | pujurr | U |
| **12** | karrukalkalka | D | **38** | purlangkanu | L |
| **13** | kata-pawulanta | KP | **39** | puwalypa | G |
| **14** | kayarraninpa | KR | **40** | puyurr-puyurr | PY |

| | | | | | |
|---|---|---|---|---|---|
| **15** | kiyarr-kiyarr | H | **41** | rarrpa | RR |
| **16** | kuunypa | F | **42** | rarrpantarlpa | RR |
| **17** | kuwiyarlpa | Z | **43** | ruka-ruka | C |
| **18** | langa | LA | **44** | warla | WR |
| **19** | martaly-martaly | T | **45** | wira | W |
| **20** | martar | T | **46** | yukuri-yukuri | Y |
| **21** | martarr-martarr | T | **47** | yakuripiti | Y |
| **22** | martarrpilyilyi | T | **48** | yari | YA |
| **23** | maru-maru | M | **49** | yungan-yungan | O |
| **24** | miji-miji | I | **50** | unknown | WA |
| **25** | mirta-mirta | X | **52** | unclear | ZZ |
| **26** | munga-turrkatingu | MU | | | |

Nevertheless, all of the speculations that have been outlined only apply to five of the 33 anomalous terms in Table 4.12. Since Hargrave (1982) noted that the Martu Wangka cohort included multilingual speakers who had a command of a few other unspecified indigenous Australian languages, it is possible that the bulk of the anomalous terms in Table 4.12 are from these other lexicons or misinterpretations thereof. A case-in-point: The term *karntawarra* features both in the World Colour Survey dictionary file of Table 4.11 and the print dictionary of Marsh (1992). It means either 'wattle tree' or 'yellow ochre' and it also refers to a species of tree.

Marsh (1992) listed *karntawarra* with the dual translations of 'wattle tree' and 'yellow ochre' whereas Hanson (2008c) featured it with the English translation 'yellow' in her wordlist for Warnman, a Pilbara Aboriginal language whose components have infused Martu Wangka. It is also interesting to note that Hale (1995) listed *karntawarra* (with the English translation 'yellow ochre') in his *Elementary Warlpiri Dictionary*. The Warlpiri term *karntawarra karntawarra* was listed as meaning 'yellow.' The Warlpiri reside in Central Australia, north and west of Alice Springs in the Northern Territory in semi-arid locales such as Yuendumu and Lajamanu. The point here is that the traditional lands of the Warlpiri are a significant geographic distance from the Martu Wangka (or the Warnman for that matter).

The Pintupi/Luritja dialects prevalent of the Western Desert also use *karntawarra* to denote 'yellow' (Hansen and Hansen, 1992). The Walmajarri people of the Great Sandy Desert to the south of the Kimberley in Western Australia also use this word but in their dialect it translates only to 'yellow ochre' (Richards and Hudson, 1990). Given the apparent commonality of the word in this broad geographic region, the appearance of *karntawarra* in the World Colour Survey Martu Wangka dictionary file featured in Table 4.11 is yet another indication that the cohort was populated by multilingual speakers whose responses would interfere with the true determination of the set of basic colour terms for Martu Wangka.

**Table 4.12 - Anomalous Martu Wangka colour terms featured in World Colour Survey dictionary file and excluded from Marsh (1992)**

| | Anomalous Martu Wangka colour term | World Colour Survey Code | | Anomalous Martu Wangka colour term | World Colour Survey Code |
|---|---|---|---|---|---|
| **1** | jupirr-jupirr | J | **17** | mirta-mirta | X |
| **2** | jurnpaly-jurnpaly | R | **18** | munga-turrkatingu | MU |
| **3** | jurturr-juturr | JT | **19** | mungarr | MU |
| **4** | juurlkarr | S | **20** | ngarntan ngarntan | NT |
| **5** | karawangarlpa | KG | **22** | parrjunu | PJ |
| **6** | karranjiyal | V | **23** | piila-piila | P |
| **7** | karrukalkalka | D | **24** | purlangkanu | L |
| **8** | kata-pawulanta | KP | **25** | puyurr-puyurr | PY |
| **9** | kayarraninpa | KR | **26** | rarrpa | RR |
| **10** | kiyarr-kiyarr | H | **27** | rarrpantarlpa | RR |
| **11** | kuunypa | F | **28** | yakuripiti | Y |
| **12** | kuwiyarlpa | Z | **29** | yari | YA |
| **13** | martaly-martaly | T | **30** | yungan-yungan | O |
| **14** | martar | T | **31** | unknown | WA |
| **15** | martarr-martarr | T | **32** | unclear | ZZ |
| **16** | martarrpilyilyi | T | | | |

### 4.5.3 Martu Wangka World Colour Survey Data - Diversity Minima

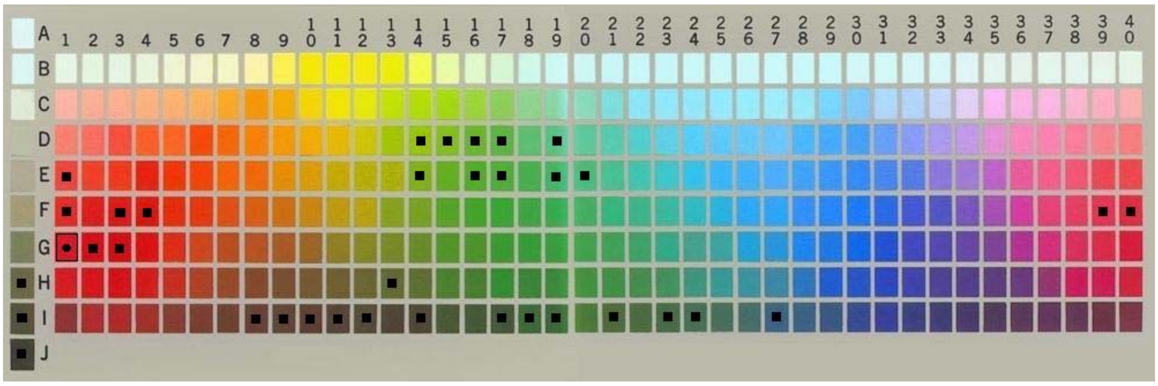


**Figure 4.8 - Martu Wangka diversity minima**

Figure 4.8 displays minimum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index less than 0.4, constituting 36 out of the 330 colour chips. Minor clustering of these points is evident in the Red hue band of the World Colour Survey Munsell Chart in Figure 4.8. Similarly, minor clustering is also present in the Green-Yellow and Green hue bands There also appears to be an aggregation of points in the row of Munsell chips with coordinates that share a common low value (i.e. brightness) of 2.0 (out of 9.5). One could possibly speculate that this is a weak indicator of dullness being a partial salient quality in colour stimuli presented to Martu Wangka subjects, perhaps a reflection of perceptual conditioning instilled by the arid terrain often encountered by the informants.

The colour chip with the lowest diversity index in the selection above in Figure 4.8 is G1. Comparing this to the Sturges and Whitfield (1995) colour foci chart featured in Figure 4.1, G1 is close to F4, this being the English focal colour ‘red.’ As can be seen from Figure 4.8 above, F4 is also a member of the cluster of low diversity points found in the Red hue band.

Table 4.13 explicitly displays all the Brillouin minimum diversity index values shown in Figure 4.8 but this time as associated with the Martu Wangka colour term codes as shown in Table 4.11 above. Only one World Colour Survey colour chip had a diversity index of zero for the Martu Wangka cohort and this was for G1.

What can be seen from Table 4.13 is that Martu Wangka codes M and Y have garnered the highest sum total frequencies for diversity index values that are less than 0.4. Martu wangka code M (*maru-maru* or English equivalent 'black') has a sum total of 17, while Y (*yakuripiti* - most likely a misnomer for *yukuri-yukuri* or English equivalent 'green') has a sum total of 12. Based on the diversity index analysis of the World Colour Survey data it would seem that 'red', 'black' and 'green' are salient colours to Martu Wangka speakers.

**Table 4.13 - Brillouin minimum diversity values for Martu Wangka**

| **Brillouin diversity index** | **Frequency per recorded Martu Wangka code** | | |
|---|---|---|---|
| ***(minimum values < 0.4)*** | **I** | **M** | **Y** |
| 0 | 1 | | |
| 0.128755 | | 3 | |
| 0.228151 | | | 2 |
| 0.255877 | 4 | 3 | |
| 0.309627 | | | 2 |
| 0.353571 | | 2 | 6 |
| 0.381297 | 4 | 9 | 2 |

G1 in Figure 4.8 is the World Colour Survey colour chip with the minimum diversity in the Martu Wangka cohort and this can be more accurately specified by its coordinates in the Munsell colour order system, which is:

2.5R 4.0/14

(The colour chip is positioned to the edge of the red hue band, with a value (i.e. brightness) of 4.0 out a possible 9.5 and a chroma (i.e. saturation) of 14 out of a possible 16.) This can be translated into something with a more colloquial English meaning using the terminology from the ISCC-NBS colour name designation scheme (Kelly and Judd, 1976). Using this nomenclature the Munsell coordinate above is represented as:

*vivid red*

Based on the available World Colour Survey data at the time, Hargrave (1982) notes the Martu Wangka vernacular terms used by subjects in colour naming as well as their corresponding English glosses (i.e. equivalent terms). This is represented in Table 4.14, along with the number of Martu Wangka subjects who used the colloquial term 5 or more times according to Hargrave (1982), who only features those terms used by over half of the participants. The appearance of *maru-maru*, *miji-miji* and *yukuri-yukuri* in the top three of Table 4.14 aligns with the finding above, using diversity index analysis, that these were most likely the salient colour terms for the Martu Wangka cohort and possible candidates for basic colour terms. However, the presence of *kartawarra* is an inconsistency given the present World Colour Survey Martu Wangka data set.

**Table 4.14 - Martu Wangka colour terms from World Colour Survey study (Hargrave, 1982)**

| Martu Wangka vernacular colour term | English gloss | No. of subjects who used Martu Wangka term 5+ times |
|---|---|---|
| *maru-maru* | black | 24 |
| *miji-miji* | red | 24 |
| *yukuri-yukuri* | green | 22 |
| *karntawarra* | yellow or yellow ochre | 16 |

### 4.5.4 Martu Wangka World Colour Survey Data - Diversity Maxima

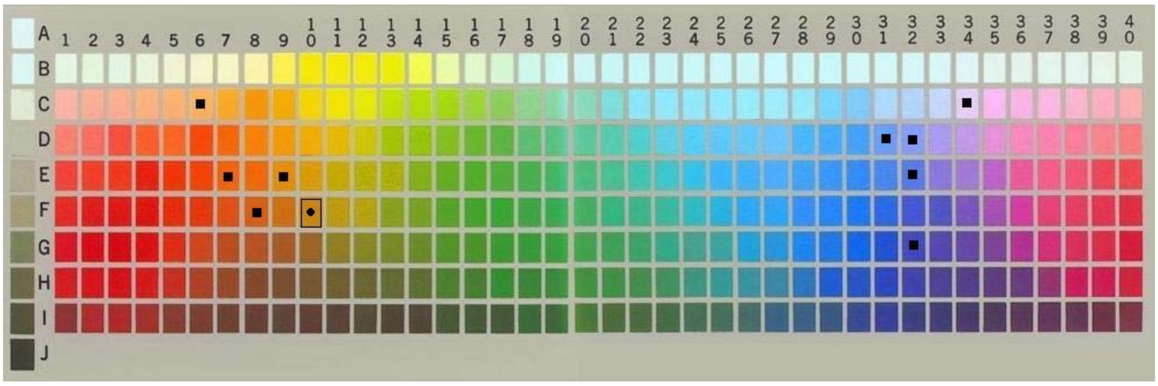


**Figure 4.9 - Martu Wangka diversity maxima**

Figure 4.9 displays maximum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index greater than 1.6, constituting 10 out of the 330 colour chips.

The World Colour Survey colour chip with the maximum diversity value in the Martu Wangka group is F10 in Figure 4.9. Its coordinates in the Munsell system are:

5Y 5.0/8

(This colour chip is positioned midway in the yellow hue band, with a value (i.e. brightness) of 5.0 out a possible 9.5 and a chroma (i.e. saturation) of 8 out of a possible 16.) If this is translated into its ISCC-NBS colour name designation, the result is:

*light olive*

In colloquial terms, the colour ‘olive’ can be considered as a dark shade of yellow (Paterson, 2004). Since it is conjectured in this thesis that high diversity in colour naming equates with an elevated level of confusion in the act, one can speculate that this may in part be due to the vague nature of the hue and the fact that ‘yellow’ would have particular environmental significance to Martu Wangka speakers given the cultural significance of ochre, which comes in this hue (i.e. *karntawarra* or ‘yellow ochre.’)

### 4.5.5 Martu Wangka World Colour Survey Data - Commentary

Based on the preliminary analysis of the World Colour Survey data at the time, Hargrave (1982) concluded that Martu Wangka speakers probably have two basic colour terms in their lexicon, these being the terms denoting ‘black’ and ‘red.’ In fact, Jim Marsh, the World Colour Survey fieldworker dealing with the Martu Wangka cohort, was mentioned in the latter as stating that this limited range of colour nomenclature was true, based on his day-to-day encounters with subjects.

Hargrave (1982) noted that one female informant aged over 60 used only Martu Wangka terms *maru-maru* and *miji-miji* (‘black’ and ‘red’) to name all of the 330 World Colour Survey colour chips. This woman, when asked by the World Colour Survey investigator to name the colour of ashes as well as the colour of a white gum tree, replied with a term of unknown meaning (*piinta*) and she considered this idiosyncratic colour of hers to be absent from all those displayed in the World Colour Survey chart. It would appear that creative naming was prominent within the Martu Wangka cohort. (Incidentally, the term *piinta* is absent from the current version of the World Colour Survey Martu Wangka dictionary file.) Hargrave (1982) cited two other Martu Wangka subjects as using only three terms to denote all the World Colour Survey colours.

The most glaring anomaly, here as borne out by the diversity analysis of the World Colour Survey Martu Wangka data set and as observed by Hargrave (1982), is the absence of a term to denote 'white.' Hargrave (1982) pointed out that this runs counter to what would be expected due to the Berlin and Kay (1969) colour encoding sequence. Following this the first terms to emerge in any lexicon should be ones that equate to the categories 'macro-black' and 'macro-white' (these being analogous to 'dark' and 'light.') Based on the World Colour Survey data set at the time, Hargrave (1982) claimed that 22 informants did in fact focus a colour term in the pure 'white' area of the World Colour Survey chart, but a variety of words were employed with five subjects using two or three terms to name this colour. Apparently, twelve different terms in all were used to denote 'white,' including *karntawarra* (which supposedly has the general meaning 'yellow ochre.') This suggests a high degree of diversity in naming 'white' for the Martu Wangka cohort but this was not evident in the analysis results displayed in Figure 4.9 (i.e. Martu Wangka diversity maxima.)

The absence of 'white' in the Martu Wangka lexicon is an anomaly. Hargrave (1982) speculated that it might be related to the fact that Martu Wangka speakers were by tradition inhabitants of a desert environment. Other Western Desert dialects such as Pintupi also fail to abstract the colour 'white' as a distinct attribute of environmental phenomena, more often having this hue being a descriptive part of a specific reference to a natural object as well, such a 'white gum tree' or a 'white stone' (Hansen and Hansen, 1992). Hargrave (1982) alluded to the possibility that desert nomads may have a greater perceptual connection to texture, which may include the surface shine possessed by objects.

For example, based on available data at the time, Hargrave (1982) noted that 12 informants used the term *parnaly-parnaly* or *parna* (meaning 'earth' amongst other similar things) to denote colour chips focused in 'brown,' 'orange' and 'pink' regions of the World Colour Survey chart. According to the Sturges and Whitfield (1995) array of focal colours (featured in Figure 4.1) these would the areas centred on chips E5 ('orange'), H8 ('brown') and D39 ('pink'). An inspection of the World Colour Survey diversity minima in Figure 4.8 indicates the presence of minor clustering in these chart regions. This is an indicator of level of agreement in naming of stimuli in these hue bands.

Independent colour naming research carried out on Anbarra speakers in Arnhem Land within Australia's Northern Territory revealed that to at least one informant the matte colours of the Munsell stimuli used in that study failed to adequately represent an idiosyncratic hue that was likened to the appearance of a piece of reflective foil used for cooking purposes (Jones and Meehan, 1978). In this case, the Anbarra term *-gungaltja* which purportedly translated to 'light, white' was clearly being employed by the indigenous subject to denote the complex interplay between surface texture and colour in an object.

With this in mind, Hargrave (1982) contends that the lack of agreement on a term for 'white' in the World Colour Survey Martu Wangka cohort could be an artefact of the colour stimuli used which would have been items alien to the culture of the informants. The ecological validity of the World Colour Survey experimental regime is questionable within the typical indigenous Australian context. Ideally, any kind of cross-cultural psychology experiment such as the World Colour Survey should seek to devise methods, materials and setting that would approximate the real-life situation that is under scrutiny. The real-life situation in the World Colour Survey is colour naming and greater consideration should have been shown to the nature of the stimuli being presented to subjects. The two-dimensional Munsell chips display surface colours only to an observer and they fail to encapsulate the three-dimensional reality of an indigenous environment.

## 4.6 Murinh-Patha

### 4.6.1 Murinh-Patha - Geographical and Lexical Background

According to Hargrave (1982), there were 25 subjects in the Murinh-Patha cohort, 10 males and 15 females ranging in age from 35 to 75. The Murinh-Patha subjects were located at the Wadeye community, formerly known as Port Keats, situated about 420 kms south-west of Darwin in Australia's Northern Territory. At present, this represents the largest indigenous Australian community in the Northern Territory, these are comprised of at least 23 tribal groups and seven language groups (Trial Sites - Wadeye, N.T., 2008). These language groups are listed as on the latter Australian Government website as being 'Murinh Patha', 'Marri Ngarr', 'Murrinh Kura', 'Murrinh Nguwan', 'Marri Tjevin', 'Mati Ke' and 'Marri Arnu'. English is uncommon amongst the indigenous populace.

The most widespread language in use at Wadeye is Murrin-Patha, however this may be the second or third dialect of several members of the population. As Hargrave (1982) noted, the World Colour Survey Murin-Patha cohort at the time consisted of speakers who were fluent to some degree in a variety of other indigenous languages (more than likely those listed above.) All the informants apparently had some knowledge of English but none were fluent.

Table 4.15 features Murinh-patha colour terms obtained from wordlists featured in Street (1987) and Walsh (1995). (The latter source lists the major language groups at Wadeye as being 'Murinh-Patha', 'Marri-Ngarr', 'Marri-Djabin', 'Magati-Ge' and 'Djamindjung'.) As noted by Hargrave (1982, the World Colour Survey investigators for the Murinh-Patha cohort were Chester and Lyn Street, the former being the author of the previously cited text.

**Table 4.15 - Colour terms derived from Street (1987) and Walsh (1995)**

| English | Murinh-Patha |
|---|---|
| black | thipmam |
| green | ngatin |
| red | bukmantharr |
| white | bamam |

The word *ngatin* is featured in Walsh (1995) but does not appear in Street (1987) and is given the additional meanings ‘raw’ and ‘uncooked,’ as well as ‘green (in colour).’ The word *thipmam* according to Walsh (1995) means ‘black,’ ‘dark’ or ‘dirty,’ whereas Street (1987) features the term *thipinhi* (‘dark’) which is absent from the latter source. Street (1987) also contains the word *parnturtparn* (‘light’) with it too not being referenced by Walsh (1995). Other Murinh-Patha words with a remote chromatic connotation include *pemarr pulu (nanthi)* (‘grey hair’ - Street, 1987) and *yulirn (nanthi)* (‘grey ashes’ - Walsh, 1995).

### 4.6.2 Comments on the Murinh-Patha World Colour Survey Dictionary File

Hargrave (1982) noted that the colour terms used by Murinh-Patha informants ranged from 3 to 10. This maximum elicited amount of 10 is contradicted by the World Colour Survey Murinh-Patha dictionary file displayed in Table 4.16. This contains the final version of the Murinh-Patha terms elicited in gathering the World Colour Survey data. The second column of the table features the field-worker’s transcription of the Murinh-Patha colour term elicited, while the third column features the code or unique World Colour Survey term abbreviation denoting it for analysis.

**Table 4.16 - World Colour Survey Murinh-Patha dictionary file**

| | Elicited Murinh-Patha colour term | World Colour Survey Code | | Elicited Murinh-Patha colour term | World Colour Survey Code |
|---|---|---|---|---|---|
| **1** | thipman | H | **18** | tumanka | T |
| **2** | thipmanka | H | **19** | tupmanka | T |
| **3** | bamam | A | **20** | ngirrwu | G |
| **4** | bamamka | A | **21** | trangka | R |
| **5** | bukamtharr | U | **22** | wuwunka | Q |
| **6** | bukmanka | U | **23** | damkalarrang | DA |
| **7** | ngatin | N | **24** | dirrmu | D |
| **8** | kabat | K | **25** | mamguguth | GU |
| **9** | wipmanarri | I | **26** | denturr | DR |
| **10** | wipmanka | I | **27** | tililtililmam | S |
| **11** | wudanil | W | **28** | yibimtamka | Y |
| **12** | wudandarriwil | W | **29** | kanthi | O |
| **13** | wudandarriwu | W | **30** | punhpush | P |
| **14** | wudanthewa | W | **31** | ngatinka | ZZ |
| **15** | wudankawu | W | **32** | wudanthewu | W |
| **16** | wudankawil | W | **33** | dewu | DW |
| **17** | wudanwuwu | W | | | |

The World Colour Survey Murinh-Patha dictionary file contains several different words that have been assigned the same World Colour Survey code. This suggests either that the terms were classed as synonyms or that it was difficult to differentiate between them due to imprecise pronunciation in the field. Another possibility is that this is another artefact of transcription errors in the World Colour Survey data. The common feature of these terms is that they do not appear in the Murinh-Patha wordlists featured in Street (1987) and Walsh (1995). One assumption is that these words are not part of the Murinh-Patha lexicon and belong to one of the other indigenous languages spoken by the informants.

The full complement of colour terms from Table 4.15 appear in the World Colour Survey Murinh-Patha dictionary file shown in Table 4.16, even though *thipmam* ('black') is spelt as *thipman*. The dictionary file in Table 4.16 also contains *ngirrwu* which Walsh (1995) includes as meaning as 'red clay.' The word *denturr* is possibly *dendurr* which Walsh (1995) lists as meaning 'hot,' this being a probable reference to 'warm' colours. Apart from these the other terms in the World Colour Survey Murinh-Patha dictionary file featured in Table 4.16 are anomalous in their inclusion.

### 4.6.3 Murinh-Patha World Colour Survey Data - Diversity Minima

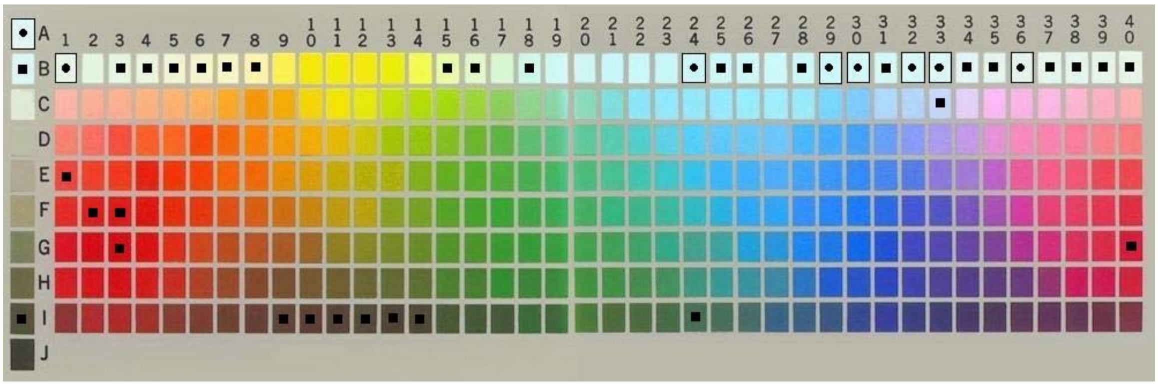


**Figure 4.10 - Murinh-Patha diversity minima**

Figure 4.10 displays minimum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index less than 0.4, constituting 42 out of the 330 colour chips. There appears to be minor clustering of these points in the Red hue band of the World Colour Survey Munsell Chart in Figure 4.10 but there is a more significant pattern of aggregation evident in the row containing colour chips that share a common high value (i.e. brightness) of 9.0 (out of 9.5).

The conjecture here is that this is a possible weak indicator of brightness being a partial salient quality in colour stimuli presented to Martu Wangka subjects, perhaps a reflection of perceptual conditioning evoked by the ambient illumination of their Torrid Zone habitat. The Torrid Zone is the geographic region of the Earth situated between the Tropic of Cancer and the Tropic of Capricorn and is signified by a hot and humid climate (Bergman and McKnight, 1993). This gives rise to the colloquial term the 'Tropics' which technically comprises all the areas on the planet where the sun arrives at a point directly overhead at least once during the solar year. Vaguely similar clustering was observed in the Kuku-Yalanji analysis but not in the examination of the Kriol data. Both of these cohorts inhabit Torrid Zone locales but the conforming nature of the English-like influences of the latter Creole dialect may play a part in downplaying the natural salience of brightness in this context.

The colour chips with equal lowest diversity indices in the selection above are A0, B1, B24, B29, B30, B32, B33 and B36. Comparing this to the Sturges and Whitfield colour foci chart in Figure 4.1, A0 is in fact the English focal colour 'white.' The clustering of low diversity points in the high value (i.e. brightness) row of Figure 4.10 is also within the vicinity of the English focal term 'yellow' (this being the point that straddles colour chips B10 and C10 in the Sturges and Whitfield (1995) chart of Figure 4.1). Similarly the minor clustering of points in the Red hue band of Figure 4.10 are near the English focal colours 'red' and 'orange' (these being chips F4 and E5 respectively in the Sturges and Whitfield (1995) chart of Figure 4.1.)

Table 4.17 explicitly displays all the Brillouin minimum diversity index values shown in Figure 4.10 but this time as associated with the Murinh-Patha colour term codes as shown in Table 4.16 above. Eight World Colour Survey colour chips had a diversity index of zero and these were for A0, B1, B24, B29, B30, B32, B33 and B36 in Figure 4.10.

**Table 4.17 - Brillouin minimum diversity values for Murinh-Patha**

| **Brillouin diversity index** *(minimum values < 0.4)* | **Frequency per recorded Murinh-Patha code** | | |
|---|---|---|---|
| | **A** | **H** | **U** |
| 0 | 8 | | |
| 0.128755 | 9 | 4 | |
| 0.228151 | 1 | 1 | 2 |
| 0.255877 | 7 | | |
| 0.353571 | 2 | 1 | 1 |
| 0.381297 | 2 | 2 | 2 |

What can be seen from Table 4.17 is that the Murinh-Patha code A has garnered the highest sum total frequencies for diversity index values that are less than 0.4. Murinh-Patha World Colour Survey code A (*bamam* / *bamamka* or English equivalent ‘white’) has a sum total of 29, while H (*thipman* / *thipmanka* - or English equivalent ‘black’) has a sum total of 8. The lowest sum total of 5 was garnered by U (*bukmantharr* / *bukmanka* or English equivalent ‘red’). Based on the diversity index analysis of the World Colour Survey data it would seem that ‘white’, ‘black’ and ‘red’ are salient colours to Murinh-Patha speakers, with a far greater prominence being assigned to ‘white.’ This is perhaps more of a reflection on the perceptual significance of brightness to the Murinh-Patha cohort, rather than an indication of their greater appreciation of that particular hue.

A0, B1, B24, B29, B30, B32, B33 and B36 in Figure 4.10 are the World Colour Survey colour chips that share equal minimum diversity in the Murinh-Patha cohort and they can be more accurately specified by their coordinates in the Munsell colour order system. These are displayed in Table 4.18. The first column contains the World Colour Survey coordinate for the colour chip, with the second column featuring the equivalent Munsell coordinate. Column three contains the location of the chip in the relevant hue region of the World Colour Survey Munsell chart. Columns four and five contain the associated Value (i.e. brightness) and Chroma (i.e. saturation) figures respectively. (Colour chip A0 is a so-called ‘neutral’ colour in the Munsell system. By definition, these have no Chroma (i.e. saturation) and vary only in terms of Value (i.e. brightness).) The corresponding colloquial English colour name is the relevant ISCC-NBS designation as derived from Kelly and Judd (1976) and this is featured in column six of the table.

**Table 4.18 - Murinh-Patha: Munsell coordinates for minimum diversity World Colour Survey colour chips**

| World Colour Survey coordinate | Munsell coordinate | Hue region | Value (/9.5) | Chroma (/16) | ISCC-NBS colour name |
|---|---|---|---|---|---|
| A0 | N 9.5/ | neutral | 9.5 | N/A | *white* |
| B1 | 2.5R 9.0/2 | red | 9.0 | 2 | *pale pink* |
| B24 | 10BG 9.0/2 | blue-green | 9.0 | 2 | *very pale green* |
| B29 | 2.5BP 9.0/2 | blue-purple | 9.0 | 2 | *very pale blue* |
| B30 | 5BP 9.0/2 | blue-purple | 9.0 | 2 | *very pale blue* |
| B32 | 10BP 9.0/2 | blue-purple | 9.0 | 2 | *very pale purple* |
| B33 | 2.5P 9.0/2 | purple | 9.0 | 2 | *very pale purple* |
| B36 | 10P 9.0/2 | purple | 9.0 | 2 | *pale purplish pink* |

Based on the available World Colour Survey data at the time, Hargrave(1982) notes the Murinh-Patha vernacular terms used by subjects in colour naming as well as their corresponding English glosses (i.e. equivalent terms). This is represented in Table 4.19, along with the number of Murinh-Patha subjects who used the colloquial term 5 or more times according to Hargrave (1982), who only features those terms used by over half of the participants. The appearance of *bamam*, *thipmam* and *bukmantharr* in the top three of Table 4.19 aligns with the finding above, using diversity index analysis, that these were most likely the salient colour terms for the Murinh-Patha cohort and possible candidates for basic colour terms. However, these three terms are listed by Hargrave (1982) as being used by all members of the cohort, whereas the current diversity index analysis of the data indicates that such uniform consensus is only apparent with the term *bamam* / *bamamka* (i.e. 'white.')

Four terms on the list by Hargrave (1982) were unspecified with regards to their respective English equivalents. The term *wudanil* appears in the World Colour Survey Dictionary File of Table 4.16 as part of the "family" of eight terms assigned the common World Colour Survey code of W. This is one indicator of its ambiguity; with the other being that Hargrave (1982) claims that there was much idiosyncratic variability in the informants' focal placement of this colour term: In the component of the World Colour Survey devoted to the determination of focal colour positions, the term *wudanil* was apparently used to designate the best examples of 'yellow,' 'orange,' 'purple,' 'pink' and 'green' respectively by various subjects in the cohort. "Best example" here refers to a selection that signifies a personal prototype.

This scattering of focal colour placements was also true with *tumamka~tupmanka* and *wipma (na) narri* according to Hargrave (1982). The former term was seemingly used by various informants to denote the best examples of 'blue,' 'green,' 'purple' and 'brown' respectively, while the latter term labelled the best examples of 'brown,' 'yellow,' 'red,' 'orange,' 'purple' and 'black.' While *ngatin* was observed by Hargrave (1992) to have an unspecified English gloss, other sources (e.g. Walsh, 1995) indicate that this term does in fact translate to 'green.' An interesting aspect of this term is that 12 informants used it to name their best example of 'yellow,' whereas only three subjects chose this word to denote their best example of 'green.' This would signify some confusion between these two colours. A lack of consensus was also present with *bukmantharr* ('red'): According to Hargrave (1992), 16 informants nominated this term to designate their notion of a focal 'red,' but the remaining subjects used it to name best examples of 'brown,' 'orange,' 'purple' and 'pink.'

**Table 4.19 - Murinh-Patha colour terms from World Colour Survey study (Hargrave, 1982)**

| Murinh-Patha vernacular colour term | English gloss | No. of subjects who used Murinh-Patha term 5+ times |
|---|---|---|
| *bamam* | white | 25 |
| *thipmam* | black | 25 |
| *bukmantharr* | red | 25 |
| *wudanil* | unspecified | 23 |
| *ngatin* | unspecified | 20 |
| *tumamka~tupmanka* | unspecified | 19 |
| *wipma (na) narri* | unspecified | 16 |

### 4.6.4 Murinh-Patha World Colour Survey Data - Diversity Maxima

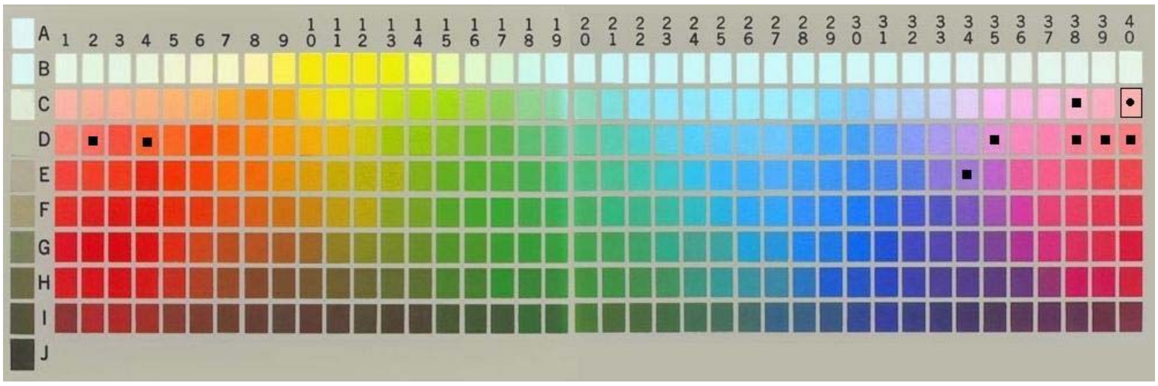


**Figure 4.11 - Murinh-Patha diversity maxima**

Figure 4.11 displays maximum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index greater than 1.6, constituting 9 out of the 330 colour chips.

The World Colour Survey colour chip with the maximum diversity value in the Murinh-Patha group is C40 in Figure 4.11. Its coordinates in the Munsell system are:

10RP 9.0/6

(This colour chip is positioned to the right-most edge in the red-purple hue band, with a value (i.e. brightness) of 9.0 out a possible 9.5 and a chroma (i.e. saturation) of 6 out of a possible 16.) If this is translated into its ISCC-NBS colour name designation, the result is:

*pale pink*

It is worth noting that minor clustering is present in the Red-Purple hue band of the World Colour Survey Munsell chart in Figure 4.11.

### 4.6.5 Murinh-Patha World Colour Survey Data - Commentary

Based on the preliminary analysis of the World Colour Survey data at the time, Hargrave (1982) concluded that Murinh-Patha speakers probably have three basic colour terms in their lexicon, these being the terms *bamam* ('white'), *thipmam* (‘black’)and *bukmantharr* (‘red.’) This was also supported by comment from the World Colour Survey investigators who confided that the aforementioned terms were the only ones used solely for the purpose of denoting colours. (The term *ngatin* (‘green’) was used to describe something as being ‘raw’ or ‘unripe,’ as well as being employed to refer to ‘green grass.’) This finding is supported by the diversity analysis of the extant Murinh-Patha World Colour Survey data set. What is noticeable from the current interpretation of the data is that there appears to be a greater salience towards ‘white’ amongst the informants. It is speculated here as being a predilection to the quality of brightness and this could be attributed to the levels of natural ambient illumination present in the habitat of the informants. Given the small sample size of the existing Murinh-Patha World Colour Survey data set further comments on this matter cannot be made.

## 4.7 Warlpiri

### 4.7.1 Warlpiri - Geographical and Lexical Background

According to Hargrave (1982), there were 23 subjects in the Warlpiri cohort, 14 males and 9 females ranging in age from 30 to over 70. The Warlpiri subjects were located at Lajamanu (formerly known as Hooker Creek) which is situated about 550 km south-west of Katherine in Australia’s Northern Territory. The indigenous Australian community resident here lives in a semi-arid terrain on the edge of the Tanami Desert. Only four informants were monolingual in Warlpiri, according to Hargrave (1992) with seven being able to converse in other dialects of the region (Gurindji, Walmajarri, Pintupi.) A form of pidgin English (as well English per se) was used by 16 of the cohort but none were fluent in these.

Table 4.20 features Warlpiri colour terms as obtained from a 1995 published version of a Warlpiri dictionary (Hale, 1995) and a Warlpiri-English dictionary available online in a text file format (Swartz, 1996). The latter was compiled by the co-investigator of the World Colour Survey Warlpiri cohort.

**Table 4.20 - Colour terms derived from Warlpiri dictionaries assembled by Hale (1995) and Swartz (1996)**

| English | Warlpiri |
|---|---|
| black | kirdily-kirdilypa / maru / maru-maru / nguyu-nguyu / parnparnku-karrimi / wuju-wuju / wumpurrarni /yurrpurlu |
| blue (light) | mawulyparu |
| brown | ngarr-ngarr-pari / puun-puunpa / walyawalya |
| green | kurraly-pari / wajirrki wajirrki /yukuriyukiri / wikirri-wikirri / yarringki(-yarringki) |
| grey | pulyurr-pulyurrpa / yulyurduyulyurdu |
| orange | pangki-parnta |
| pink | kurdunjuru |
| purple | yulyurduyulyurdu |
| red | pulyurrulyurru / tirirtiri / yalyu yalyu / yalyulpari / yinjilirrpilirrpi / yurlpayurlpa / warntirily-pari |
| white | kardirri / liirl-nyinami / marnararrpa / yarltiri / palkarra / piirn-pari / rdarrwarlku-karrimi / rdarrwarl-pari / warntikirli / wirliriny-ngunami |
| yellow | karntawarra karntawarra / yamangayiwarna |

Hale (1995) noted that, apart from ‘black,’ the term *maru* had the additional meaning of ‘dark in colour.’ (The word *marumaru* translated to ‘blackish.’ As noted earlier, *maru-maru* was used in Martu Wangka to denote ‘black.’) Apart from the latter terms, Swartz (1996) offered a plethora of synonyms for this colour, though some are peripheral in their direct reference to ‘black’ and dealt more with diminished aspects of brightness, like *parnparnku-karrimi* which meant ‘to be charred or blackened’ or *wuju-wuju* (‘darkish’ or ‘blackish.’)The term *walyawalya* translated to ‘brown’ according to Hale (1995) but it also denoted a type of snake known as a ‘death adder.’ Whereas *walya* refers to ‘ground,’ ‘earth,’ ‘dirt,’ ‘sand’ or ‘soil.’ Swartz (1996) translated *walyawalya* as ‘brownish or tan in colour,’ but also included two synonyms for the colour: *ngarr-ngarr-pari* (‘light brown, bronze, or tan colour’) and *puun-puunpa* (‘brownish in colour.’)

While *wajirrki wajirrki* translated to 'green,' *wajirrki* had the meaning 'green grass.' (Hale, 1995). However, Swartz (1996) claimed that this also translated to 'blue.' Similarly, Swartz (1996) stated that *wikirri-wikirri* translated to 'colour term used for shades of green and blue.' Perhaps both these were examples of the categorization of 'green-blue' or 'grue.' The term *yarringki(-yarringki)* had the triple meanings of 'blue, as of sky,' 'green' and 'fresh growth or foliage' (Swartz, 1996). Also, *yukiri* (or *yukuri*) described the green that is characteristic of living plants (Hale, 1995). It is interesting that Swartz (1996) claimed that *yulyurduyulyurdu* translated to 'grey' or 'purple.' There are no specific terms for these in Hale (1995). Other oddities from Swartz (1996) included *kurdunjuru* ('pink') and *pangki-parnta* ('orange'), albeit the latter was used to denote either the fruit or the colour.

The word *yalyu yalyu* translated to 'red,' but *yalyu* referred to 'blood.' Similarly *yurlpayurlpa* equated to 'red,' whereas the word *yurlpa* (or *yurlpu*) had the meaning 'red ochre.' While *kardirri* translated to 'white,' it also had the additional meaning of 'light in colour.' The term *yarltiri* had synonymous meanings, with the addition that it also could be used to refer to the mineral 'quartz.' Hale (1995) only included the terms *kardirri* and *yarltiri* and the other synonyms denoting 'white' emanated from Swartz (1996).

The word *karntawarra karntawarra* denoted 'yellow,' while *karntawarra* referred to 'yellow ochre.' As previously noted, the term *karntawarra* appeared in the World Colour Survey Martu Wangka dictionary file, as well as the World Colour Survey Warlpiri dictionary file. It was also used in the Pintupi/Luritja and Walmajarri dialects (Hansen and Hansen, 1992; Richards and Hudson, 1990). Hale (1995) included *piirrpiirpa*, a term that incorporated the qualities of colour and pattern with its meaning of 'half white, brown and white.' Apparently this word was used to describe the colour of a whistling eagle.

### 4.7.2 Comments on the Warlpiri World Colour Survey Dictionary File

Hargrave (1982) noted that the colour terms used by Warlpiri informants ranged from 3 to 12. This maximum elicited amount of 12 is contradicted by the World Colour Survey Martu Wangka dictionary file displayed in Table 4.21. This contains 62 terms, these being the final version of the Martu Wangka terms elicited in gathering the World Colour Survey data. The second column of the table features the field-worker's transcription of the Martu Wangka colour term elicited, while the third column features the code or unique World Colour Survey term abbreviation denoting it for analysis.

Of the 62 term recorded in Table 4.21, 32 of these have been corroborated as being components of the Warlpiri lexicon using Hale (1995) as a checkpoint. (The remaining terms are probably from the lexicons of other languages spoken by the informants.) Regarding the colour terms from Table 4.20 above, all are present in the World Colour Survey Warlpiri dictionary file. The term *yalyu yalyu* ('red') probably appears as '*yalu-yalu*' and '*yurlpupiya*' is suspected as being a misrepresentation of *yurlpayurlpa* ('red'). The term *karntawarra karntawarra* ('yellow') is present as '*karntawarra*.' Of course, in the latter case, this could be interpreted as comparing the colour of a stimulus chip to 'yellow ochre.' In the latter instance, it most likely is a transcription error in the WCs data set. This is probably also true of *wajirrkikajirrki* and this is probably *wajirrki wajirrki* ('green').

As to the remaining terms in the World Colour Survey Warlpiri dictionary file, all are non-colour related words and these have been isolated in Table 4.22. These can be broadly classed as referring to the atmospheric surroundings (e.g. *yarringki* - 'blue, as of sky'), flora (e.g. *wapurnungku* - 'ghost gum'), fauna (e.g. *kalupa* (*kalypa*) - 'joey / infant kangaroo'), minerals (e.g. *karrku* - 'dark red ochre') and topography (e.g. *ngalyurrpa* (*ngalyarrpa*) or 'sandhill.') There are also terms that encompass the quality of pattern (or texture), namely *pawutawu* (*pawu*) or 'fur (of animal).' This tenuous association with perceptions of texture and surface patterns influencing colour naming could also be true with words such as *kiliki* ('running water' /'runoff after rain'), *nguku* ('neck') and *wini-wini* ('burnt country / burnt-off spinifex' - the latter being a type of grass found in arid lands.)

**Table 4.21 - World Colour Survey Warlpiri dictionary file**

| | Elicited Warlpiri colour term | World Colour Survey Code | | Elicited Warlpiri colour term | World Colour Survey Code |
|---|---|---|---|---|---|
| **1** | kiliki | C | **32** | jirijiri | J |
| **2** | mirawarri | MI | **33** | jurntuljurntulpa | JU |
| **3** | nguyunguyu | NY | **34** | kalupa | KA |
| **4** | rrarrpa | X | **35** | kirntilarri | O |
| **5** | warparlanganji | WR | **36** | kuru-kuru | KU |
| **6** | mangkurdupiya | MG | **37** | munga | V |
| **7** | maru | M | **38** | naglkirdi | NI |
| **8** | mawulypari | MW | **39** | ngapari | NP |
| **9** | pulyurr-pulyurrpa | PU | **40** | nguku | NK |
| **10** | kunyjuru-kunyjuru | U | **41** | nguru | NR |
| **11** | yilyyurdu-yilyurdu | L | **42** | patutu | PT |
| **12** | wajirrkikajirrki | WJ | **43** | pawutawu | PW |
| **13** | wikirriwikirri | WI | **44** | pirily | PR |
| **14** | yakuri/yukuri | K | **45** | rronkarrpa | RK |
| **15** | warrkini | WK | **46** | wantapuralyi | WA |
| **16** | walyawalya | W | **47** | wanukurdu | WD |
| **17** | karrku | R | **48** | watilyi | WT |
| **18** | kurdunjurupiya | E | **49** | wingkilypari | WG |
| **19** | mardalpa | Q | **50** | wini-wini | WN |
| **20** | ngalyurrpa | NL | **51** | wintajilypa | WO |
| **21** | yalu-yalu | Y | **52** | wulyuwulypa | WL |
| **22** | yurlpupiya | YP | **53** | wurrkalpa | WU |
| **23** | kalyji | B | **54** | yapurnupiya | PY |
| **24** | kardirri | D | **55** | yardingki | YD |
| **25** | ngunjungunju | N | **56** | yarluwarnu | YU |
| **26** | palkarra | P | **57** | yarringki | YR |
| **27** | pardapardija | PD | **58** | yirntirintiri | YN |

| | | | | | |
|---|---|---|---|---|---|
| **28** | wapurnungku | WP | **59** | pilyirrpilyirrpa | PL |
| **29** | warntikirli | T | **60** | rtirirtiri | RT |
| **30** | yarltiri | YT | **61** | yajanpi | YJ |
| **31** | karntawarra | A | **62** | yukamirra ka | YK |

**Table 4.22 - List of non-chromatic terms in World Colour Survey Warlpiri dictionary file**

| | **Elicited Warlpiri colour term** | **English translation** |
|---|---|---|
| **1** | kiliki | ‘running water’ /‘runoff after rain’ |
| **2** | mirawarri (*miriwari*) | ‘mirage’ (?) |
| **3** | nguyunguyu (*nguyu*) | ‘blacking from charcoal’ (?) |
| **6** | mangkurdupiya (*mangkurdu*) | ‘raincloud’ (?) |
| **17** | karrku | ‘dark red ochre’ |
| **20** | ngalyurrpa (*ngalyarrpa*) | ‘sandhill’(?) |
| **28** | wapurnungku | ‘ghost gum’ |
| **32** | jirijiri (*jiri*) | ‘thorn / sticker’ (?) |
| **34** | kalupa (*kalypa*) | ‘joey / infant kangaroo’ (?) |
| **37** | munga | ‘dark / darkness of night’ |
| **39** | ngapari (*ngapiri*) | ‘river red gum’ (?) |
| **40** | nguku | ‘neck’ |
| **41** | nguru | ‘sky’ |
| **43** | pawutawu (*pawu*) | ‘fur (of animal)’ |
| **44** | pirily (*pirilyi*) | ‘charcoal’ (?) |
| **47** | wanukurdu | ‘white wood’ |
| **50** | wini-wini | ‘burnt country / burnt-off spinifex’ |
| **52** | wulyuwulypa | ‘late evening’ |
| **56** | yarluwarnu (*yarlu*) | ‘clear, clean, as of ground’ (?) |
| **57** | yarringki | ‘blue, as of sky’ |
| **61** | yajanpi (*yajarnpi*) | ‘ironwood’ (?) |

Note: The question mark (?) denotes translation inferences with the assumption that the elicited term is misspelt due to a transcription error. The equivalent words from Hale

(1995) with closest spelling to the elicited terms are featured adjacent to these in the table above and are displayed in italics within parentheses.

### 4.7.3 Warlpiri World Colour Survey Data - Diversity Minima

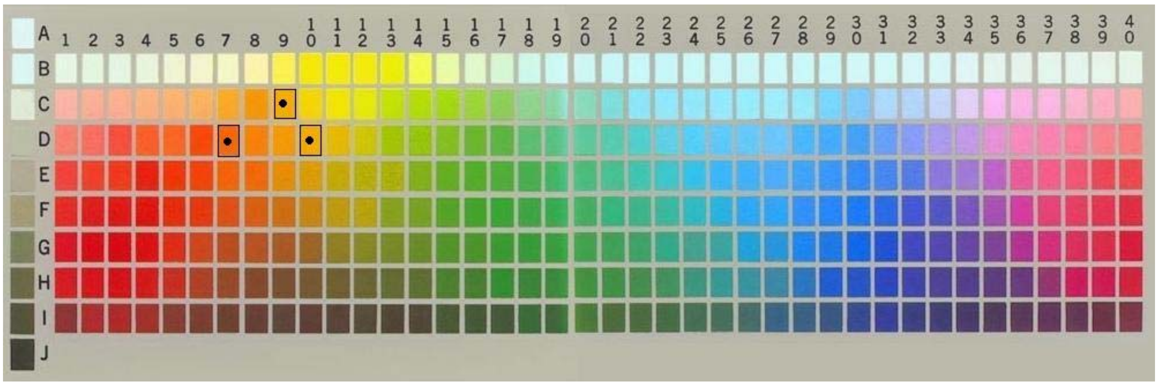


**Figure 4.12 - Warlpiri diversity minima**

Figure 4.12 displays minimum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index less than 0.4, constituting only 3 out of the 330 colour chips and these appear to cluster in the Yellow-Red / Yellow bands of the World Colour Survey Munsell chart shown in Figure 4.12.

Comparing the Warlpiri colour chips with equal minimum diversity index figures (i.e. C9, D7 and D10 from Figure 4.12) to the Sturges and Whitfield colour foci chart featured in Figure 4.1, C9 is close to the English focal colour 'yellow,' this being the point midway between chips B10 and C10 in the Munsell chart.

No World Colour Survey colour chip had an associated diversity index of zero in the Warlpiri cohort and there were only three that had a figure less than 0.4, this being 0.372953. The World Colour Survey code that equated with these three colour chips sharing this diversity index figure was A, which represents the Warlpiri term *karntawarra*. The small number of minimum diversity index figures seen here when compared to other indigenous Australian language groups in the World Colour Survey suggests a low level of agreement in colour naming. At best, the diversity index analysis of the World Colour Survey offers tentative support that 'yellow' is a salient colour to

Warlpiri speakers. (However, since the word also means 'yellow ochre,' this perceptual significance could be attributed to qualities of the latter instead.)

The colour chips with the equal lowest diversity indices for Warlpiri are C9, D7 and D10 and they can be more accurately specified by their coordinates in the Munsell colour order system. These are displayed in Table 4.23. The first column contains the World Colour Survey coordinate for the colour chip, with the second column featuring the equivalent Munsell coordinate. Column three contains the location of the chip in the relevant hue region of the World Colour Survey Munsell chart. Columns four and five contain the associated Value (i.e. brightness) and Chroma (i.e. saturation) figures respectively. The corresponding colloquial English colour name is the relevant ISCC-NBS designation as derived from Kelly and Judd (1976) and this is featured in column six of the table.

**Table 4.23 - Warlpiri: Munsell coordinates for minimum diversity World Colour Survey colour chips**

| World Colour Survey coordinate | Munsell coordinate | Hue region | Value (/9.5) | Chroma (/16) | ISCC-NBS colour name |
|---|---|---|---|---|---|
| C9 | 2.5Y 8.0/16 | yellow | 8.0 | 16 | *vivid yellow* |
| D7 | 7.5YR 7.0/14 | yellow-red | 7.0 | 14 | *vivid orange yellow* |
| D10 | 5Y 8.0/16 | yellow | 8.0 | 16 | *vivid yellow* |

Based on the available World Colour Survey data at the time, Hargrave(1982) notes the Warlpiri vernacular terms used by subjects in colour naming as well as their corresponding English glosses (i.e. equivalent terms). This is represented in Table 4.24, along with the number of Warlpiri subjects who used the colloquial term 5 or more times according to Hargrave (1982), who only featured those terms used by over half of the participants. The appearance of *kantawarra* in the top two of Table 4.24 aligns with the finding above, using diversity index analysis, that this is possibly a salient colour term for the Warlpiri cohort. However, no similar evidence was found in the analysis to support the prominence of *yalyu-yalyu* and *maru-maru* as basic colour terms. Hargrave

(1982) listed *walya-walya* as having an 'unspecified' English gloss, whereas both Hale (1995) and Swartz (1996) had this as translating to 'brown.' The term *tumamka~tupmanka* in Table 4.24 is one that is not present in the World Colour Survey Warlpiri dictionary file in Table 4.21 and was also undefined in both Hale (1995) and Swartz (1996).

**Table 4.24 - Warlpiri colour terms from World Colour Survey study (Hargrave, 1982)**

| Warlpiri vernacular colour term | English gloss | No. of subjects who used Warlpiri term 5+ times |
|---|---|---|
| *yalyu-yalyu* | red | 20 |
| *kantawarra* | yellow | 20 |
| *maru-maru* | black | 19 |
| *walya-walya* | unspecified | 16 |
| *kardirri* | white | 15 |
| *tumamka~tupmanka* | unspecified | 19 |
| *yukuri-yukuri* | green-blue ('grue') | 14 |

### 4.7.4 Warlpiri World Colour Survey Data - Diversity Maxima

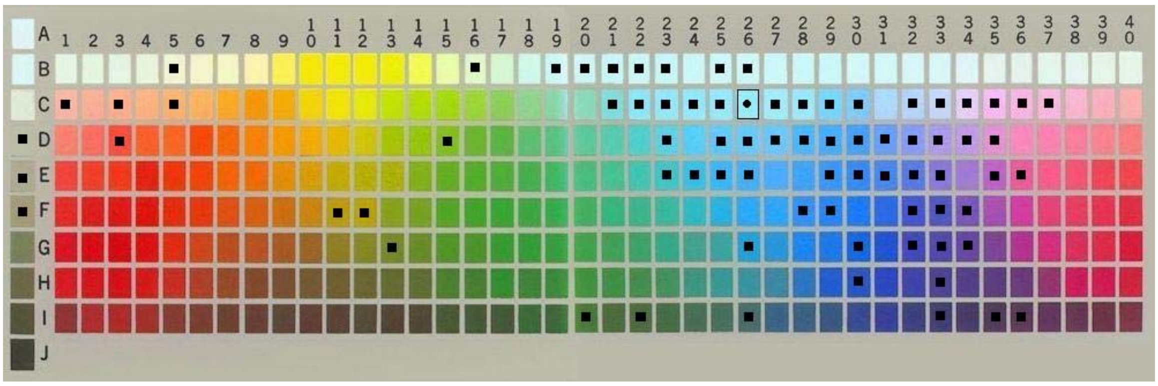


**Figure 4.13 - Warlpiri diversity maxima**

Figure 4.13 displays maximum values of the Brillouin diversity index as computed for each colour chip in the World Colour Survey array. The points indicated in the chart above are those with a diversity index greater than 1.6, constituting 77 out of the 330 colour chips.

The colour chip with the highest diversity index in the selection above is C26. Its coordinates in the Munsell system are:

5B 8.0/4

(This colour chip is positioned midway in the blue hue band, with a value (i.e. brightness) of 8.0 out a possible 9.5 and a chroma (i.e. saturation) of 4 out of a possible 16.) If this is translated into its ISCC-NBS colour name designation, the result is:

*very light greenish blue*

It is worth noting that significant clustering is present across the Green, Blue-Green, Blue, Blue-Purple and Purple hue bands of the World Colour Survey Munsell chart in Figure 4.13. This is a probable indicator of a high degree of confusion in the naming of colours in these regions.

### 4.7.5 Warlpiri World Colour Survey Data - Commentary

Based on the preliminary analysis of the World Colour Survey data at the time, Hargrave (1982) concluded on the sceptical note that no clear evidence was at hand to suggest what the basic colour terms were for the Warlpiri cohort. The findings of the present analysis outlined in this thesis would seem to support this tentative conclusion, with the exception of *kantawarra* (*-kantawarra*) (‘yellow’) as a possible candidate for basic colour term status. However, this would be negated by the observations that this word has the possible alternative meaning of ‘yellow ochre,’ not to mention that it appears to be shared as a loanword by the Martu-Wangka, Pintupi/Luritja and Walmajarri lexicons, so its uniqueness to any one specific language group is in question. This could also mean that the cultural significance of ‘yellow ochre’ to these indigenous Australians who shared a common desert habitat was the salient aspect here and not a property that was encoded within the language itself per se, something that Hargrave (1982) alluded to in passing.

Hargrave (1982) stated that five terms were used by the Warlpiri cohort in all to denote ‘white.’ This by itself suggests a high degree of diversity but Table 4.20, derived from Hale (1995) and Swartz (1996), shows that at least ten terms exist that translate to 'white.' According to Hargrave (1982), this variability in naming 'white' was attributed by the World Colour Survey investigator to possible disparities in dialects when referring to an object that might be perceived as being shiny. This comment once again reflects the importance of texture in the perceptual world of the indigenous Australian. However, as can be seen from Table 4.20, the extant Warlpiri dictionaries contain a variety of synonyms per colour, with 'black' having eight, 'red' seven and 'green' five. This would suggest that variability in colour naming is an idiosyncratic trait of Warlpiri culture or that translation issues may have tainted the data.

In undertaking this research, it was only possible to personally contact one of the World Colour Survey field-workers, this being Stephen Swartz, who was responsible for the Warlpiri cohort. When asked via e-mail as to what was the greatest hindrance faced in the World Colour Survey field work, the following response was obtained from Swartz without any further elucidation: *"Patience, or lack thereof! I won't even go into the translation difficulties which were/are legion!"* (personal communication, 2003).

## 4.8 Conclusion

This chapter outlined the analysis of the indigenous Australian component of the World Colour Survey data set. To begin with, a reference point for the subsequent analyses was depicted, this being the previously mentioned determination of English focal colours by Sturges and Whitfield (1995). Next, the analyses for the indigenous Australian cohorts in the World Colour Survey data set were expressed following a standard format in the text. The language groups in question were Kriol, Kuku-Yalanji, Martu Wangka, Murinh-Patha and Warlpiri.

Each cohort analysis section began with a geographical and lexical background of the language group, featuring a breakdown of existing colour terms determined from print or web-based dictionaries, as well as any second-hand knowledge of the informants themselves. This was followed by a commentary on the World Colour Survey Dictionary File for that language group, this being the indigenous terms that were elicited from the informants by field workers. The next part of each analysis section included overviews of the diversity minima and maxima obtained for that language group with respect to the colour terms elicited in the World Colour Survey. Each individual analysis of the indigenous Australian cohorts concluded with a commentary on the findings for that language group.

Table 4.25 displays the percentage of the World Colour Survey colour stimuli with high diversity indices (>1.6) per indigenous Australian cohort and Warlpiri is clearly leader of the pack. This indicates that of the five groups, the Warlpiri probably experienced the greatest degree of confusion in colour naming in that there was less of a consensus present in categorization.

**Table 4.25 - Indigenous Australian World Colour Survey cohorts: Percentage of World Colour Survey colour stimuli with high diversity indices**

| Indigenous Australian World Colour Survey cohort | Percentage of World Colour Survey colour stimuli with Brillouin diversity indices > 1.6 |
|---|---|
| Kriol | 0.3 |
| Kuku-Yalanji | 4.9 |
| Martu-Wangka | 3.0 |
| Murinh-Patha | 2.7 |
| Warlpiri | 23.3 |

# CHAPTER 5

# 5 Discussion

## *5.1 Recapitulation of the Aim and its Consequences*

The aim of the research presented in this thesis is to explore the World Colour Survey within the context of the indigenous Australian component in order to seek out and comment on any colour categorization patterns that may be present and determine whether or not they align with the Berlin and Kay (1969) framework of basic colour term theory. The rationale behind this directed approach being that in isolation salient patterns of colour categorization could be determined for one major geographic region and perhaps commonalities could be established or contradictions identified. To achieve this required a technique that would estimate the diversity in classification behaviour and in so doing provide a metric to indicate levels of agreement in nomenclature within designated communities.

An original aspect of the research presented here is the adoption of a statistical metric used in the biological sciences. Analysis of species diversity as originally used in the domain of ecological modelling was the designated technique employed in the examination of the indigenous Australian component of the World Colour Survey. The analogy was drawn that if one can imagine a single Munsell colour chip from the set of World Colour Survey stimuli to be a chromatic “ecosystem” (or, more appropriately, a lexical system), then the possible names that can be given to the chip take on the role of different “species” that occupy this conceptual domain. The World Colour Survey colour chart can be conceived of as a global set of 330 of these schemas. The foci (or basic colour terms) in this model would then correspond to those lexical systems in which the species diversity index is at a minimum because that would imply a greater level of agreement in nomenclature and a reduced number of alternate colour terms. By minimum diversity, the latter hypothesis assumed this would correspond to a Brillouin index value of zero in the case of the research outlined here.

The extant World Colour Survey data concerning indigenous Australian populations revealed poor levels of agreement with respect to cultural consensus in colour naming behaviour. This was evident in that few of the Munsell colour stimuli in the data set rated a zero when their Brillouin diversity indices were computed. Idiosyncratic categorization regimes appeared to be dominant, signalling a marked degree of confusion in communicating the designation of colours. While the analysis did identify vague patterns of minimum diversity in the data that correspond to what could construed as basic colour terms in four of the cohorts (i.e. Kriol, Kuku-Yalanji, Martu Wangka and Murin-Patha), the findings were tenuous and eccentric in parts. This was particularly evident with the Warlpiri cohort.

The word “findings” is perhaps too strong a word here, as the term implies that a definite set of conclusions was found. Based on the small number of informants involved in each of the indigenous Australian cohorts of the World Colour Survey any “findings” can at best be described as small effects that cannot be extrapolated to a wider population of speakers. As the research progressed, though, it was observed that the diversity analysis technique applied in the examination of colour categorization data provided a means to gauge non-discrete predispositions. However, these could only be deemed to be valid for the particular small sample size of indigenous Australian informants that were the subject of that analysis.

The vague and, at times, unusual predispositions that were revealed in the indigenous Australian component of the World Colour Survey were as follows:

*Predisposition 1*: Both the Kriol equivalents of ‘blue’ and ‘green’ scored the greatest minimum Brillouin diversity index values in the selection of colour terms elicited from this particular cohort. This could indicate a trend towards a greater salience for ‘grue’ (‘blue-green’) however data integrity of this cohort was observed to have been compromised.

*Predisposition 2*: Diversity analysis of the Kuku-Yalanji World Colour Survey data hinted at brightness being a particularly salient quality in colour naming behaviour for this language group. However, there also appeared to be minimal salience for ‘grue’ (‘blue-green’) amongst the participants of the study. In fact, it was found that no diversity minima existed within the general vicinity of the focal point for ‘green’ as determined by Sturges and Whitfield (1995), on the other hand diversity maxima were observed in the ‘green’ focal area of the World Colour Survey colour chart. This indicates a poor level of agreement for the focal placement of 'green' amongst the Kuku-Yalanji informants.

*Predisposition 3*: Diversity analysis indicated a lack of salience for 'white" amongst the Martu Wangka informants, supporting the observations by Hargrave (1982). However, this would imply a high degree of diversity in naming 'white' for the Martu Wangka cohort but this was not evident in the analysis results dealing with diversity maxima. Minor clustering of diversity minima in the 'orange,' 'brown' and 'pink' hue bands of the World Colour Survey chart were observed for the Martu Wangka informants. Since none of these had a value of zero they were only deemed to be possible naming predispositions.

*Predisposition 4*: Diversity analysis indicated a greater salience for 'white" amongst the Murinh-Patha informants possibly due to the quality of brightness.

*Predisposition 5*: Of all the five indigenous Australian cohorts of the World Colour Survey, Warlpiri had the highest level of diversity in colour categorization behaviour signifying a significant level of confusion, possibly indicating more serious flaws in how the colour terms were elicited in the field.

In short, the messy nature of the indigenous Australian component of the World Colour Survey data set, at best, provides weak corroboration of the Berlin and Kay (1969) frame work of basic colour term theory, especially given the small sample sizes involved that were comprised of less than ideal subjects (i.e. not monolingual).

As described in the literature survey, the restated definition of a basic colour term, according to Crawford (1982), clearly signposted its attributes. First off, it is a word that should be used in common parlance by all informants in a colour naming study.
In tandem with this is the criterion that they should be constant in their reference use across different practical situations. The style of the World Colour Survey itself was arguably counterproductive to offering support for either of these characteristics primarily because it did not have ecological validity for the indigenous informants. Munsell colour chips would have been unnatural stimuli for these subjects. Reference use of colours in different practical situations was not examined as subjects were merely

asked to offer verbal labels for Munsell chips. As to determining the communal manner of speaking related to colours that was shared by each, individual cohort, the evaluation of this was not evident in the material provided in the current online World Colour Survey data set.

To understand the collective vernacular of a group of speakers with respect to colour, a linguistic approach is required and this background was not featured anywhere in the World Colour Survey data set. What is present is chiefly a collection of codes representing words elicited by informants and that is all. The analysis of results undertaken in this thesis has shown that significant diversity in naming these stimuli was present in all indigenous Australian cohorts. It would be expected that focal colours for the various languages should have garnered high levels of agreement, possibly even close to 100%, but this was not the case for any of the indigenous Australian cohorts.

The display of colour chips would be a most unnatural event for indigenous Australian subjects living a traditional lifestyle. A better prospect to elicit common colour words in such a cohort would have been to show natural objects found in their environment and then query them as to the name of the colour that they possess. This approach would have gauged the day-to-day colour vernacular in a less intrusive manner, even though discussions about the colour of such objects is probably not a regular occurrence for these peoples. However this tactic would have damaged the experimental validity of the project with the introduction of non-standard colour stimuli. It also could have introduced far more colour words that are associated with objects into the data.

Words whose uses are applied in discourse surrounding limited types of objects are not deemed to be basic colour terms. Following on from the reinterpretation of the definition by Crawford (1982), the additional criterion for a basic colour term of having its signification not included in any other would imply a full knowledge of synonyms for colour words by the World Colour Survey field investigators. This information is not apparent given the contents of the current online World Colour Survey data set. Dictionaries consulted regarding the indigenous languages analysed for this thesis did indicate that some colours were referred to by multiple names but it was not clear whether these were synonyms or loan words from other languages. Either would have introduced confounding factors into a colour naming study.

The analysis of the indigenous Australian component of the World Colour Survey data set has proved to be inconclusive in determining the set of basic colour terms for each of the languages included when compared to the strictures of Crawford's (1982) simplified redefinition of the concept. What is evident in the analysis is the prevalence of diversity in colour naming. This reflects poor levels of agreement amongst indigenous Australians, but is this due to the poor design of the World Colour Survey, other contributing factors or a combination of the two? The remainder of this chapter will speculate on the possible reasons that could explain the variability observed.

## 5.2 Linguistic Diversity and the Power of Place

In the 1992 science fiction classic "Snow Crash," author Neal Stephenson ponders the question of why humanity does not all speak the same language (Stephenson, 1993). If we all share the same genetic framework and common physiology then why have a plethora of natural languages evolved over time? The theme of linguistic divergence is a prevalent one in the latter work of fiction and the fanciful reason for it there is attributed to a virus. In reality, the basis for linguistic diversity is probably due more to something as mundane as the insular effects of distance between communities afforded by the geography of habitat (de Blij, 2009).

The social forces of information and communication technologies may appear to be initiating conformity in dialects across the globe. The telephone and the Internet have brought people closer together in a virtual sense and in so doing set common standards for communication interchange. For example, some would contend that English is rapidly becoming a global language for these and other reasons (e.g., Crystal, 2003), but the "power of place," as de Blij (2009) argues, is still influential in shaping cultures at a local level, especially in those societies who are less technologically advanced. This echoes the thoughts of Diamond (1997) who argues that disparities in power and technological infrastructure between human societies stem from environmental variations augmented by a mixture of positive feedback loops. How does all of this relate to the topic at hand, namely colour categorization?

The original 1969 exposition of the Berlin and Kay (1969) theory of basic colour terms posited that the semantic maturity of colour naming behaviour with a culture is allied to the levels of technological sophistication within that culture (Bornstein, 1973). We may all share the same neurophysiological basis for colour categories but the classic set of eleven emerges in those cultures with the right infrastructure. So it would seem in theory that technology begets both global languages and conformity in colour nomenclature. But what of indigenous Australian communities, for example, whose often daunting geography of habitat also contributes to linguistic diversity and whose lifestyles are less reliant on the paraphernalia of technology?

One of the major aims of initiating the World Colour Survey in the first place was to verify the original Berlin and Kay (1969) theory of basic colour terms advanced in 1969 by improving on its methodology. One such enhancement would be that informants had to be sourced from monolingual communities with minimal exposure to Western culture, a point emphasized by Hargrave (1982) in her conclusion. This would address a previous criticism that much of the original exposition of the Berlin and Kay (1969) theory was based on work undertaken with university students as test subjects, as well as being derived from evidence in dictionaries and published ethnographies. While many of the indigenous Australian World Colour Survey component had a poor if any command of English, almost all appeared to be multilingual in indigenous languages other than their own. This information is available from Hargrave (1982), who presumably acquired it from the World Colour Survey investigators closer to the time that the field work was actually undertaken. This testimony is not present in the current online version of the World Colour Survey data set it would seem due to a privacy embargo preventing personal details of the informants to be exposed.

## 5.3 Anomalies in the Indigenous Australian World Colour Survey Data Sets

Given that the indigenous Australian informants were primarily multilingual the unanticipated side-effects of linguistic interference could have tainted the results of the World Colour Survey. Weinrich (1953) defined linguistic interference in bilingual speakers as being those cases of variation from the norms of either language. One can imagine then that such effects could be even more complex in a multilingual speaker with emergent phenomena being a distinct possibility within the interlanguage of such an informant. Regardless of this there are also individual differences that may account

To a desert people such as the Warlpiri the ability to read and follow tracks is of paramount importance for survival. This requires being attuned to the natural environment with a heightened sense of awareness to ascertain clues of where prey is to be found on a hunt (Lowe, 2002). These inklings may be extremely subtle and completely overlooked by a non-indigenous observer. Texture may in fact take precedence over colour in how these stimuli in the landscape evoke a response in the aboriginal tracker. Or it may be an inextricable combination of colour, shape and texture that governs how indigenous Australians perceive the world around them, given that some have argued that they could possess a visuospatial predisposition to thought rather than having a temporal bias in this regard (Davidson and Klich, 1981, Ten Houten, 1985).

In her condemnation of the notion of colour universals existing in language and thought, Wierzbicka (2008) extends arguments in Wierzbicka (1990, 1999) by indicating that the Warlpiri people have no custom of speaking about colour and consequently they have no practical sense of it as a quality unto itself. One reason for this is that many indigenous cultures (such as the Warlpiri) do not even have a word to denote the concept of colour (Wierzbicka, 2005). Rather than being obsessed with all matters chromatic, Wierzbicka (2005, 2008) advocates an emphasis on universals of seeing as being an all-inclusive alternative, as well as noting that texture may well be more important a visual concept to a desert people such as the Warlpiri then colour. In this regard, the quality of “shininess” is singled out. However, it must be stated that Wierzbicka’s opinions are based on analyses of secondary sources, such as dictionaries of indigenous languages, and not from a deep scrutiny of the World Colour Survey data set. Nevertheless, her insights on the primacy of texture in the visual semantics of indigenous peoples are echoed in MacLaury (2005) who discusses the variability of brightness categories present in the World Colour Survey data set. MacLaury (1992) had earlier suggested that colour categorization research should move away from a fixation on hue and embrace the influence of brightness more. Indeed, MacLaury (2005) argues for more concerted efforts in ethnographic research to investigate purported brightness naming systems in indigenous cultures before the languages they speak become extinct.

A process-oriented appraisal of colour is described by Young (2006) who contends that the effect of colours working together should be should be studied amongst indigenous peoples, rather than interrogating these subjects on their naming of individual hues presented in a random sequence. A change in colour is argued as being representative of transformation and not just a symbolic entity. For example, the “brilliance” in the colours of indigenous art produced by the Yolgnu of northern Australia is undertaken through the adept mixing of earth pigments to express meanings that have ancestral significance (Young, 2006). The reference to “brilliance” here once again stresses the prominence of brightness in indigenous Australian culture, something that was also a partial finding in the diversity analysis of the World Colour Survey data set cohorts undertaken in this thesis. “Greenness” as a process is also significant to the Pitjantjatjara and Yankunytjatjara peoples of the central Australia, according to Young (2006). Their habitat is the desert and the land becoming green occasionally during the passing of the seasons is a course of action with particular transformative power.

At this point it is worth noting that a major limitation of studies such as those featured in the latter references is that they treat Australian Aborigines as a generic ethnic group whose members all share common characteristics. No effort is made to differentiate between observed cognitive findings on the basis of indigenous language, for example. However, if it is true that skill in the visual perception of spatial relationships takes precedence over verbal performance amongst indigenous Australians on the whole, as Ten Houten (1985) alludes to, then abstraction that leads to categorization would also perhaps not be dominant within their cognitive routines. This could explain the significant levels of confusion in colour naming, rather than agreement, which was displayed by the indigenous Australian World Colour Survey cohorts.

Cultural as well as ecological factors can dictate the level of learning potential within any given environment. Varying conditions as mentioned can evoke differentials in the patterns of ability that emerge within those who dwell in these surroundings (Ferguson, 1956). All human populations may share a common set of perceptual and cognitive processes but optimal development of these as practical abilities is subject to external constraints such as culture and geographic location and not merely reliant on latent aptitude within the individual (Irvine and Berry, 1988). Thus the supposed universal human ability to classify colours could also be conditional on external influences that actually promote diversity rather than facilitate convergence in behaviour.

## *5.4 Colour Categorization Considered as a Cline in Indigenous Communities*

Halliday (1961, p. 249) redefined the biological construct known as cline in a linguistic context as follows: “A cline resembles a hierarchy in that it involves relation along a single dimension; but instead of being made up of a number of discrete terms a cline is a continuum carrying potentially infinite gradation.” Perhaps the colour spectrum can be thought of then as a cline to the indigenous Australian observer participating in the World Colour Survey. The number of colours discernible to the human eye has been estimated to exceed the 2 million mark (Pointer and Attridge, 1998). This is in terms of what is referred to as just-noticeable-differences rather than assigning names to all these. One would assume that this approximation is for the standard Western observer, since no consideration is given to the possible influence of cultural or ecological factors. It may very well be that indigenous Australians of hunter-gatherer descent apprehend this prospective million plus barrage of colours as a cline that relates to the parallel cline that is the texture of their landscape. Being finely attuned to this notion of a natural environment welling over with hybrid visual stimuli is then a resource that can possibly accentuate their renowned tracking abilities (Lewis, 1976).

Using an analysis of the World Colour Survey data set to support their research, Philipona and O’Regan (2006) contend that the cause for the colours ‘red’, ‘yellow’, ‘green’ and ‘blue’ commonly being the most salient of all other colours in terms of their worth to be named, is that surfaces with these colours distinctively alter incoming light to human photoreceptors in a simpler way than other surfaces. So, categorization appears to take advantage of this economy of perception. Discussing the philosophical implications of this finding they advance the notion that what determines the perceived quality of sensations, such as colours, are the inherent characteristics of the general constraints imposed on the interaction of an organism with its environment. This hints at sensorimotor involvement of an organism with its cognitive abilities (O'Regan and Noë, 2001) and suggests that there is a possible new kind of neurophysiological basis for colour categorization that also relies on external context in the physical sense.

People interact with their environment and perception is shaped accordingly which, in turn, leads to categorization being influenced in a certain way. Even though Clark (2008) disagrees with the sensorimotor models advocated by Noë (2005), for example, he too is of the opinion that conscious perception arises from a delicate interchange between brain, body and environment. Neural plasticity has been found to be a factor that can attune colour vision to one's perceptual environment (Neitz, Carroll, Yamauchi, Neitz and Williams, 2002). New models of conscious perception, such as those remarked on, could offer another explanation for the colour naming behaviour observed in indigenous Australian informants who inhabit arid regions of the country.

In Edwin Land's "retinex" theory of vision, perceived colour was dependent not only on the reflected spectrum, but also the surroundings as well (Land, 1977). To Land (1977), then, the perception of colour was reliant more on how surfaces reflect light rather than the nature of the light illuminating those surfaces. In this model, colour was ultimately something that emerged from the interaction of the retina and the visual cortex, hence the term "retinex." But it was processing that was influenced by the environment in which an observer was engaged in perception. Yendrikhovskij (2001) argued that the structure of colour categories resembled the structure of the distribution of colours in the perceived world. Pursuant to this, he discussed a model of colour categorization in which the distribution of colours in a perceived environment could be represented as colour statistics in some perceptual and approximately uniform colour space from which insights could be drawn. This model apparently revealed that the number of colour categories in a language was most likely governed by the compromise between precision in representation of the perceived environment and the level of ease afforded by the category system. In short, the natural world of the observer influenced colour categorization.

Given that Berlin and Kay (1969) originally surmised that a society's ability to categorize the full complement of 11 basic colour terms is a de facto indicator of its level of technological complexity, this is actually a case of the environment shaping human perception. Biederman and Vessel (2006) advanced the hypothesis that humans possessed an "infovore" system that generated a craving for information that was activated when other more base level needs, such as food and shelter, were satisfied. They contended that such a system evolved to augment the degree to which individuals could attain knowledge in situations where there might be no direct requirement for the information. But this information could be stored away for use when more appropriate.

In the model espoused by Biederman and Vessel (2006), an appetite for information was driven by the pleasure-seeking regions of the brain and would in part be subject to the technological refinement of the environment that an individual inhabited since this would govern whether or not fundamental human needs were satiated first. Perhaps this infovore behaviour could manifest itself in the development of a full set of 11 basic colour terms as maintained by Berlin and Kay (1969). In a less industrial ambience, such as the environments inhabited by members of the indigenous Australian World Colour Survey cohorts, if the theory is correct then this could lead to less of an emphasis in superfluous categorization.

## *5.5 Thought without Language Rendering Colour Categories as an Optional Extra?*

The paucity of colour terms in the Warlpiri lexicon is also replicated in their approach to the naming of numeric concepts, as it has a very limited number vocabulary which is a characteristic that is apparently shared by other indigenous Australian languages. It is claimed that equivalent number words exist only exist for the likes of 'one, 'two' and 'many.' However, Harris (1982), cited in Klich (1988), claimed that if number terms were not present in an indigenous Australian language then it was because a suitable functional context had not been discovered yet by linguistics researchers or such a context-specific system might have fallen into disuse.

In a study of children aged 4 to 7 years who are monolingual speakers of Warlpiri and another language of Northern Territory origin (Anindilyakwa ) it was found that they have the same numerical concepts as a similar group of English speaking indigenous Australian children based in the urban setting of Melbourne, Australia (Butterworth et al, 2008; Butterworth and Reeve, 2008). What this research implied was that thoughts are possible without the words to give them form. In this context, it meant that a full counting vocabulary was not a prerequisite for the development of numeric concepts. The authors of this study posited that conceptual evolution took place first to initiate the attainment of counting words and not vice versa.

The notion of prelingual thought has been discussed in the past (e.g. Furth, 1966; Bermúdez, 2003) and the capacity for numeric thought without counting words may be one example of this. In the case of the neurological phenomenon known as blindsight, people are unable to see objects in a certain region of their visual field, yet they can still express a limited reaction to the visual stimuli (Weiskrantz, 1986). This suggests the possible existence of unconscious processing in cognition and this would be another example of thought without language, since the latter requires awareness for action. Perhaps such a mechanism is also in place with respect to colour concepts, meaning that a functional appreciation of these would also be possible without having a complete vocabulary in which to express them. Awareness of colours by some could be driven more by intuition in order to take advantage of the speed afforded by unconscious processing in certain cognitive tasks.

## *5.6 The Cultural Salience of Entities*

The notion of colour as "determined communication" was explored in Jacobson and Bender (1996), but their idea of colour was free of the influence of culture almost by assumption. They used their paper to announce further studies into the links between colour and emotion. As to communication, they contended that the dimensions of how colour was experienced make up the internal context in which a message is received, setting up a sense-of-order or expectation with the potential to be violated and then later resolved. The problem with this line of reasoning is that colour can probably only be a form of communication if a culture allows it to be so.

In a study to evaluate timed picture naming of culturally salient objects across seven languages – these being English, German, Spanish, Italian, Bulgarian, Hungarian and Chinese – Bates, D'Amico, Jacobsen, Székely, Andonova, Devescovi, Herron, Ching Lu, Pechmann, Pléh, Wicha, Federmeier, Gerdjikova, Gutierrez, Hung, Hsu, Iyer, Kohnert, Mehotcheva, Orozco-Figueroa, Tzeng & Tzeng (2003) found that agreement in naming target objects was high in all of the language groups surveyed. Levels of accord ranged from a minimum of 71.9% for Chinese speakers to a maximum of 85.0% for the English group. Such consensus in English speakers is also reflected in allied studies dealing with colour naming behaviour (Sturges and Whitfield, 1995). While research such as this does not indicate unanimous agreement in naming, even by Western-influenced informants, by comparison it still far exceeds the concordance in nomenclature observed in the indigenous Australian World Colour Survey cohorts.

Why the high degree of confusion in colour naming amongst the indigenous Australians taking part in the World Colour Survey? One possible reason may be due to communication issues in undertaking the study itself. These relate to discourse practices amongst these groups as was outlined in the literature review of this thesis. As was mentioned it generally impolite to ask most Australian aboriginals a direct question. By its very nature, the overarching format of the World Colour Survey asks its subjects the following direct question 330 times, “What colour is this stimulus chip that is being presented to you?” Now the latter question may not have been overtly uttered that many times in the field but it is implicit in the fabric of the experiment.

To be a culturally appropriate question for the indigenous Australian, such a query must be framed in an indirect fashion as noted in the literature review. However, the response time, even for questions such as these, is not necessarily to be expected as soon as possible after they are asked. Muecke (2004) refers to the indigenous Australian concept of time as not being metrical in quality but periodic nonetheless when acted out in shared rituals. Aboriginal culture on the whole would seem to be event-driven rather than being constrained by Western notions of schedules governed by the clock. Thus the ecological validity of a field study such as the World Colour Survey is suspect given that the notion of reaction (or response latency) time in naming stimuli (either explicit or implicit) is not applicable to informants from such a culture. In retrospect it would seem that asking indigenous Australians to name stimuli at an individual level is not a suitable strategy in all cases. Perhaps if all subjects in a cohort could be shown colour stimuli as a massed group then a more valid consensus is attainable with regards to what the group designates the colour to be.

When cultures meet the dominant one would tends to exert social influences in the guise of such forms as education and urbanisation, not to mention the linguistic, political and religious transformations that occur as well (Irvine and Berry, 1988). A process of acculturation such as this would explain the close similarity in form between Kriol and English colour terms as noted in this thesis. In effect all Kriol colour terms are loanwords, being as they are mirror words of English in a Creole dialect, so their candidature as basic colour terms would immediately be suspect.

## *5.7 Stochastic Resonance: Another Explanation for Anomalies in Colour Categorization?*

The word “dither” is a British colloquial term that means “undecidedness,” a state of being where certitude is submerged by the noise of choice. In image and digital audio processing, though, dither is a positive system attribute that can enhance output (Roberts, 1962; Vanderkooy and Lipshitz, 1987). This intentional application of noise serves to randomize certain types of errors and in so doing assists to prevent large-scale stochastic patterns within system output that are more intolerable than noise devoid of any associative correlation. In digital audio processing, for example, the addition of an appropriate amount of noise can diminish some types of sonic distortion.

Braiman, Lindner and Ditto (1995) reported on their revelation that certain kinds of complex systems could achieve a semblance of order by the inclusion of a degree of variability and disorder. This challenged the conventional wisdom that noise within a physical system had the tendency to damage spatial and temporal uniformity. Allied to this is the phenomenon of stochastic resonance (Weisenfeld and Moss, 1995). Noise within dynamical systems is generally viewed as being an annoyance. However, in selected nonlinear systems, such as electronic circuits and biological sensory apparatus, it has been observed that the inclusion of noise has the paradoxical effect of amplifying the detection of weak periodic signals.

The mechanism known as stochastic resonance is a non-linear cooperative effect in which a weak stimulus of a recurrent nature can give rise to large-scale environmental perturbations, with the consequence being that the periodic component of the system is accentuated. Weisenfeld and Moss (1995) speculated on a variety of applications of stochastic resonance within physical, technological and biological contexts, citing one intriguing example from palaeoclimatology that stochastic resonance could have been the underlying cause of periodic recurrences of ice ages in Earth's history. Spinney (2008) discusses neuroscience research into the possible role of stochastic resonance within the brain as a catalyst to improve the performance of neurons in processing signals, such as during sensory perception.

What has not been touched upon in the scholarly literature dealing with stochastic resonance is its potential manifestation in linguistic systems. Language itself has been described as a complex adaptive system by Steels (2000), who postulates discrimination games as contributing to the evolution of meaning repertoires in category formation. Smith, Brighton and Kirby (2003) contended that language emerged from the interaction of three complex adaptive systems, these being biological evolution, learning and culture. So, could the complex system of language accentuate its order by the insertion of a degree of variability and disorder as well? For example, within a certain language group, if there is a high degree of diversity in the initial creation and adoption of a new word that denotes a particular thing, then this could be construed as a kind of noise, especially to observers outside of the linguistic cohort. Analogous to the processes of stochastic resonance in physical systems, this "noise" of diversity could over time enhance the semantic signal that associates word and referent.

In linguistics it has generally been agreed since the work of Ferdinand de Saussure (1983), originally published in 1916 (Saussure, 1916/1983), that there is no special relationship between the form of words and that which they refer to. This is known as the arbitrariness of the sign, whereby there should be no natural reason for the existence of predetermined association between a sign and a concept that it signifies. A connection between form and meaning would imply the existence of iconicity, which Gasser (2004) contends is a possibility in a language with a small corpus of words. However, he also argues that arbitrariness becomes essential within a language as more and more words are created. It evolves as a strategy to deal with the rising complexity of concepts that are discovered over time.

From a different perspective, one can say that when there is a smaller number of words within a language and iconicity may be more prevalent, there is a possibility that greater lexical diversity exists. Colour names, for example, could be represented by objects which visibly display that quality. Dependent on the environment, there could be several natural objects that could be used to denote the same colour in an iconic fashion. As the number of words in that language increases due to ongoing concept generation then arbitrariness would supposedly take hold. As a consequence, lexical diversity in the colour domain, as well as other areas, could decrease because of the diminishing of iconicity in form-meaning relationships. This would imply that arbitrariness actually promotes the level of conceptual agreement within a language.

# CHAPTER 6

# 6 Conclusion

Due to the encroaching influence of English language and culture, replicating a cross-cultural experiment as ambitious in scope as the World Colour Survey seems highly unlikely. In the case of the indigenous Australian component of the World Colour Survey, while languages such as Warlpiri and Murinh-Patha are managing to survive, Aboriginal English (Arthur, 1996) is becoming a lingua franca for many, thus introducing possible confounding factors for any future colour categorization study in a similar vein. Arguably, Kriol should have been omitted by the original project team as a choice in the indigenous Australian component of the World Colour Survey due to its close affinity in form to the English language (Hagan, 2007). As was indicated in this work the indigenous Australian World Colour Survey data set was derived from informants who were chiefly polylingual, not monolingual, as in the original intentions of the project. Due to the probable cognitive interference of multiple languages it is then uncertain whether colour categorization results from subjects can be associated with a single language that is deemed to be their mother tongue. This is a major limitation in the analysis of the World Colour Survey data set, the other being the small sample sizes for language groups.

Statistically significant judgments ideally should not be based on data gleaned from sample sizes averaging 25 individuals, this being the case in the World Colour Survey. Yet in anthropological circles, scholars such as Mead and Métraux, (1953) have argued that a single informant, given the proviso that his or her social and cultural status is thoroughly understood, could be an acceptable source of information about widely distributed patterns within a larger group. With respect to an individual's knowledge of colour, an awareness of this social and cultural background would be of paramount importance. Elkin (1937) considered indigenous Australian world-views in culturally pristine times to have been a kind of philosophy or multiplicity thereof. This being the case, knowledge of such a suite of indigenous philosophies would also have been of use in the analysis of something like the World Colour Survey data set, but little or no documentation in this respect exists.

With respect to the individual World Colour Survey informants, social and cultural positions were not even mentioned in the available online data set since the personal data was embargoed, presumably on an indefinite basis, on privacy grounds. (The original microfiches of the World Colour Survey data set, which do contain personal data on informants, cannot be used for valid research purposes due to the inherent errors therein as reported by the original project team, not to mention the aforementioned privacy issues as well.) The only personal data that could be legitimately accessed for analysis was through a secondary published source, namely Hargrave (1982). Given all these limitations any analysis of the World Colour Survey data set should be tinged with uncertainty. Also, since the content of the World Colour Survey data set is over 30 years old, it is in fact archival in nature and any analyses are at best historical exercises in gathering past knowledge whose verification in the future is improbable.

The originality of this work lies in the fact that it represents a first attempt at an independent analysis of the indigenous Australian component of the World Colour Survey data set. The analytical approach taken was also unique in that the concept of diversity from ecological modelling was adapted as a framework in understanding the data. Other analyses, as indicated in the literature survey of this work, have examined the World Colour Survey data set in a holistic manner, almost as a single entity, with clear patterns emerging coupled with opaque explanations and the end product being a justification of the Berlin and Kay (1969) position. Examining the indigenous Australian component of the World Colour Survey in isolation was thought to offer a more directed interpretation of what patterns could be found therein. To seek out these potential patterns led to the other original aspect of this work, namely the application of diversity analysis techniques from the domain of ecological modelling and the concurrent metaphorical reframing of the colour term concept as a species. The hypothesis in the latter instance was that if categorization in a community of speakers relies on a shared set of specifics then there exists a level of consensus that minimises diversity.

The findings of the work as presented here can at best be described as being inconclusive. Diversity analysis of the colour naming data from the indigenous Australian component of the World Colour Survey did not reveal any patterns that would strongly support the existence of a set of basic colour terms in the Berlin and Kay

(1969) tradition within any of the constituent language groups. At best only weak evidence is present in the diversity analysis of such patterns, such as in the case of Kriol, Kuku-Yalanji and Murinh-Patha. However, this is more weak evidence that denotes the salience of certain colours to the informants in these cohorts, rather than concrete support of the Berlin and Kay (1969) theory. Given the polylingual background of the cohort members involved, as well as the small number of informants, no statistically significant determination of a set of basic colour terms existing could be deemed a feasible proposition in this case. Rather there were allusions to earlier observations of the indigenous Australian component of the World Colour Survey as noted by Hargrave (1982) before the data were remastered for online public distribution.

One intimation from the diversity analysis indicated that the salience of ‘yellow’ was accentuated in the Warlpiri cohort, possibly due to cultural connotations associated with the mineral pigment, yellow ochre. However, the Warlpiri term associated with yellow ochre was found to also be used by speakers of other dialects living in nearby desert regions. Hence, it was uncertain whether the salience of yellow was unique to the Warlpiri or whether it was an idiosyncratic characteristic of all desert peoples in that general locale, given the common value assigned to yellow ochre. The diversity analysis also supported the observation by Hargrave (1982) that there appeared to be an absence of ‘white’ in the Martu Wangka colour lexicon.

On the other hand, the diversity analysis of the Murinh-Patha World Colour Survey data revealed that informants demonstrated a greater salience towards ‘white.’ Rather than indicating a greater affinity for the ‘white’ as a colour, the latter could be a suggestion that the quality of brightness is a prominent stimulus for these informants. This was speculated in this work as being a cultural side-effect of being immersed in the ambient illumination present within the habitat of the informants (i.e. Wadyeye, located south-west of Darwin in Australia’s Northern Territory.) But this is only conjecture and an equally valid one could also be that the members of the Murinh-Patha cohort have a heightened salience for texture. They could be misinterpreting something that appears to them as ‘shiny’ as being the equivalent of ‘white’, given that the latter is a bright colour. Perhaps this was also true of the Martu Wangka cohort: They could have misinterpreted ‘white’ for ‘shiny’ and not have been satisfied that the colour stimuli presented to them were representative of this quality, an inference put forward by Hargrave (1982).

Diversity analysis was found to be a useful diagnostic tool that could indicate levels of confusion in gathering the original World Colour Survey data, especially with respect to the indigenous Australian cohorts. Based on what was revealed in the analysis detailed in this work, ambiguity appears to reign supreme within the World Colour Survey data set, at least with respect to the indigenous Australian component. Diversity analysis cannot state that what is present in the extant data shows any kind of obvious conformity to the original Berlin and Kay (1969) theory in how the patterns of colour terms are dispersed. To achieve true wisdom in cross-cultural colour categorization within respect to the indigenous Australian populations that were surveyed would require a deep understanding of the social and cultural constructs underpinning their existence. This is sorely lacking in what is available for distribution in the World Colour Survey data set as it currently is presented. A macro-analysis of the entire World Colour Survey data set might reveal patterns that support the Berlin and Kay (1969) position but in this instance a micro-analysis, focused on the continent of Australia, exposed ambivalent consternation in the findings.

# 7 References


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# Appendix 1 - World Colour Survey Munsell Chart Legend

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 18 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9.5 |
| B | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 6 | 6 | 6 | 6 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 9.0 |
| C | 0 | 6 | 6 | 6 | 6 | 6 | 6 | 8 | 14 | 16 | 14 | 12 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | 6 | 6 | 8.0 |
| D | 0 | 8 | 8 | 10 | 10 | 10 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 8 | 8 | 10 | 10 | 8 | 8 | 7.0 |
| E | 0 | 12 | 12 | 12 | 14 | 16 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 10 | 10 | 10 | 10 | 12 | 12 | 6.0 |
| F | 0 | 14 | 14 | 14 | 16 | 14 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 14 | 14 | 5.0 |
| G | 0 | 14 | 14 | 14 | 14 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 8 | 8 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 8 | 8 | 10 | 10 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 4.0 |
| H | 0 | 10 | 10 | 12 | 10 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | 8 | 8 | 10 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 8 | 10 | 10 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 3.0 |
| I | 0 | 8 | 8 | 8 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 8 | 10 | 8 | 8 | 8 | 6 | 6 | 8 | 8 | 8 | 8 | 2.0 |
| J | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1.5 |
| | | 2.5 | 5 | 7.5 | 10 | | 5 | | 10 | | 5 | | 10 | | 5 | | 10 | | 5 | | 10 | | 5 | | 10 | | 5 | | 10 | | 5 | | 10 | | 5 | | 10 | | 5 | | 10 | |
| | | | R | | | | YR | | | | Y | | | | GY | | | | G | | | | BG | | | | B | | | | BP | | | | P | | | | RP | | | |

**Figure A1 - World Colour Survey Munsell Chart**

Note: The above represents the Munsell colour order system and WCS coordinates for the collection of stimuli presented to informants in the WCS study. The column at the very left and the row at the top designate the WCS coordinates for brightness and hue respectively. Figures in the body of the table indicate the associated Munsell chroma numbers (i.e. degree of saturation.) By convention there are no Munsell hues at the boundaries of value (i.e. brightness): 9.5 ('white') and 1.5 ('black')

Source: http://www.icsi.berkeley.edu/wcs/data/cnum-maps/WCS-Munsell-chart.html, last accessed: December 20, 2008

# Appendix 2 - Miscellaneous Details Regarding the World Colour Survey Munsell Chart

The comments below refer to the World Colour Survey Munsell chart legend featured in Figure A1 of Appendix 1:

According to the late Robert MacLaury (personal communication, 2000), elements A0 to A40 of each colour chart (i.e. the first row) represented the Munsell colour chip N9.5, while elements J0 to J40 of each chart (i.e. the bottom row) represented the Munsell colour chip N0.5. The example template for the World Colour Survey chart format provided by MacLaury in his personal communication indicated column designations ranging from 1 to 40, rather than from 0 to 40 as per the original. This was presumably the same template used in his published research on colour categorization (MacLaury, 1997). The principal investigator of the World Colour Survey, Paul Kay, also indicated that column designations on the Munsell colour charts range from 1 to 40 (personal communication, 2000), according to details obtained by him from Hale Color Consultants, Inc. (http://www.halecolorcharts.com) the suppliers of the stimuli set.

Both Kay and MacLaury referred to the row designations on the World Colour Survey charts as corresponding to the measure of Munsell Value (or "lightness"). The chart letter "A" maps to the Munsell Value 9.5, "B" maps to 9.0, "C" maps to 8.0 and so on, until the letter "J" which maps to 0.5. The column designations in World Colour Survey notation represented Munsell hues. No representation was offered for Munsell Chroma (i.e. saturation) in World Colour Survey notation. According to MacLaury (personal communication, 2000) then, C9 in World Colour Survey notation would translate to 2.5Y8.0/16 in Munsell notation. This is a "vivid yellow" (Kelly and Judd, 1976). Using Kay's translation scheme the equivalent Munsell notation would in fact be 2.5Y8.0/14.

# Appendix 3 - Kriol Diversity Index Data

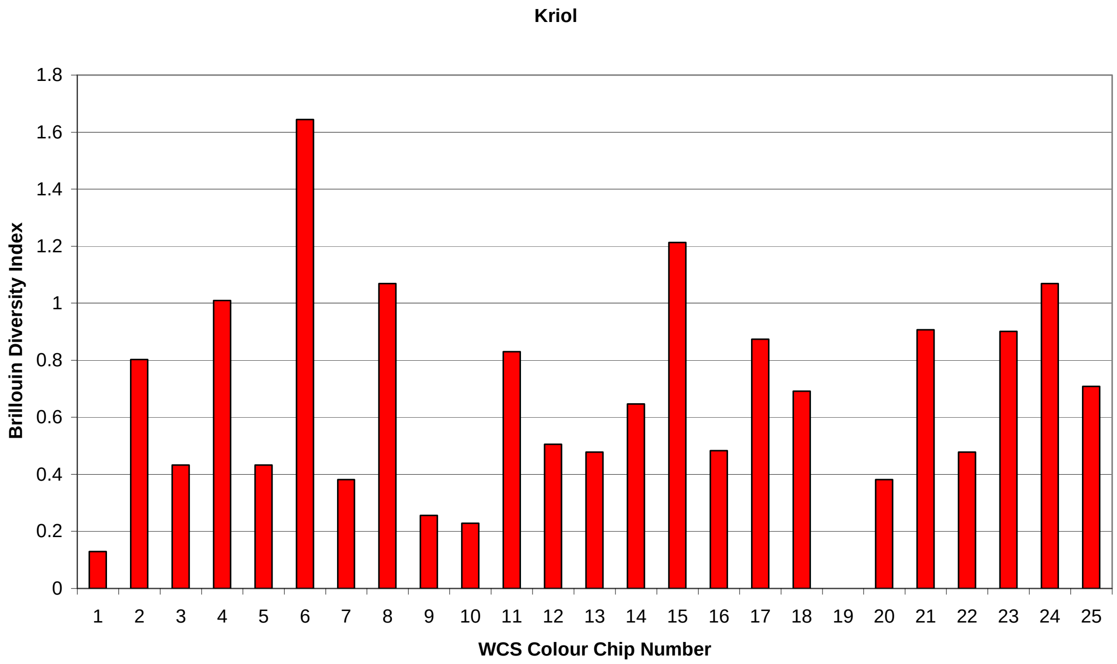


**Figure A3.1 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 1 to 25**

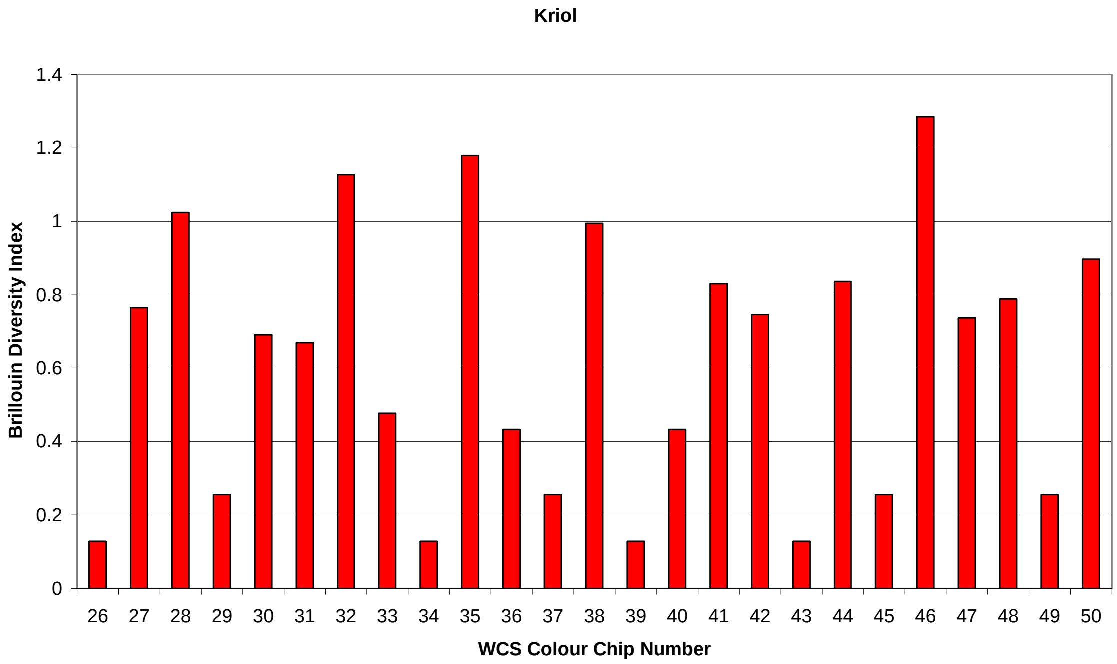


**Figure A3.2 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 26 to 50**

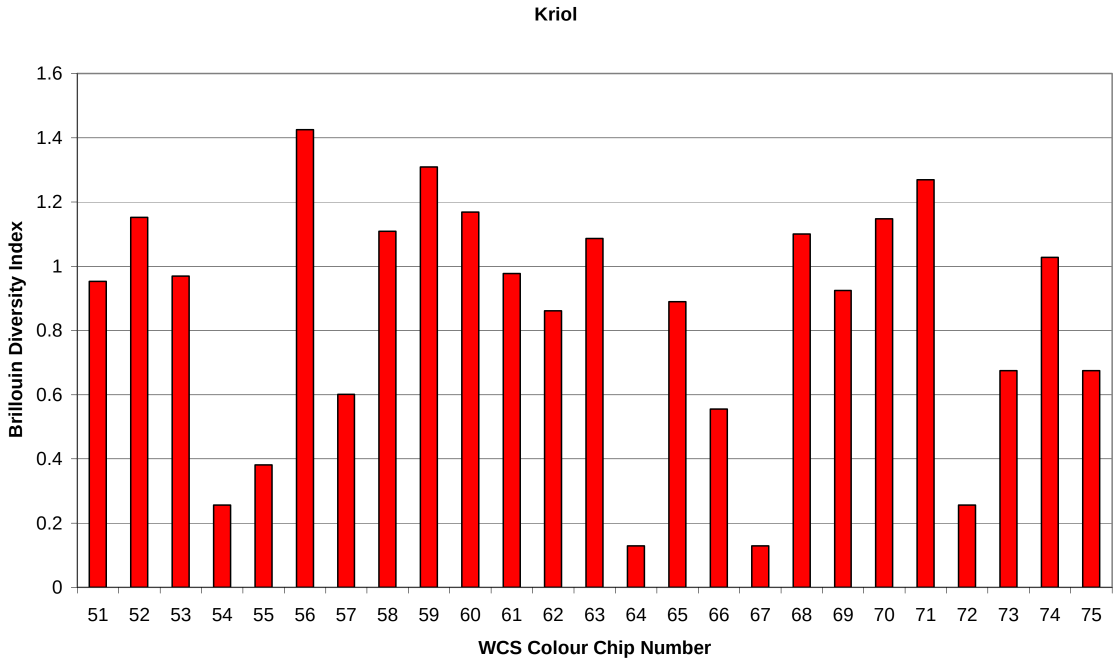


**Figure A3.3 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 51 to 75**

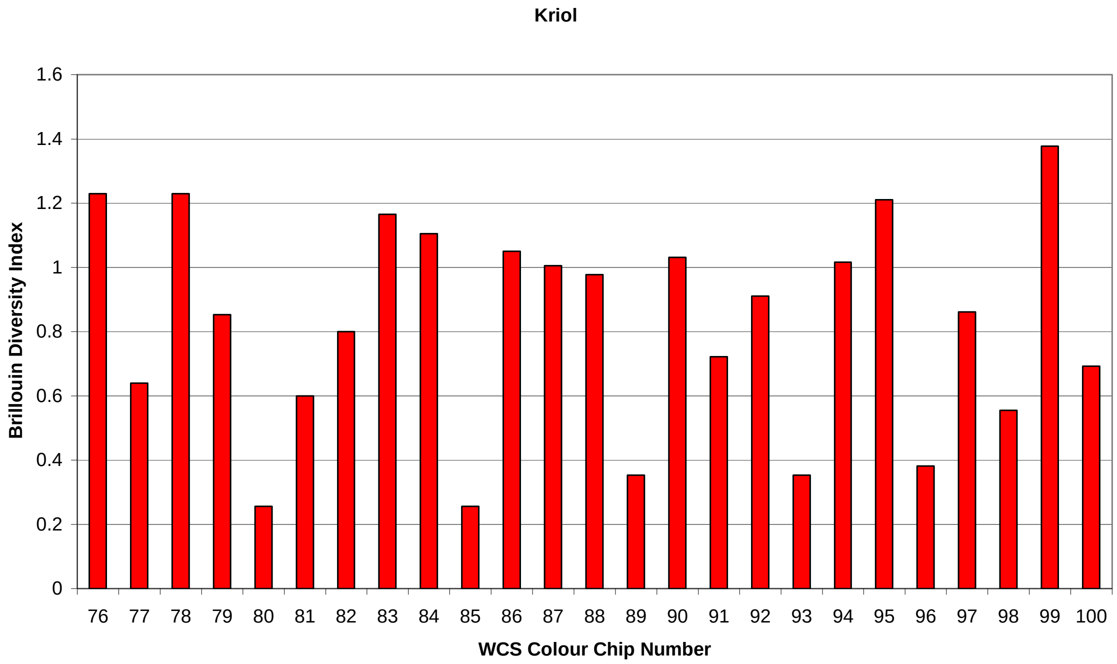


**Figure A3.4 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 76 to 100**

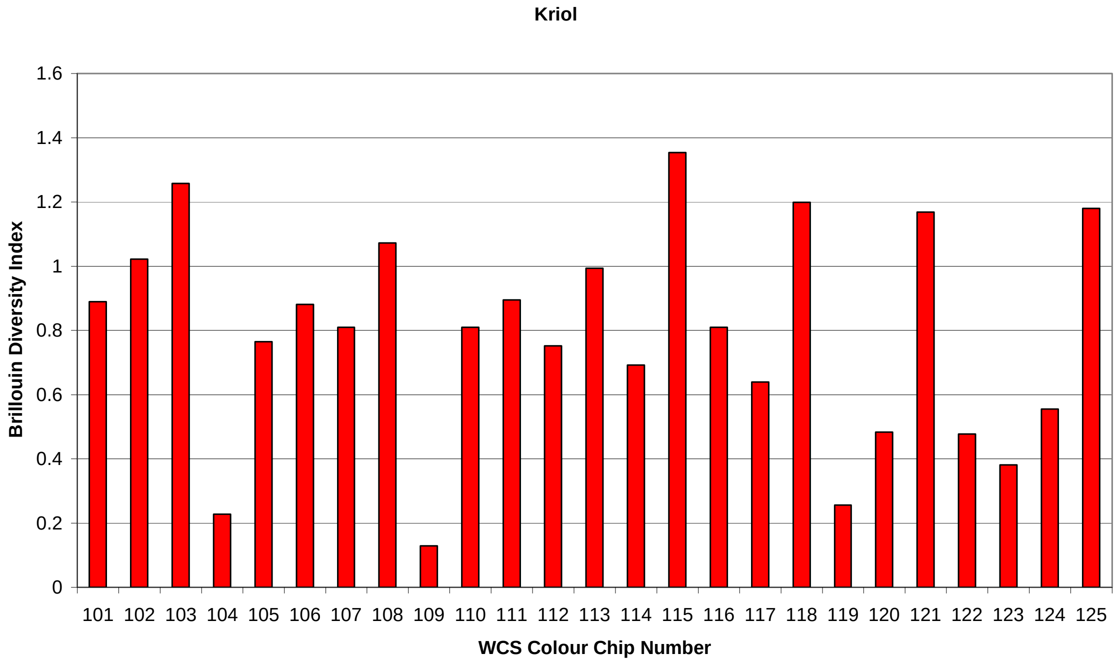


**Figure A3.5 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 101 to 125**

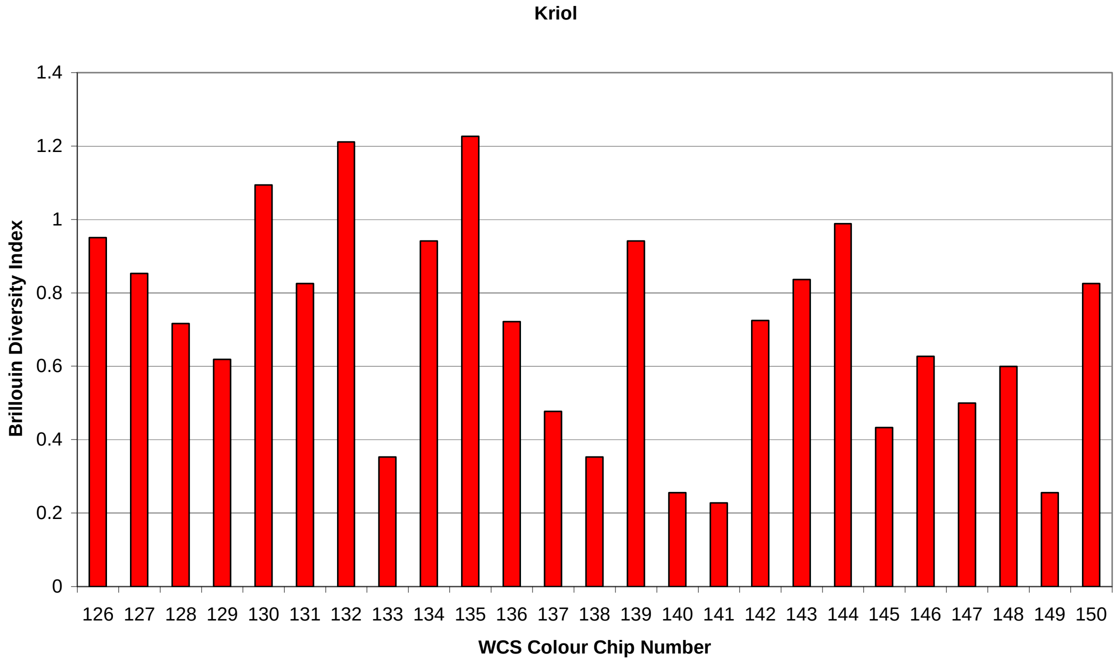


**Figure A3.6 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 126 to 150**

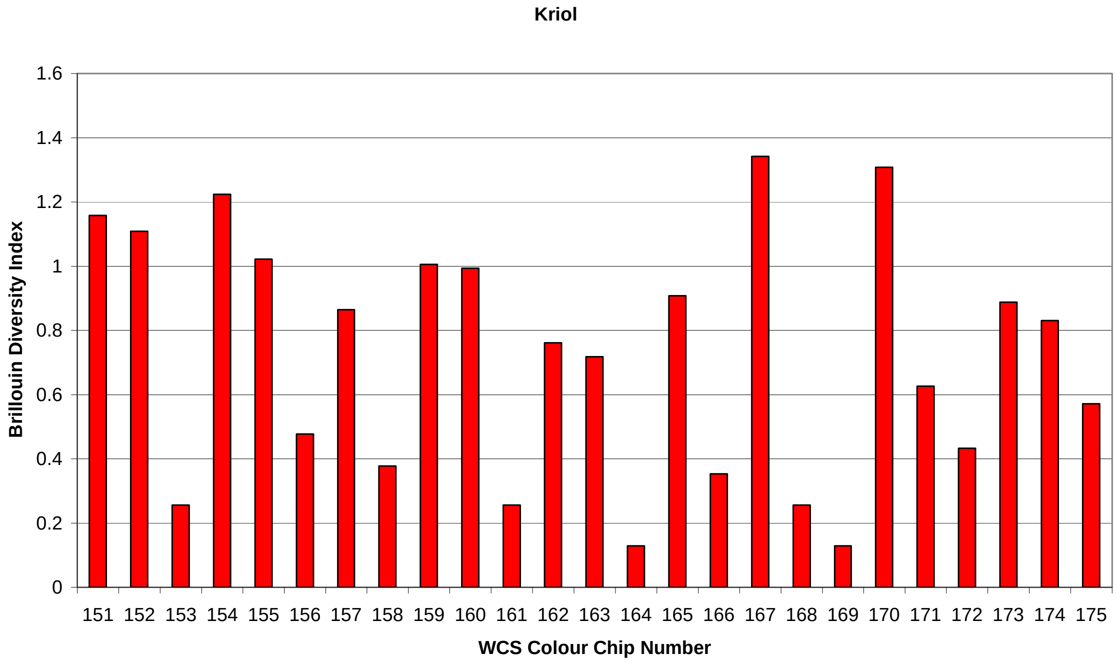


**Figure A3.7 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 151 to 175**

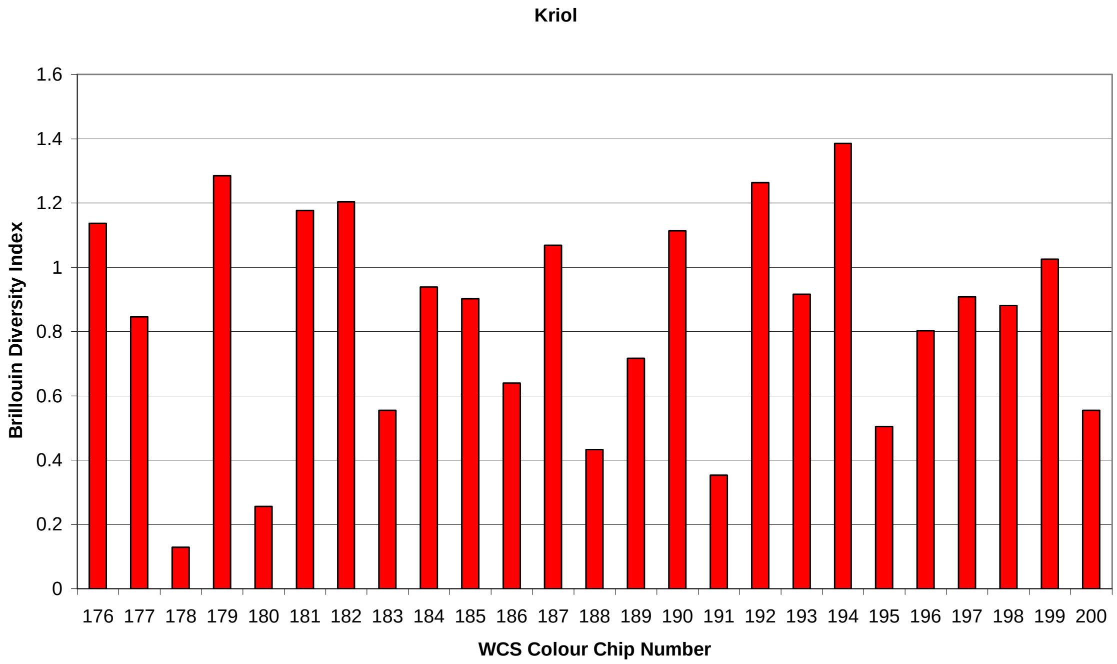


**Figure A3.8 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 176 to 200**

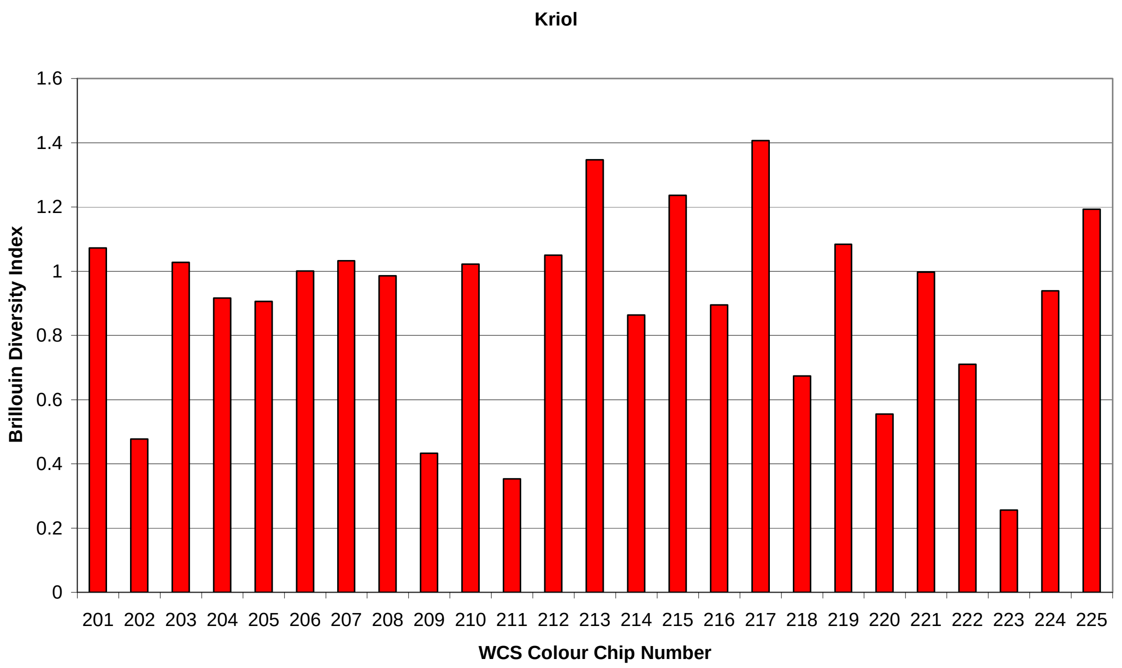


**Figure A3.9 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 201 to 225**

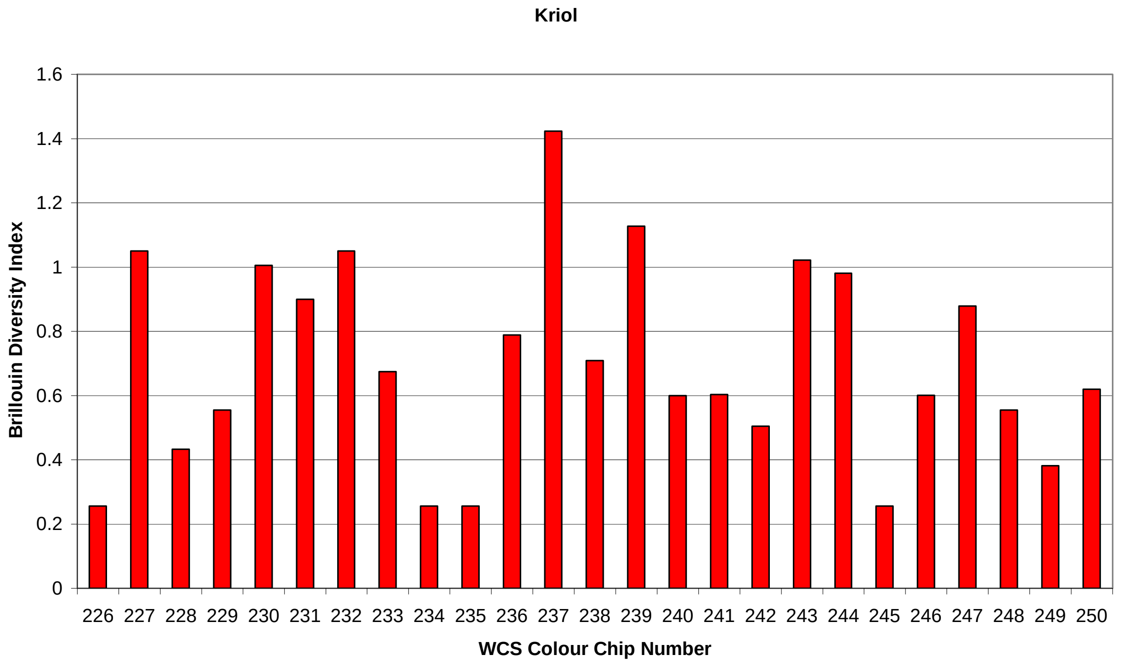


**Figure A3.10 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 226 to 250**

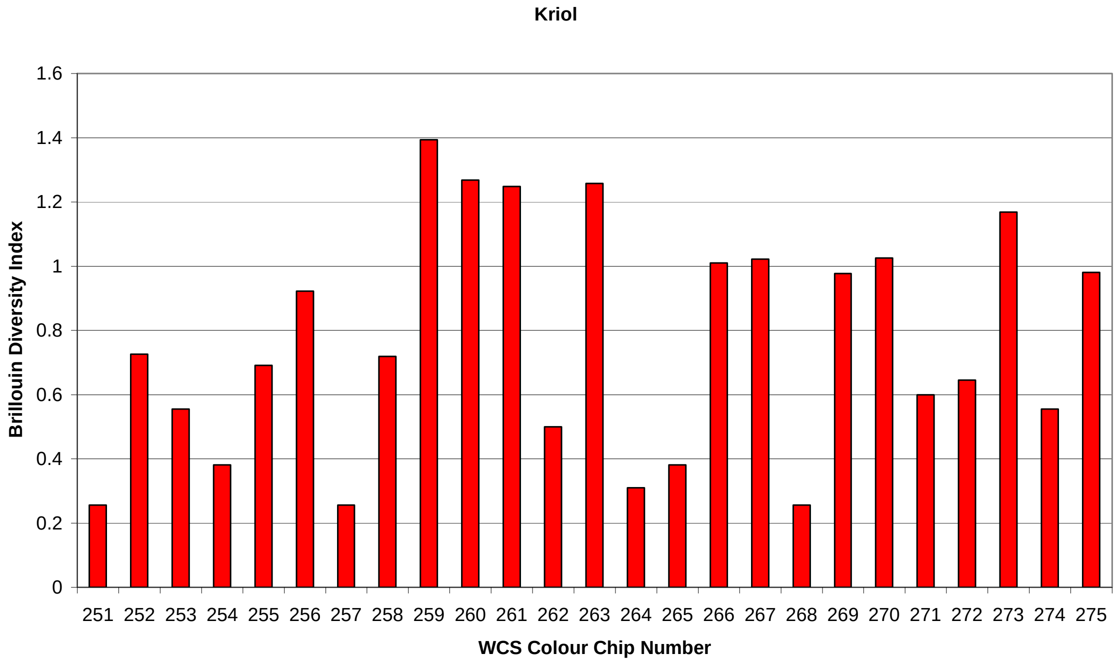


**Figure A3.11 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 251 to 275**

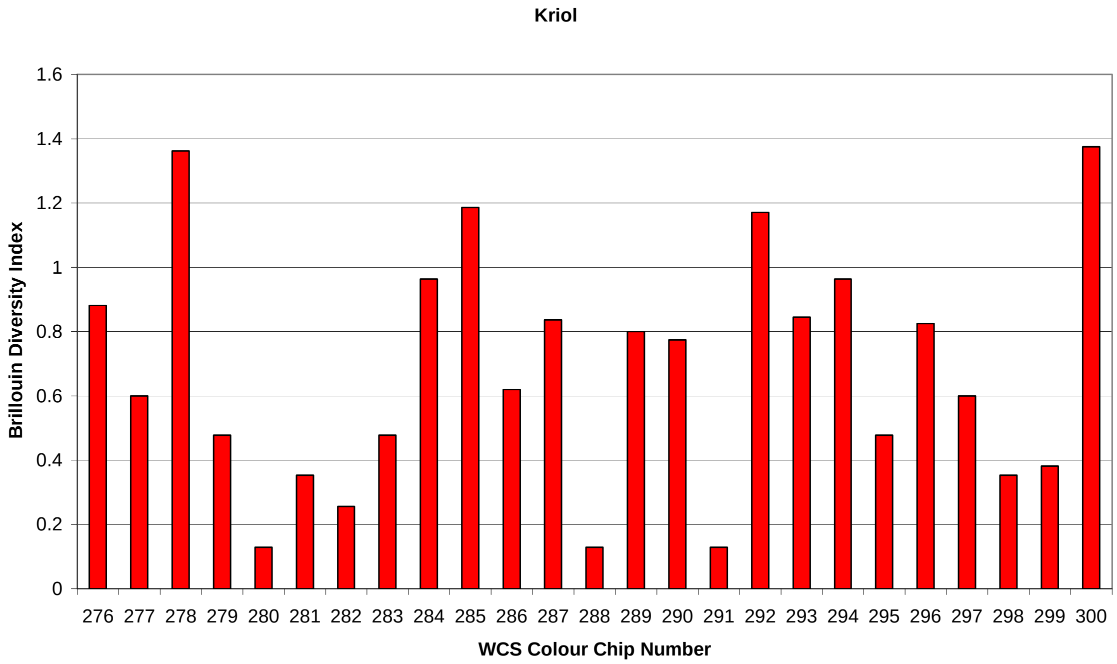


**Figure A3.12 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 276 to 300**

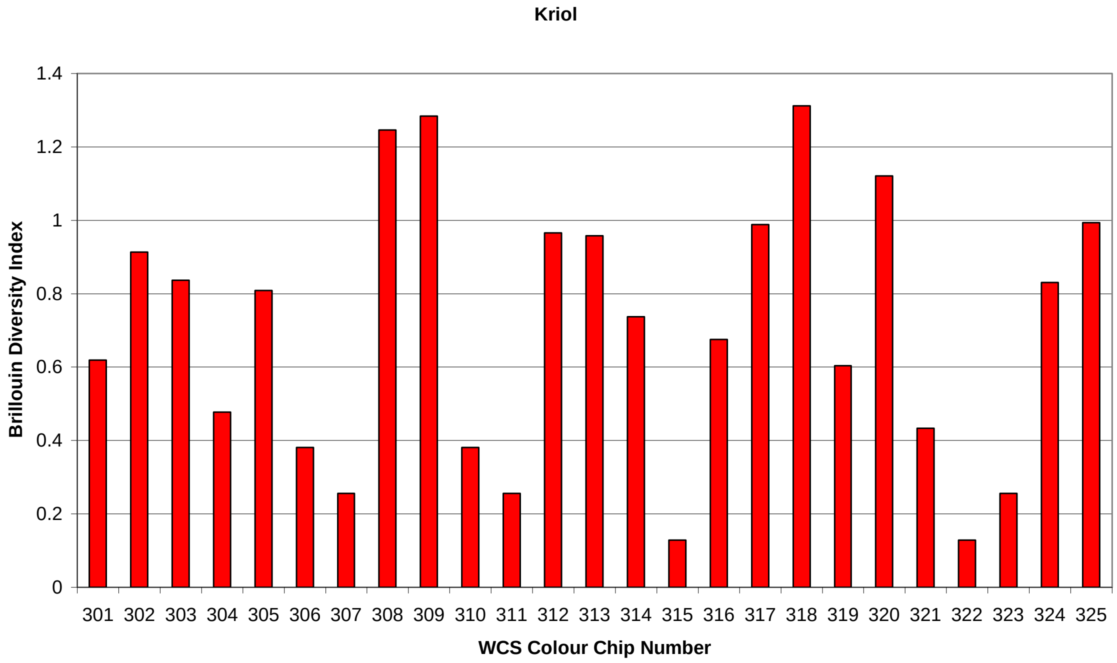


**Figure A3.13 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 301 to 325**

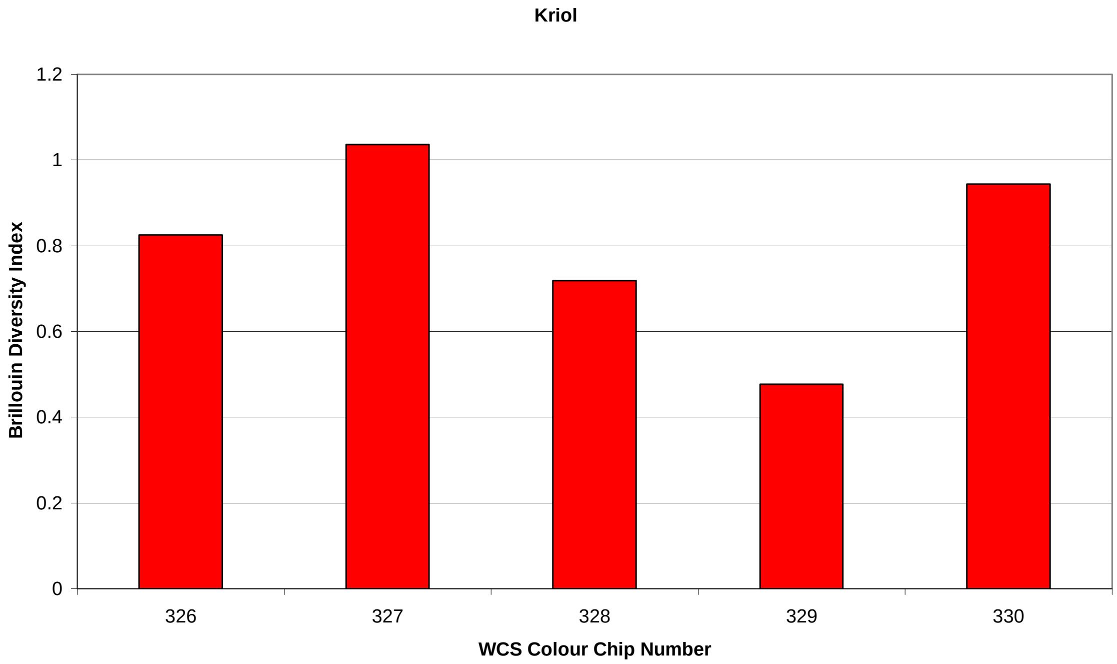


**Figure A3.14 - Kriol:**
**Brillouin diversity index data for Munsell colour chips 326 to 330**

# Appendix 4 - Kuku-Yalanji Diversity Index Data

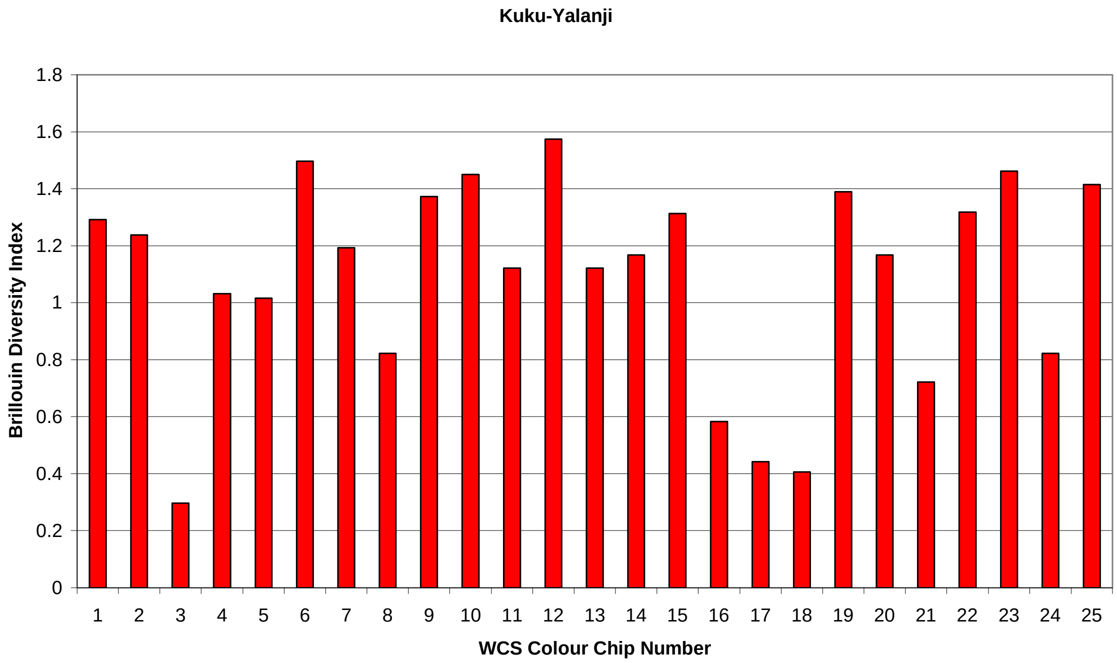


**Figure A4.1 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 1 to 25**

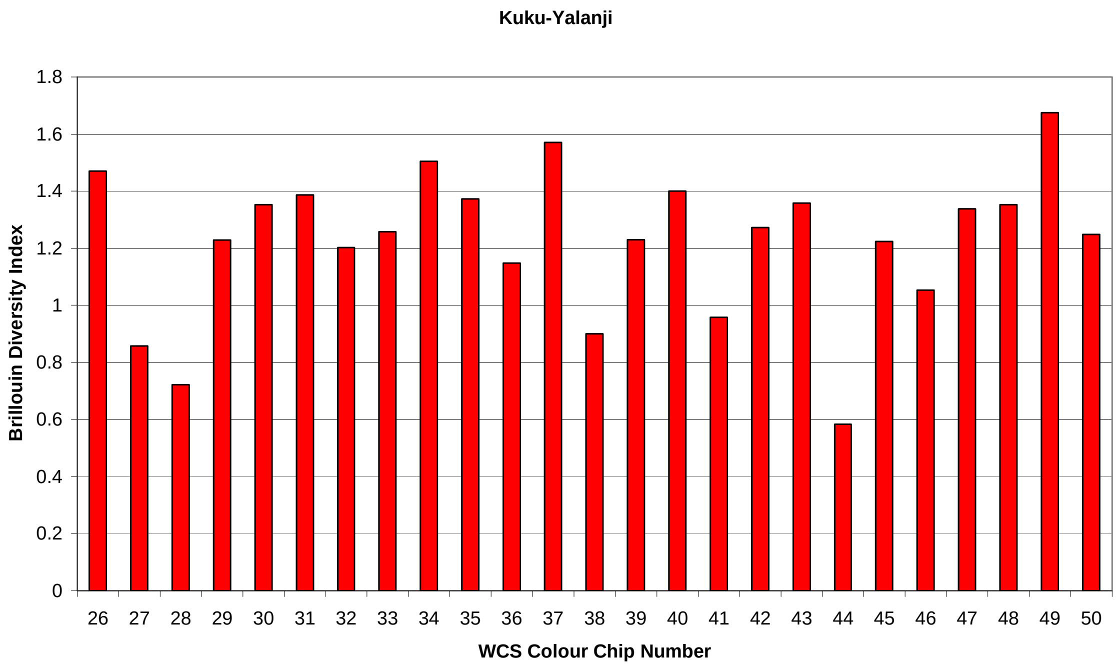


**Figure A4.2 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 26 to 50**

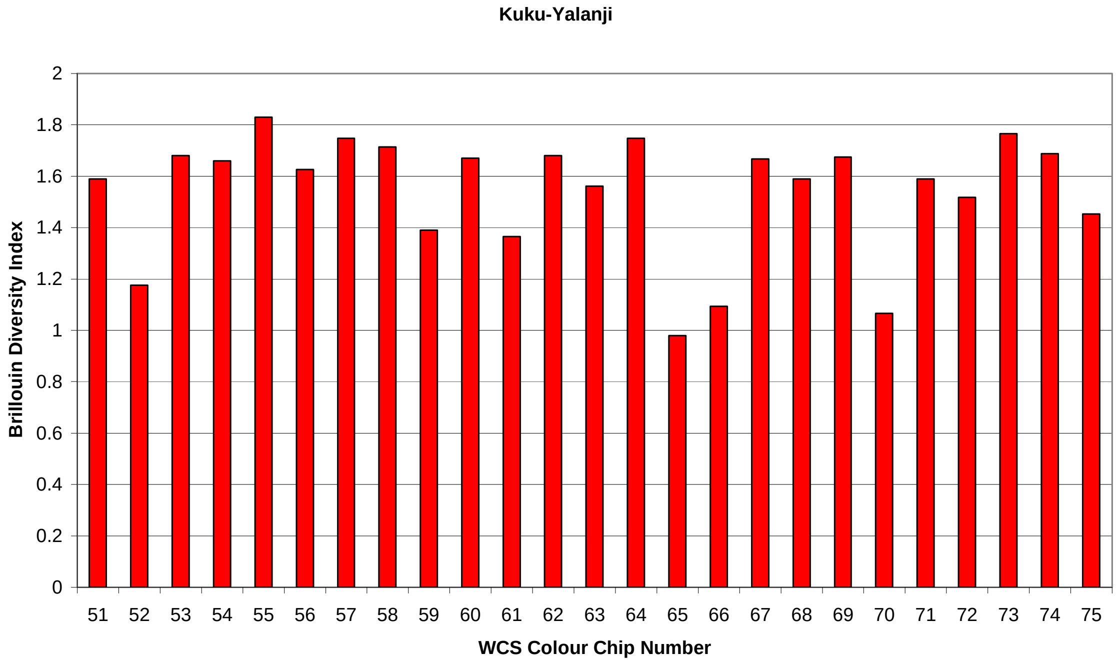


**Figure A4.3 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 51 to 75**

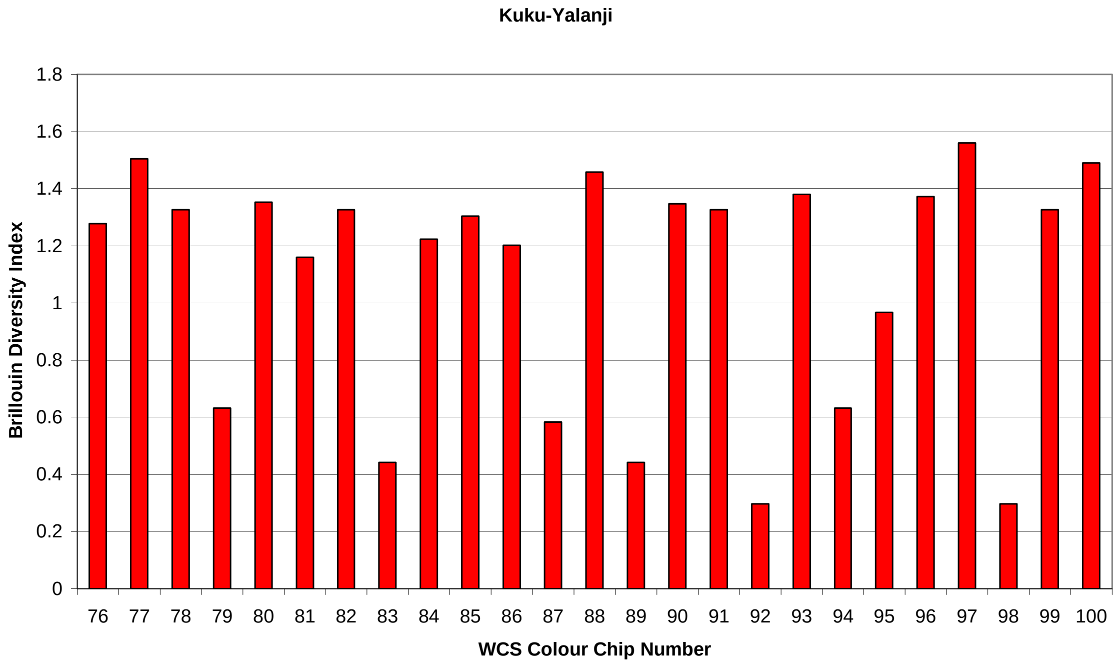


**Figure A4.4 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 76 to 100**

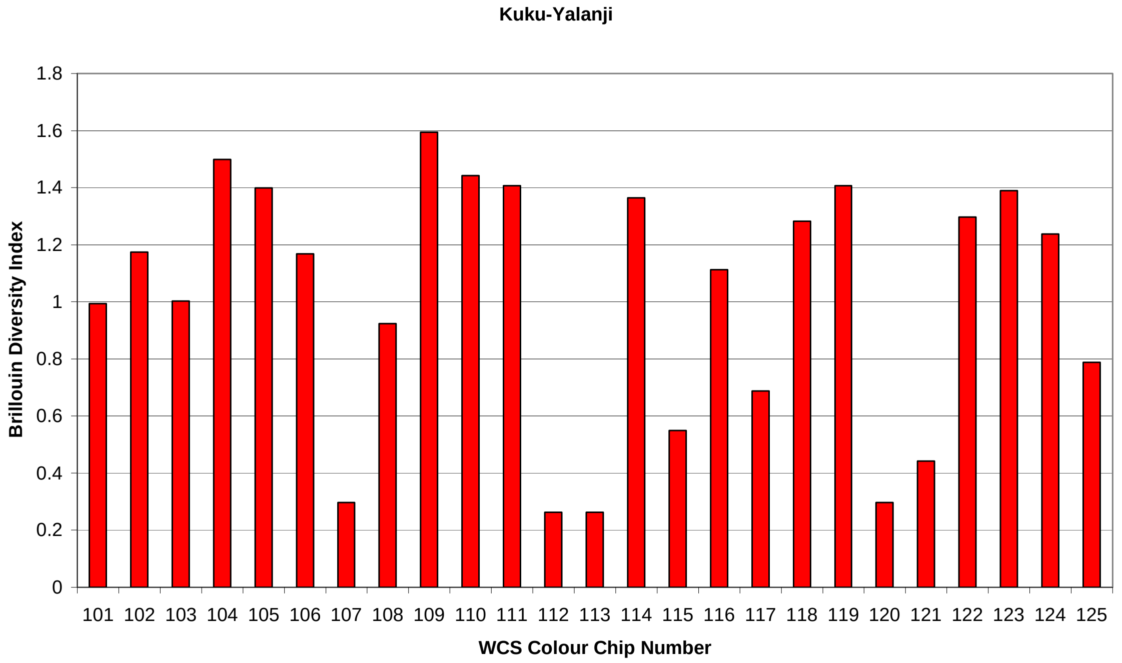


**Figure A4.5 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 101 to 125**

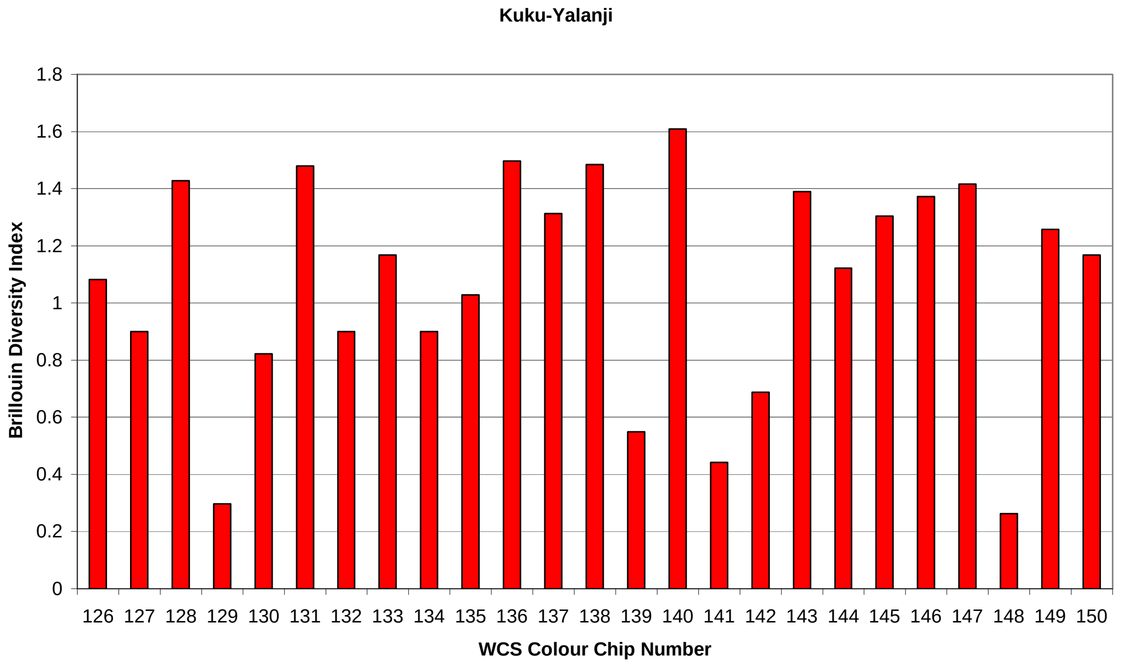


**Figure A4.6 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 126 to 150**

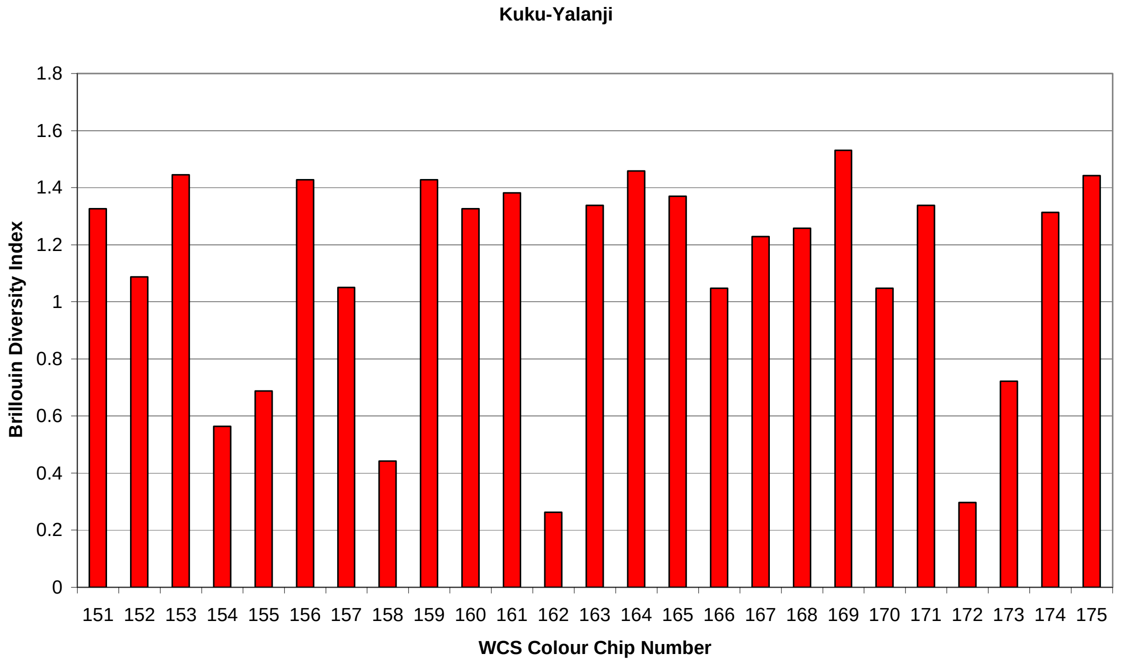


**Figure A4.7 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 151 to 175**

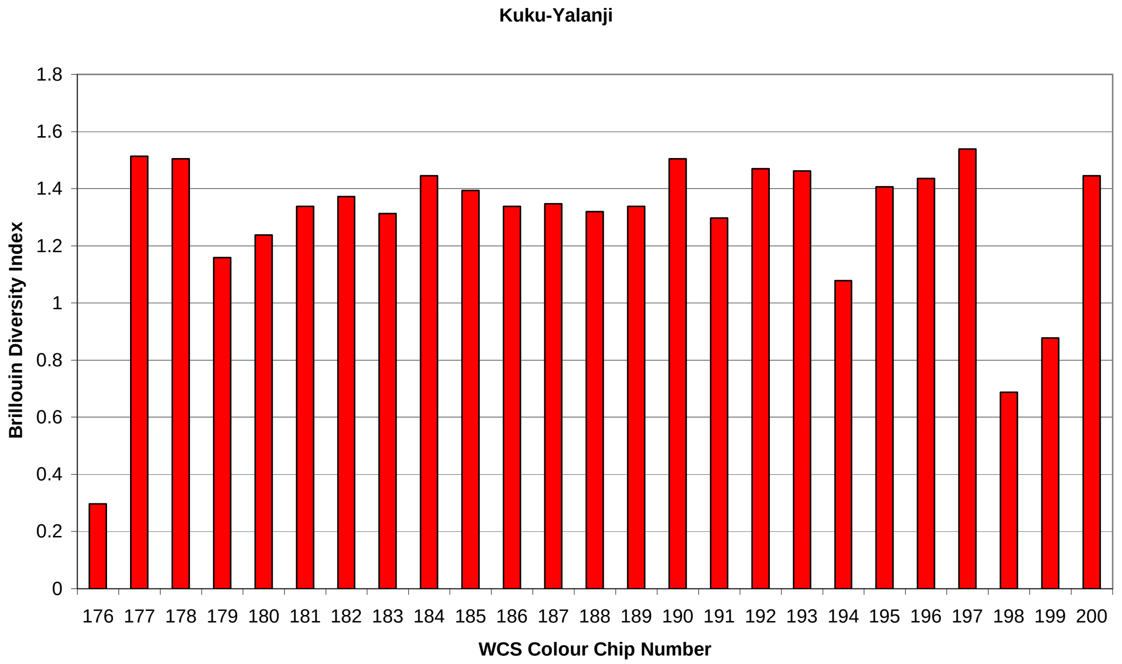


**Figure A4.8 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 176 to 200**

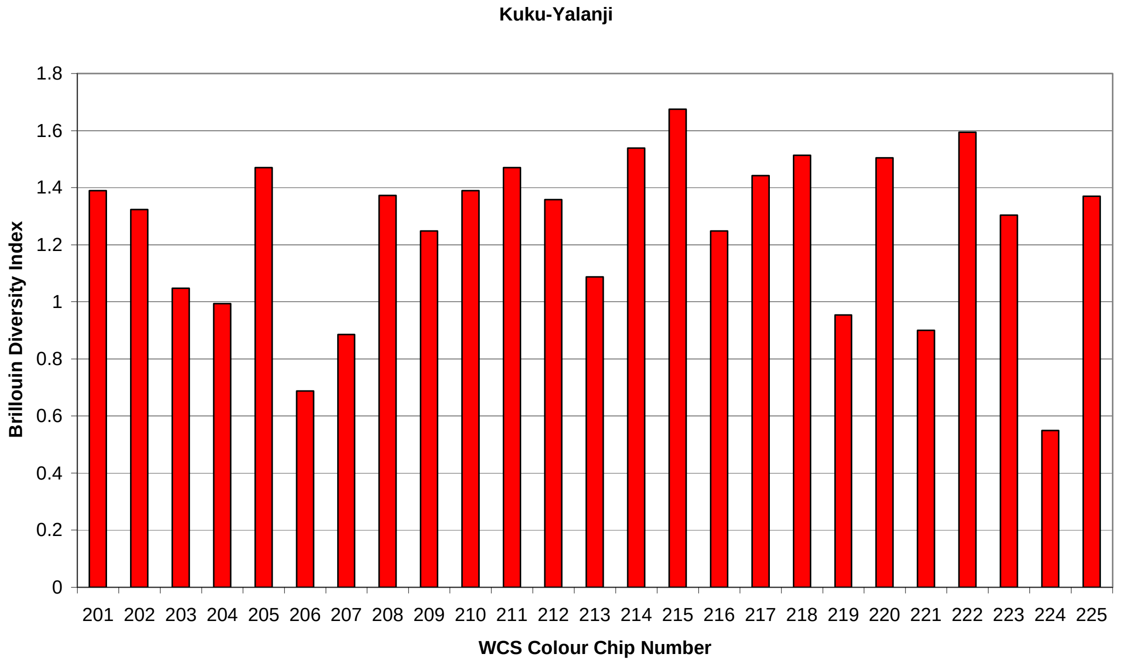


**Figure A4.9 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 201 to 225**

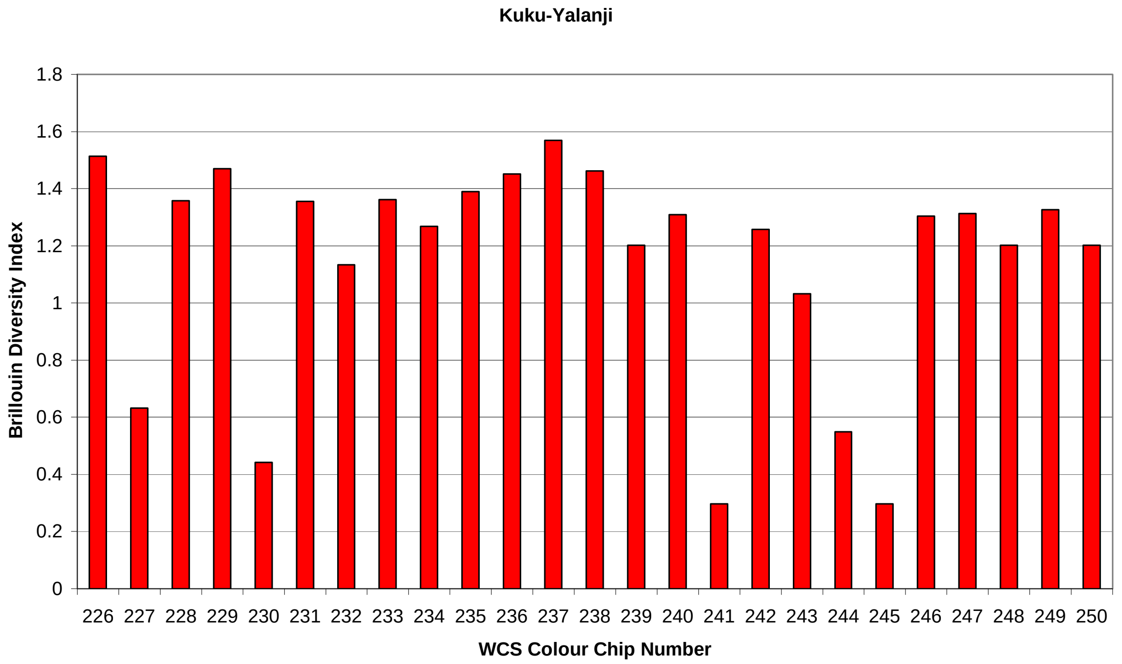


**Figure A4.10 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 226 to 250**

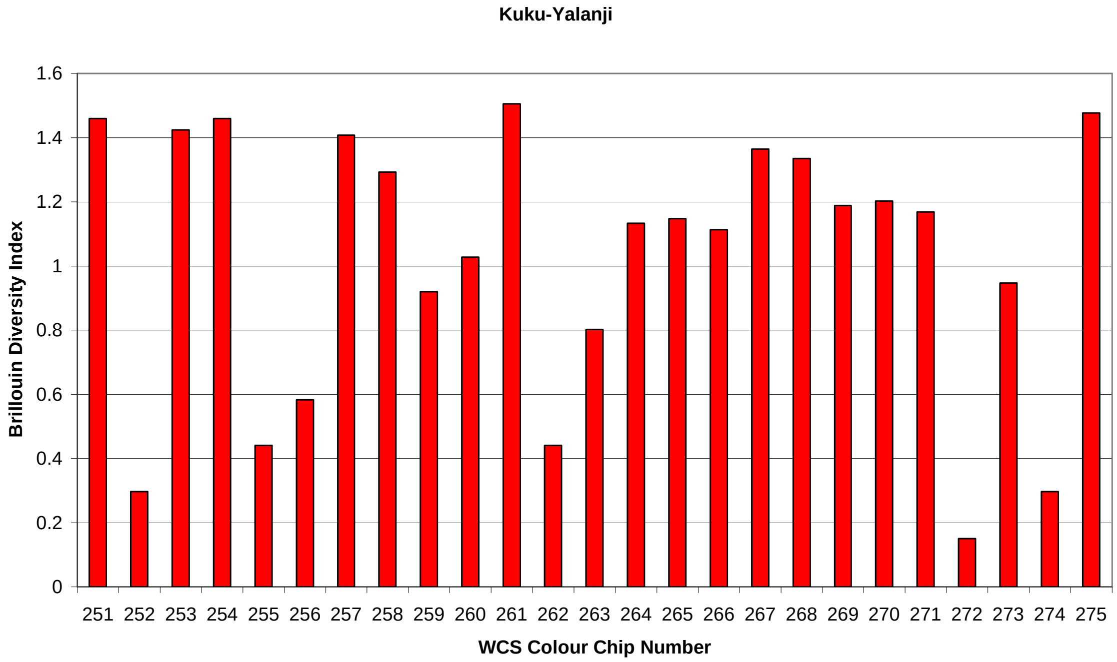


**Figure A4.11 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 251 to 275**

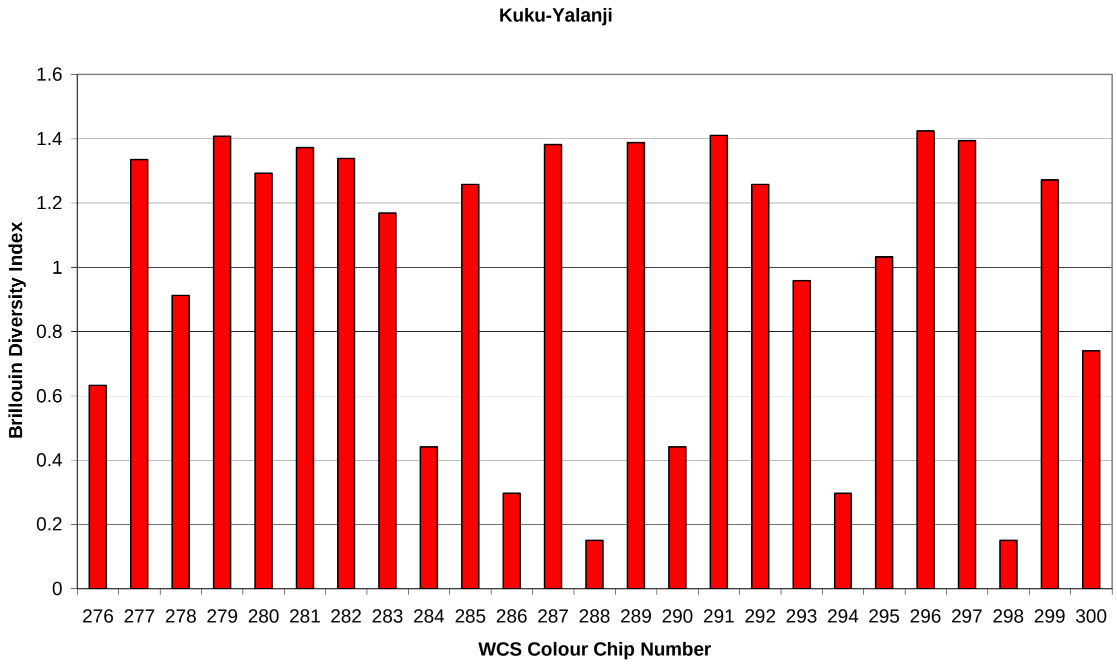


**Figure A4.12 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 276 to 300**

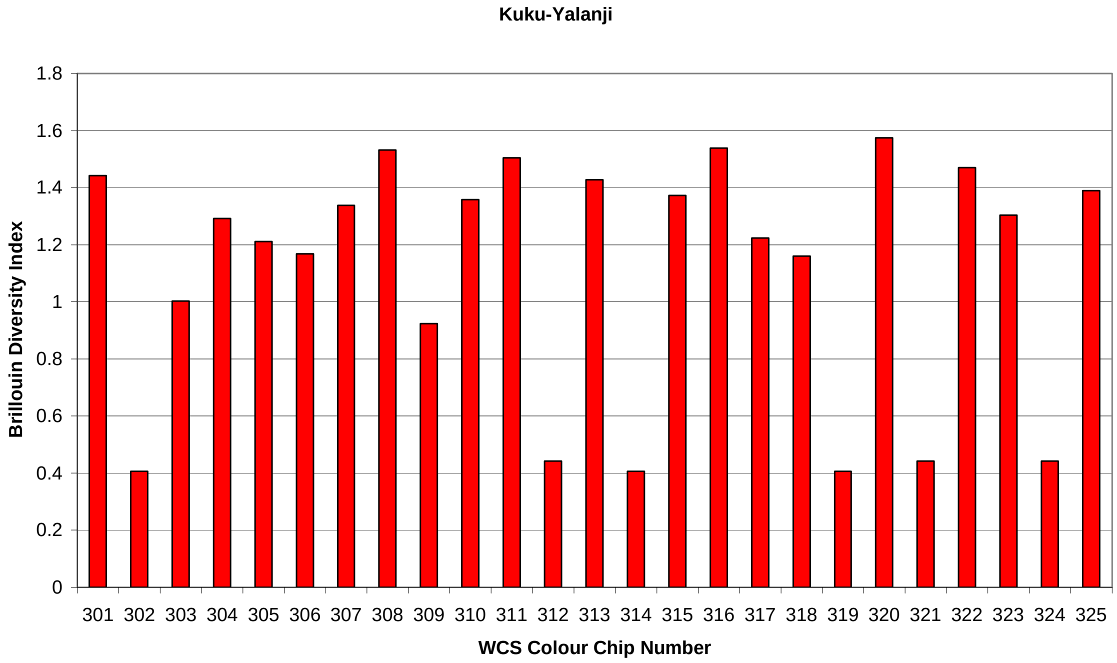


**Figure A4.13 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 301 to 325**

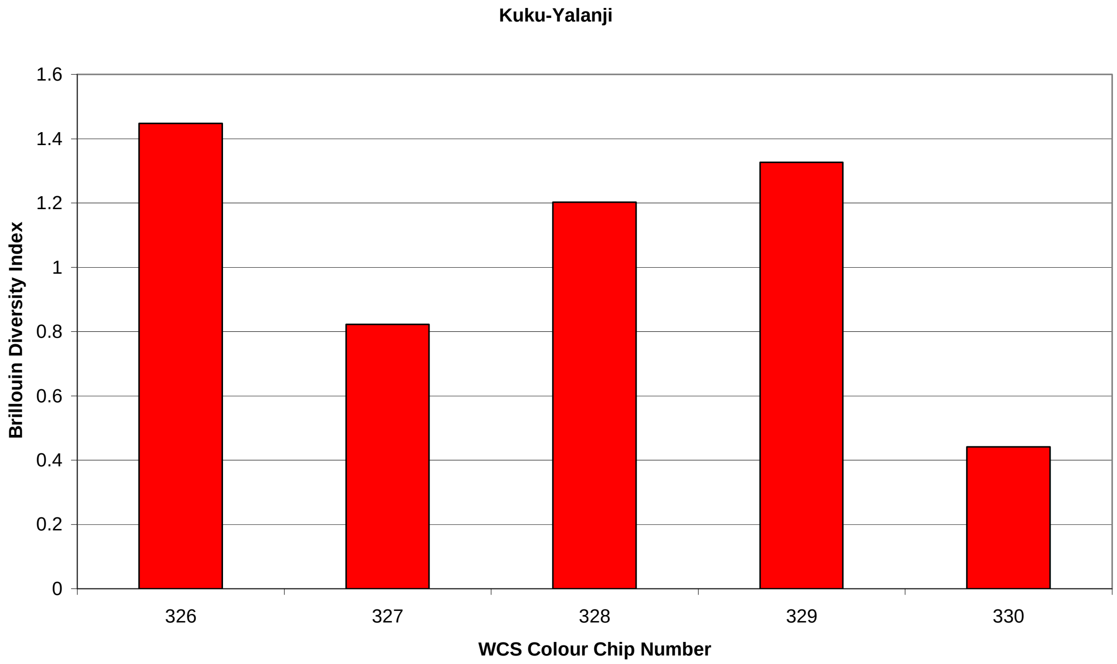


**Figure A4.14 - Kuku-Yalanji:**
**Brillouin diversity index data for Munsell colour chips 326 to 330**

# Appendix 5 - Martu Wangka Diversity Index Data

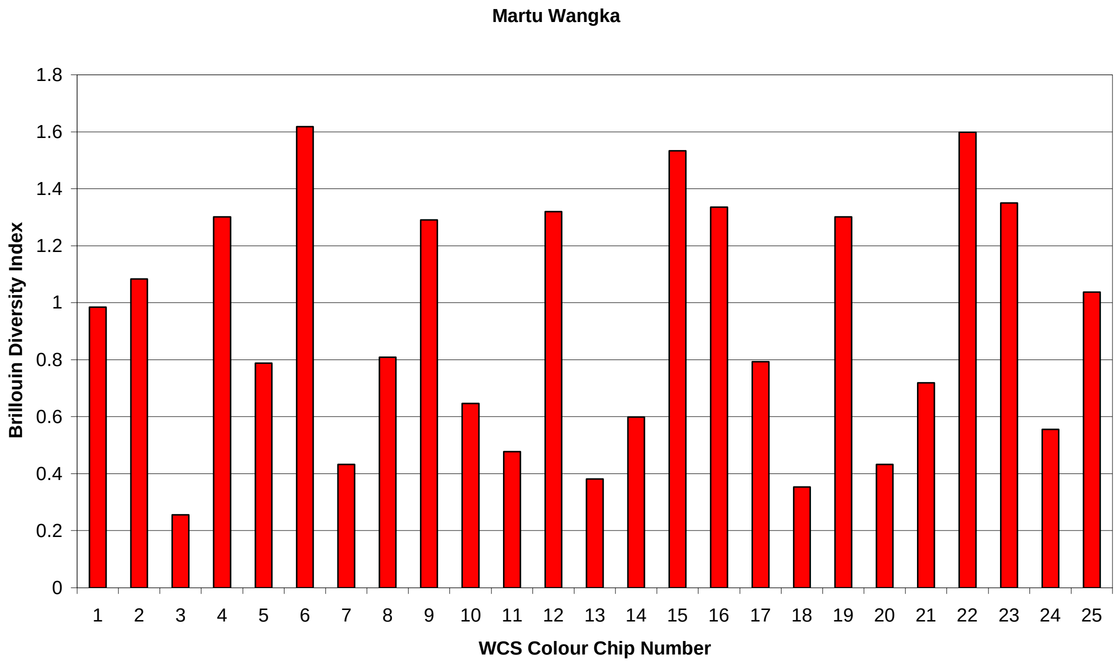


**Figure A5.1 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 1 to 25**

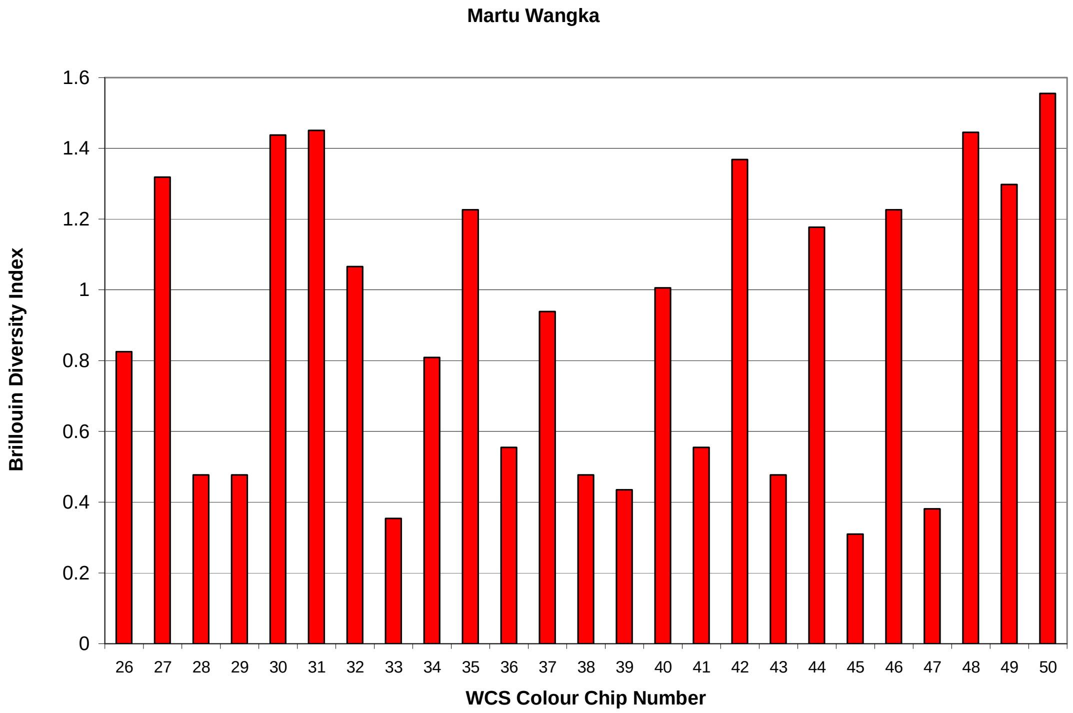


**Figure A5.2 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 26 to 50**

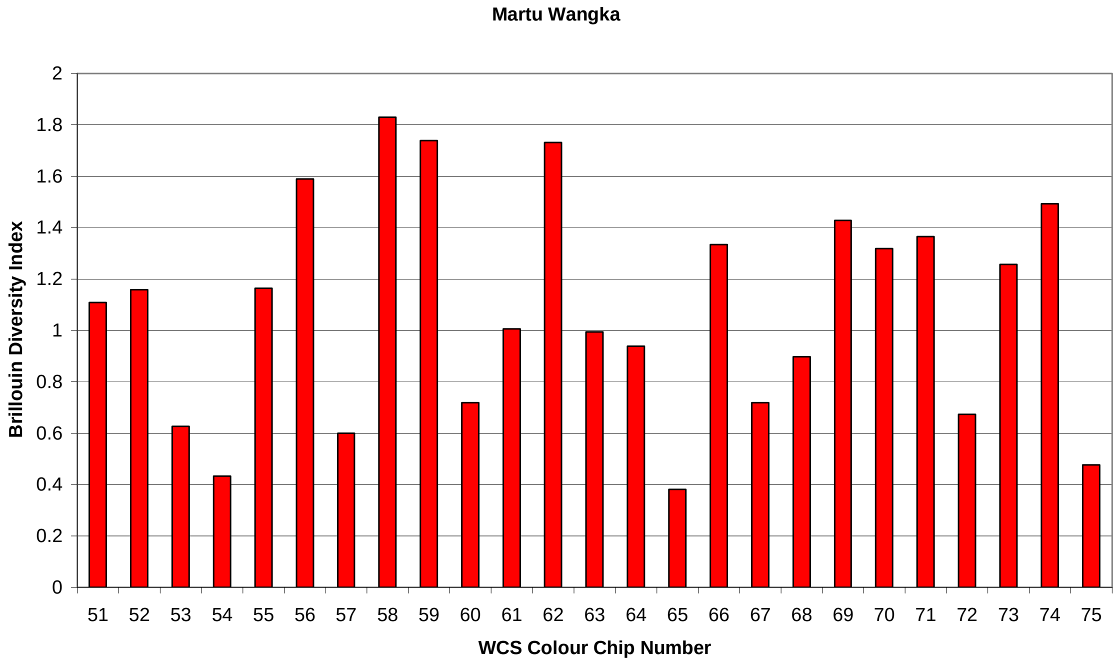


**Figure A5.3 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 51 to 75**

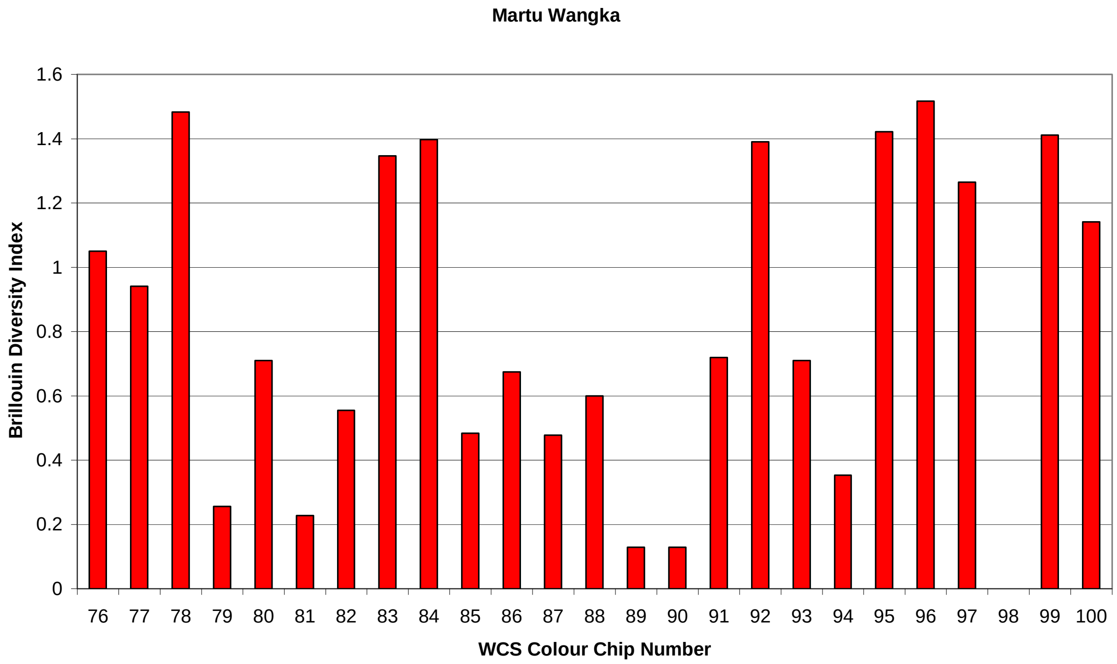


**Figure A5.4 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 76 to 100**

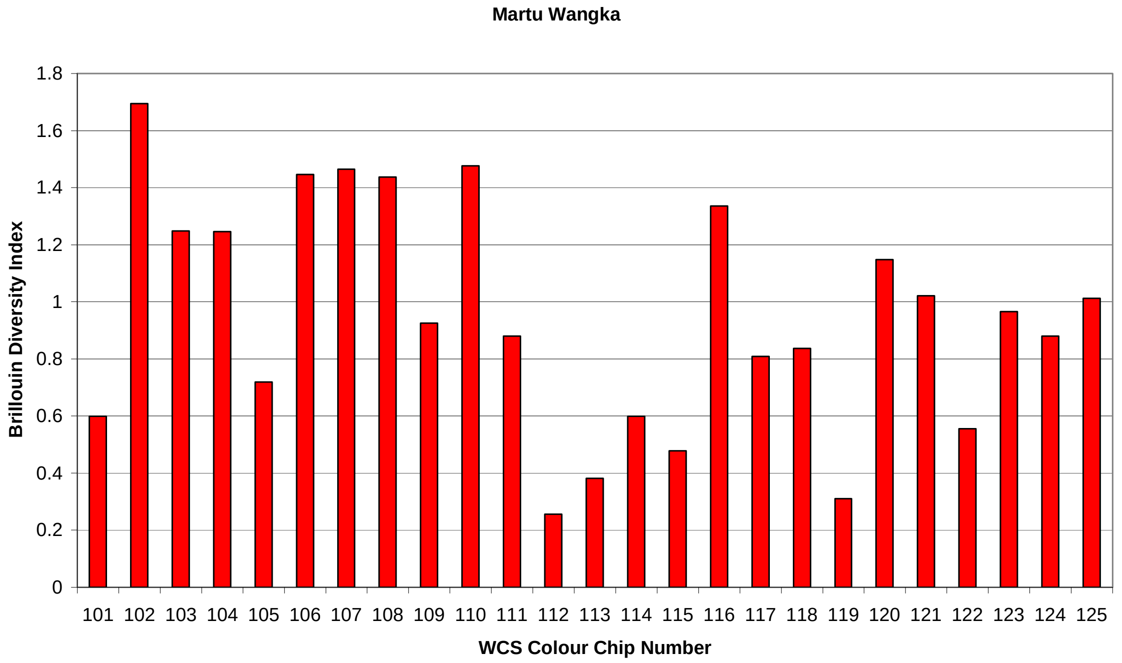


**Figure A5.5 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 101 to 125**

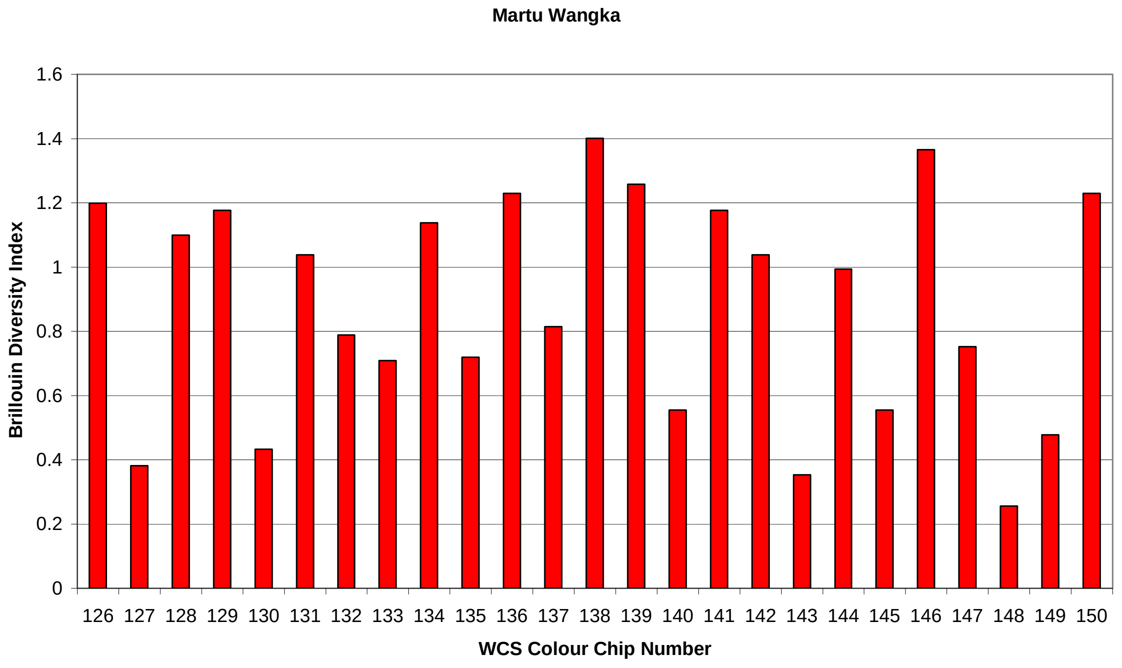


**Figure A5.6 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 126 to 150**

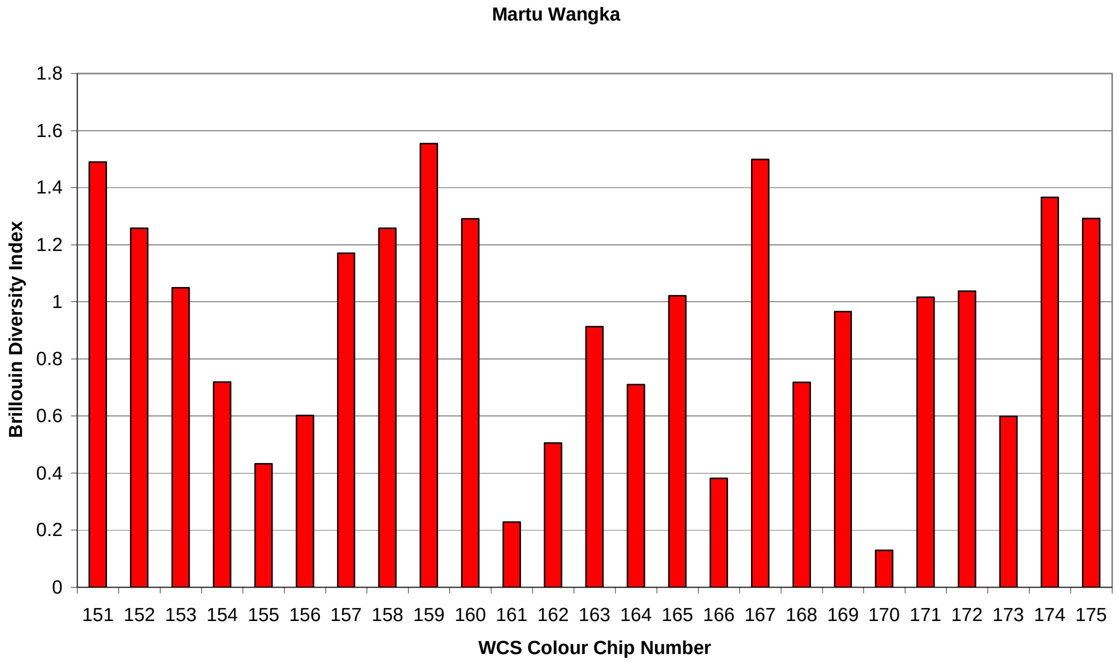


**Figure A5.7 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 151 to 175**

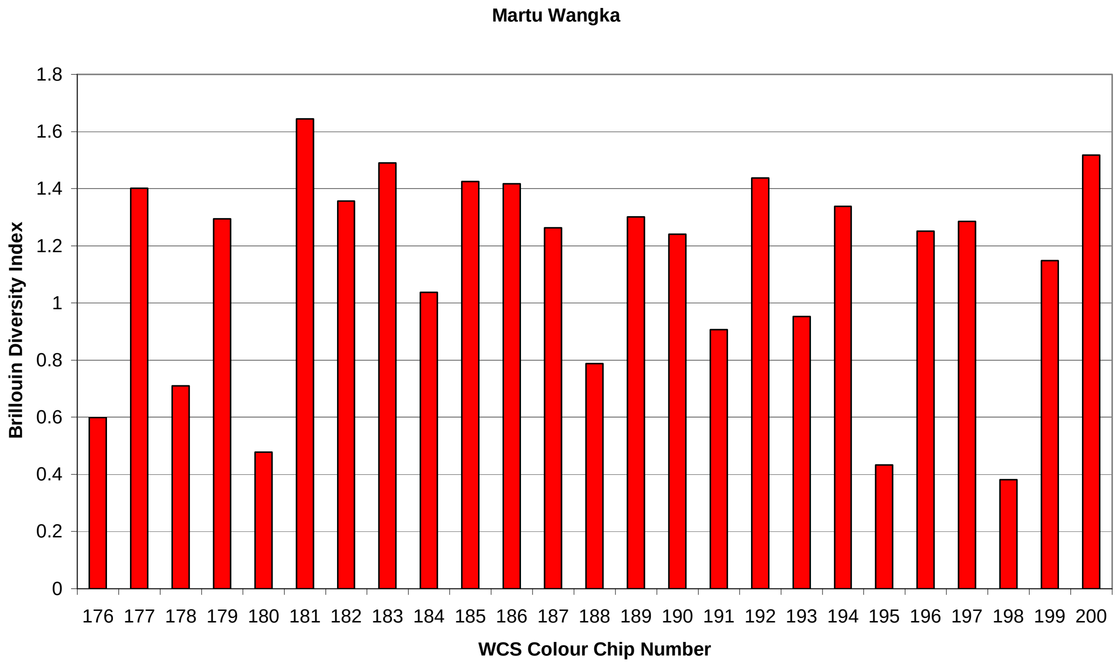


**Figure A5.8 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 176 to 200**

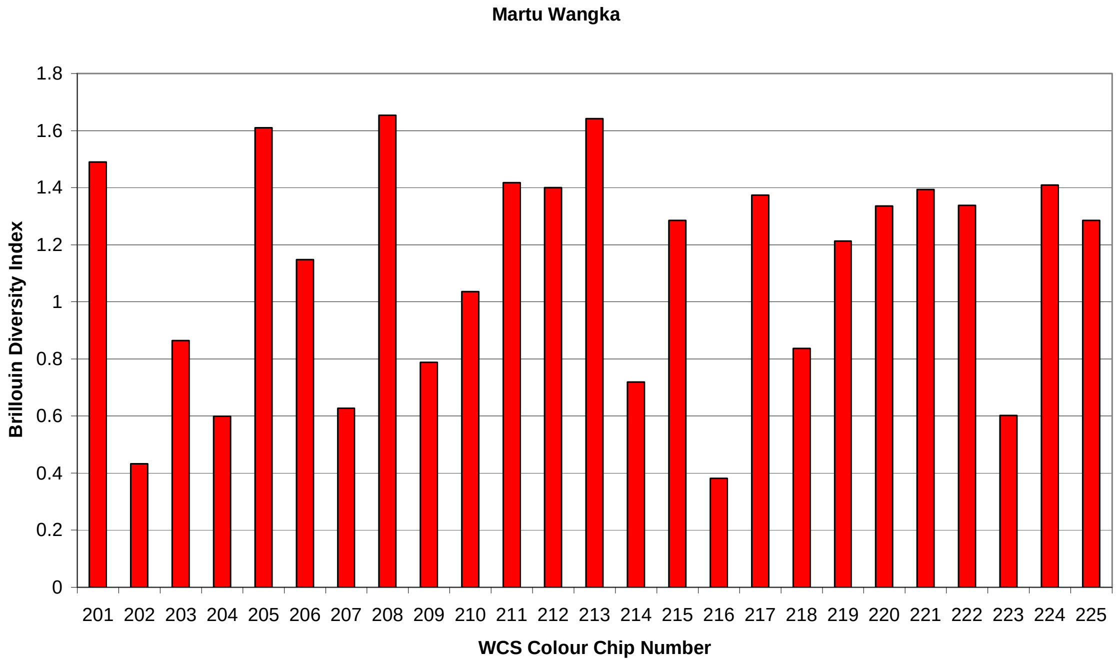


**Figure A5.9 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 201 to 225**

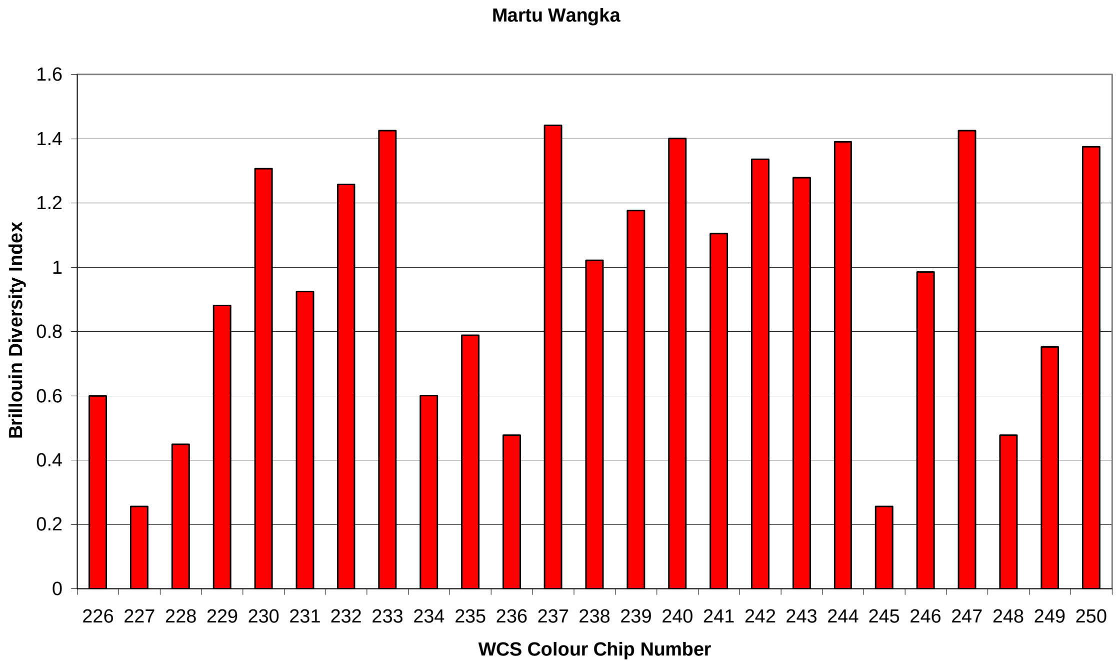


**Figure A5.10 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 226 to 250**

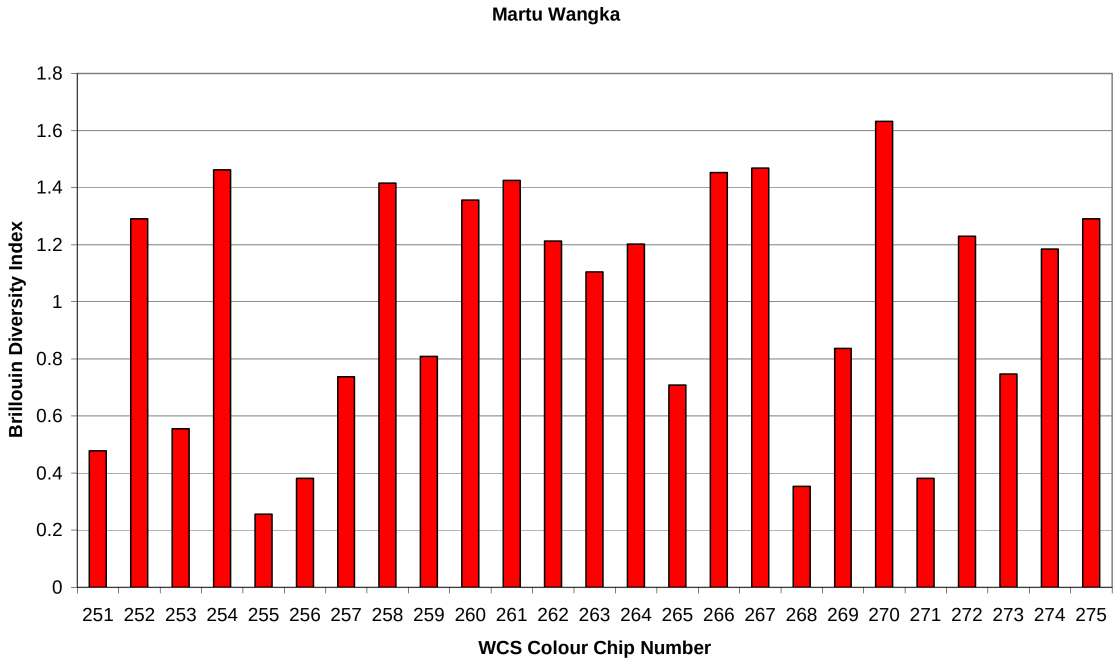


**Figure A5.11 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 251 to 275**

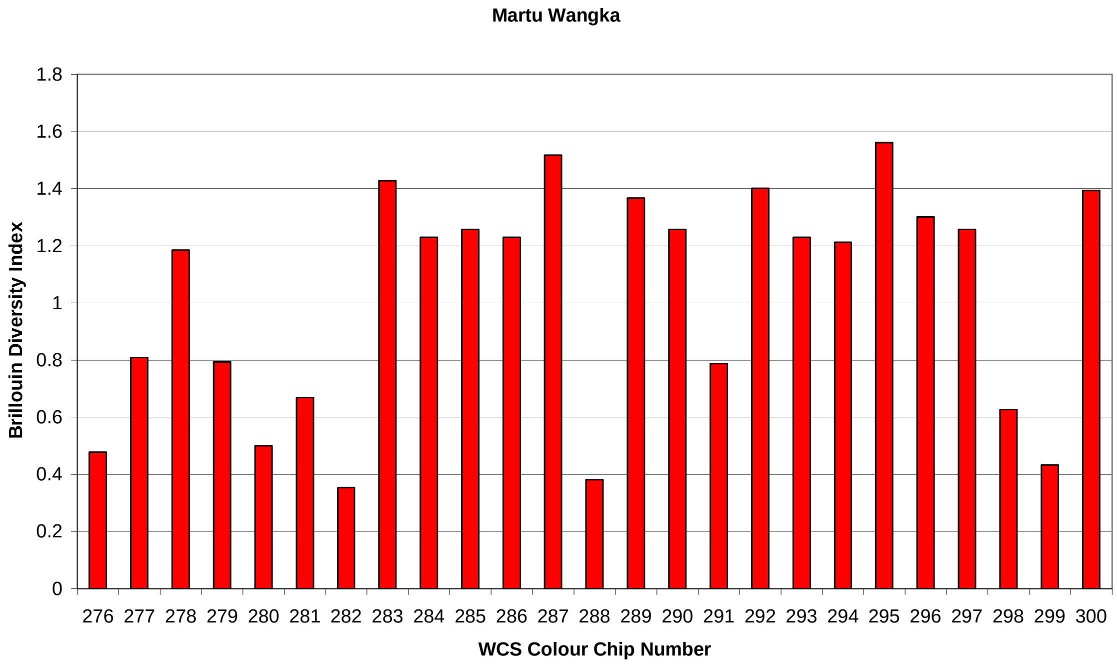


**Figure A5.12 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 276 to 300**

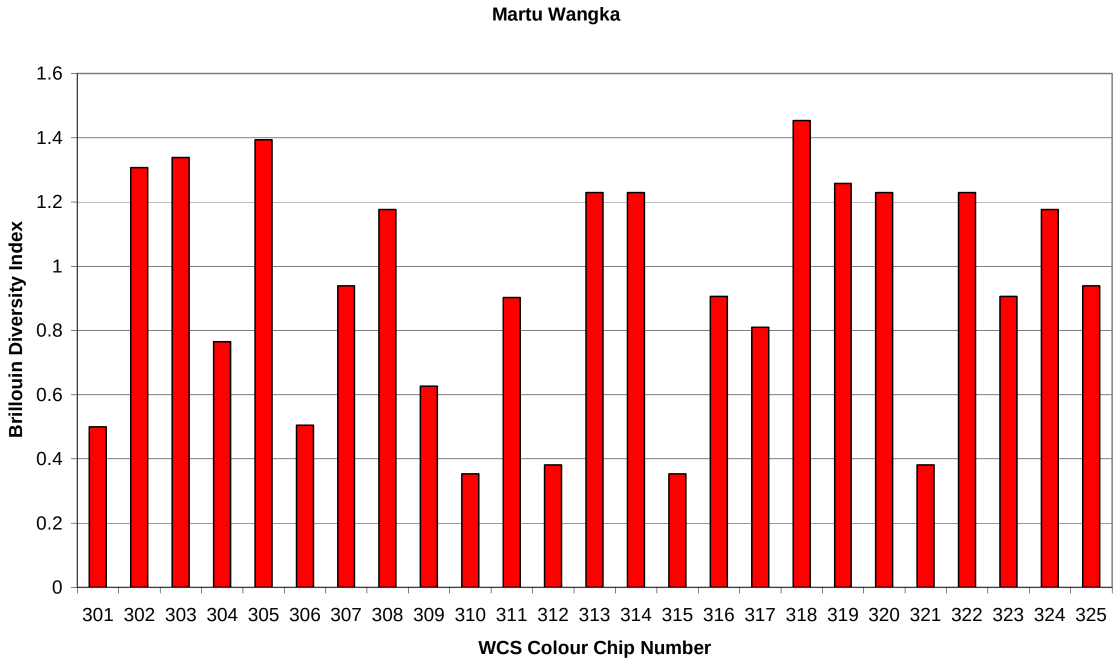


**Figure A5.13 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 301 to 325**

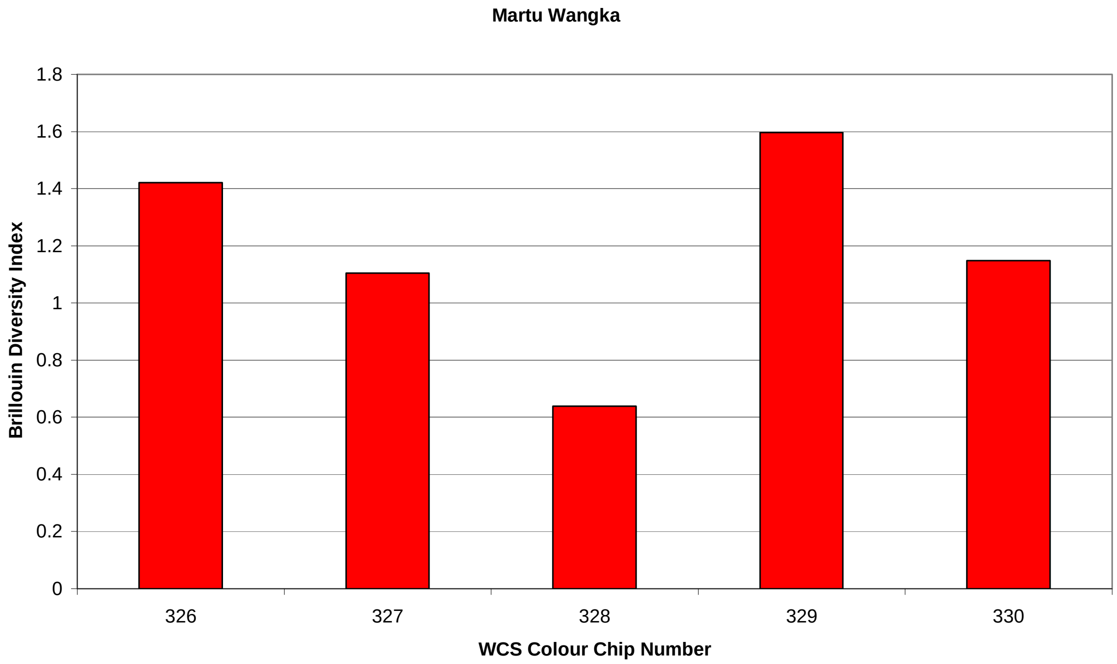


**Figure A5.14 - Martu Wangka:**
**Brillouin diversity index data for Munsell colour chips 326 to 330**

# Appendix 6 - Murinh-Patha Diversity Index Data

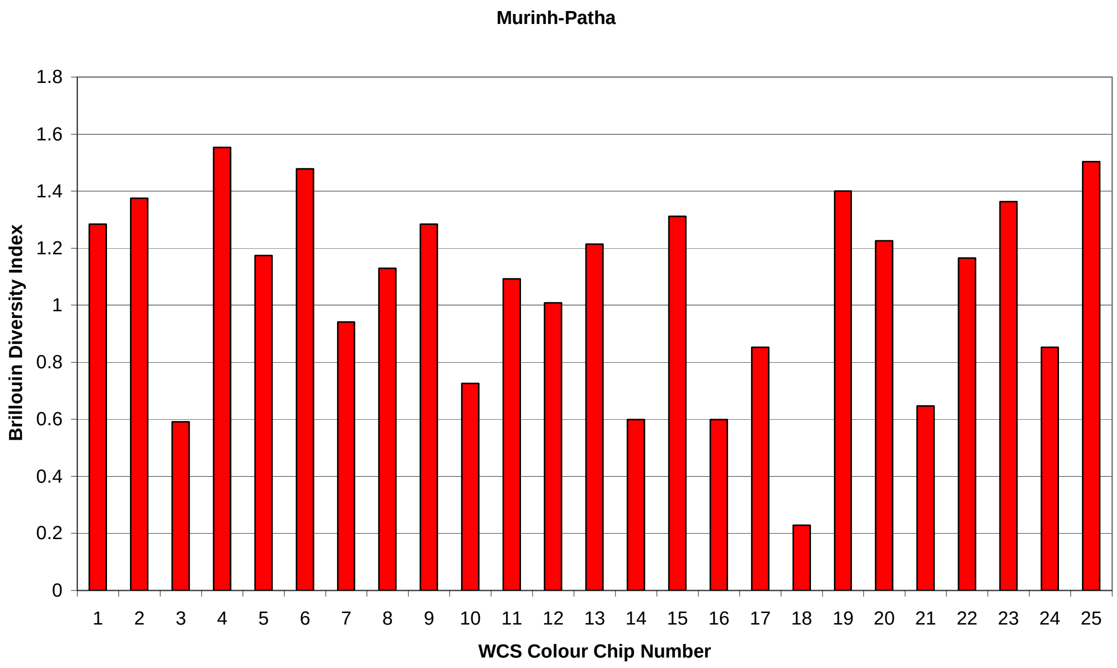


**Figure A6.1 - Murinh-Patha:
Brillouin diversity index data for Munsell colour chips 1 to 25**

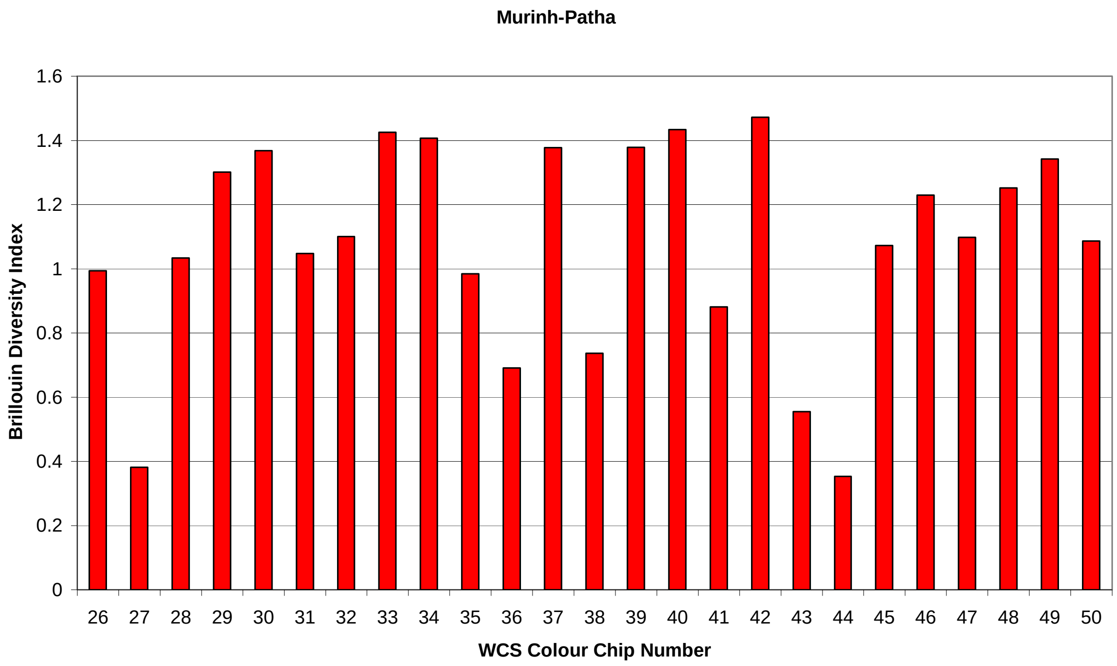


**Figure A6.2 - Murinh-Patha:
Brillouin diversity index data for Munsell colour chips 26 to 50**

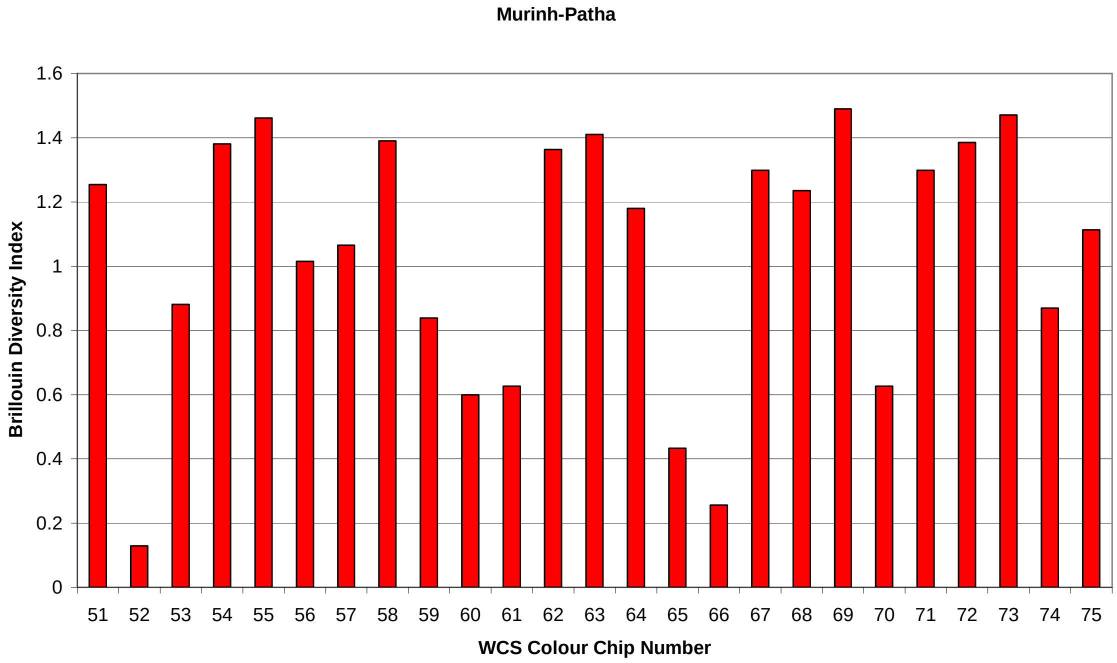


**Figure A6.3 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 51 to 75**

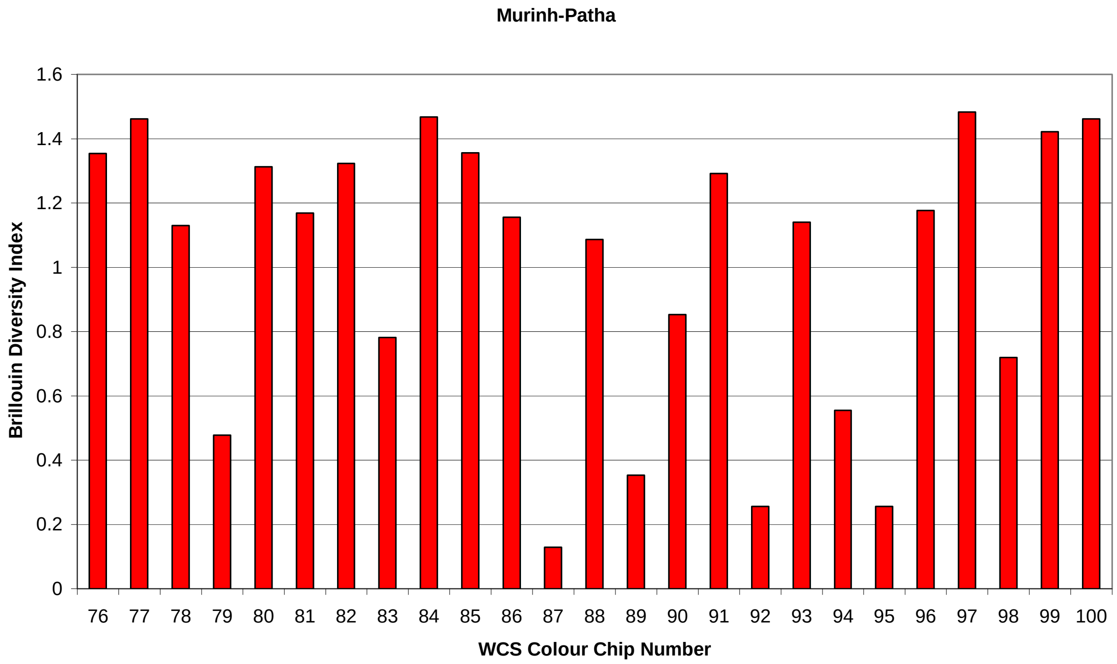


**Figure A6.4 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 76 to 100**

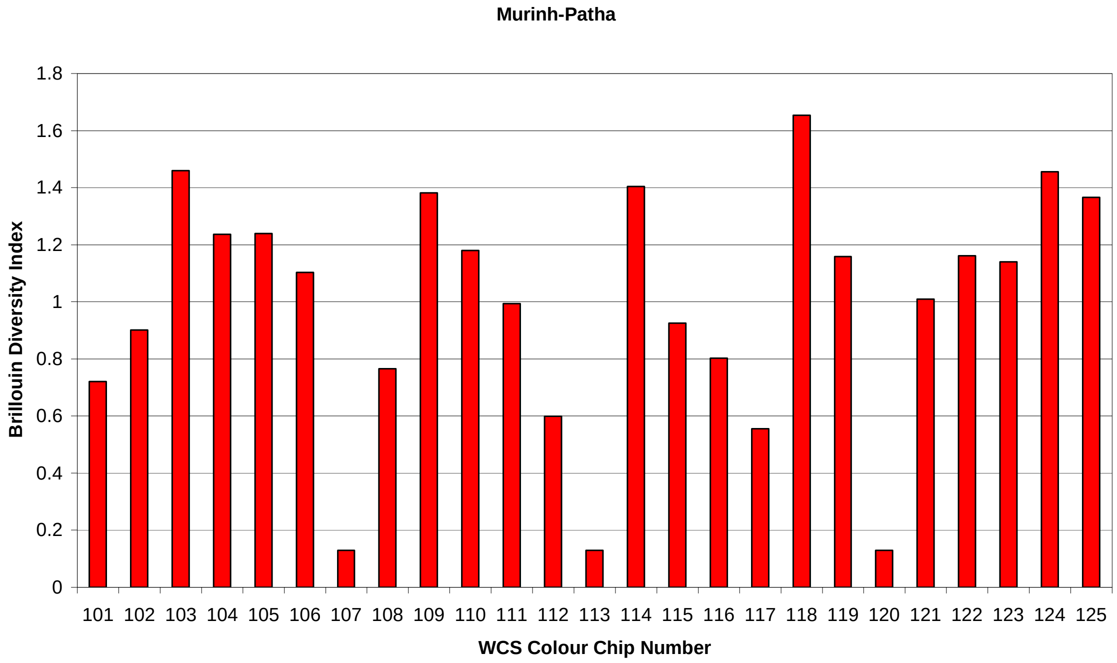


**Figure A6.5 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 101 to 125**

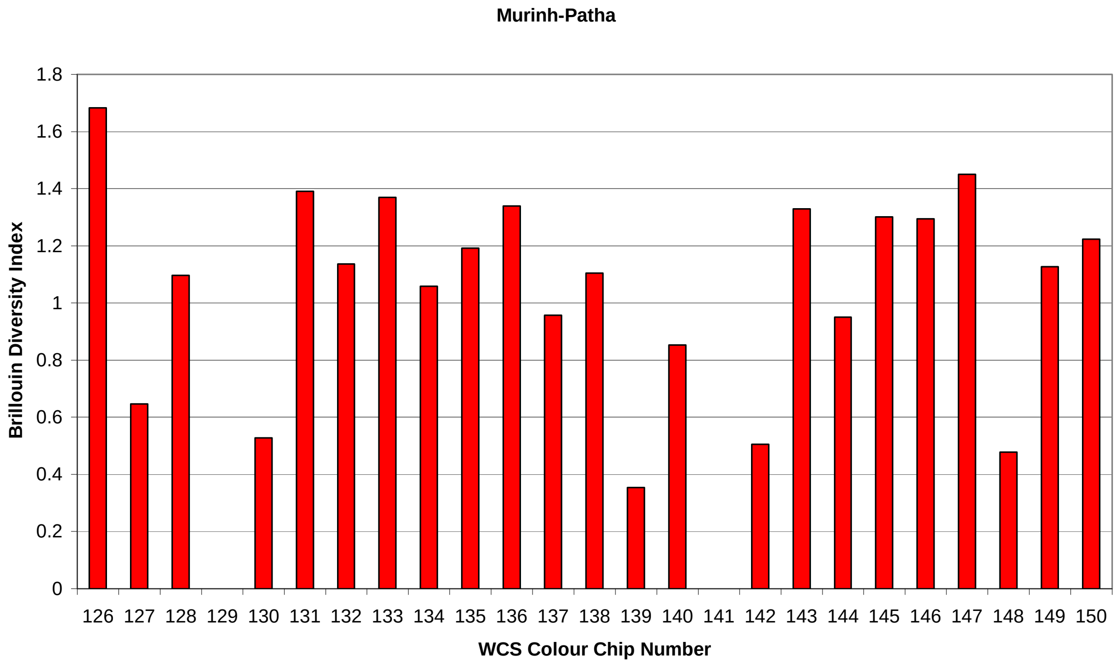


**Figure A6.6 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 126 to 150**

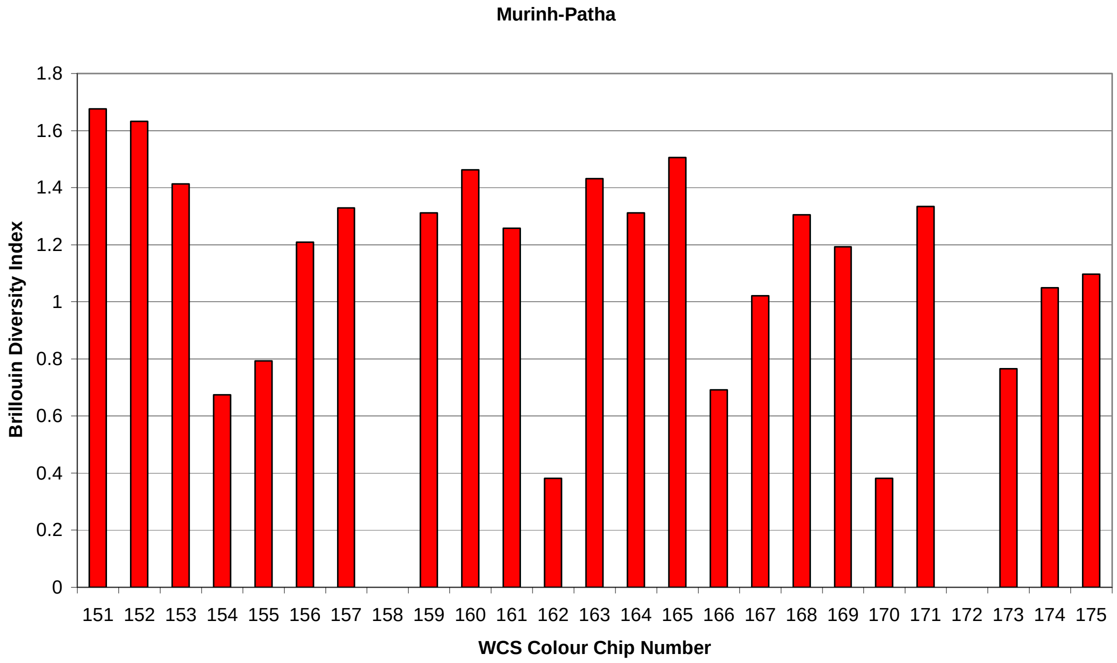


**Figure A6.7 - Murinh-Patha:**

**Brillouin diversity index data for Munsell colour chips 151 to 175**

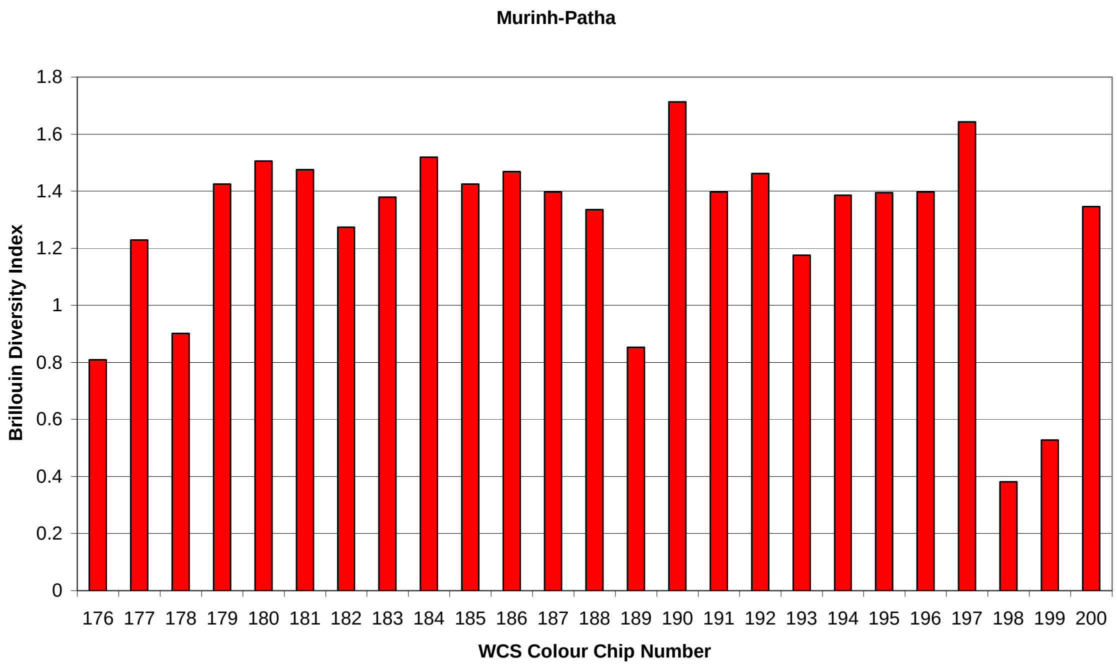


**Figure A6.8 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 176 to 200**

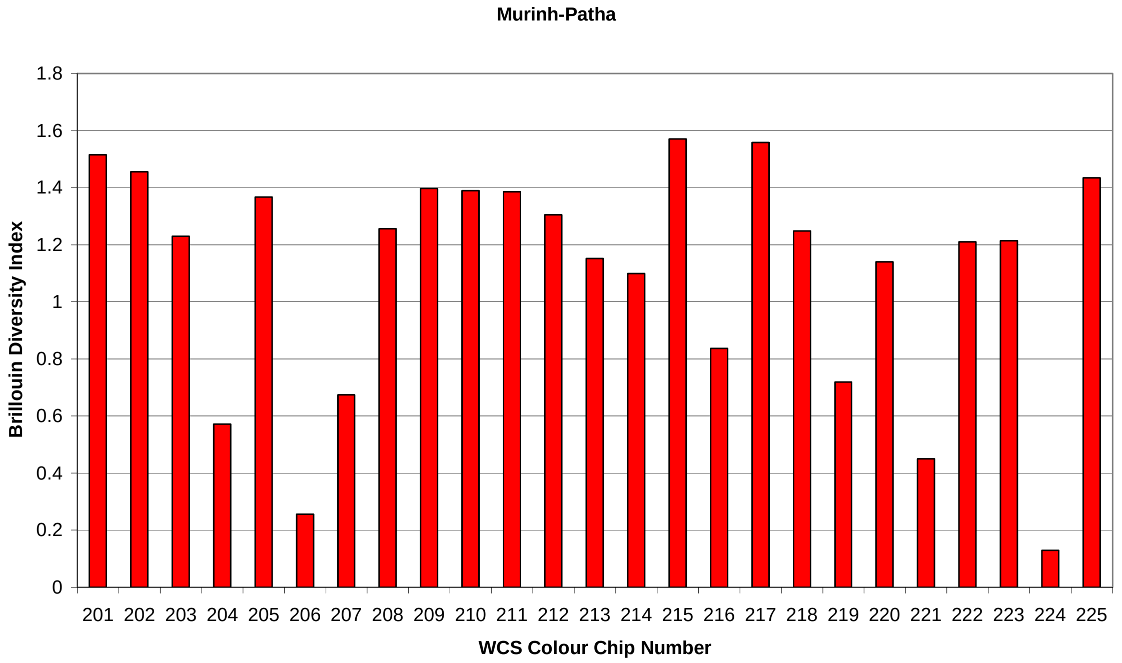


**Figure A6.9 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 201 to 225**

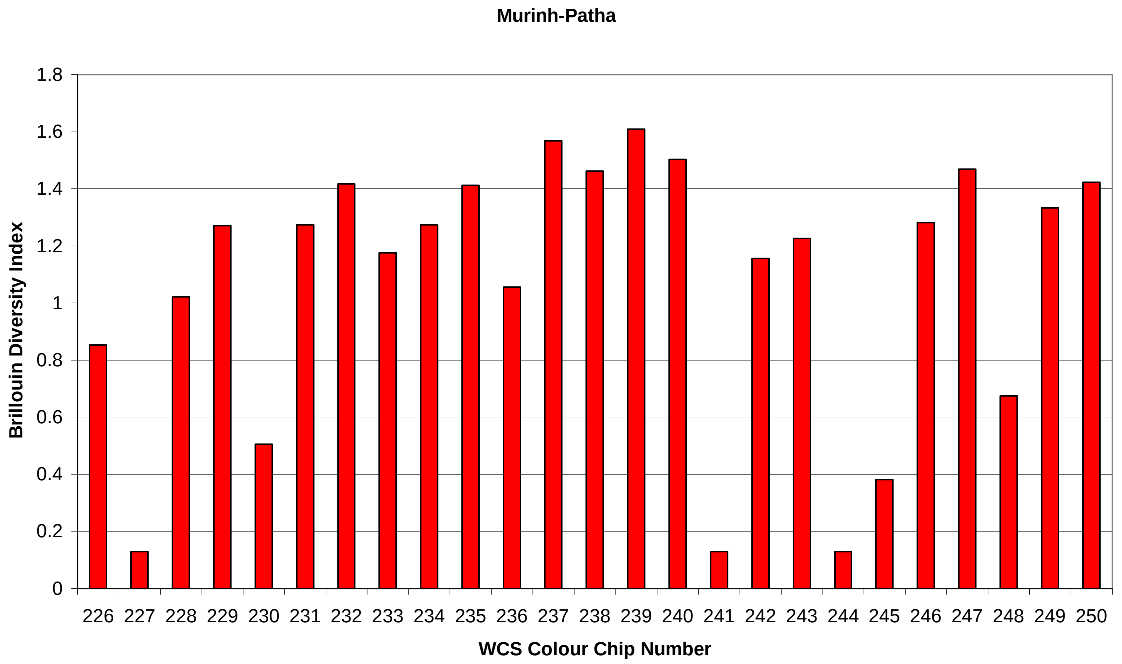


**Figure A6.10 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 226 to 250**

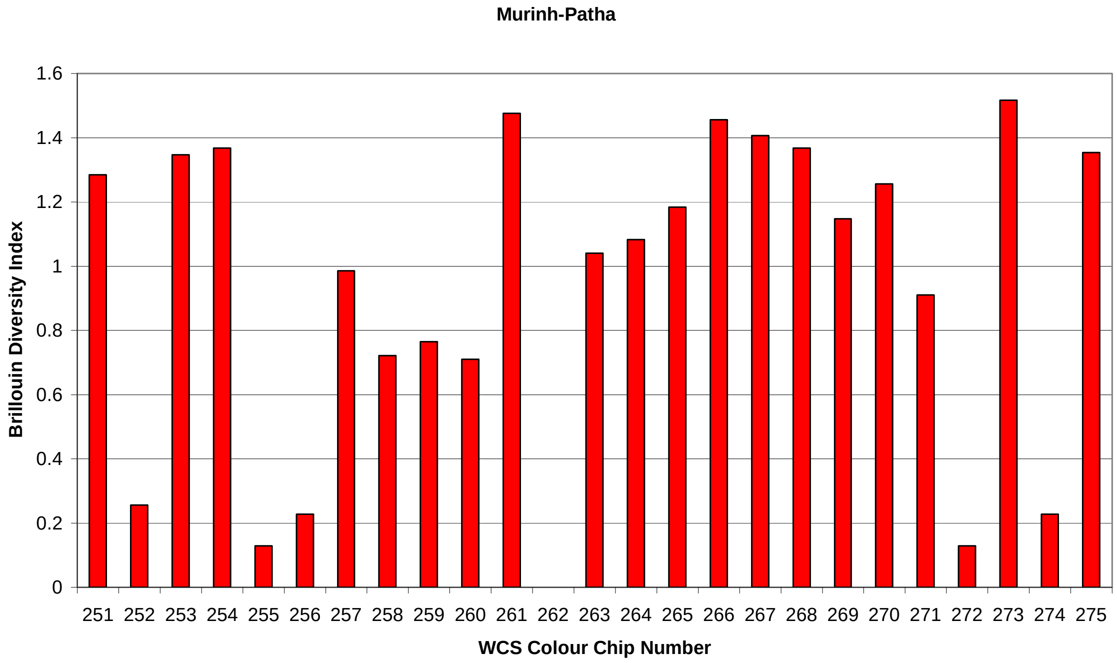


**Figure A6.11 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 251 to 275**

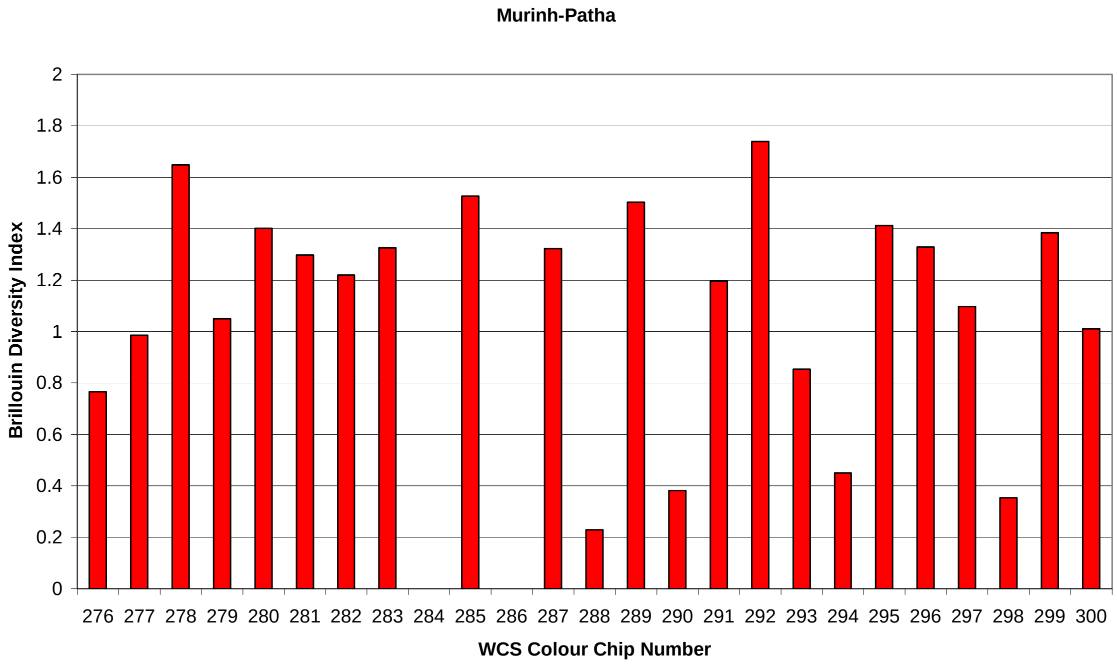


**Figure A6.12 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 276 to 300**

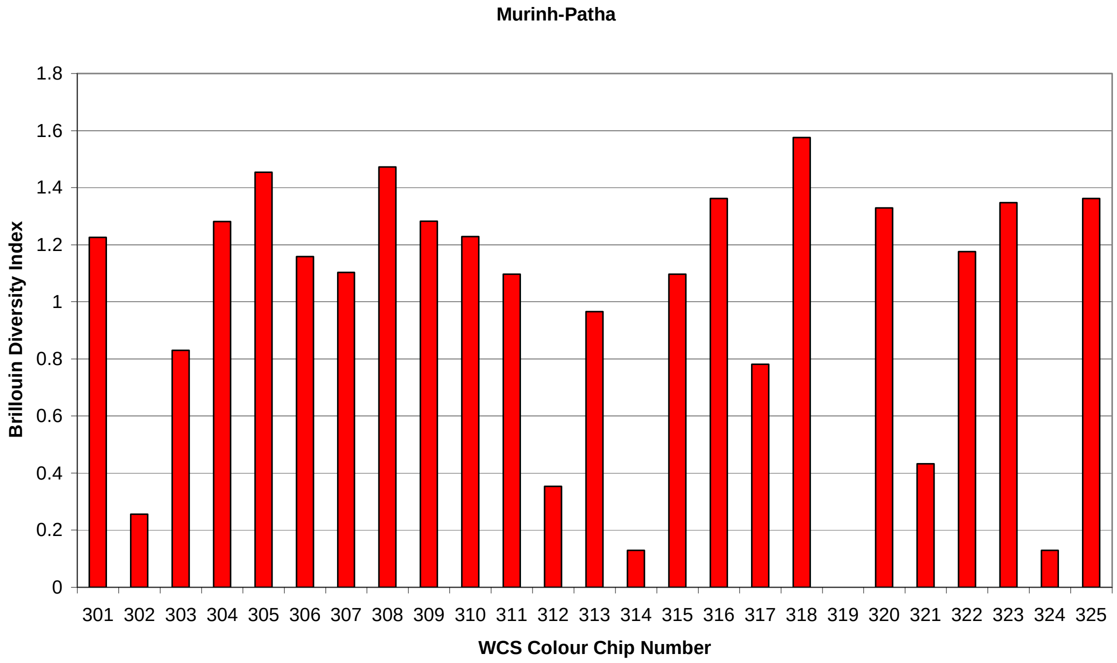


**Figure A6.13 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 301 to 325**

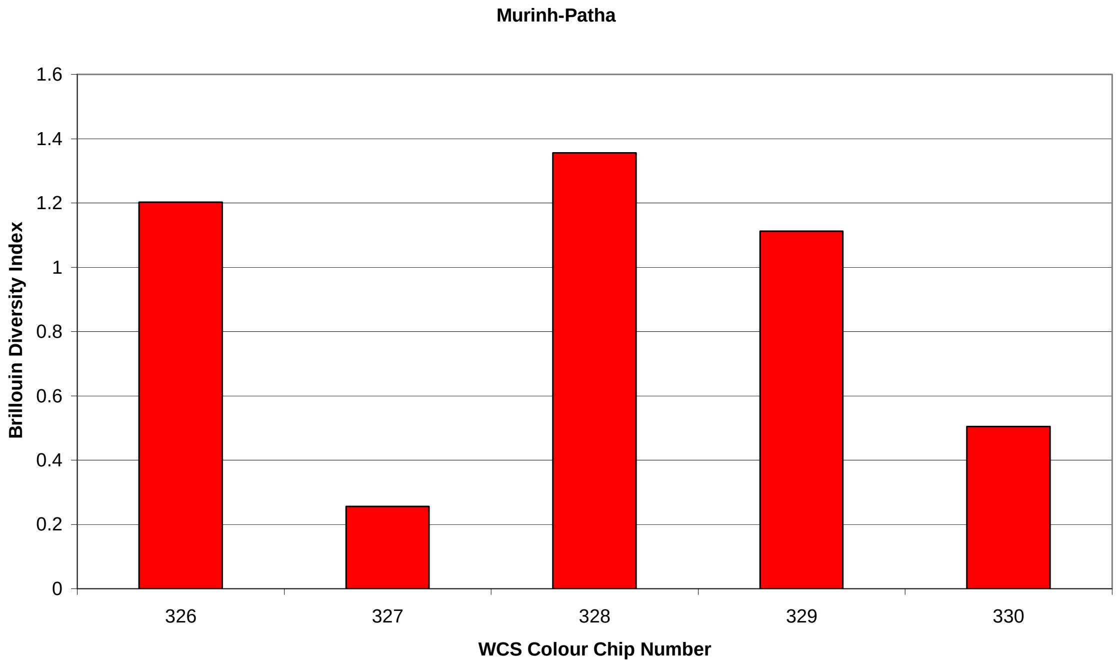


**Figure A6.14 - Murinh-Patha:**
**Brillouin diversity index data for Munsell colour chips 326 to 330**

# Appendix 7 - Warlpiri Diversity Index Data

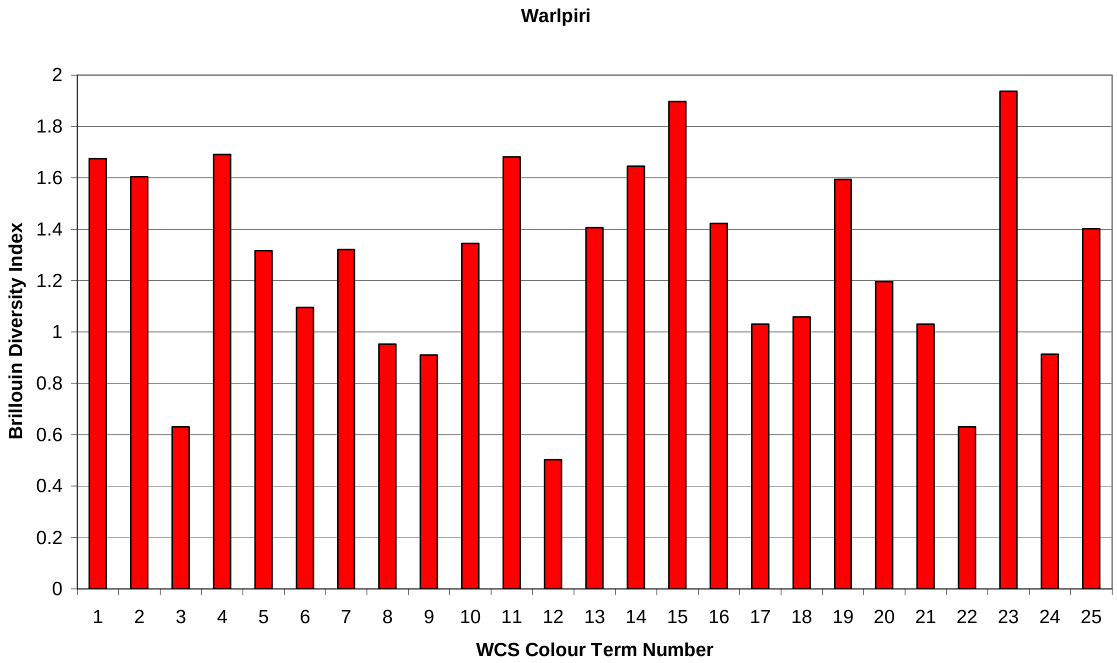


**Figure A7.1 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 1 to 25**

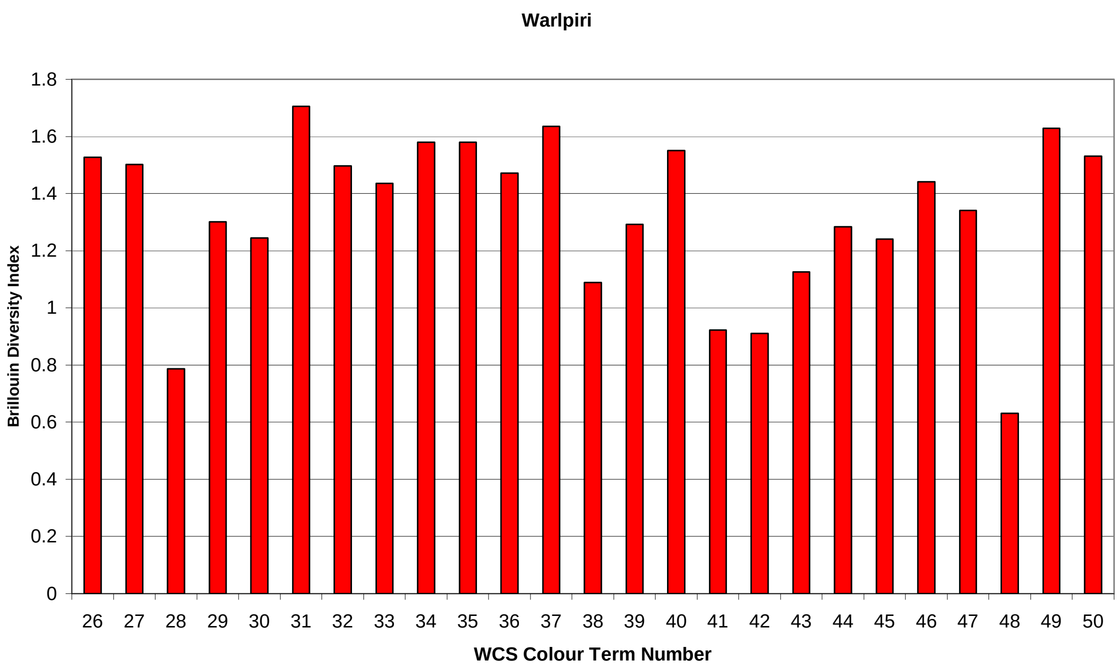


**Figure A7.2 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 26 to 50**


**Figure A7.3 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 51 to 75**


**Figure A7.4 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 76 to 100**


**Figure A7.5 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 101 to 125**


**Figure A7.6 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 126 to 150**

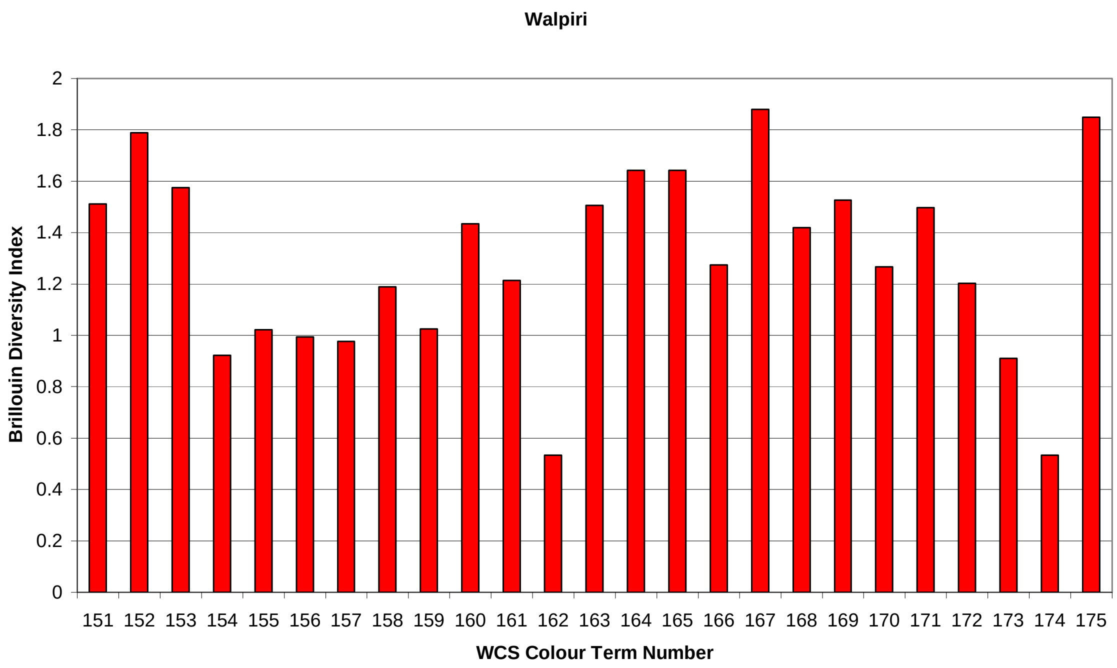


**Figure A7.7 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 151 to 175**

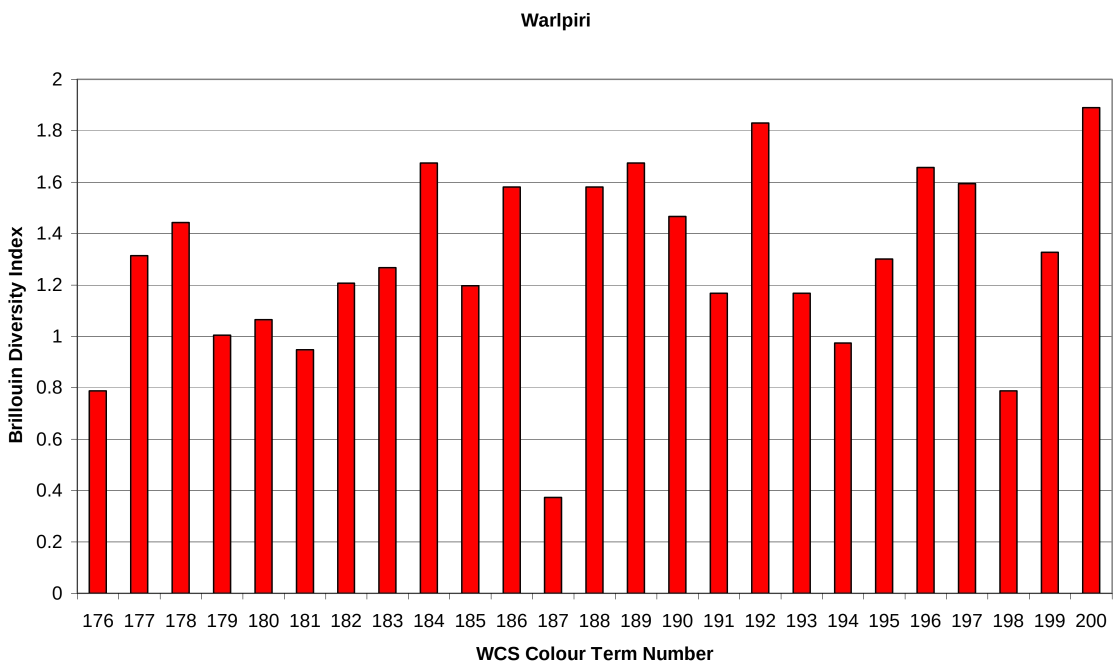


**Figure A7.8 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 176 to 200**

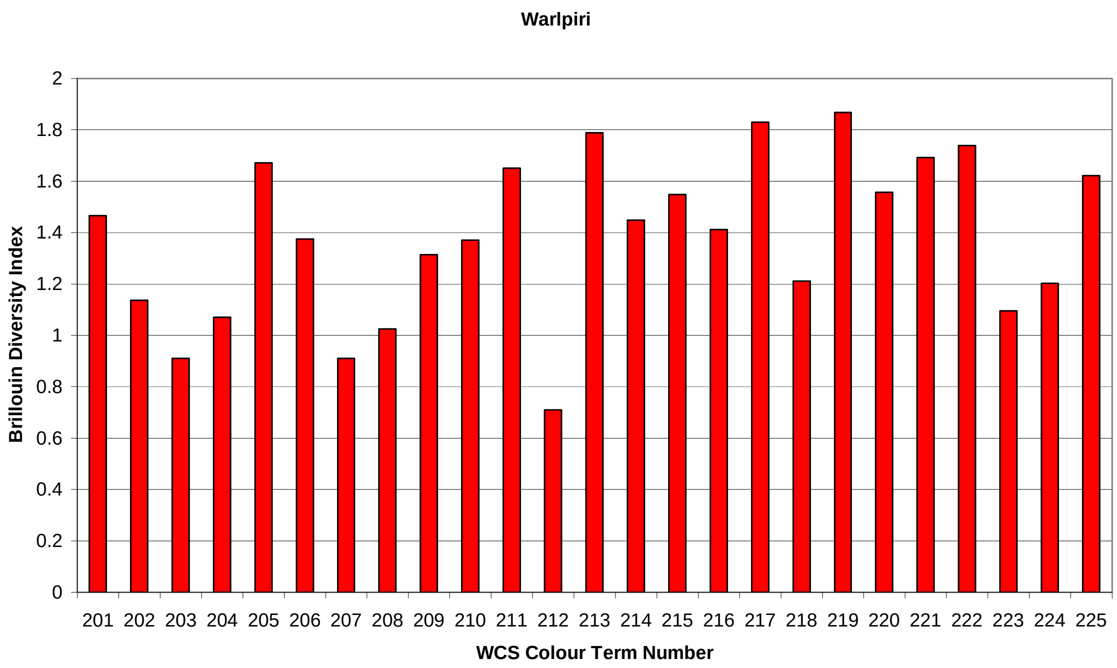


**Figure A7.9 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 201 to 225**

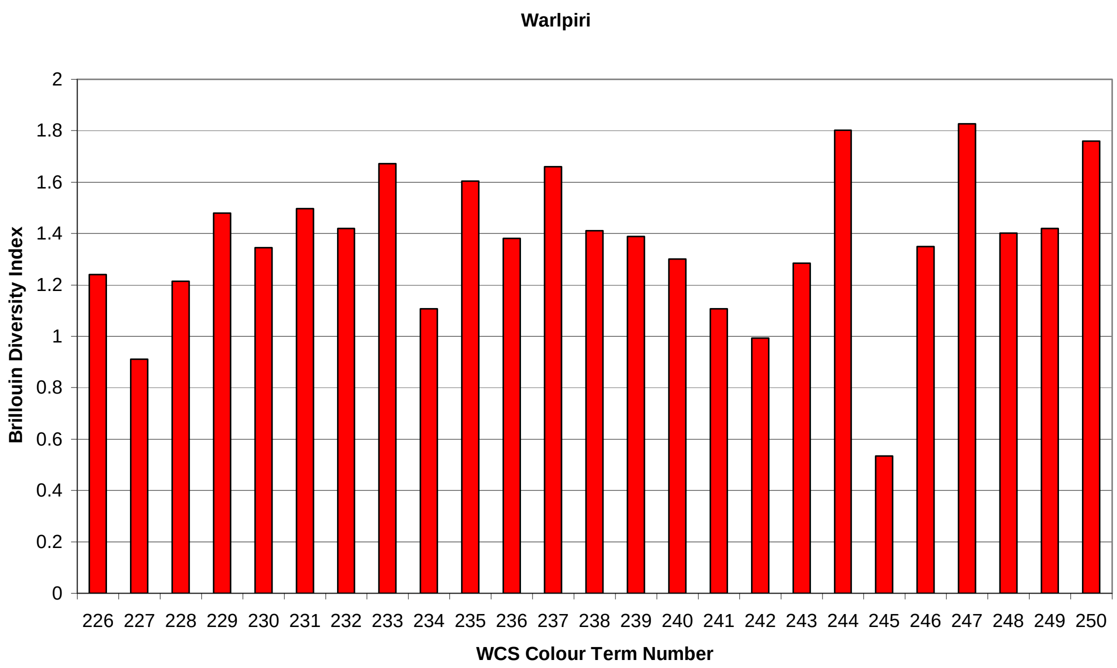


**Figure A7.10 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 226 to 250**

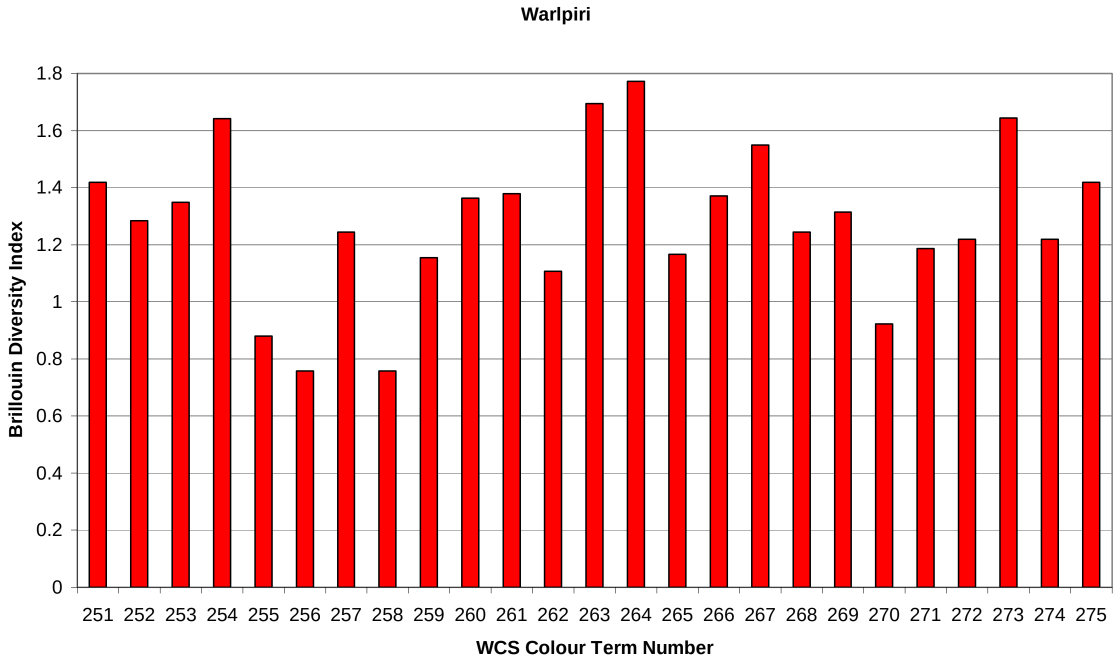


**Figure A7.11 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 251 to 275**

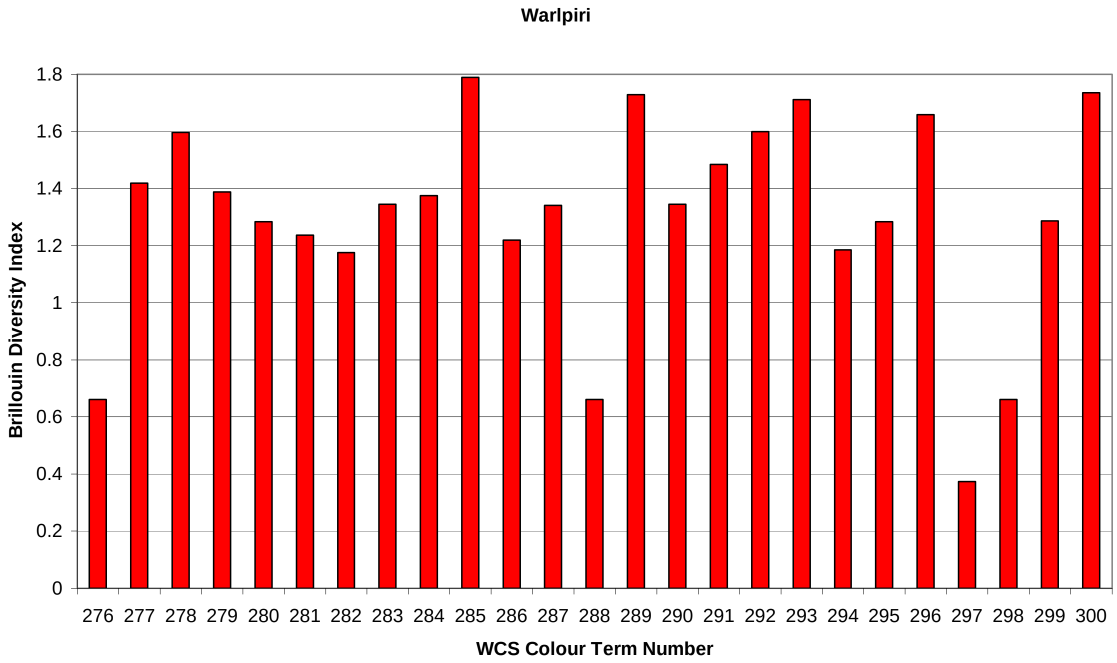


**Figure A7.12 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 276 to 300**

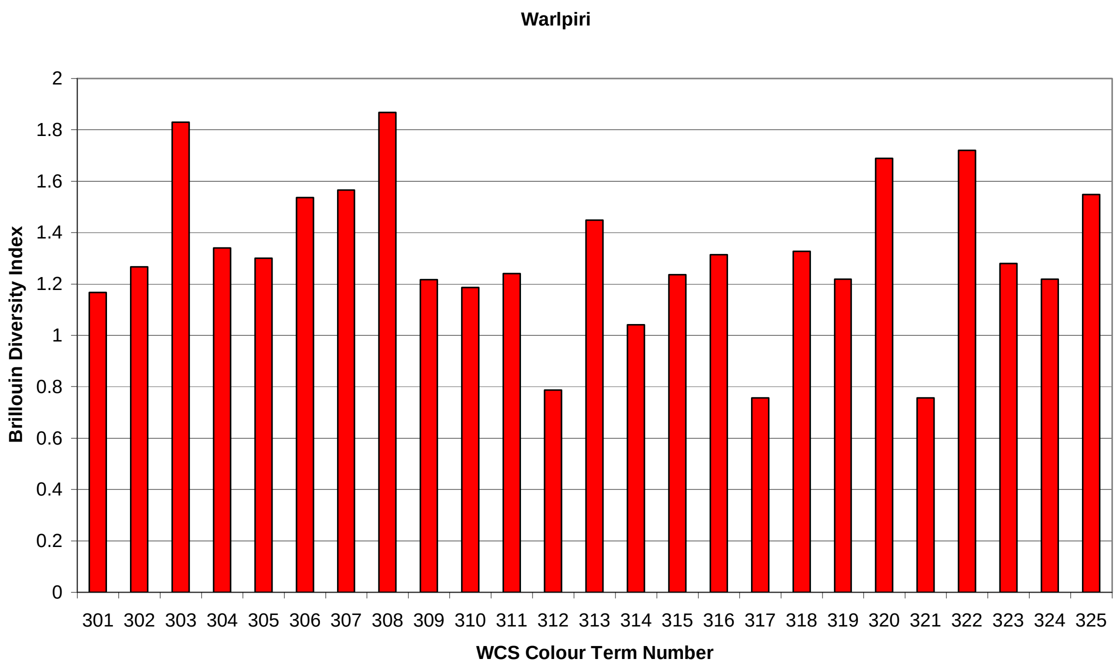


**Figure A7.13 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 301 to 325**

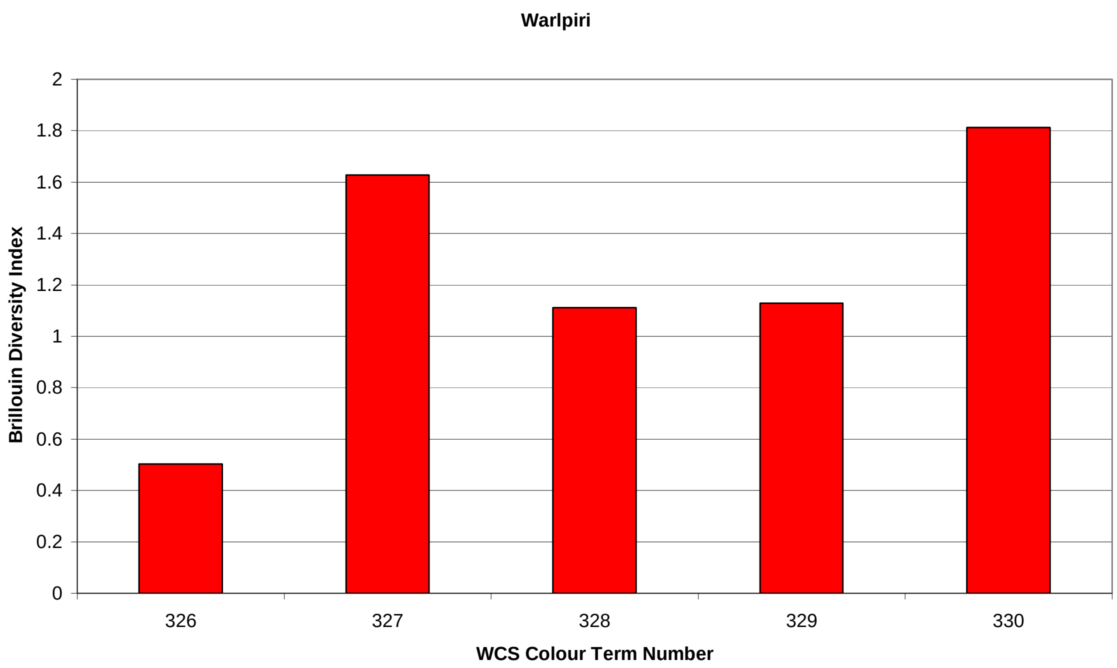


**Figure A7.14 - Warlpiri:**
**Brillouin diversity index data for Munsell colour chips 326 to 330**