Colour memory and similarity judgement in isiXhosa-English bilinguals: the case of *luhlaza*

By

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DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously, in its entirety or in part, submitted it for obtaining any qualification.

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ABSTRACT

Colour categorisation has been a well-known topic of enquiry in the cognitive sciences. There is an abundance of literature examining colour categorisation in speakers of different languages. The findings indicate that cross-linguistic variation in colour term repertoires to some extent influences the way speakers perceive colour.

English and isiXhosa differ in their categorisation of colour, as isiXhosa, unlike English, does not have a lexical distinction between green and blue, but instead has the basic colour term *luhlaza* to refer to this colour space. The aims of the current study is, firstly, to see whether these cross-linguistic differences modulate memory accuracy and similarity judgements of the green-blue colour space and, secondly, to see whether experience with English language influences isiXhosa speakers to behave more like speakers of English on these measures.

A pre-experimental study is conducted in order to obtain baseline colour data of South African English. The data collected on the colours green and blue is then used for the main experiments of the current study. The main experiments include a memory task, examining the recognition memory for the relevant colour space among the participants, and a similarity judgement task, examining perceived similarity of triads of colour stimuli belonging to same and different categories of colour. Overall, 60 participants, isiXhosa-English bilinguals and first language South African English speakers, participated in the main experiments. Findings from both the memory and the similarity judgement experiments show certain differences, but also to a greater extent, similarities between the two language groups. Additionally, the isiXhosa-English bilingual speakers' English experience is assessed, but direct effects of English language experiential variables are not found.

OPSOMMING

Kleurkategorisering is ‘n bekende navordingsonderwerp in die kognitiewe wetenskappe. Daar is ‘n oorvloed literatuur wat kleurkategorisering in sprekers van verskillende tale ondersoek. Die bevindinge dui aan dat variasie in kleurtermrepertoires oor verskillende tale, tot ‘n seker mate, die manier waarop sprekers kleur waarneem, beïnvloed.

Engels en isiXhosa verskil in hul kategorisering van kleur, aangesien isiXhosa, anders as Engels, nie ‘n leksikale onderskeid tussen groen en blou het nie, maar eerder die basiese kleurterm *luhlaza* het om na hierdie kleurruimte te verwys. Die doel van die huidige studie is eerstens om vas te stel of hierdie kruislinguistiese verskille die geheue-akkuraatheid en ooreenkoms-oordele van die groen-blou kleurruimte moduleer, en tweedens om vas te stel of ervaring met die Engelse taal isiXhosa-sprekers beïnvloed om meer soos Engelssprekendes op te tree in hierdie metings.

'n Pre-eksperimentele studie word uitgevoer om die basislyn-kleurdata van Suid-Afrikaanse Engels te verkry. Die data wat oor die kleure groen en blou versamel is, word dan gebruik vir die hoofeksperimente van die huidige studie. Die hoofeksperimente sluit 'n geheue-taak in, wat die herkenningsgeheue vir die betrokke kleurruimte onder die deelnemers ondersoek, en 'n ooreenkomsbeoordelingstaak, wat die deelnemer-waargeneemde ooreenkomste van drie groepe kleurstimuli wat aan dieselfde en verskillende kleurkategorieë behoort, ondersoek. Altesaam het 60 deelnemers, isiXhosa-Engelse tweetaliges en eerste taal Suid-Afrikaanse Engelssprekendes, deelgeneem aan die hoofeksperimente. Bevindinge uit beide die geheue- en die ooreenkoms-oordeelstake toon sekere verskille, maar ook in 'n groter mate, ooreenkomste tussen die twee taalgroepe. Verder word die Engelse ervaring van die isiXhosa-Engelse tweetalige sprekers getoets, maar direkte gevolge van Engelse taal-ervaringsveranderlikes word nie gevind nie.

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LIST OF ABBREVIATIONS

L1	First language
L2	Second language
AoA	Age of Acquisition
BCT	Basic Colour Term
CP	Categorical Perception
RVF	Right Visual Field
LVF	Left Visual Field
vMMN	Visual mismatch negativity

1. Introduction

1.1 Background

For centuries, the relationship between language and thought has been subject to scholarly inquiry. This is mainly because, we, as humans, differ from other species due to our language capacity. Philosophers, psychologists, and linguists have thus delved into the investigation of the nature of the relationship between language and the mind. When we examine languages from different contexts, it becomes evident that not only do the rules of the languages differ, but languages also differ in how they carve up the world into different categories (Pavlenko, 2005:434-435). A question that arises is thus whether these linguistic differences reflect some sort of differences in thought.

The way that we perceive colour has been a central topic in research on this question. Specifically, this line of inquiry has focused on colour categorisation. The notion of colour, generically defined as wavelength variation in the spectrum visible to the human eye, has a significant role in various cognitive processes linked to memory, language, and perception. This has resulted in several theories being established with regards to the categorisation of colour. It has been shown that languages differ in the number of colour terms that they possess which, in turn, causes variances in the number of categories that they encode in colour space (Alvarado, 2013:2; Ozgen, 2004:95, Kay & Regier, 2006:52). This finding has been famously associated with Whorf's (1956) principle of linguistic relativity, which posits that the way we think is influenced by the language(s) that we speak.

In contrast, Berlin and Kay's (1969) universal hypothesis predicts that speakers of all languages actually categorise colour in the same way. Yet an alternate account, which seeks to steer away from these opposing and somewhat binary views, holds that features of both relativistic and universal viewpoints are justifiable: Findings from a number of studies (e.g., Roberson, Davies & Davidoff, 2000; Roberson *et al*., 2005; Athanasopoulos, 2009) have shown evidence for both viewpoints such that colour naming patterns differ from one language to another, while colour categories tend to be formed in a similar way between languages. By investigating, from this perspective, the varied ways that colour is encoded by speakers of different languages, we can gain a more in-depth understanding of the connection between language and thought (Ozgen, 2004:95; Wolf & Holmes, 2011:253).

There is a vast body of literature examining colour categorisation in speakers of different languages (e.g., Davies & Corbett, 1994, Philling & Davies, 2004, Roberson, Pak & Hanley, 2008). The generated findings indicate that cross-linguistic variation in colour term repertoires to some extent influences the way speakers perceive colour. Importantly, however, the bulk of these studies have examined monolingual speakers only. While a monolingual focus is common, it ignores the fact that the majority of the world's population use two or more languages daily (Aronin & Singleton, 2012).

More recent research on colour cognition has focused on speakers who are fluent in two or more languages (i.e., bilingual), and the findings here have shown that bilinguals vary in their categorisation and colour naming behaviour due to their varied cultural backgrounds and the characteristics of the languages that they speak (Alvarado, 2013:1). Studies have found that bilinguals whose first language (L1) encodes the colour spectrum differently to their second language (L2), may exhibit shifting colour categorisation patterns, depending in part on their frequency of use and proficiency with their second language (e.g., Athanasopoulos, 2009; Athanasopoulos *et al*., 2011).

The current MA thesis concentrates on assessing colour memory and similarity judgements of colour in isiXhosa-English bilingual speakers, isiXhosa being a Southern Bantu language spoken in South Africa. IsiXhosa and English colour terms differ in that isiXhosa, unlike English, does not make a lexical distinction between 'green' and 'blue', but instead has the basic colour term *luhlaza* to refer to this colour space. Previous research on other Southern Bantu languages such as Ndebele and Setswana, also found that these languages do not possess distinct terms for 'green' and 'blue' (Davies *et al.*, 1992, Davies, Davies, & Corbett, 1994). Thus, the question arises as to whether speakers of these languages process the perceptual boundaries of these colours differently from speakers whose languages do mark the green-blue distinction (Ozgen, 2004:95-96).

Since memory and similarity judgements of colour have not yet been tested in bilingual speakers in Southern Africa, it seemed fitting to conduct this study and offer a contribution to bilingual colour cognition research. Personally, this research topic is of great interest for me as I come from the Eastern Cape where isiXhosa is a prominent language. I learnt isiXhosa throughout my schooling career and I took it as a subject up until my second year of university. Conducting my Honours research, which examined the basic colour terms that occur among isiXhosa-English bilinguals, was truly enjoyable as I had this personal connection with the topic, and so, continuing with this line of research has been very fulfilling.

1.2 Aims and research questions

Since English and isiXhosa vary in their categorisation of colour, the aim of the current study is to see whether these cross-linguistic differences modulate memory accuracy and similarity judgements of the green-blue colour space. Furthermore, the study aims to examine whether their experience with the English language influences isiXhosa speakers to behave more like speakers of English on these measures.

For the purpose of this study, the following questions are addressed:

1) Do English speakers and isiXhosa speakers differ in memory accuracy of the green-blue colour space?

2) Do English speakers and isiXhosa speakers differ in judgements of the above colour space?

3) To what extent does the English language experience among isiXhosa speakers modulate memory accuracy and similarity judgements?
   In other words, do isiXhosa speakers who are exposed to English shift towards similar behaviour as monolingual English speakers?

Based on previous research (Winawer *et* al, 2007, Roberson *et al.*, 2005, Philling & Davies, 2004, Davies *et al.*, 1998), the working hypotheses are that, first, isiXhosa and English speakers will differ to some extent in their memory and judgements of the green-blue colour space, and second, that the isiXhosa speakers will vary in their colour behaviour partly as a function of their English language experience.

1.3 Methodology

In order to obtain baseline colour data of South African English, a pre-experimental study was conducted. This included four simple colour tasks aimed at examining the categorisation of colour among L1 speakers of English. In total, the pre-experimental study included 20 participants. The data collected in the pre-experimental study, specifically with regards to the colours *green* and *blue*, was then utilised for the main experiments of the current study.

The main experiments were a conceptual replication of the method used by Roberson *et al*. (2005), which made use of a colour memory task and a similarity judgement task. Before performing the main experiments, the participants first had to complete a colour discrimination task (the Ishihara test) aimed at examining their overall ability to discriminate different colours. The memory experiment then examined the recognition memory for the relevant colour space among the participants. Lastly, the judgement task examined the perceived similarity of triads of colour stimuli belonging to same and different categories of colour. A total of 60 participants (isiXhosa-English bilinguals and L1 English speakers) were included in the main experiments.

1.4 Thesis layout

This thesis consists of seven chapters. The first and current chapter has provided the background to the topic of the study, explained the aims of the study, and stated the research questions.

The second chapter presents a review of the literature on colour perception and cognition. It provides an overview of the studies which have examined the categorisation of colour. This chapter also reviews existing research focusing on colour categorisation of Southern Bantu languages, and more recent research focusing on bilingual colour cognition.

The third chapter is aimed at highlighting the fundamental theoretical concepts introduced in chapter two, and provides the theoretical structure within which the current study is conducted.

The fourth chapter is divided into two parts. Firstly, the methodology and results of a pre-experimental study on baseline colour data of South African L1 English are presented. Secondly, the methodology of the main experiments are explained.

The results are presented in chapter five. This chapter provides a report on the results obtained from the main experiments of this study. Firstly, the performance of the English participants and the isiXhosa-English bilingual participants on memory and similarity judgements of the green-blue colour space is analysed, followed by an assessment of the results within the isiXhosa-English bilingual group.

The sixth chapter provides a discussion on the findings of this study, relating the findings to literature discussed in the previous chapters, and to the research questions posed in the current thesis.

The seventh chapter concludes this thesis by summarising the results of the main experiments, discussing the limitations/shortcomings of the study, and lastly, explaining the contribution of the study and providing suggestions for further research.

2. Literature review

This chapter provides an overview of studies which examined colour categorisation. In section 2.1, the relationship between language and cognition is discussed, followed by a review of studies investigating the categorisation of colour in monolingual speakers of different languages. This is followed by section 2.2, in which existing research on colour categorisation in Southern Bantu languages is reviewed. Lastly, section 2.3 provides an overview of research on bilingualism as it relates to colour cognition.

2.1 Language and cognition

One of the main questions that has been raised among linguists, psychologists, and philosophers concerns the relationship between language and thought (Bassetti & Cook, 2011:3). One possibility could be that the language(s) spoken by individuals is/are influenced by the way that they think. Another possibility could be that the way in which individuals think is influenced by the languages that they speak (Bassetti & Cook, 2011:3).

We can then ask, do people of different languages not only speak differently, but also show differences in cognition? For instance, studies examining object classification have found that speakers of varied languages differ when asked to classify objects. In one categorization experiment, English speakers and Japanese speakers were shown a cork pyramid (primary object) and asked whether a piece of cork (secondary object) or a plastic pyramid (secondary object) was most similar to the primary object. These findings reveal a classifier effect such that the Japanese speakers were influenced by material as they selected the piece of cork, whereas the English speakers instead were influenced by shape as they selected the plastic pyramid (Imai & Gentner, 1997; Carrol & Casagrande, 1958 for similar findings).

2.1.1 Colour terms and colour cognition

The cognitive processing of colour and its relation to colour terms has been at the forefront of rivalling theories of relativity and universality since the 1950's (Kay & Regier, 2006:52). According to the relativistic view, one's language influences the way in which one perceives reality. Since languages vary in the number of colour terms that they possess, colour naming patterns will differ, resulting in effects on colour cognition (Kay & Regier, 2006:52).

In contrast to the relativistic view, Berlin and Kay (1969:3) put forward the idea that basic colour terms, across all languages, are categorised according to a constrained set, viewed as the universal hypothesis. According to Berlin and Kay (1969:6), a *basic colour term* (BCT) possesses the following characteristics:

I. It is mono-lexemic
II. Has an independent meaning from other terms
III. It is salient (i.e., frequently used)
IV. Its use is unconstrained (i.e., the meaning is not limited to a certain number of items)

Seven different levels of languages were proposed whereby the number of BCTs possessed by each language determines which level they fall under. Level 1 languages (e.g., Himba spoken in Papua New Guinea) possess only two colour terms for "cool-dark" hues and "warm-light" hues. Level 2 languages (e.g., Tiv spoken in Africa) have terms for *black*, *white*, and a term for *red*. Level 3 (e.g., Ibibo spoken in Africa) and level 4 languages (e.g., Tzeltal spoken in Mexico) have a similar pattern as they both possess terms for the above mentioned colours with additional terms for *green* and *yellow* in either order. Level 5 languages (e.g., Plains Tamil spoken in South India) have terms for all of the abovementioned colours as well as a term for *blue*. Level 6 languages (e.g., Bari spoken in Africa) have an additional term for *brown*. Level 7 languages (e.g., English, Arabic, and Hungarian) possess eight or more colour terms including terms for *pink*, *grey*, *purple*, and *orange* (Berlin & Kay, 1969:3).

But how exactly was this hypothesis formed? Berlin and Kay (1969:5) tested speakers of 20 different languages including Mandarin, Hungarian, and Spanish to name a few. They first conducted an *elicitation task* where they asked each participant to write down as many colour terms as they could think of. Secondly, they conducted a *naming task* where they asked the participants to select colour chips that best represent the colour terms in order to obtain best exemplars (prototypes). The results of the elicitation task showed that some variation occurred with regards to the number of colour terms provided. However, the results of the naming task showed that across all of the languages, the placement of the prototypes were quite similar, resulting in the colour terms being labelled as *universal foci* (Berlin & Kay, 1969:10). Furthermore, it was suggested that 11 BCTs could account for the majority of the terms in each of the 20 languages (Berlin & Kay, 1969:11). The findings of this study showed that some variation was apparent regarding the number of colour terms used among speakers of the different languages. However, the positioning of best exemplars (prototypes) in colour space was similar across all of the languages. Thus, Berlin and Kay (1969) concluded that the variation of colour is limited since languages group colour in similar ways, in other words, categorisation of colour is not language-specific.

Although Berlin and Kay's (1969) theory gained support in subsequent studies (Rosch-Heider, 1972), it was also subject to criticisms, which led to various key revisions of the hypothesis being formulated. The World Colour Survey (WCS) was established in 1976 (Kay & Cook, 2015:1265). The key purpose of the WCS was to further examine the original hypothesis, formulated by Berlin and Kay (1969), by extending the hypothesis to a larger empirical database (Kay & Regier, 2006). During their work with the WCS, Kay and McDaniel (1978:624) proposed the *fuzzy set formulation* theory, which postulated that BCTs could be accessed straight from the neural responses involved in the perception of colour. Six *fundamental neural responses* (FNRs) were established with each category containing a corresponding semantic category (Kay & McDaniel, 1978:636). Another revision came in the form of the *Emergence Hypothesis* (EH) (Kay & Maffi, 1999:744) which was formed in dismissal of Berlin and Kay's (1969) claim that all languages possess a certain number of words which represent colour categories and whose meaning divides colour space. Various studies (Kay & Regier, 2003; Regier *et al.*, 2007) examined languages included in the WCS in order to investigate universals of colour categorisation. The findings showed that the colour categories were placed around universal foci.

2.1.2 Colour categorisation

This section will provide an overview of studies which examined the categorisation of colour in varied languages. The following types of tasks are used:

(i) *Elicitation tasks*, where participants are asked to provide the terms that they know in their respective language(s). This task is used in order to identify potential BCTs of a language; it examines the colour terms according to frequency of use among speakers and the position of the terms on the lists.

(ii) *Naming tasks*, where participants are asked to select prototypes for each colour term they listed.

(iii) *Mapping tasks*, where participants are asked to group colour stimuli according to the colour terms that they provided in the first task. The mapping task is done in order to obtain the perceptual category boundaries of the terms.

Rosch-Heider (1972:12) conducted four studies using four different experiments, aimed at examining the proposal presented by Berlin and Kay (1969) which predicted that speakers of all languages essentially categorise colour in the same way. The participants in the first experiment included 20 monolingual English speakers and another group consisting of 10 speakers with varied L1s such as Japanese, Chinese, Italian, Navaho, Hungarian, Spanish, and Portuguese, who all had knowledge of a L2, English. They were asked to complete a naming task in order to establish the position of colour prototypes in colour space. This task entailed the participants selecting prototypes for the colour terms available in their respective languages. The findings showed that both groups chose the most saturated (i.e. pure colour) colour chips for their prototypes of their colour terms (Rosch-Heider, 1972:13).

The second experiment examined the way in which the colours named in experiment 1 were encoded in colour space. The participants included 23 L1 speakers of Hindi, Javanese, Mandarin, Arabic, and Hungarian. Of the 23, 14 participants were tested in America with English as the language of instruction, and the remaining nine participants were tested in Indonesia with Bahasa as the language of instruction. An elicitation task was conducted where the participants were presented with individual cards illustrating three types of colours: Focal colours are those that represent the prototype of a colour category, internominal colours are those that represent the regions of colour space where no prototypes were named, and boundary colours are those that fall in line with a focal colour category and a internominal colour category (Rosch-Heider, 1972:13).

The participants had to write down the terms that they would use in their respective languages to describe each of the colours presented to them. The results of this task showed that shorter names (i.e., those containing fewer letters) were provided for focal colours and less time was taken to write down these terms. No differences were found between internominal and boundary colours with regards to name length and the time taken to name the colours (i.e., name latency) (Rosch-Heider, 1972:14).

In another study, Roberson, Davies, and Davidoff (2000) aimed to re-examine the findings of Rosch-Heider (1972) in order to test the proposal that colour categorisation is universal. Their participants included adult monolingual speakers of Berinmo and L1 speakers of English.

Berinmo is a language spoken in Papua New Guinea, specifically in the Bitara and Kagiru villages. Berinmo contains five BCTs with a boundary *nol/wor*: Berinmo speakers do not distinguish between blue and green; they separate the green region with the terms *nol* (in English: green) and *wor* (in English: yellow). By contrast, English has 11 BCTs and a boundary blue-green distinguishing between the two separate colour regions (Roberson, Davies & Davidoff, 2000:371).

The English and Berinmo participants completed a naming task. For the naming task, they were asked "what is this called" while the researcher pointed to colour chips. The participants were also asked to select a best exemplar for each of the names that they had provided (Roberson, Davies & Davidoff, 2000:371). The Berinmo speakers used five BCTs to name the majority of the stimuli: *wapa* (white and pale), *kel* (black, charcoal, and something burnt), *mehi* (red), *wor* (ranging from yellow, orange, brown, and khaki), *nol* (ranging from green, yellow-green, blue, and purple). The results of the naming task also revealed that the Berinmo speakers provided fewer prototypes. For the *wor* (in English: yellow) category, the focal yellow chip was selected by four participants and for the *nol* (in English: green) category, a chip close to focal green was selected (Roberson, Davies & Davidoff, 2000:372).

In another study, Korean and English participants were asked to complete a naming task as well as a grouping task, for an array of 90 colour tiles ranging between red, yellow, green, blue, purple, pink (Roberson, Pak & Hanley, 2008:755-756). The naming task entailed the participants being shown a range of green colour stimuli and they had to provide the term that they would use in their respective language to name the stimuli. Results of the naming task revealed that the English participants named all of the colour stimuli green and the Korean participants made use of both *yeondu* (yellow-green) and *chorok* (green). Both groups portrayed high levels of agreement in naming patterns (i.e., Korean 94%; English 91%) (Roberson, Pak & Hanley, 2008:756).

2.1.3 Colour memory

This section will provide an overview of studies which examined the memory of colour among speakers of varied languages. Memory tasks typically entail the participants being shown "target" stimuli which are then removed, followed by an array of stimuli. The participants must then select the stimulus that resembles the "target".

Memory recognition of colour, in a language containing only two colour terms (i.e., *mili* referring to 'dark', and *mola* referring to 'light') was examined by Rosch-Heider (1972:15). The participants were 20 L1 English speakers and 21 monolingual Dani speakers, a language spoken in New Guinea, Indonesia. For this task, the participants were presented with individual colour chips for a duration of 5 seconds, followed by a 30-second delay, then a full array of colours (160 colour chips) were shown to the participants. They were asked to select the "target" colour which was previously shown to them (Rosch-Heider, 1972:16). The results showed that the English speakers had higher memory accuracy scores than the Dani speakers. Additionally, focal colours were shown to be more accurately remembered compared to non-focal colours in both language groups (Rosch-Heider, 1972:17).

In another experiment, also testing Dani speakers, long-term memory of focal colours was examined. This task entailed participants learning 16 different stimuli pairs which consisted of colour stimuli (used in experiment 2 and 3) and words specific to Dani, in the form of "clan" names (Rosch-Heider, 1972:18). The memory task was spread out over a few days where the participants were presented with cards illustrating colour names, the names for each colour were revealed by the researcher, and the participants had to repeat the names. Subsequently, the participants were shown the individual cards and had to recall the colour names. Names for focal colours (red, pink, green, orange, purple, blue, yellow, brown) were found to be learnt faster than internominal colours (Rosch-Heider, 1972:19). The findings of these experiments revealed that focal colours were encoded across the various languages, suggesting that colour is categorised in a universal way despite differing colour term repertoires, providing support for Berlin and Kay's (1969) universal colour hypothesis (Rosch-Heider, 1972:19).

An examination of colour memory amongst speakers of English and Berinmo was conducted by Roberson, Davies, and Davidoff (2000:379). For the memory task, the participants were presented with individual colour chips for a duration of 5 seconds, a 30-second delay followed, and then the participants were asked to select the "target" colour chip from an array of 40 colours (Roberson, Davies & Davidoff, 2000:371).

The results showed that the overall memory performance among the Berinmo speakers was poor compared to the English speakers. The L1 English speakers had more accurate memory recognition than the Berinmo speakers. This could be as a result of the varied colour vocabularies available in each language. It was thus concluded that patterns of naming and memory differed between Berinmo and English, but showed to be comparable within Berinmo

(Roberson, Davies & Davidoff, 2000:373). Furthermore, these findings provide support for previous findings that patterns of memory are similar to within-language naming patterns rather than to patterns of memory of other languages (Roberson *et al.*, 2005:391).

2.1.4 Colour discrimination

This section will provide a review of studies which examined discrimination of colour amongst speakers of different languages. Discrimination tasks entail participants rating the similarity of colour stimuli either shown in pairs or triads which range between within-category (i.e., all stimuli belonging to the same colour category) and cross-category (i.e., stimuli belonging to more than one colour category).

Roberson, Davies, and Davidoff. (2000:389) examined English speakers and Berinmo speakers on a similarity judgements task. Triads of within category and cross-category stimuli was created to investigate the English blue-green boundary and the Berinmo *nol-wor* boundary. The participants were asked to judge the stimuli by selecting the two colour chips which looked most similar to each other (Roberson, Davies, & Davidoff, 2000:388).The results showed that both, Berinmo and English, groups judged the similarity of the colour stimuli according to their respective colour vocabulary, suggesting that colour category boundaries influence similarity judgments of colour. Similar findings were found by Roberson *et al.,* (2005). The prediction was that the Himba speakers would judge within-category stimuli to be more similar to one another than cross-category stimuli. The results revealed that the English speakers selected predicted pairs more frequently than the Himba speakers. The Himba participants, similar to Berinmo and English, judged within-category pairs to be more similar. More specifically, the Himba participants judged those stimuli which was in the same category in Himba to be more similar (Roberson *et al*., 2005:396-398).

2.1.4.1 Electrophysiological evidence of language on colour discrimination

Recent studies (e.g, Winawer *et al*., 2007, Thierry *et* al., 2009) have examined the effects of language on colour cognition from a more biological perspective by using brain potentials in perceptual tasks in order to collect physiological evidence.

Examination of colour discriminations in Russian and English speakers was conducted (Winawer *et al.,* 2007:7780). Like Greek and Japanese (Athanasopoulos, 2009;

Athanasopolous *et al*., 2011), Russian distinguishes between light blue (*goluboy*) and dark blue (*siniy*). Cross-linguistic differences, between other languages, have been found in previous studies which made use of similarity judgement tasks and memory tasks (Roberson, Davies, & Davidoff, 2000; Roberson *et al*. 2005; Philling and Davies, 2004). For instance, speakers of some languages are likely to judge colour stimuli that share the same name in the respective language to be more similar. On the other hand, speakers of some languages where the same two colour stimuli have two distinct names, would not judge these colours to be similar.

It has also been found that these cross-linguistic differences in similarity judgements and memory tasks may be interrupted by "direct verbal interference" (Roberson, Davies, & Davidoff, 2000; Philling *et al*., 2003) or by an indirect attempt at steering participants away from making use of their usual colour naming patterns (Kay and Kempton, 1984), which brings about the assumption that judgements of colour in this regard rely on online linguistic representations.

Twenty-six L1 speakers of Russian and 24 L1 English speakers were examined on a colour discrimination task. They were instructed to select, as fast as possible, one of two bottom colour tiles which matched the top colour tile. Selections were made by either pressing "R" or "L" key on a keyboard. There were three different conditions in which this discrimination task took place: *No-interference* where only the colour triads were included; *Verbal interference* where the participants were instructed to recite an 8-digit number sequence at the same time as completing the colour discrimination task; *Spatial interference* where the participants were shown a square, containing four blocks which were shaded in black. They were then instructed to memorise the pattern in which the shaded blocks were positioned. The participants first completed the discrimination task followed by the spatial interference task (Winawer *et al*., 2007:7781). The results showed that the Russian participants exhibited a category advantage when tested under the first condition (i.e., no-interference), whereas the English participants did not show any such effect under any condition. The category advantage shown by the Russian participants was removed only under the verbal interference condition (Winawer *et al*., 2007:7782). Specifically, this category advantage resulted in the Russian participants performing quicker when discriminating between cross-category stimuli (*siniy* and *goluboy*).

Furthermore, the more challenging discriminations (i.e., "near-colour" pairs) showed these language effects more noticeably. These findings show that colour categories of a language could influence the performance on perceptual colour discrimination tasks. Discrimination accuracy was shown to be high in both the English and Russian participants as the colour stimuli was visible for the duration up until the participants provided an answer (Winawer *et al*., 2007:7783).

Additionally, these findings indicate that performance (i.e., accuracy and reaction time) on colour discrimination tasks vary from language to language depending on the perceptual colour boundaries available in the respective languages. It was noted that speakers of English are also able to make the distinction between light and dark blue; however, the point is not that speakers of English are unable to separate blue into light and dark, but that speakers of Russian make the distinction between the two shades of blue in everyday instances (Winawer *et al*., 2007:7783).

Roberson, Pak and Hanley (2008:753) conducted a study aimed at examining colour category discriminations among speakers of Korean and English. Previous studies (Roberson, Davidoff & Davies, 2000; Philling *et al*., 2003) showed results in support of categorical perception (CP) of colour. Korean possesses 15 BCTs and divides the green region of colour space into two namely, yellow-green (*yeondu*) and green (*chorok*), compared to English which has 11 BCTs and only one term for the green region (Roberson, Pak and Hanley, 2008:754).

The participants included L1 speakers of Korean and L1 speakers of English. The Korean participants were all students at a Korean university and the English participants were all students at a university in Essex, United Kingdom. It was also noted that none of the participants had any colour perception difficulties. Both the Korean and English participants were examined on three colour tasks: *visual search task*, *naming task*, *grouping task*.

For the visual search task, participants had to judge colours surrounding the boundary between the Korean-specific categories of *yeondu* (yellow-green) and *chorok* (green). They were asked to select whether the "odd-one-out" stimuli occurred in the left or right side of the computer screen and they had to do this as fast as they could. The results of the visual search task showed that accuracy among both language groups was high (i.e., Korean 96.2%; English 94.5%). There was a significant effect found for language but not for the visual field. A significant interaction between language and target type was also found: Korean participants performed faster when discriminating cross-category "targets" than within-category "targets", whereas the English participants did not show any effect for either "target" type (Roberson, Pak & Hanley, 2008:757-758).

The average reaction time of the Korean participants was slower than that of the English participants, a possible reason being that for Korean speakers, the "odd-one-out" stimulus could vary from the distractors at prototype or colour category level. However, for the English speakers, all of the stimuli would be within the same category green. Therefore, Korean speakers could find the visual search task to be more difficult than the English speakers (Roberson, Pak & Hanley, 2008:758). Within the Korean group, reaction times varied. The fastest and slowest respondents were compared and it was revealed that for slow responders, cross-category "targets" were discriminated much quicker in both visual fields. In other words, the category effect occurred in both the right field of vision (RVF) and the left field of vision (LVF). For the fast responders, cross-category "targets" were discriminated significantly faster only in the RVF, thus the category effect was specific to the RVF. This is in line with the proposal that CP in both visual fields come about as a result of category label processing in the left hemisphere (Roberson, Pak & Hanley, 2008:760-761). No CP effects were found among the English speakers at the Korean-specific boundary, which corroborates the results of Roberson *et al.* (2005) and Roberson, Davies and Davidoff (2000) in terms of illustrating that CP effects arise at category boundaries of colours that are available in one language but not the other (Roberson, Pak & Hanley, 2008:759-756).

In another study, Thierry *et al.* (2009:4567) examined the possible effects of colour vocabularies in varied languages on visual perception. The participants included monolingual speakers of Greek and English. They were tested on an *oddball shape task*, consisting of four experimental blocks of colour stimuli: two blocks with light and dark blue and two blocks with light and dark green. For each block, the stimuli was presented on a monitor and the participants were asked to press a key on the keyboard only when they saw a "square" (i.e., target stimulus) within a sequence of circles. The target stimuli was in the same colours (light or dark green and blue) as the circle stimuli. A block consisted mainly of light or dark circles (i.e., standard stimulus) with some of circles in the opposite luminance (i.e., deviant stimulus). The luminance of the deviant stimuli was predicted to result in *visual mismatch negativity* (vMMN) which is an electrophysiological index of perceptual deviancy detection (Thierry *et al*., 2009:4567). The main focus of the participants was the shape of the stimuli and not the varied luminance of the circles. Since the participants were not consciously focused on the deviant stimuli, the vMMN was elicited. (Thierry *et al*., 2009: 4567). The findings of the vMMN revealed that the Greek participants distinguished more between varied shades of blue compared to varied shades of green. In contrast, the English participants did not show any preference for the varied shades of the two colours (Thierry *et al*., 2009:4569).

After the participants completed the oddball task, they were asked to name the stimuli. The Greek participants named *ble* for dark blue, *ghalazio* for light blue, and *prasino* for both light and dark green. The English participants simply named blue and green no matter the difference between light and dark (Thierry *et al*., 2009:4567). Previous studies have shown effects of CP in language groups differing in cultural background and environment. Although, all the speakers of these languages possess two different terms to separate the blue region of colour space in terms of light and dark (Athanasopoulos, 2009, Winawer *et al*., 2007). The findings of this study demonstrated that without consciously thinking, the perception of colour is influenced by the colour repertoires available in one's respective L1 (Thierry *et al*., 2009:4569).

2.2 Categorisation of colour in Southern Bantu languages

Bantu languages belong to the phylum referred to as Niger-Congo (Nurse & Philippson, 2003:1). It tends to be difficult to quantify just how many Bantu languages there actually are as scholars provide varied estimations: Guthrie (1967) proposes that there are around 440 Bantu language "varieties", whereas Grimes (2000) proposes that there are 501 Bantu languages (Nurse & Philippson, 2003:24).

Since there are so many Bantu languages, they are classified according to Zones (1-16) and decades which is based on Guthrie's (1967) classification system (Nurse & Philippson, 2003:3). Zone 5, according to Guthrie's (1967) classification, includes languages such as isiXhosa, Setswana, and Ndebele (Nurse & Philippson, 2003:609).

IsiXhosa is a Nguni-language, specifically southern Nguni, spoken mostly in the Eastern Cape and Western Cape provinces of South Africa. Davies and Corbett (1994:1) examined colour terms occurring in isiXhosa, as a test of Berlin and Kay's (1969) universality colour hypothesis. The isiXhosa participants resided in Transkei, South Africa. They were native speakers of isiXhosa and also had knowledge of English and Afrikaans (Davies & Corbett, 1994:4).

For the elicitation task, the results revealed that, on average, the participants provided 5 colour terms per list. Overall, 22 distinct terms were given, but nine of those were only provided by single participants, including those terms considered to be "cattle terms" (i.e., description of the cattle's skin), for example, *bhonte* referring to "black and white spotted". There were also borrowed terms from English, for instance *pink* (pink) and *blue* (blue). It was also revealed that the most frequent terms – *mhlophe* (white), *mnyama* (black), *bomvu* (red), *luhlaza* (green and blue), and *tyheli* (yellow) – appeared in the first five positions of the lists compared to the less frequent terms (Davies & Corbett, 1994:9).

For the naming task, the participants were asked to identify prototypes for the elicited colour terms when shown individual colour chips of a 160 array (Davies & Corbett, 1994:8). The findings of the naming task revealed that the top four terms – *mhlophe* (white), *mnyama* (black), *bomvu* (red), and *tyheli* (yellow) – were seen to be basic. However, according to Davies and Corbett (1994:16), the term *luhlaza* appeared to have a complicated position in colour space, yet it was still considered to be basic. It was suggested that this "grue" term (i.e. green and blue, a composition category), could be disintegrating as *luhlaza* mainly occurred in the green region of colour space with *blue* emerging in the blue region, but not frequently.

Around 20 years later, another data set was collected on isiXhosa-English bilinguals residing in the Western Cape, South Africa. This study (Parshotam, 2018; also Bylund, Parshotam & Athanasopoulos, 2019) aimed at replicating Davies and Corbett's (1994) findings regarding the BCTs among isiXhosa speakers. A novel dimension in this study, compared to Davies and Corbett's earlier study, was that the participants' knowledge of a second language (i.e., English) was taken into account, as this might influence their colour categorisation behaviour.

The participants completed three colour tasks: an elicitation task where participants were asked to write down the isiXhosa colour terms that they know, a naming task where participants were asked to identify prototypes for the terms that they provided in the first task, and, lastly, a mapping task where the participants had to group colour chips together which they believed represented the colour terms previously provided and draw boundaries around these chips. The results of the elicitation task showed that the most frequently provided terms were as follows: *bomvu* (red), *mhlophe* (white), *luhlaza* (green or blue), and *mnyama* (black).

Zooming in on the term *luhlaza*, the two most frequent colour chips named, by 48.7% of the participants, was in the green region of colour space, and only 15.3% of the participants named chips in the blue region. This illustrated that *luhlaza* was represented across the green and blue regions of colour space, indicating that it was going in the direction of being used to describe green or blue instead of an amalgamation of the two (i.e., grue, Parshotam, 2018:19-25). For the mapping task, the results showed that for the term *luhlaza*, the most frequent chip selections for the boundaries occurred in the green region with very few chips selected in the blue region, suggesting that the green region was the most dominant (Parshotam, 2018:30-32).

Further analysis was done in order to examine the effects of the participants' bilingual background on their behaviour with *luhlaza*. With regards to the elicitation task, a significant effect was found between the ranking of *luhlaza* on the lists and self-reported proficiency in English, showing that a lower ranking of *luhlaza* was correlated with higher English proficiency levels (Parshotam, 2018:38). In the study by Davies and Corbett (1994), participants translated the term as "green and blue" (i.e., grue) whereas, in Parshotam's (2018) study, the term was translated as "green or blue".

In another study, Davies, Davies, and Corbett (1994:36) examined colour categorisation in Ndebele, a Bantu language spoken in South Africa, also belonging to the Nguni group (Nurse & Phillipson, 2003:610). The participants included L1 Ndebele speakers ranging from 11-57 years of age and they had knowledge of English. The tasks included an elicitation task and a mapping task. In general, the findings of the various tasks showed that Ndebele possesses four BCTs: *kumhlophe* (white), *kumnyama* (black), *kubomvu* (red), and *kuluhlaza* (green and blue). As in the Davies and Corbett's (1994) study on isiXhosa colour terms, the Ndebele "grue" term is suggested to also be disintegrating.

The elicitation task revealed English-borrowed terms such as *bulu* (blue) and *igilini* (green). The mapping task revealed four terms appearing for blue namely, *kuluhlaza* (grue), *okuyisibhakabhaka* (sky), *okulizulu* (sky), and *bulu* (blue). Again, bilingualism was not accounted for even though the participants had knowledge of English and the appearance of borrowed English terms was evident (Davies, Davies & Corbett, 1994:42-46). In another study, Davies and Corbett (1997:1) examined colour categorisation amongst Setswana speakers, English speakers, and Russian speakers. Setswana is a Bantu language belonging to the Nguni group and most commonly spoken in South Africa, Botswana, and to some extent in Namibia and Zimbabwe (Nurse & Philippson, 2003:609).

The participants were examined on various tasks such as an elicitation task, naming task, and sorting task. The results of the naming task showed that Setswana speakers were not able to name as many colour stimuli compared to the English and Russian speakers as they listed fewer colour terms (Davies & Corbett, 1997:9). The sorting task entailed the participants grouping colour chips together such that those chips which looked alike were in a group. The results of this task revealed that for blue-green, Russian speakers divide it into *zelenyj* (green), *goluboy* (light-blue), and *siniy* (dark-blue); English speakers divide it into green and blue; Setswana only has one category *botala* (blue-green) which is considered to be a “grue” term (Davies & Corbett, 1997:9). Therefore, the variances in the grouping of colours were shown to be influenced by language which was evident in the position of category boundaries, specifically between blue and green (Davies & Corbett, 1997:18).

A study by Philling and Davies (2004:433) examined speakers of Ndonga and English in order to analyse direct and indirect effects of language on the cognition of colour. Ndonga is a Bantu language spoken in areas of Angola and Namibia and it belongs to the Wambo language group (Nurse & Phillipson, 2003:566). These two languages vary with regards to their colour term inventory, as English contains 11 BCTs and Ndonga only contains six BCTs. The placement and number of colour category boundaries among these two languages also vary. Ndonga does not possess terms for pink, orange, and purple. Instead, the English category pink occurs in *oshitiligane* (red); orange falls between *oshitiligane* (red) and *oshishunga* (yellow); and purple falls between *oshitiligane* (red) and *oshimbulau* (blue). Thus, English and Ndonga do not have any mutual category boundaries.

Speakers of these two languages were examined on four colour tasks: *colour naming task*, *colour sorting task*, *colour triads task*, and *visual search task*. For the colour sorting task, participants were instructed to group the colour chips so that those chips that look the same were in a group. The results showed that there was no significant difference with regards to the number of different colour category groups for each language. Both English and Ndonga had between six and seven different groups and a similar grouping pattern was found among the two languages. There were separate groups for each colour prototype in both English and Ndonga, but not for orange and red. The similar grouping pattern between the two languages suggests that the perceptual structure promotes the 6-7 grouping outcome. Furthermore, Ndonga has the same perceptual colour categories to English even though, in Ndonga, not all of the colour categories are distinguished lexically (Philling and Davies, 2004:436-441).

Direct and indirect language effects were shown to influence the selection of tiles for grouping due to the colour names available in each respective language. In other words, those tiles which were considered to have the same colour name in a language were often grouped together compared to those tiles which had different colour names in a language (Philling and Davies, 2004:452). In the colour triads task, participants were presented with individual triads and were instructed to select the “odd-one-out” of the three tiles. It was expected that in instances where triads varied in structure of naming among the two languages, it would result in selections being made in line with the respective naming structure. Variances in the structure of colour naming could come about due to the fact that Ndonga does not possess BCTs for pink or orange. Therefore, for Ndonga speakers, triads could consist of colour tiles which all have the same name (i.e., *oshitiligane*) whereas, for English speakers, two tiles could belong to the same category (i.e., red) and one tile could belong to a different category (i.e., pink) (Philling and Davies, 2004:441).

The results showed that the selections were comparable between English and Ndonga, namely for the control triads, as the average scores were similar for both languages. This finding was also evident in the colour sorting task. Although, with regards to the experimental triads, the English speakers' average scores were higher compared to the Ndonga speakers' scores which suggests language effects on the tile selections. Furthermore, findings of selection patterns were seen to be in accordance with the Whorfian hypothesis, for both English and Ndonga, namely participants' leaned more towards selecting colour tiles in line with predictions of within-language than cross-language. Lastly, the English participants portrayed slower reaction times for distractor stimuli belonging to the same category in English but not in Ndonga (Philling and Davies, 2004:448). The visual search task was not as susceptible to direct language processes. In this task, participants were presented with a range of colour stimuli and were instructed to select the colour tiles, as fast as possible, which looked the same as the 'target' tile. The stimuli consisted of various sets which made up a trial set (i.e., the target was red and green distractors) and two experimental conditions (i.e., orange target with varied within and cross-category distractors) (Philling and Davies, 2004:448-449). The main finding of this task was with regards to the two conditions where the English speakers showed an increased difference compared to the Ndonga speakers. This finding suggests an indirect language effect and is in line with the Whorfian hypothesis (Philling and Davies, 2004:451).

A study by Roberson *et al*. (2005) intended to extend the previous findings connected to varied colour labelling in a population with the similar number of colour terms (Roberson, Davies & Davidoff, 2000). A different language, Himba, a Bantu language spoken in Northern Namibia which contains five BCTs and a boundary *dumbu* (yellow, beige)-*burou* (blue, green, purple), was examined. The participants were observed on the following tasks: *naming task, memory task*, and *similarity judgement task*. The results showed that the Himba range of colour terms is similar to those found in Berinmo (Roberson, Davies & Davidoff, 2000). However, Himba speakers demonstrated less consistency in naming responses. The Himba speakers lifestyle and their cultural environment (i.e., cattle herding) also showed somewhat of an influence on their naming responses as a few "cattle terms", describing the hides of animals (e.g., *vahe*, *kuze*, *vinde*), were elicited during the naming task.

In an attempt to analyse the extent to which differences and similarities among Berinmo and Himba colour terms compare to the cognitive organisation of colour among English speakers, a memory task was administered (Roberson *et al*., 2005:390). The results showed that the Himba participants listed significantly fewer BCTs than Berinmo. Those colours that had corresponding labels in Himba were recognised more frequently by the Himba speakers than those colours with corresponding labels only in English. Thus, no evidence was found to suggest that English colour terms influence the memory performance of Himba speakers as their performance was in accordance with the specific colour terms available to them in their language.

The Himba participants and English participants then performed a similarity judgement task with the prediction that the Himba speakers would judge within-category stimuli to be more similar compared to cross-category stimuli specific to their language. This task required the participants to judge the similarity of colour triads with the Himba-specific boundary *dumbu* (yellow, beige)-*burou* (blue, green, purple) and the green-blue boundary in English (Roberson *et al*., 2005:394). The results revealed that the English speakers selected predicted pairs more frequently than the Himba speakers. The Himba participants, similar to Berinmo and English, judged within-category pairs to be more similar. More specifically, the Himba participants judged those stimuli which was in the same category in Himba to be more similar (Roberson *et al*., 2005:396-398).

Overall, the studies reviewed above concentrated on monolingual speakers (or disregarded the fact that knowledge of another language could have had an influence on participants' performance on the experimental tasks). Monolingual speakers indeed provide us with essential insight into the way in which one perceives colour in one's respective language(s); however, examining bilingual speakers would provide us with a better understanding of the relationship between language and thought as it allows for an examination of the malleability of colour representation.

2.3 Bilingual colour cognition and linguistic relativity

Colour perception has been an infamous area of examination for the linguistic relativity hypothesis (Whorf, 1956; discussed in chapter 3). Early studies (e.g., Brown & Lenneberg, 1954) revealed that speakers of a language which contains a single term for the colours orange and yellow, are not able to accurately discriminate between the two categories, unlike speakers of English. The participants performed a memory task where they were shown individual colour chips, the stimuli was removed, a delay of a certain amount of time commenced, and then they had to recall the "target" stimuli that they had previously seen. The findings of the memory task showed that the Zuni participants performed poorly compared to the English participants. The performance of the Zuni speakers could have been caused by the fact that Zuni only has a single term for two colour categories (see Ervin, 1961 for similar findings). These results indicate that the colour behaviour of bilingual speakers differs from the colour behaviour of monolingual speakers (Bassetti & Cook, 2011:148). Nonetheless, research on linguistic relativity fizzled out not long after, due to findings of universal features in the categorisation of colour by researchers such as Berlin and Kay (1969). This, in turn, resulted in the decline of bilingual cognition research (Bassetti & Cook, 2011:148).

Only in the late 1900s did bilingual cognition research make a comeback (Pavlenko, 2005, Bassetti & Cook, 2011:150). Jameson and Alvarado (2003) conducted a cross-linguistic study on colour among monolingual English speakers, monolingual Vietnamese speakers, and Vietnamese-English bilingual speakers, although the factor of bilingualism was not examined at a deeper level; rather, findings were merely examined as to whether they were in line with findings of monolingual speakers of the respective languages. Berlin and Kay (1969) also made use of participants who had knowledge of a second language (i.e., English), but this factor was not examined. Berlin and Kay (1969) drew the conclusion that colour was universal across all languages even though differences in the categorisation of colour occurred.

Thus, the colour domain has been a major topic of discussion in the debate between universality and relativity with regards to bilingual cognition. This is due to many reasons. Firstly, participants' knowledge of additional languages has been ignored. For instance, participants' in Berlin and Kay's (1969) study all had knowledge of English. However, this factor was overlooked even though their findings revealed that their participants portrayed colour- naming patterns similar to those of English speakers. Despite prior research (Ervin, 1961) revealing that knowledge of an additional language could result in a shift in colour naming patterns, Berlin and Kay (1969) understood their findings as support for universality. Secondly, bilingualism is seen as a perfect prospect to examine "whether cognitive representations of entities such as colour is innate and fixed from birth, or whether it is a learned socio-cultural construct that overrides presumably universal perceptual mechanisms." (Bassetti & Cook, 2011:242). Furthermore, bilingualism enables the examination of variables (i.e., L2 proficiency, L2 age of acquisition, immersion in L2 culture, etc.) not possible in the examination of monolingual subjects, and it provides vital information to researchers with regards to cognition and language (Bassetti & Cook, 2011:242). Lastly, Whorf's formulation of the linguistic relativity hypothesis was based on the idea of bilingualism, which also played a major part in the re-emergence of the relativity hypothesis. Furthermore, the examination of bilingual cognition entails the use of methods aimed at examining language effects on cognition (Bassetti & Cook, 2011:242).

2.3.1 Semantic representation of colour in bilinguals

Previous studies showcasing the semantic representations in bilingual speakers have found shifts occurring with regards to colour prototypes. Ervin (1961) investigated colour naming behaviour of Navajo-English bilingual speakers with monolingual speakers of each respective language. The results of a colour naming task revealed that the bilingual participants shifted towards naming patterns similar to monolingual speakers of their L2, English. Similar findings were revealed by Caskey-Sirmons and Hickerson (1977) who examined colour naming among bilingual speakers of Japanese, Korean, Chinese, Hindi, and Cantonese, all with English as their L2. The results revealed that the participants tended to move their category prototypes towards those found in English. Consequently, these results guided researchers to believe that bilinguals' cognitive patterns tend to mirror those of L1 speakers of their L2, in this case, English (Ervin, 1961; Caskey-Simmons & Hickerson, 1977).

Another study, which examined colour categorisation in Vietnamese-English bilinguals, revealed that the bilingual participants would adapt their colour naming behaviour to correspond with their L2 (English). Vietnamese possesses fewer colour terms than English, suggesting that bilingual speakers make use of either of their languages depending on which one tends to be most informative (Jameson & Alvarado, 2003). The above studies highlight the semantic characteristics of words available in the lexicon of bilingual speakers, and offers the necessary information for studies examining the conceptual representations of colour (Cook & Bassetti, 2011:244).

2.3.2 Cognitive shifts in bilinguals

Some researchers (Pavlenko, 2005; Jarvis & Pavlenko, 2008) have highlighted that non-verbal methodology (i.e., similarity judgements) could be valuable in understanding the representation of concepts among bilingual speakers. Since languages vary in the way in which they perceive colour space, the question arises as to how bilingual speakers of varied languages differ with regards to cognitive behaviour. The first scenario could be that bilingual speakers perceive and categorise colour according to their L1. The second scenario could be that a cognitive shift takes place where their L1 colour categorisation patterns would be altered. The third scenario could be that their behaviour lies between the patterns of either of their languages. This suggests that bilingual speakers could, more times than not, demonstrate more than one of the scenarios which are influenced by variables such as L2 proficiency, L2 use, and age of acquisition of L2 (Bassetti & Cook, 2011:243).

In the domain of grammatical number marking, studies (Athanasopoulos, 2006, 2007; Athanasopoulos & Kasai, 2008) have found that L2 proficiency correlated with the extent to which Japanese-English bilingual speakers moved towards judging “countable” and “uncountable” objects to be similar, mirroring monolingual speakers of their L2, English. In the domain of colour, Athanasopoulos (2009:6) examined bilingual cognition amongst Greek-English bilinguals. In Greek, the blue region is divided into dark (*ble*) and light (*ghalazio*) blue. The participants were instructed to make similarity judgements between dark and light blue stimuli which consisted of pairs. Various factors were examined such as L2 proficiency, L2 age of acquisition, and length of stay in the L2-speaking country. These factors were correlated with the bilingual participants’ similarity scores. The results revealed that those bilinguals who resided in the L2-speaking country (United Kingdom) for a longer period of time distinguished between the varied blue shades less frequently, positioned *ble* lower on the semantic memory lists, and positioned blue higher on the lists.

As an extension to Athanasopoulos’ (2009) study, Athanasopoulos *et al*. (2011:9) further examined bilingual colour cognition in Japanese-English bilingual speakers by investigating categorical perception effects. In Japanese, the blue region is also divided into dark (*ao*) and light (*mizuiro*). The participants consisted of Japanese monolinguals, English monolinguals, and Japanese-English bilinguals. They were examined on a similarity judgements task where they were shown varied pairs of stimuli and were instructed to rate the similarity between the pairs. The results showed that the Japanese monolingual speakers rated two colours to be more similar if they were within-category rather than cross-category, the English monolingual speakers did not show any effects for either pair type, and the bilingual speakers who used English more frequently distinguished between light-blue and blue pairs less frequently than those who used Japanese more often. Thus, the findings of both Athanasopoulos (2009) and Athanasopoulos *et al*. (2011) provide evidence that L2 use influences colour behaviour in bilinguals, resulting in a cognitive shift towards that of the L2.

The above studies provide insight regarding the influence that various factors could potentially have on cognition in bilinguals.

3. Theoretical framework

This chapter offers a discussion of the linguistic relativity hypothesis and the developments thereof in section 3.1. Section 3.2 introduces and discusses bilingualism. It also introduces the concept of categorical perception in bilingual speakers by defining this concept and explaining findings of studies that are in favour of categorical perception of colour. Finally, this section discusses the various variables that have been shown to have an effect on cognitive processing in bilinguals. Section 3.3 discusses the link between colour and cognition by providing an overview of the theories regarding colour categorisation.

3.1 Linguistic relativity

One of the most fundamental views regarding the relationship between language and thought is the *linguistic relativity hypothesis*. The relativity hypothesis is a well-known and a popularly debated topic among many scholars. The theory was formulated by Edward Sapir (1921) and Benjamin Lee Whorf (1956). The relativity hypothesis presents the notion that the language(s) an individual speaks influences the way in which the individual thinks (Pavlenko, 2005:434; Wolff & Holmes, 2011:253). In the words of Whorf (1956):

> "The linguistic relativity principle…means, in informal terms, that users of markedly different grammars are pointed by their grammars toward different types of observations and different evaluations of externally similar acts of observation, and hence are not equivalent as observers but must arrive at somewhat different views of the world." (Whorf, 1956:248)

The basic prediction of this hypothesis is that although we all see the same reality, syntactic constructs and lexical denotations in different languages vary significantly. Linguistic relativity also hypothesises that we tend to perceive and conceptualise reality differently as a result of the differing categories that are available to us in our specific languages (Wolff & Holmes, 2011:253).

It is said that there are two 'versions' of linguistic relativity. The two 'versions' are named *strong* and *weak*. The *strong* version implies that an individual's language determines their thoughts for all time, which is also referred to as *linguistic determinism*. However, Whorf himself never really espoused this idea. Linguistic determinism proposes that some concepts that are not found in a language cannot be thought about or understood by speakers of that language (Wolff & Holmes, 2011:254). Whorf (1956) conducted research on various Native American languages and came to the conclusion that "differences in language, in terms of grammar and the number of terms available to name objects, indeed paves the way in which individuals think about the world". For example the Hopi language possesses a single term to describe any flying object, from an insect to a helicopter. In terms of grammatical structure, Hopi does not mark tense (i.e., past, future, present) according to Whorf, whereas, in English, the structure of verbs illustrates the notion of tense. Another example would be the concept of time. In English, time is regarded as something that is countable and divisible (e.g., "I sleep for 8 hours" or "I walk for 30 minutes"). In other words, concepts such as "minutes", "hours", and "days" are measured objectively in English. Unlike English, Hopi speakers do not measure time objectively (e.g., "I sleep in the evening" or "I walk in the morning"). Whorf concluded that Hop was a "time-less" language for which he could not find any evidence for tense-marking. Whorf also argued that these variances among the languages results in conceptual variances in each culture and determines the way people think (Tohidian, 2009:68).

Whorf's (1956) methodology was criticised as his claims were made solely on verbal evidence which does not automatically correspond with variances in perception. A solution to this problem would be to examine both verbal and non-verbal behaviour (Whorf, 1956:28). Garnham and Oakhill (1994:48) pointed out that Whorf's (1956) translations of a Native American language to English was problematic and inaccurate. This was due to the fact that these were direct, "word-for-word" translations which could result in sentences that do not make complete sense as the structure and meaning of sentences vary from one language to another. Green (1975) pointed out that a back-translation of sentences from English to for example, Hopi, would result in various inconsistencies and the intended meaning of sentences will be misunderstood and/or lost. These criticisms reveal that Whorf's analyses of the data collected on Native American languages such as Hopi was contested (Wolff & Holmes, 2011:253-254; Pavlenko, 2005:434-436, Tohidian, 2009:69).

The *weak* version implies that an individual's language, in terms of language use and linguistic categories, merely influences their thoughts. This influence is not permanent and it can change. However, up until the 1990s the claims of linguistic relativity was not substantiated by empirical research, because the way in which the proposal was formulated brought about a number of paradoxes/contradictions (Wolf & Holmes, 2011:253).

Recent research examining the premise of the relativity hypothesis has started to focus on the examination of non-verbal behaviour (i.e., behaviour that occurs outside of overt speech production, such as different tasks of categorization, classification, sorting, and memory) compared to previous research which only examined verbal behaviour (i.e., overt speech production elicited through, e.g., descriptions of pictures or objects, and interviews). This allowed for the investigation into linguistic differences across languages as well as differences in cognitive processes (Pavlenko, 2005:435-437; Bylund & Athanasopoulos, 2014:955). In light of non-verbal behaviour, the influence of language on cognitive processes has been studied in various perceptual domains such as colour (Athanasopoulos *et al*., 2009; Roberson *et al*., 2005) and time (Casasanto, 2008).

Wolff and Holmes (2011:253) suggest that linguistic relativity now encompasses a "family" or a set of proposals that are interlinked. These proposals do not function according to a general strong-weak continuum which was initially dominated by two conflicting views namely, linguistic determinism and linguistic relativity. The view of language as "*language-of-thought"* suggests that thought is affected by language when the units of thought are characterised in terms of words as a result of natural language (Wolff & Holmes, 2011:253). Those in favour of this view included Muller (1909), who claimed that "language is identical to thought" (p. 254), and Plato (1892:252), who wrote, "the soul when thinking appears to me to be just talking…" (p. 254). In contrast, Pinker argued that "people can have thoughts that are difficult to express, but this would never be the case if thoughts represented entirely natural language" (p. 254).

In light of this argument, we are directed towards conceptual representations which do not rely on representations denoting lexical meaning or language structures (Wolff & Holmes, 2011:254). This is in contrast to linguistic determinism (as explained above) which claims that language dominates conceptual and perceptual abilities. Even though linguistic determinism evolved from *language-of-thought* with regards to viewing the conceptual system as being independent of language, linguistic determinism has been rejected empirically because it holds flawed predictions with regards to the relationship between language and thought (Wolff & Holmes, 2011:253-254).

Thinking before speaking suggests that thought could be influenced by language in the instance where it arises just before the use of language. For example, in Turkish, speakers must specify whether events that occurred in the past were observed or not. By utilising language, speakers of different languages are then required to heed to specific elements of language experience which is referred to as *thinking for speaking* (Wolff & Holmes, 2011:255). In contrast to the notion of *thinking for speaking*, current research is directed towards *thinking with language*. On this view, non-linguistic processes occur together with language-related processes. "*Thinking with language"* encompasses: "*language as meddler", "language as augmenter",* and "*thinking after language"*, the latter entailing *"language as spotlight"* and "*language as inducer*" (Wolff & Holmes, 2011:256-260). These distinctions will be discussed below.

"*Language as meddler"* refers to the occurrence of language effects when non-linguistic codes are in conjunction with linguistic codes throughout the decision-making process (Wolff & Holmes, 2011:256). One of the perceptual domains where studies have shown effects of '*language as meddler*' is colour. In a study by Roberson, Davies, and Davidoff (2000:403), colour categorisation was examined among speakers of a Papua New Guinea tribe, Berinmo. Berinmo only has five basic colour terms compared to English which has 11. The findings showed that recognition memory performance of the Berinmo speakers was higher for colours specific to Berinmo compared to those specific to English. Similar findings were reported for speakers of Russian and English. In Russian, there is a distinction between two blue terms with regards to light (*goluboy*) and dark (*siniy*). A matching task was administered and the results showed that the Russian participants performed much quicker when the colour stimuli was cross-category than when it was within-category (Winawer *et al*, 2007). The findings of the abovementioned studies show that meddling can occur between language and cognition by means of non-linguistic and linguistic codes (Wolff & Holmes, 2011:256).

"Language as augmenter" refers to instances where linguistic and non-linguistic representations come together in order for actions to be accomplished which could not be possible with only a single kind of representation (Wolff & Holmes, 2011:257). Loewenstein and Gentner (2005:322-325) examined spatial analogies in young children (3.5 years) who resided in Chicago and spoke English. The children were instructed to look at a star while its position on a shelf changed (i.e., top, middle, and bottom) and then they had to find the star on a similar shelf. When the researcher mentioned words such as "top", "under", and "bottom", the performance of the children was better. The findings show that the children were able to position the spatial relations when facilitated by "relational language" (Wolff & Holmes, 2011:258).

As mentioned above, "*language as meddler*' and "*language as augmenter*' effects take place in contexts where representations of language are employed online by thought. A different way in which thought could be affected by language is referred to as "*thinking after language*". This occurs when thought takes place after language use (Wolff & Holmes, 2011:259). "*Thinking after language*" separates into two categories, the first being "*language as spotlight*", which suggests that continuous language use could lead individuals to pay attention to particular features available in the world (Wolff & Holmes, 2011:259). Studies which examine grammatical gender have found effects of "*language as a spotlight*". For instance, in German, "key" is masculine but in Spanish it is feminine. The word for "bridge" is masculine in Spanish but feminine in German. This shows that cross-linguistic differences of grammatical gender are determined more so by aspects which are language-specific than general associations of the world (Wolff & Holmes, 2011:259).

The second category under "*thinking after language*" is "*language as inducer"*, which suggests that language may prime a specific processing system which persists even when language use has stopped (Wolff & Holmes, 2011:260). Studies (Holmes & Wolff, 2010; Freyd *et al*,. 1988) that examined motion simulation in static scenes found that, for example, when a certain object was taken away which initially was a means of support for another object (e.g., a table beneath a flower pot), individuals tended to mimic notions of gravity on the object which was no longer supported (Wolff & Holmes, 2011:261).

As discussed above, two versions of the linguistic relativity hypothesis can be rejected namely, language as "*language-of-thought*" and linguistic determinism. However, empirical support has been provided for the five remaining versions: "*thinking for speaking*", "*language as meddler*", "*language as augmenter*", "*language as spotlight*", and "*language as inducer*". Thus, language introduces various systems of representation which allows different types of thinking to come about (Wolff & Holmes, 2011:261).

3.2 The bilingual mind

In the majority of the world's population, the use of two or more languages is widespread (Aronin & Singleton, 2012). However, in the past it was believed that a confounding factor for the study of language and cognition was bilingualism as monolingualism were viewed as the norm. Only in the last 20 years has this belief been re-evaluated. There has been a growing body of research, by cognitive psychologists, linguists, and neuroscientists, on bilingualism which concentrates on language and cognition. Recent findings have shown that bilingual speakers are a distinctive group as they develop cognitive control which allows them to manage the activity of the multiple languages, which, in turn, influences cognition (Kroll, Bobb, Hoshino, 2014:159; Pavlenko, 2005:433).

Kroll, Bobb and Hoshino (2014:160-162) identified three ways which they believe underpin the recent increase of bilingualism research. Firstly, findings have shown that a bilingual's languages are "active" all of the time. This activity of the two languages are demonstrated in actions such as reading, listening and speaking. Linguistic activation in a bilingual's mind takes place parallel where both languages are in play, and even when a bilingual is in a situation where only one of their languages is being used, the other language is still active and has to be suppressed intentionally or unintentionally to avoid interference (Kroll, Dussias, Bice, & Perrotti, 2015:380). Secondly, it has been found that a bilingual speaker's language system adjusts according to the situation or context. In other words, the L2 and L1 influence each other with regards to cognition depending of the level of proficiency in each respective language and the environment in which these languages are used (Kroll, Dussias, Bice, & Perrotti, 2015:382).

Even though valuable insights have been provided by the study of age of acquisition, recent research on bilingualism has suggested that in fact the proficiency of language could be more significant when examining the co-activation contact of a bilingual speaker's L1 and L2 (Kroll, Dussias, Bice, & Perrotti, 2015:379). Lastly, it is said that through the years, the bilingual speaker's L1 and L2 manipulates the organisation of the brain and the way in which it operates. An alleged benefit of this is that it allows bilingual speakers to gain certain skills to train the brain to support cognitive functioning even in the event of cognitive disabilities or old age (Kroll, Dussias, Bice, & Perrotti, 2015:386; see however Lehtonen et al., 2018, for a critical appraisal of this effect).

Bilinguals are then described as those individuals who are fluent in two or more languages, and are said to have a unique way of perceiving the world due to the influence of their first and second languages on each other. Furthermore, there are different types of bilinguals who are classified according to how and when they acquire the additional languages (Kroll, Dussias, Bice, & Perrotti, 2015:378).

Some bilinguals acquire both languages simultaneously from birth and they make use of both languages for the duration of their lives. These individuals are classified as *early* bilinguals. Individuals who are classified as *late* bilinguals are exposed to one language from birth and only acquire a second language at a later stage in their lives. Both types of bilingual speakers may either live in an environment where both languages are used or where a single, dominant language is used. Thus, not all individuals who are exposed to these environments will acquire additional languages and become bilingual (Kroll, Dussias, Bice, & Perrotti, 2015:378).

In the domain of colour, Alvarado (2013:1) suggests that the examination of cross-linguistic colour categorisation behaviour among bilingual speakers highly depends on their level of language proficiency in their respective L1 and L2 languages. For instance, some individuals may have knowledge of two or more languages because they were immersed into a new culture or environment where they either acquired an additional language while still making use of their L1 or their use of their L1 became less frequent. In another instance, an individual resides in an environment where they are exposed to various languages and they are able to make use of each language to such an extent that they maintain a sufficient level of proficiency in each language. Thus, language proficiency in conjunction with the context of acquisition are vital factors that are necessary to observe when examining colour behaviour in bilingual speakers.

It can be deduced that various factors play a role in the language development of the bilingual speaker; these include the environment in which the L2 is used, level of L2 proficiency, variances among the L1 and L2, and the extent to which the L2 is used (Kroll, Dussias, Bice, & Perrotti, 2015:378; Bylund and Athanasopoulos, 2014:969-977). These factors will be discussed in detail in the following section.

3.2.1 Factors influencing cognitive processing in bilinguals

Research examining bilingualism has been said to mainly focus on the "individual cognitive processes" and rarely on the ways in which two or more languages could impact cognitive processes (Pavlenko, 2005:433). Generally, psycholinguistic studies pertaining to bilingualism have concentrated on the processing of syntactic elements at the sentence level and not on "linguistic and cultural specificity of conceptual representation" (Pavlenko, 2005:433). Thus, we do not have much knowledge with regards to the influence of cross-linguistic and cross-cultural variances on cognition. However, we have extensive knowledge regarding bilingual lexical processing and cognition (Pavlenko, 2005:433).

In order to gain a better understanding of the relationship between language and thought, it is important to address certain factors which may influence bilingual speakers' cognitive performance. Bylund and Athanasopoulos (2014:969-977) identify six factors that have proven to have an influence on the cognitive restructuring in second language speakers. Pavlenko (2005:438) also identifies these six factors and suggests that when bilingualism and thought is being examined, one should make use of these factors as a general "framework". They are discussed below.

3.2.1.1 Language proficiency

Language proficiency indicates the overall proficiency of an L2 speaker with regards to either their L1 (i.e., if attrition of language occurred) or their L2. In some instances, proficiency may also refer to specifically knowledge of L2 semantic features that are being examined, since it is assumed that acquiring semantic features specific to the L2 could result in cognitive changes in the L2 speaker. Thus, it would be fitting to predict that the higher the proficiency in the L2, the better the chances of cognitive restructuring in the L2 speaker (Bylund & Athanasopoulos, 2014:969).

Studies on various perceptual domains have shown that there is a correlation between task performance and proficiency in the L1and/or L2. Athanasopolous (2006) examined cognitive number representation by observing L1 Japanese- L2 English bilinguals' sensitivity to adjustments in the number of countable and non-countable objects and substances. It was found that the performance of the L2 English speakers' varied depending of their overall English (L2) proficiency. Athanasopoulos *et al.* (2015:146) examined the categorisation of motion events in speakers of English and German. The results showed a significant effect of language proficiency such that those L1 English speakers who were learning German and had high proficiency levels of German (L2) were more likely to judge the motion events similar to L1 German speakers.

In the domain of colour, L1 attrition resulted in altered colour categorisation patterns. Athanasopolous (2009:90) observed a significant correlation for the semantic saliency of L1-specific blue term (*ble*). In other words, the lower down the list *ble* occurred, the less likely it was that the Greek bilingual speakers could differentiate between within-category (i.e., stimuli belonging to one category such as blue) and cross-category (i.e., stimuli belonging to more than one category such as blue and light-blue).

In contrast, some studies have been unable to demonstrate correlations between non-verbal cognition and language proficiency. Athanasopoulos (2009) was unsuccessful in illustrating an effect of L2 proficiency on the categorization of colour. In another study, no L2 proficiency effect was revealed for the categorization of objects among L1 Japanese- L2 English bilingual speakers (Cook *et al.*, 2006).

3.2.1.2 Language contact

Language contact represents the amount and ultimately the frequency of use of a bilingual speaker's respective languages (Bylund & Athanasopoulos, 2014:970). Bylund and Athanasopoulos (2005:197) suggest that "the strength of the weightings of the elements that make up conceptual representation would be subject to continuous readjustment as a function of the individual's language usage patterns". Thus, it can be predicted that the use of a language influences linguistic elements and non-verbal behaviour that is distinctive of a certain language.

Athanasopoulos *et al*. (2011:14) examined colour categorization among L1 Japanese- L2 English bilinguals. The frequency of L2 (English) use was observed and the findings showed that those bilingual speakers who used English most of the time, shifted more frequently towards L2 cognitive patterns. In another study (Bylund *et al.*, 2013), the categorisation of motion events among L1 Afrikaans- L2 English bilingual speakers was examined. The findings revealed that instances of motion event categorisation was influence by the frequency of English use which, in turn, caused the bilingual speakers to portray similar categorisation behaviour to L1 English speakers. Bylund and Athanasopoulos (2014) found that during the categorization of motion events, L1 isiXhosa speakers who had knowledge of aspect languages such as English and siSwati, would tend to portray similar behaviour to L1 speakers of these languages which contains grammatical aspect. (For a similar finding, see Bylund & Athanasopoulos, 2015).

Language contact has also been observed to affect the restructuring of cognition in L2 speakers in an indirect way. Studies pertaining to L1attrition and L2 attainment have shown that the degree of proficiency is influenced by the frequency of which a specific language is used. This would ultimately enhance or maintain language proficiency with the linguistic element that could affect cognitive restructuring in the L2 speaker (Bylund & Athanasopoulos, 2014:971).

3.2.1.3 Context of acquisition

In some language-specific studies, results have illustrated independent effects of L2 acquisition in both natural (Athanasopoulos, 2009) and taught (Kurinski & Sera, 2011) acquisition contexts, as well as contexts where the L2 is taught at school and used within the society (Bylund & Athanasopoulos, 2014). These studies illustrate that various contexts of L2 acquisition may influence the restructuring of cognitive processes in L2 speakers despite the fact that they offer limited evidence for the degree to which cognition is affected by contexts of acquisition (Bylund & Athanasopoulos, 2014:972).

3.2.1.4 Bilingual language mode

This refers to the extent to which both the L1 and L2 is activated in a bilingual's mind.

Grosjean (1988:132) states that "the languages of the bilingual is activated to different degrees depending on variables such as the linguistic repertoire and code-switching practices of the interlocutor". Thus, the bilingual speaker's categorical discriminations may be influenced by the language mode which they are in (Bylund & Athanasopoulos, 2014:973).

Boroditsky, Ham, and Ramscar (2002) examined action event categorization in L1 Indonesian-L2 English bilingual speakers. The findings showed that Indonesian speakers who were instructed and tested in English portrayed behaviour similar to that of L1 English speakers in contrast to those participants who were instructed and tested in Indonesian. In a study by Kersten *et al*. (2010), an examination of the categorization of motion events in L1 Spanish- L2 English bilinguals was conducted. It was demonstrated that when participants were instructed and tested in English, they would portray similar behaviour to that of L1-English speakers, whereas when they were instructed and tested in Spanish, they would portray behaviour similar to L1 Spanish speakers. These findings are similar to those of Borodistky, Ham, and Ramscar (2002). A study by Athanasopoulos *et al.* (2015:521) examined motion event categorisation in German-English bilinguals. The findings revealed that those bilinguals who received task instructions in English tended to categorise events similar to L1 English speakers, whereas the opposite was the case for those bilinguals who received task instructions in German.

However, some studies did not demonstrate effects of bilingual language mode. One such study was by Filipovic (2011) who examined memory recognition of motion events among L1

Spanish- L2 English bilingual speakers. The results of this study showed that the language in which instructions and testing took place had no effect on the performance of the participants. Bylund and Athanasopolous (2014:974) suggest that the language of instruction and testing may play a part with regards to prompting perceptual aspects linked to or acquired through the particular language.

3.2.1.5 Age of L2 acquisition

The age of L2 acquisition indicates the age when the learning of an L2 started. The cognitive behaviour of an L2 speaker may be affected by the acquisition age in various ways. Firstly, age of L2 acquisition may influence the degree to which the bilingual language mode influences an L2 speaker's cognitive behaviour. Secondly, language proficiency may be influenced by age of acquisition which then results in effects in cognitive behaviour (Bylund & Athanasopoulos, 2014:974).

A study by Kersten *et al*. (2010) which examined the cognition of motion events in L1 Spanish-L2 English bilinguals demonstrated evidence in favour of the first condition. The results showed that the language of instruction and testing affected those bilinguals who acquired the L2 at a later stage in their lives in contrast to those bilinguals who acquired the L2 at an early age. These findings illustrate that those bilinguals who acquire additional languages at a time further apart from their L1 age of acquisition, in varied learning contexts such as at home compared to school, may be more dependent on divergent representation systems. In contrast, those bilinguals who acquire an L2 not long after their L1 acquisition commenced and in similar (natural) learning contexts, may present categorisation behaviour indicative of both languages (Bylund & Athanasopoulos, 2014:974). A study by Athanasopoulos and Kasai (2008), who examined the categorization of objects among L1 Japanese-L2 English bilingual speaker's, demonstrated evidence in favour of the second condition. The findings showed that changes in the bilingual categorisation preferences toward similar cognitive patterns seen in L1 English speakers may be expected due to L2 age of acquisition as well as the level of proficiency in the L2 (Bylund & Athanasopoulos, 2014:974).

There are however studies which did not provide evidence for effects of age of L2 acquisition. Athanasopoulos' (2009:90) study, which examined categorization of colour in L1 Greek- L2 English bilingual speakers, observed no L2 age of acquisition effects among the participants whose age of acquisition ranged from 1 to 13 years. Similar findings were observed in a study by Bylund *et al*. (2013), where the categorization of motion events were examined among speakers of L1 Afrikaans- L2 English bilingual speakers whose age of acquisition ranged from 3 to 18 years (Bylund & Athanasopoulos, 2014:975).

3.2.1.6 Length of immersion in an L2 context

This factor refers to when one is residing in an environment where one's L2 is being spoken as an L1. This may have a part to play in the reformation of an L2 speaker's cognitive structure, since behaviour of categorisation may be altered over a period of time due to the extent of knowledge of a particular language (Bylund & Athanasopoulos, 2014:975-976). In this regard, knowledge may involve the following aspects, as stated in Bylund and Athanasopoulos (2014:976):

I. Evolving proficiency
II. Various occasions where the L2 speaker needs to grapple with the target linguistic element
III. An environment in which the L2 speaker may intentionally or unintentionally demonstrate non-verbal behaviour at L1 level of the L2 i.e., the L2 speaker is on par with an L1 speaker of the L2

Various studies have presented findings portraying altered cognitive behaviour due to longer immersion in the environment where the L2 is spoken as L1 (Bylund & Athanasopoulos, 2014:976). The categorisation of objects in L1 Japanese- L2 English bilingual speakers was examined by Cook *et al*. (2004). It was observed that those speakers who resided in the L2 environment for longer than 3 years showed a significant change in cognitive behaviour, with a tendency to categorise objects in a similar manner to L1 speakers of the L2, compared to those who resided in the L2 environment for less than 3 years (Bylund & Athanasopoulos, 2014:976). The processing of colour in L1 Greek- L2 English speakers was examined by Athanasopoulos *et al*. (2010). The findings showed that those bilinguals who resided in the L2-speaking country (United Kingdom) for a longer period of time discriminated between their L1 blue terms less frequently than those bilinguals who resided in the L2-speaking country for a brief period of time (Bylund & Athanasopoulos, 2014:976).

However, some studies did not show any effects with regards to length of stay in an L2 environment. One such study was by Boroditsky (2001), The L1 Mandarin participants in this study resided in an L2 (English) environment for around 10 years but no effect was found between the conception of time and the duration of stay in the L2 environment (Bylund & Athanasopoulos, 2014:976). Bylund and Athanasopoulos (2014:976) suggest that findings such as the ones of Boroditsky (2001), may be explained by the factor of language proficiency: If the L1 speakers of Mandarin actually had low proficiency levels of the L2 (English) even though they resided in the English-speaking environment for a long period of time, that would explain why length of stay in the L2 environment did not influence task performance.

Reviewing the discussion of the abovementioned factors, one can conclude that some of these factors are connected and may in fact influence one another. For example, context of acquisition may affect age of L2 acquisition which could in turn affect language proficiency, therefore affecting bilingual language mode (Bylund & Athanasopoulos, 2014:977).

3.3 Colour and cognition

Colour has been argued to play a significant role in many cognitive processes related to memory, language and perception. Various theories have been formed regarding the categorisation of colour. There are two main views namely, universality versus relativity. The general debate about the cognition of colour and naming of colour has been formulated around two questions: (a) "Is colour naming across languages largely a matter of arbitrary linguistic convention?" (b) "Do cross-language differences in colour naming cause corresponding differences in colour cognition?" (Kay & Regier, 2006:52).

Berlin and Kay (1969:3) suggested that all languages categorise colour according to a specific, fixed order which was referred to as the universality hypothesis. Roberson. Davies, and Davidoff (2000:369-396) aimed to replicate results found by Rosch-Heider's (1972) on Dani speakers. They examined colour naming and memory among L1 speakers of Berinmo and L1 speakers of English. The findings of this study showed that speakers of Berinmo named colours according to the category boundaries available in their specific language and not according to the universal prototypes suggested by Berlin and Kay (1969) and Rosch-Heider (1972).

As a further study, Roberson *et al.* (2005:379-406) examined colour categorisation among speakers of Himba and English. Himba does not have distinct terms for green and blue unlike English. The study consisted of a colour naming task, memory task, and similarity judgements task. The Himba participants possessed fewer basic terms to name colour stimuli, and they also performed poorly on the memory tasks overall. It suggests that their memory performance is linked to their colour vocabulary. The Himba speakers judged stimuli pairs to be more similar when the members of the pairs belonged to the same category in Himba but not in English. These findings show that colour categories available in an individual's language affects the way an individual distinguishes between boundaries.

Thus, an alternative view was proposed to shift from the universal versus relativist debate. It was suggested that aspects of both views are valid and were illustrated by findings of various studies (Roberson *et al.*, 2005; Roberson, Davies, & Davidoff, 2000; Athanasopoulos, 2009). The main characteristics of this alternate view is as follows:

I. Colour categories are arranged around universal prototypes, but
II. Colour naming differences across languages prompt variances in the cognition of colour

As discussed above, by rejecting the notions of "universals versus relativity", the relationship between cognition and colour can be refined and further investigated by looking at phenomena such as colour categorical perception (Kay & Regier, 2006:53).

3.3.1 Categorical perception of colour in bilinguals

Categorical perception (CP) is the phenomenon by which the categories available to an individual influences the individual's perception (Ozgen, 2004:95, Goldstone & Hendrickson, 2009:1). It can be said that we perceive differences between items belonging to different categories more than differences between items belonging to the same category. Goldstone and Hendrickson (2009:1) state that CP plays an important part in cognitive sciences as it encompasses the interaction with regards to "high-level conceptual systems" and "low-level perception systems" in humans (Goldstone & Hendrickson, 2009:1). One area in which CP is investigated is with regards to vision. In terms of colour, it has been shown that speakers of languages who vary in the categorisation of colour reveal differences in cognitive processes such as memory, as a result of the categories available in the respective languages (Goldstone & Hendrickson, 2009:5).

Early studies of bilingual colour perception mainly focused on the semantic aspect of colour. This was aimed at examining whether bilinguals used different colour terms to those of monolingual speakers of a specific language and whether bilinguals shifted towards colour naming behaviour of monolingual speakers of their specific L2. For instance, Jameson and

Alvarado (2003:129) examined colour naming behaviour between English and Vietnamese. In Vietnamese, the term *xanh* is used to describe both green and blue regions of colour space and there is no BCT for orange. The bilingual speakers, instructed and tested in Vietnamese, tended to name the orange category by using an object classification (i.e., the name of the fruit), while the L1 Vietnamese speakers made use of a modified basic term *vang dam* meaning dark yellow. Their results showed that the bilingual Vietnamese-English speakers shifted towards adapting their colour naming behaviour to the way their L2 (English) made colour distinctions.

Recent research has focused on CP. Consider a simple concept such as the rainbow: even though the rainbow is scientifically wavelengths of light, we, as humans, perceive it in terms of various colours such as red, yellow, blue and violet – that is, if the language(s) that we speak has/have the available terms for these colours. When one is able to discriminate colours belonging to different categories better than colours belonging to the same category, CP effects are revealed (Goldstone & Hendrickson, 2009:1, Ozgen, 2004:95).

Ozgen (2004:95) suggests that certain African languages are perfect test languages for CP effects. The reason for this is that Ndebele, for example, possesses a monolexemic term (*kuluhlaza*) to describe both blue and green regions of colour space. English, in contrast, possesses two distinct terms for these two colour regions. This suggests that languages such as Ndebele do not have category boundaries between colours such as green and blue. Even though this is the case, green and blue can be conveyed by adding a qualifier to *luhlaza*. There are some tasks that could illustrate CP effects. One such task is a similarity judgements task, where participants are shown triads of colours (e.g., a triad comprising of two blue chips and one green chip or vice versa) and are asked to choose the odd coloured chip and rate the similarity. Theoretically speaking, speakers of a language such as Ndebele would not show any CP effects as the colours would appear to be from the same category. Speakers of English would choose the coloured chip that does not fit into the same category.

Athanasopoulos (2009:6-9) investigated bilingual colour cognition in L1 Greek- L2 English bilinguals. The participants had to judge the similarity of colour chips according to light and dark blue as Greek makes a distinction between these two shades, *ghalazio* (light) and *ble* (dark), but English does not. The results showed a weak but significant correlation for length of stay in an L2-speaking country, resulting in the bilinguals distinguishing between categories less and behaving more similar to L1 English speakers the longer they had resided in the English-speaking country. Furthermore, those bilinguals who listed *ble* higher on the list, distinguished cross-category stimuli more often, thus revealing CP effects since Greek as two terms for blue colour space, whereas those bilinguals who listed *ble* lower on the list and distinguished between categories less often, demonstrated a cognitive shift towards L1 speakers of their L2, English. In a further study, Athanasopoulos *et al.* (2011:9) examined bilingual colour cognition by looking at L1 Japanese- L2 English bilinguals as Japanese also makes a distinction between light (*mizuiro*) and dark blue (*ao*), the way Greek does. The results of the similarity judgement task showed that the Japanese monolinguals judged two colours to be more similar if they were from the same category, the English monolinguals did not show any CP effects between within-category or cross-category pairs, and the Japanese bilinguals who used English more often distinguished blue and light blue pairs less than those who used Japanese more often. However, they also did not portray colour behaviour similar to L1 English speakers. The Japanese-English bilinguals seemed to demonstrate behaviour that is a blend of both languages. Therefore, the findings of these studies show that L2 use modulates an effect on colour behaviour which, in turn, illustrates a shift in cognitive behaviour towards the L2.

4. Methodology

This chapter is divided into two main sections: The first one reports on the baseline study carried out on South African English speakers in order to establish a baseline for colour categories in this English variety. The second section provides a detailed account of the main experiments used in the study.

4.1 Pre-experimental study: Baseline colour data on South African English

While the English language has been studied extensively with respect to colour categories, the studies to date on this topic have mainly concerned UK and US English, and there is, to the best of my knowledge, no published study in this regard on South African English. Since the English variety is different in South Africa and the cultural context is different, relying on these prior studies to select the blue and green stimuli for the current thesis would not have been optimal. Therefore, it was decided to run a baseline study to establish the basic colour terms of South African L1 English as well as the prototypes and boundaries for blue and green, thereby ensuring that the experimental design is as robust as possible.

4.1.1 Participants

4.1.1.1 Recruitment methods

Prospective participants were recruited via snowball sampling where participants were asked if they knew anyone else who would fit the criteria (i.e., adult L1 South African English speakers who had to have learnt only English from birth and who were aged between 18 and 40 years) and who would be interested in participating in the study. Prospective participants were also recruited by means of a flyer (see Appendix A) which included details regarding the purpose of the study, participant criteria, and what participation in this study entailed. The social media platform of Instagram was also used as a means of inviting prospective participants to participate in the study. This was achieved by posting the recruitment flyer (same as above) from the researcher's personal Instagram account and the Stellenbosch University's Multilingualism and Cognition Laboratory's account. The researcher's contact details appeared on the flyer, thus any interested prospective participants were able to contact the researcher, telephonically or via email, for further information. It was also indicated that prospective participants would not be remunerated for their participation in the baseline study.

Additionally, institutional permission was obtained from Stellenbosch University in order to contact students via their Stellenbosch University email addresses to invite them to participate in the study. The email (see Appendix B) included details about the study such as the purpose of the study, who qualified to participate, what the participants could expect from participating in the study, and the researcher's contact details. Although the assumption was that the majority of the participants would be Stellenbosch University students, this study was not aimed at specifically examining these students. Therefore, prospective participants were not limited to this particular group.

Once prospective participants contacted the researcher, they were asked questions regarding their language background which included how old they were, if they were born in South Africa or not, and the language(s) which they spoke in order to make sure that each participant satisfied the required criteria.

4.1.1.2 Participant characteristics

The 20 adult L1 South African English speakers had an average age of 21 years 1 month. These participants had to have learnt South African English from birth as their only language and thus their L1. Overall, there were 14 female participants and six males. The participants' places of birth varied across four South African provinces: 12 were born in the Western Cape (WC), five were born in Gauteng (GT), two were born in the Eastern Cape (EC), and one was born in KwaZulu-Natal (NL). Their language proficiency in English was self-assessed on a scale from 1 to 5, where 5 represented excellent proficiency and 1 represented poor proficiency. On the whole, participants rated their English proficiency 5 out of 5. Language use among the participants was also self-rated on a scale from 1 to 5, where 5 represented the use of a language(s) the majority of the time and 1 represented the seldom use of a language(s). On the whole, participants rated their English language use 5 out of 5. The participants were, in other words, very suitable for partaking in the baseline study.

All of the 20 L1 English speakers had learnt additional languages at a later stage in their lives. The main language that was common among all of the participants was Afrikaans. Ninety-five percent (19 out of 20) of the participants learnt Afrikaans formally such as at school or at university. This was expected as in the South African education system, it is compulsory to take a first additional language as a subject for the duration of one's school career, and Afrikaans is typically the first additional language offered at ex-Model C schools, which is the type of schools that participants attended. Other languages that the participants learnt at university included isiXhosa, South African Sign Language, German, French, Russian, and Japanese. None of the participants reported having lived in a context where these languages were the primary means of communication, or used them in their everyday lives.

4.1.2 Materials

Participants' overall ability to discriminate different colours was assessed with the Ishihara *colour discrimination test* (Ishihara, 1987; often used to test for colour blindness). This test consists of cards with coloured dots depicting various patterns. The subset of cards used in this study include the following numbers: 12, 29, 6, 42, 96, and 5 cards with lines varying in colour.

The primary stimuli was the Munsell colour chart. The colour chart included 160 saturated coloured chips with five main hues: red (R), yellow (Y), green (G), blue (B), and purple (P) and five intermediate hues: yellow-red (YR), green-yellow (GY), blue-green (BG), purple-blue (PB), and red-purple (RP) across eight lightness values (9, 8, 7, 6, 5, 4, 3, and 2, where 9 is the lightest and 2 the darkest). This follows the standard outline for colour charts.

In addition, each participant was instructed to complete a language background questionnaire (see Appendix F), which included information regarding their age, gender, place of birth, the languages they speak, and their self-rated proficiency and frequency of use of these languages.

4.1.3 Apparatus

The participants were tested individually in a room where light was controlled. Two daylight lamps were used throughout the experiments in order to replicate natural sunlight and this did not affect the colour saturation of the Munsell colour chips. Blank pieces of white paper were used during the *elicitation task*. Transparency sheets and permanent markers were used during the *colour mapping task*.

4.1.4 Procedure

The following procedure was adhered to during the pre-experimental study.

4.1.4.1 Informed Consent

The participants were welcomed by the researcher and were asked to be seated at a table in a room in the Multilingual and Cognition Laboratory at Stellenbosch University in which the light was controlled. The colour of the room was neutral in order to prevent any outside colour influence. The participants were tested individually and were each given a consent form to complete before commencing with the tasks. The researcher explained the details of the study to each participant, which included the purpose of the study and what participation entailed. The participants were assured that their participation was voluntary and if at any time a participant wanted to leave, they were able to do so. They were also told that no risks or harm was involved in the study and all personal details that were provided would be kept confidential and anonymous.

4.1.4.2 Language of instruction

All instructions and testing was conducted in English.

4.1.4.3 Task 1: Colour discrimination

The participants completed the Ishihara test. In this task, each participant was shown 10 cards with coloured dots depicting various patterns such as numbers or lines. They were asked to describe to the researcher what they saw and their responses were noted down. Cards were shown to the participant one by one, and each card was removed before the next card was shown. The colour discrimination task was completed prior to proceeding with the following three tasks, so as to serve as a screening of potential colour blindness. Overall, the participants performed very well on this task (m = 9.7, SD = 0.57). Table 1 provides a detailed summary of the discrimination scores obtained by the participants.

Table 1: Overall scores obtained by 20 L1 English speakers on the colour discrimination task with percentage of participants in brackets.

Score out of 10	Number of participants (%)
10	15 (75%)
9	4 (20%)
8	1 (5%)

In order to obtain English colour data, the 20 L1 English speakers completed three tasks: an elicitation task, a colour naming task, and a colour mapping task.

4.1.4.4 Task 2: Elicitation

For the semantic memory task, each participant was given a blank sheet of white paper. The researcher then asked them to write down the colours that they know in English. This task was done in order to establish the basic colour terms (BCTs) which occur in South African English, with the assumption that the BCTs would appear higher on the lists. The semantic memory task took an average of 5 minutes to complete.

4.1.4.5 Task 3: Colour naming

For the colour naming task, the researcher placed the 160 chip Munsell colour chart on the table in front of the participants. The participants were instructed to identify the colour chips which they thought best represented the terms that they provided during the semantic memory task (i.e. prototypes). They had to provide their answers by pointing at the relevant chip while the researcher noted down all of the responses on a grid sheet. This task took an average of 5 minutes to complete.

4.1.4.6 Task 4: Colour mapping

For the colour mapping task, the participants were shown the 160 chip Munsell colour chart covered with a transparency sheet. The researcher instructed each participant to group together colour chips and draw boundary lines around the chips which they considered to represent the terms that they provided during the semantic memory task. The colour mapping task took an average of 10 minutes to complete.

4.1.4.7 Language background questionnaire

Once all of the participants completed all 4 colour tasks, they filled out a language background questionnaire.

4.1.5 Data analysis

Analysis of the colour categories was conducted by ranking the colour terms, obtained in the semantic memory task, in terms of frequency of use across participants and salience (i.e., according to the order in which they were named) in order to form a coherent list of basic colour terms of South African English. Given their centrality in the thesis, the prototypes for *green* and *blue*, provided during the *colour naming task*, were visually reported on Munsell colour charts, indicating the frequency of the chips named to describe each respective colour term. The colour chart transparencies of the *colour mapping task* were analysed in order to see how boundaries were formed in colour space, and the most frequent chips selected for *green* and *blue* were illustrated on Munsell colour charts.

4.1.6 Results

4.1.6.1 Elicitation task (lists)

The participants offered an average of 17.85 colour terms. Although 77 different terms were elicited, 34 of these terms were only offered once. Furthermore, these 34 terms (e.g., *cerulean*, *mousy brown*) only appeared on the lists; prototypes were not selected for these terms nor were they included in the mapping task, possibly suggesting that in some cases participants actually only knew the term, but not its meaning. Table 2 below includes the colour terms provided by 5 or more (i.e., a quarter) of the participants. The sequence of the terms is in accordance with the number of participants who provided each term, and the average number on the lists (i.e., mean position) of each respective term is also provided. This procedure is standard in studies on BCT (e.g., Davies and Corbett, 1994).

Table 2: Frequency and average position of English colour terms provided by five or more participants with ranks included in brackets.

Term	Frequency and rank		Mean position and rank	
Red	20	(2.5)	4.9	(3)
Green	20	(2.5)	4.63	(2)
Blue	20	(2.5)	4.42	(1)
Orange	20	(2.5)	6.15	(5)
Purple	19	(5.5)	8.63	(6)
Black	19	(5.5)	8.84	(7)
Yellow	18	(7)	5.42	(4)
Brown	17	(8)	10.64	(11)
Pink	15	(9)	9.57	(10)
White	14	(10.5)	10.85	(12)
Grey	14	(10.5)	11.84	(13)
Turquoise	12	(12)	12.66	(15)
Maroon	8	(13)	12.37	(14)
Indigo	6	(14)	9.33	(8)
Gold	5	(16.5)	14	(16)
Silver	5	(16.5)	16.4	(17)
Beige	5	(16.5)	9.4	(9)
Navy	5	(16.5)	17.5	(18)

The first four terms, red, green, blue, and orange, were provided by all (20) of the participants. The mean positions of these 4 terms were numerically low, meaning that they appeared higher up on the participants' lists than the less frequent terms. The following five terms, purple, black, yellow, brown, and pink, were included in three-quarters or more (15-19) of the participants' lists. The terms white, grey, and turquoise, were provided by more than half (12-14) of the participants. The remaining six terms were provided by less than half (8-5) of the participants.

4.1.6.2 Colour naming task (prototypes)

The green and blue prototypes selected by L1 South African English speakers coincided with those identified by Roberson, Davies and Davidoff, (2000) for UK English.

Figures 1 and 2 illustrate the chips selected as prototypes during the colour naming task for the colour terms green and blue. These are the only two terms that will be shown here, as they are the key terms being investigated in this pre-experimental study.

Figure 1[1] illustrates the colour chips named for the term green. Participants named 5 different chips for the term green, which all occurred in the green-yellow (GY) region of colour space. The most frequent chip, 10GY5/10, was named by 9 participants, followed by the chip 10GY6/12 which was named by 6 participants. The remaining three chips, 5GY6/10, 5GY5/10, and 5GY4/8, were named by three or less participants.

Figure 2 illustrates the colour chips named for the term blue. Overall, participants named seven different chips for the term blue. These chips ranged between the blue (B) and purple-blue (PB) regions of colour space. The most frequent chip, 10B5/12, was named by 9 participants. The following most frequent chip, 5B4/10, was named by 4 participants. The other five chips were only named by one or two participants.

Figure 1: Illustrating the prototypes for green.

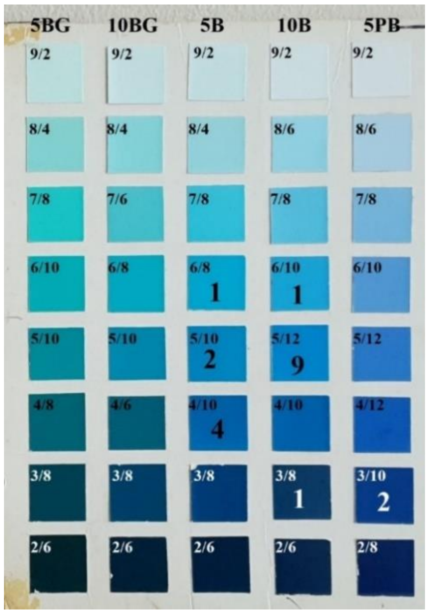


Figure 2: Illustrating the prototypes for blue.

[1] The Munsell colour charts presented here could differ in the terms of colour to the original chart as a result of screen calibration when presented on a monitor or ink and paper quality when printed.

4.1.6.3 Colour mapping task (boundaries)

The chips selected in the boundary for the term green is illustrated in figure 3. On the whole, 20 chips were most frequently grouped together to represent green. More specifically, these chips occurred from 5GY7/12-5GY3/6 to 10G7/8-10G3/6 in colour space.

Figure 4 illustrates the chips most frequently selected in the boundary for blue. Overall, 24 chips were included by the majority of the 20 L1 English participants. These chips ranged from 10BG8/4-10BG3/8 to 5PB8/6-5PB3/10.

Figure 3: Illustrating the most frequent colour chips included in the boundaries for green

Figure 4: Illustrating the most frequent colour chips included in the boundaries for blue

The figures (1, 2, 3, and 4) confirm that South African English has two distinct terms for green and blue, which can be seen by the different colour regions in which these two colours have been named.

4.2 Main Experiments

In this section, an overview of the main data collection procedures, the characteristics of the participants in the main experiments, and a description of the two experiments themselves are presented. Additionally, an explanation of the way in which the data will be categorised and analysed will also be provided.

To reiterate, the aims of this thesis is to see whether cross-linguistic differences in colour terms modulate memory accuracy and similarity judgements, and whether English language experience influences bilingual speakers of isiXhosa to behave more like L1 speakers of English. The current study made conceptual use of the methodology of a previous study by Roberson *et al.* (2005), specifically with regards to the colour memory task and the similarity judgements task.

4.2.1 Participants

The same recruitment methods were utilized as in the baseline study, with the following participant criteria: adult L1 South African English speakers who had to have learnt only English from birth and who were aged between 18 and 40 years. Secondly, adult L1 isiXhosa-L2 English bilingual speakers who had to have learnt isiXhosa from birth and English at a later stage, and who were aged between 18 and 40 years.

Initially, participants were not remunerated for their participation in the study. However, during the course of data collection, recruiting participants became slightly challenging and an incentive was introduced in the form of airtime vouchers valued at R30.00 each.

4.2.1.1 Participant characteristics

The participating 30 L1 isiXhosa- L2 English bilingual participants' had an average age of 24.83 years and were all born in the Eastern Cape (EC). There were 19 females and 11 males. The 30 L1 English participants' birth places varied across the following provinces: 14 were born in the WC, 10 were born in the EC, three were born in GT, two were born in KZN, and one was born in the Free State (FS). The participants' language proficiency in isiXhosa and English was measured on a self-rated scale from 1 to 5, where 5 represented excellent proficiency and 1 represented poor proficiency. Language use among the participants was also self-rated on a scale from 1 to 5, where 5 represented the use of a language(s) most of the time and 1 represented the seldom use of a language(s). Table 3 shows the average proficiency, use, and the age of acquisition for isiXhosa and English among the 30 L1 isiXhosa- L2 English bilingual participants. Overall, the L1 isiXhosa- L2 English bilingual participants rated their isiXhosa proficiency and use higher than English.

Table 3: Summary of the average language proficiency, language use, and age of acquisition among 30 L1 isiXhosa- L2 English bilingual speakers (standard deviation provided in brackets).

	Proficiency	**Frequency of use**	**Age of acquisition**
isiXhosa	4.63 (0.49)	4.46 (0.73)	Birth
English	4.1 (0.76)	4 (1.08)	7.43 (2.37)

Table 4 shows the average proficiency, use, and age of acquisition of English among the 30 L1 South African English participants. As expected, the L1 English participants self-reported high levels of proficiency and use of English.

Table 4: Summary of the average language proficiency, language use, and age of acquisition among 28 L1 English speakers (standard deviation provided in brackets).

	Average proficiency	**Average language use**	**Average age of acquisition (years)**
English	4.9 (0.31)	5	Birth

Various participants in the 30 L1 isiXhosa- L2 English group indicated that they had knowledge of other languages besides isiXhosa and English. Their rated proficiency levels for and usage of these additional languages were nonetheless lower than their ratings for English.

As with the L1 isiXhosa- L2 English participants, the 30 L1 English participants also indicated that they learnt additional languages later in their lives. Afrikaans was the most frequent “other” language as 28 of the participants indicated that they had mostly learnt it at school. However, two of them indicated that they had another primary means of communication than English, and also very high proficiency in these languages. Following previous research showing that additional language knowledge may indeed affect colour cognition (e.g., Athanasopoulos, 2009), it was decided that these two participants be removed from the study. This thus reduced the number of English participants to 28.

4.2.2 Materials

The Ishihara cards, as in the pre-experimental study, were used. The primary stimuli was the Munsell colour chart, as in the pre-experimental study. In addition, individual colour chips of the *blue* and *green* hues were used during experiment 1 and experiment 2.

The same language background questionnaire as in the pre-experimental study was used in the main study.

4.2.3 Apparatus

As in the pre-experimental study, the participants were tested individually in the room where the light was controlled. Two daylight lamps were used throughout the experiments in order to replicate natural sunlight without affecting the colour saturation of the Munsell colour chips.

4.2.4 Procedure

The following procedure was followed during the administering of the below experiments. It was similar to the procedure mentioned above.

4.2.4.1 Informed consent

The same informed consent procedure was followed as in the pre-experimental study.

4.2.4.2 Language of instruction

All instructions and experimental testing was conducted in English. This was the L2 of the isiXhosa-English bilingual participants and the native language of the L1 English participants.

4.2.4.3 Task 1: Colour discrimination

The Ishihara test, as used in the pre-experimental study, was administered in order to ensure that the participants' ability to discriminate colours did not differ between groups. This task was completed prior to proceeding with the other three tasks. No significant difference was shown between the two language groups, t (29) = -0.950, p = 0.346. This suggests that the isiXhosa-English participants (m = 9.37, SD = 0.77) and the L1 English participants (m = 9.64, SD = 0.62) were comparable in this regard.

4.2.4.4 Experiment 1: Memory

Using the prototype data obtained from the colour naming task, the researcher chose two prototype chips for *green* and two prototypes chips for *blue*, these four chips being selected by the majority of the L1 English participants in the pre-experimental study. The English prototypes for *green* and *blue* were shown individually to each participant for 5 seconds. The prototypes were then removed and a delay of 30 seconds commenced. Thereafter, a full array of coloured chips (the 160-chip Munsell chart) were presented to each participant and they were asked to identify the target chip, which they had initially seen. The researcher noted down all of the responses and the participants were scored according to how close their choices were to each of the target chips. Table 5 below shows the four chips selected to be used in the memory experiment. This experiment took approximately 3 to 5 minutes to complete.

Table 5: Prototype chips with codes for green and blue, used in the memory experiment

Prototype colour	**Specific codes**
Green	10GY5/10
Green	10GY6/12
Blue	10B5/12
Blue	10B4/10

4.2.4.5 Experiment 2: Similarity judgement

Using the prototype data obtained from the colour naming task, the researcher created various triads of colour. There were eight triads made up of: within-category stimuli (i.e., all three chips belong to the same category), cross-category stimuli (i.e., two chips belong to the same category, one chip belongs to another category), central stimuli (i.e., the boundary chip is in the middle), and peripheral stimuli (i.e., the boundary chip is on the side).

In this task, 8 triads of varying shades of a colour (*green* and *blue*) were presented individually to each participant, in a random order. The participants were asked "which two of these coloured chips look similar, in the way that brother's look-a-like?" Each of the eight triads was repeated four times, changing the placement of the stimuli each time.

Before commencing with the actual task, participants were asked to complete 2 practice trials which included colours (orange and purple) that were not part of the critical experimental colours. These practice triads were explicit in illustrating within-category (i.e., all three chips belonging to orange*)* and cross-category (i.e., two chips belonging to purple and one chip belonging to orange). This was done in order to ensure that each participant understood how to go about completing the task. The similarity judgements task took approximately 10 to 15 minutes to complete.

Table 6: Arrangement of the colour chips in each of the 8 triads, with x representing the specific colour chips included in each triad

Blue-green	5GY	10GY	5G	10G	5BG *category boundary*	10BG	5B	10B	5PB
Triad 1						x	x	x	
Triad 2	x	x	x						
Triad 3				x		x		x	
Triad 4				x	x	x			
Triad 5				x	x	x			
Triad 6			x		x		x		
Triad 7					x	x	x		
Triad 8			x	x	x				

4.2.4.6 Language background questionnaire

Once the participants had completed the abovementioned experiments, they were asked to fill out the language background questionnaire.

4.2.5 Data analysis

The data collected from the memory task and similarity judgement task was statistically analysed for correlations between memory accuracy and English language experience, i.e., language proficiency, age of acquisition, and language use. Similar analyses were run for the predicted pairs obtained from experiment 2 in order to see whether any differences occur within the L1 isiXhosa- L2 English group and with the L1 English group.

4.3 Ethical considerations

Ethical clearance was obtained from Stellenbosch University before proceeding with the data collection for this project. This was an online process which entailed providing detailed information regarding the purpose of the study, the informed consent process, and the data collection methods. The following documents accompanied the application: The research proposal, consent forms to be used, participant recruitment materials, and descriptions of the various tasks which included the language background questionnaire. Approval from the Research Ethics Committee for Human Research (Humanities) was received for the period of 23 April 2019 to 22 April 2022 (REC project number: 9424). Institutional permission from Stellenbosch University was also received on 2 May 2019 to recruit staff and students of this university as participants (IRPSD-1278).

5. Results

This chapter is divided into two main sections. In Section 5.1, an analysis and report will be provided for the memory accuracy scores. Section 5.2 will follow a similar outline, focusing on the similarity judgements.

5.1 Memory

5.1.1 Comparison between L1 isiXhosa- L2 English bilingual speakers and L1 South Arican English speakers

The first step of the analysis was to compare the memory accuracy scores between the two language groups. Figure 5 illustrates the results of overall memory accuracy of the L1 isiXhosa-L2 English bilingual participants and the L1 English participants. An independent *t*-test was used to compare the overall memory accuracy scores for the colours blue and green in the two language groups. There was a significant difference in the scores between the two groups, $t(56) = -2.288$, $p = 0.026$. These results suggest that the L1 English speakers selected the "target" colour chips more accurately overall than the isiXhosa-English bilingual speakers.

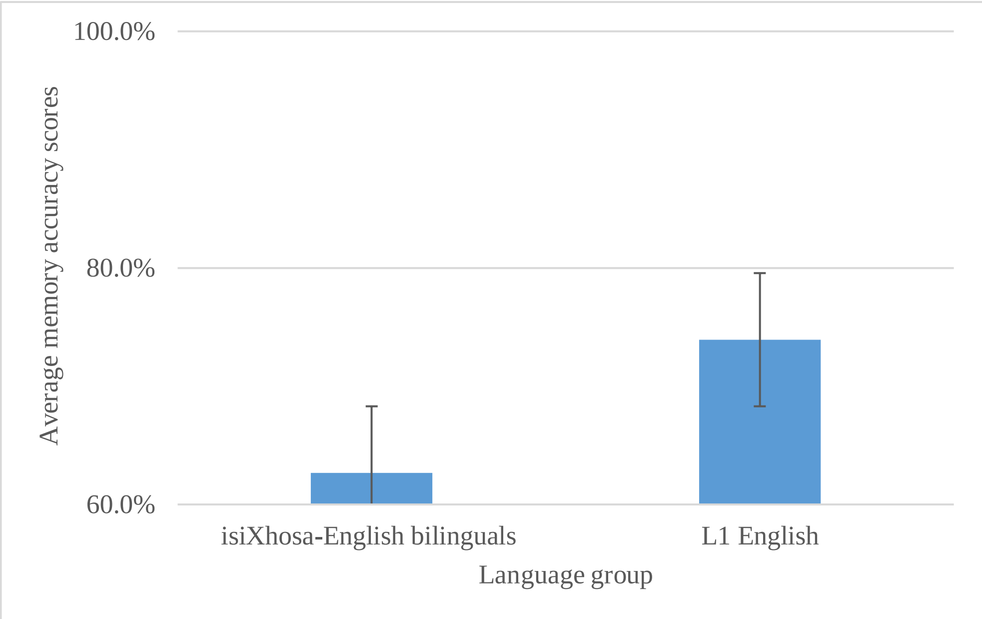


Figure 5: Overall memory accuracy scores (%) of isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

In order to tease out whether these differences occurred for memory accuracy of each individual colour chip, further analyses were conducted.

The results of the memory accuracy scores for the blue chip, 5B4/10, between the isiXhosa-English bilingual participants and the L1 English participants are illustrated in figure 6. Somewhat unexpectedly, the isiXhosa-English bilinguals' (m = 92.3, SD = 10.0) average accuracy score was marginally higher than L1 English speakers' (m = 92.1, SD = 10.6). An independent *t*-test revealed, however, that there is no significant difference in the scores between the two groups, t (56) = 0.070, p = 0.944. These results suggest that the isiXhosa-English bilinguals' memory accuracy for the *blue* colour under scrutiny is similar to that of L1 English speakers'.

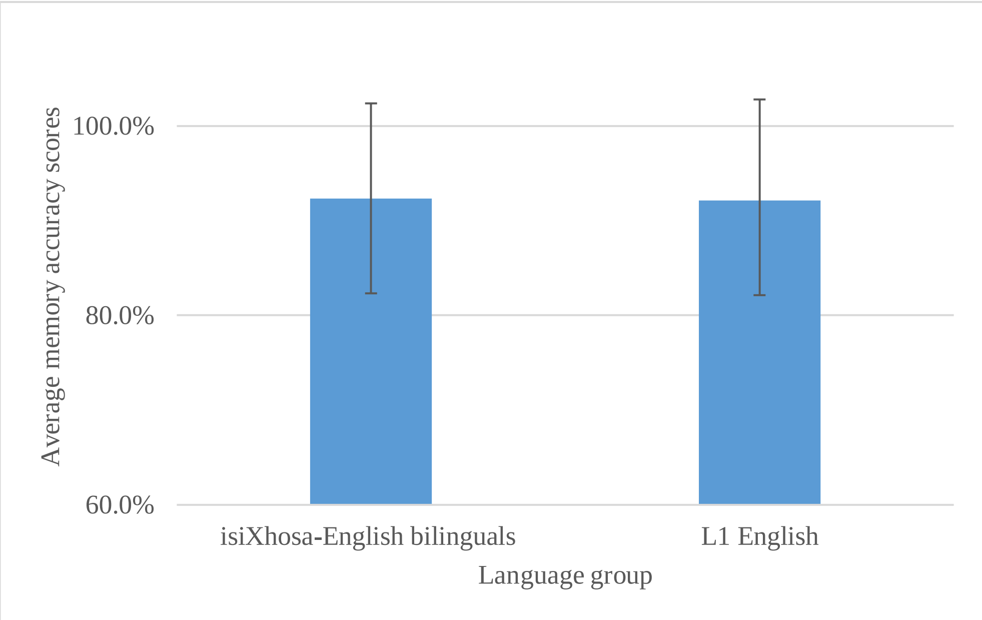


Figure 6: Average memory accuracy scores (%) for 5B4/10 between isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

The memory accuracy scores for the one green chip, 10GY6/12, was examined between the isiXhosa-English bilinguals and L1 English speakers. The results are illustrated in figure 7. An independent *t*-test was conducted to compare the memory accuracy scores for this specific colour. There was no significant difference found in the scores between the two groups, t (56) = -0.702, p = 0.485. Instead, the results suggest that both groups performed similarly in the accurate selection of the target chip whereby the isiXhosa-English bilinguals behaved like L1

English speakers. In other words, even though figure 7 seems to indicate that the L1 English speakers' memory accuracy was marginally higher than the isiXhosa-English bilingual speakers' (m = 88.6, SD = 11.4 vs m = 86.3, SD = 12.7), this difference was not statistically robust.

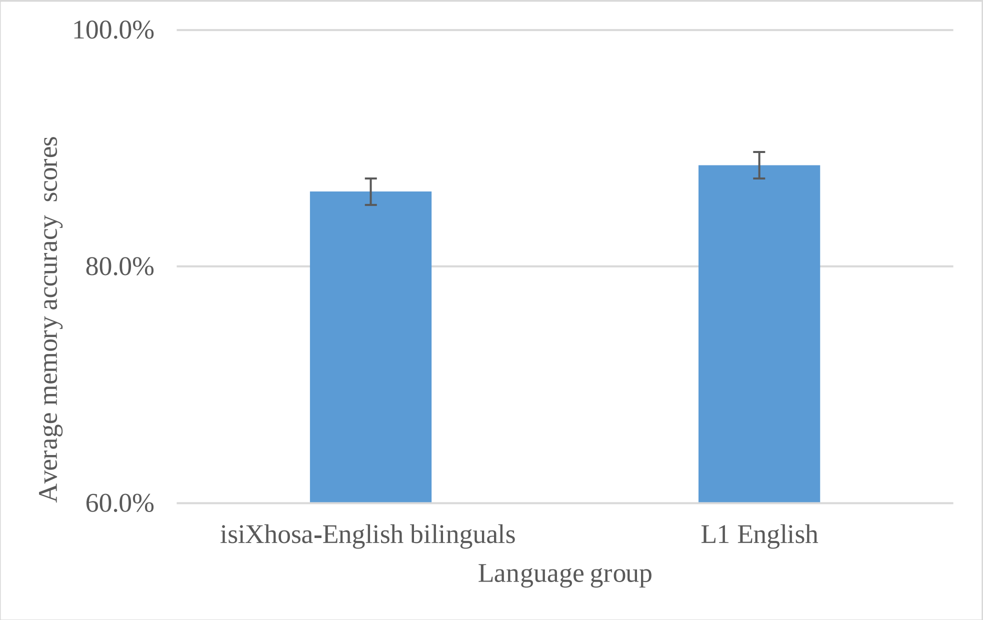


Figure 7: Average memory accuracy scores (%) for 10GY6/12 between isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

Interestingly, statistically robust differences were found for the remaining two chips.

The memory accuracy scores for the other green chip, 10GY5/10, were examined between the isiXhosa-English bilingual participants and the L1 English participants. These results are illustrated in figure 8. An independent *t*-test revealed a significant difference in the scores between the two groups, t (56) = -2.070, p = 0.043. As visible in figure 8, the L1 English speakers' (m = 95.7, SD = 05.0) average memory accuracy for 10GY5/10 is higher compared to the isiXhosa-English bilingual speakers (m = 91.3, SD = 10.0).

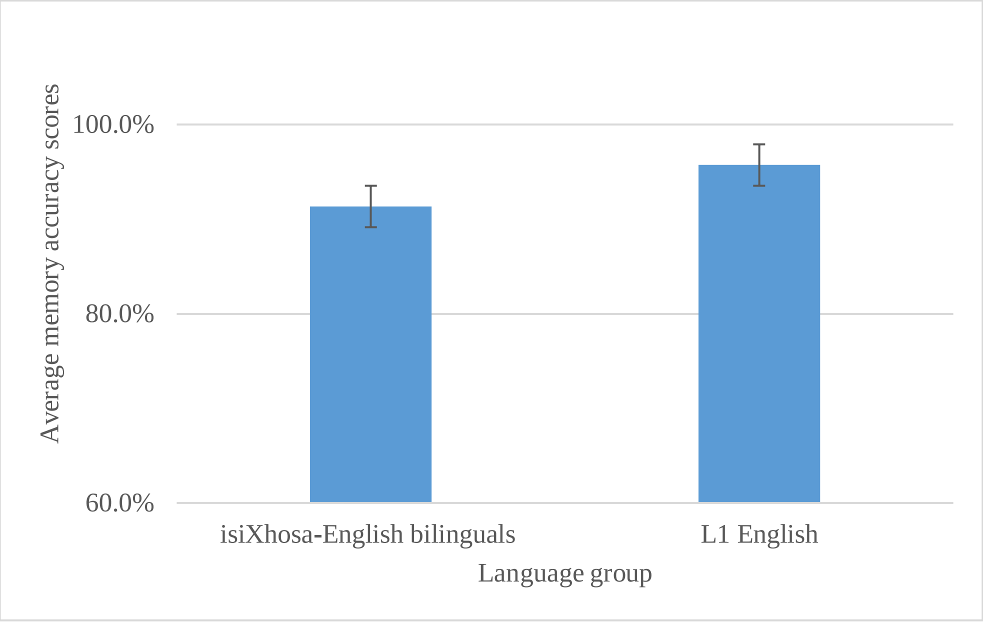


Figure 8: Average memory accuracy scores (%) for 10GY5/10 between isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

Figure 9 illustrates the memory accuracy scores for the other blue chip, 10B5/12, between the two language groups. An independent *t*-test revealed a significant difference between the two groups, t (56) = -2.74, p = 0.008. These results suggest, as figure 9 show, that the L1 English participants (m = 97.5, SD = 04.4) have a significantly higher average accuracy score to the isiXhosa-English bilinguals (m = 92.6, SD = 01.5).

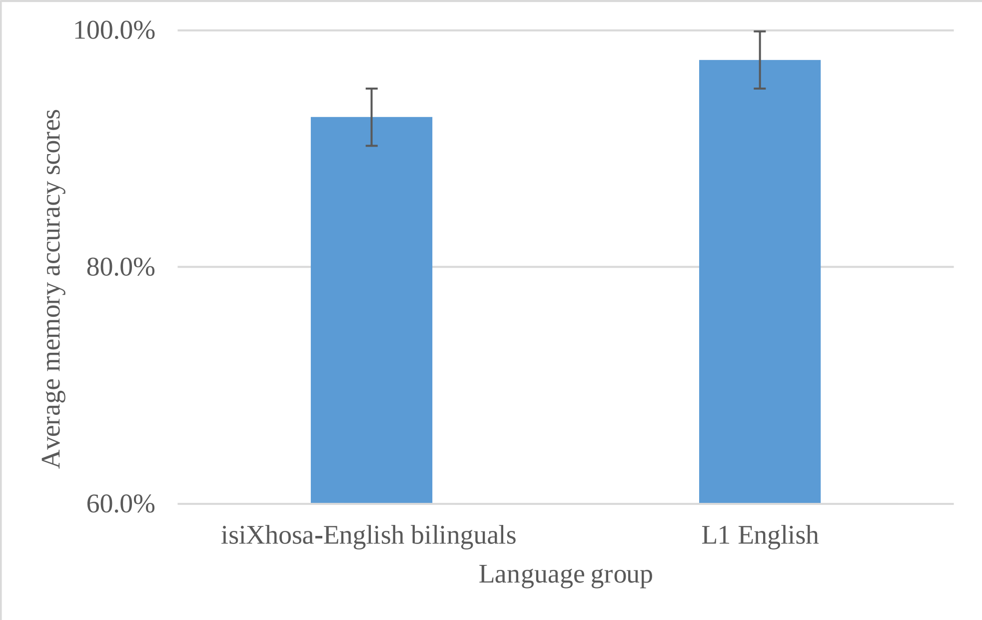


Figure 9: Average memory accuracy scores (%) for 10B5/12 between isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

5.1.2 Examining the influence of English language experience on colour memory among isiXhosa-English bilinguals

The next step in this section of the analysis consisted of assessing whether L2 English experience had any measurable effects on memory accuracy for *blue* and *green* within the isiXhosa-English bilinguals. The isiXhosa-English bilinguals were divided into two groups depending on their English language experience (i.e., L2 English proficiency, L2 English use, and L2 age of acquisition). Those who had high English proficiency levels, used English more frequently, and acquired English at a younger age were regarded as English-dominant and placed into group 1. Those who had lower English proficiency levels, used English less frequently, and acquired English at a later age were regarded as less English-dominant and placed into group 2. This information is provided in table 7.

In order to ensure that these differences in English experience were not superficial, but actually systematic enough in order to be statistically robust, a number of independent samples t-tests were run (table 7). These showed that the two groups indeed differed significantly on all the measured variables, confirming that the L2 English experience of group 1 was of greater magnitude than that of group 2.

Table 7: Summary of L2 English variables between isiXhosa-English bilinguals with standard deviation in brackets, along with t-test coefficients.

	Group 1	**Group 2**	**t**	**p**
Number of participants	21	9		
English proficiency	4.38 (0.59)	3.44 (0.72)	3.721	0.0009
Frequency of English use	4.52 (0.60)	2.77 (0.97)	6.029	0.0001
AoA of English	6.57 (1.53)	9.44 (2.83)	-3.616	0.0012

An independent *t*-test revealed no significant difference between the two groups for overall memory accuracy, t (28) = -0.526, p = 0.603. These results suggest that group 1 had similar memory accuracy for colour overall. Similarly, no significant difference was shown between the two groups for the *blue* colour 10B5/12, t (28) = -0.284, p = 0.778. This suggests that both groups performed similarly (m = 9.23, SD = 0.83 vs m = 9.33, SD = 0.86). This was an interesting finding since a significant difference was found between the isiXhosa-English bilingual participants and the L1 English participants (see 5.1.1) but not within the isiXhosa-English bilingual group. One would have expected this to exert an effect since group 1 had more English language experience.

Subsequently, no significant difference between the two groups was shown for the *green* colour 10GY5/10, t (28) = -0.311, p = 0.758. These results suggest that group 1 (m = 9.09, SD = 1.13) and group 2 (m = 9.22, SD = 0.66) had similarly high accuracy scores for the *green* chip. Analysis of the memory accuracy scores for the blue colour, 5B4/10 also showed no significant difference between the two groups, t (28) = 0.039, p = 0.969, suggesting that both groups had high accuracy scores for the specific *blue* colour under examination (m = 9.238, SD = 1.136 vs m = 9.222, SD = 0.667). Similar to the above, memory accuracy scores for the green chip, 10GY6/12, also revealed no significant difference, t (28) = -0.401, p= 0.691, indicating that group 1 (m = 8.57, SD = 1.43) and group 2 (m = 8.77, SD = 0.83) achieved similarly high accuracy scores for the specific green chip under examination.

In order to exhaust the possibility that variation in L2 English experience played a role in colour memory, a series of multiple linear regression analyses was run. As opposed to the group comparisons above, this allowed for an assessment of potentially continuous effects of variables of L2 English (see table 7).

The independent variables (English proficiency, frequency of English use, and age of acquisition of English) were inputted into a multiple regression analysis, with the dependent variable as the overall memory accuracy scores. On the whole, the regression was not significant, F = 0.540, p = 0.198, MSE = 1.882, R^2 = 0.162. This reveals that, in the case of a statistically significant outcome, only 16.2% of the variation in the isiXhosa-English bilingual participants' overall memory accuracy scores would have been accounted for by the L2 English variables, with the remaining 83.8% left unexplained. Table 8 provides the standardised coefficients, the significance values, and the collinearity diagnostics. However, it was found that age of English acquisition actually had a small albeit significant effect on overall memory accuracy. More specifically, the earlier in life the participants had learnt English, the more likely they were to achieve a high accuracy score. The Tolerance values were greater than .50 and the Variance Inflation Factor (VIF) was less than 10, thus showing that multicollinearity was not an issue (Field, 2007).

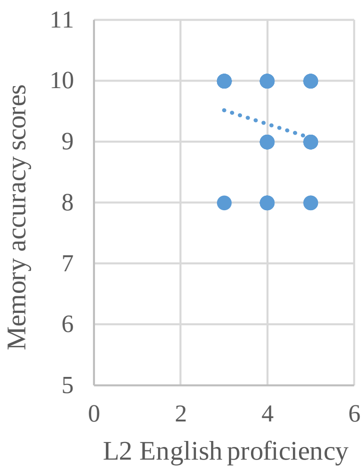
Table 8: Summary of coefficients, significance values, diagnostics for multicollinearity with overall memory accuracy as dependent variable

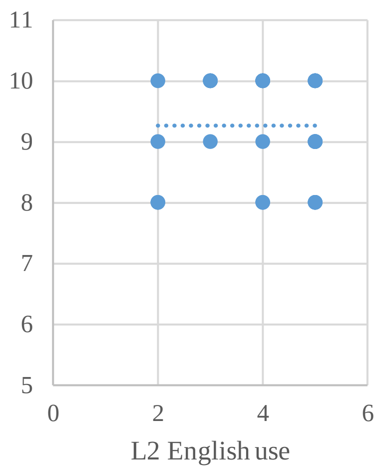
Independent variables	**Standardised coefficient**	**t**	**P**	**Tolerance**	**VIF**
Eng proficiency	0.188	0.877	0.388	0.699	1.430
Eng frequency of use	0.026	0.123	0.903	0.734	1.363
AoA of English	-0.428	-2.214	0.036	0.862	1.160

Next, similar analyses were run for each individual colour chip. Firstly, the memory accuracy scores for the blue chip, 10B5/12, were examined. No significant difference was found, F = 8.167, p= 0.660, MSE= 0.848, R^2= 0.059. None of the variables had a significant effect on the memory accuracy for the blue colour under examination (see table 9). In addition to these analyses, scatterplots for each of the independent variables were also produced, in order to visually inspect the relationship between them and the dependent variable. This was done to rule out that non-significant effects were an artefact of outliers (Cohen, 1988). Figure 10 shows the relationship between English proficiency and memory accuracy for 10B5/12 with a downward slope indicating a negative correlation between the variables. The relationship between frequency of use of English and memory accuracy where the flat slope suggests that there is no clear correlation between the two, is illustrated in figure 11. Lastly, figure 12 illustrates the relationship between age of acquisition of English and memory accuracy with a flat slope indicating that there could be no correlation between these two variables. Furthermore, in neither case does there seem to be any outliers that could have skewed the results, hence the absence of an effect seems genuine.

Table 9: Summary of coefficients, significance values, diagnostics for multicollinearity with 10B5/12 as dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	-0.284	-1.248	0.223	0.699	1.430
Eng frequency of use	0.139	0.623	0.538	0.734	1.363
AoA of English	-0.016	-0.078	0.938	0.862	1.160





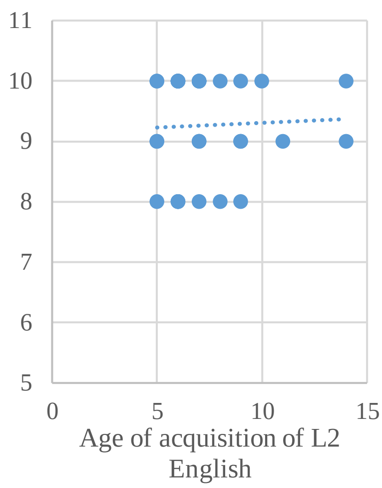


Figure 10: L2 English proficiency and memory accuracy scores for the blue colour, 10B5/12.

Figure 11: L2 English use and memory accuracy scores.

Figure 12: Age of Acquisition of L2 English and memory accuracy scores.

Similar to the above, the memory accuracy scores for the green chip, 10GY5/10, were analysed and no significant effect was found, $F = 5.015$, $p = 0.565$, $MSE = 1.024$, $R^2 = 0.074$. Again, none of the variables had a significant effect on the memory accuracy for 10GY5/10 (see table

10). The scatterplot in figure 13 illustrates the relationship between English proficiency and memory accuracy for the green chip with a slightly upward slope indicating a positive correlation between the variables. A potential outlier is also evident, showing a high English proficiency level with an average memory accuracy score. Figure 14 illustrates the relationship between frequency of English use and memory accuracy with a negative correlation between the variables indicated by a slightly downward slope. Again, a potential outlier is evident with a high level of English use and an average memory accuracy score. The relationship between age of acquisition of English and memory accuracy for the green chip, with an upward slope, is illustrated in figure 15. The same potential outlier is seen with a low age of acquisition and an average memory accuracy score. None of these potential outliers, however, seemed to break with any pattern already existent in the data (thus removing potentially significant effects), nor did they produce any significant effects.

Table 10: Coefficients, significance values, diagnostics for multicollinearity with 10GY5/10 as dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.260	1.152	0.260	0.699	1.430
Eng frequency of use	-0.133	0.605	0.551	0.734	1.363
AoA of English	0.216	1.062	0.298	0.862	1.160

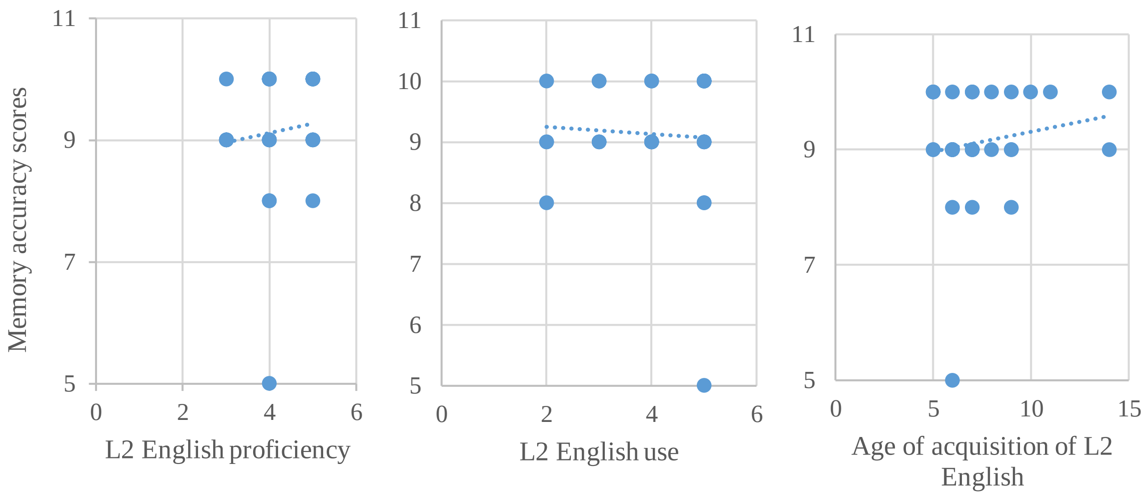


Figure 13: L2 English proficency and memory accuracy scores for the green colour 10GY5/10.

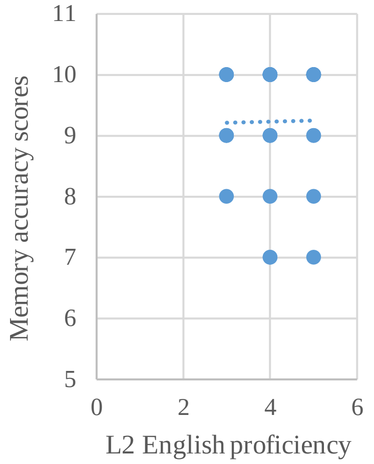
Figure 14: L2 English use and memory accuracy scores.

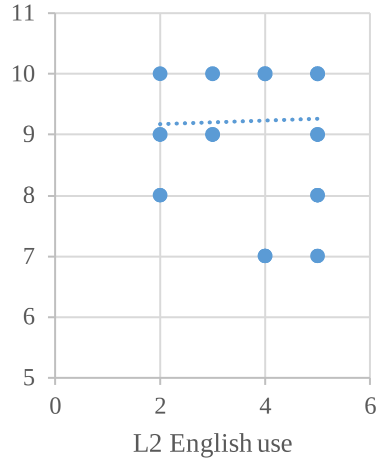
Figure 15: Age of acquisition of L2 English and memory accuracy scores.

Subsequently, no significant effect was revealed for the blue colour, 5B4/10, $F = 5.183$, $p = 0.702$, $MSE = 1.035$, $R^2 = 0.052$. None of the variables had a significant effect on the memory accuracy for 5B4/10 (see table 11). The relationship between English proficiency and memory accuracy for the blue chip under examination, with a flat slope indicating that there could be no correlation between the two variables, is illustrated in figure 16. Figure 17 illustrates the relationship between frequency of English use and memory accuracy with a flat slope suggesting that no correlation occurs between the two variables. The relationship between age of acquisition of English and memory accuracy with an upward slope is illustrated in figure 18. Notably, this slope goes in the opposite direction from the effect of age of acquisition found above, suggesting that later learning onset yielded greater accuracy. This effect was, however, not statistically robust.

Table 11: Coefficients, significance values, diagnostics for multicollinearity with 5B4/10 as dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.031	0.130	0.898	0.654	1.530
Eng frequency of use	-0.047	-0.154	0.879	0.397	2.521
AoA of English	-0.202	-1.285	0.211	0.631	1.584





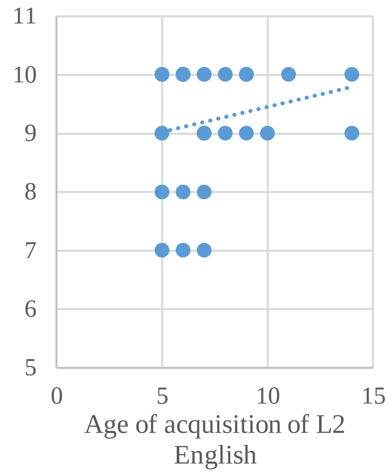


Figure 16: L2 English proficiency and memory accuracy scores for the blue colour, 5B4/10.

Figure 17: L2 English use and memory accuracy scores.

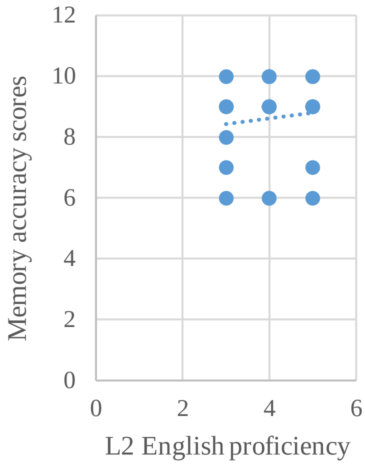
Figure 18: Age of acquisition of L2 English and memory accuracy scores.

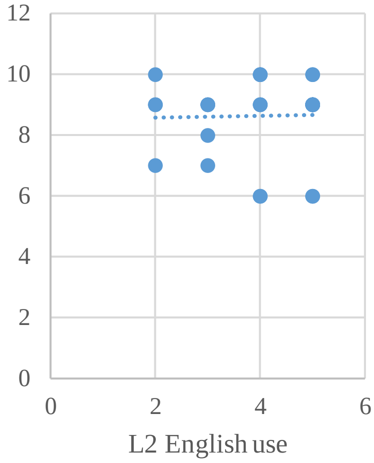
Similarly, no significant effect was revealed for the memory accuracy scores of the green chip, 10GY6/12, $F = 3.165$, $p = 0.465$, $MSE = 1.281$, $R^2 = 0.092$. Correspondingly, the memory accuracy for 10GY6/12 was not significantly influenced by any of the L2 English variables (see table 12). Figure 19 illustrates the relationship between English proficiency and memory accuracy with an upward slope suggesting a positive correlation between the variables. A flat slope, suggesting no correlation between English frequency of use and memory accuracy is illustrated in figure 20. Figure 21 illustrates the relationship between age of acquisition of English and memory accuracy.

Table 12: Coefficients, significance values, diagnostics for multicollinearity with 10GY6/12 as dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.234	0.994	0.330	0.654	1.530
Eng frequency of use	0.063	0.210	0.835	0.397	2.521

AoA of English	0.264		1.103	0.280	0.631	1.584





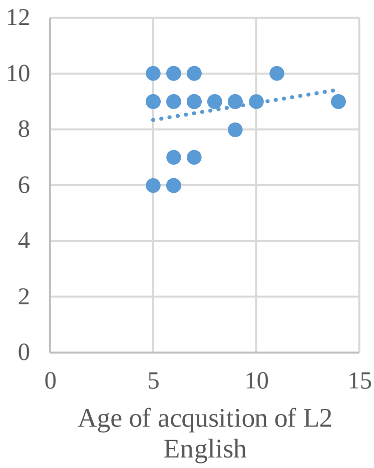


Figure 19:L2 English proficiency and memory accuracy scores for the green colour, 10GY6/12.

Figure 20:L2 English use and memory accuracy scores.

Figure 21: Age of acquisition of L2 English and memory accuracy scores.

5.2 Similarity judgements

5.2.1 Comparison between isiXhosa-English bilingual speakers and L1 South African English speakers

Firstly, an analysis was done on the similarity judgement scores of the predictive pairs for each triad between the isiXhosa-English bilinguals and the L1 English participants. Each triad was shown four times, counterbalancing the position of stimuli each time. The participants were given a score out of four depending on the number times they selected the predicted pairs for each triad.

The results of the predicted pairs for triad 1 and triad 2 for the isiXhosa-English bilinguals and the L1 English are illustrated in figure 22. The chips in triad 1 can be characterised as blue and the chips in triad 2 can be characterised as green. An independent *t*-test revealed no significant difference between the two groups for triad 1, t (56) = -0.352, p = 0.726. As with triad 1, no significant difference was found between the two groups for triad 2, t (56) = -0.132, p = 0.895. These results suggest that the two groups behaved similarly when selecting similar pairs.

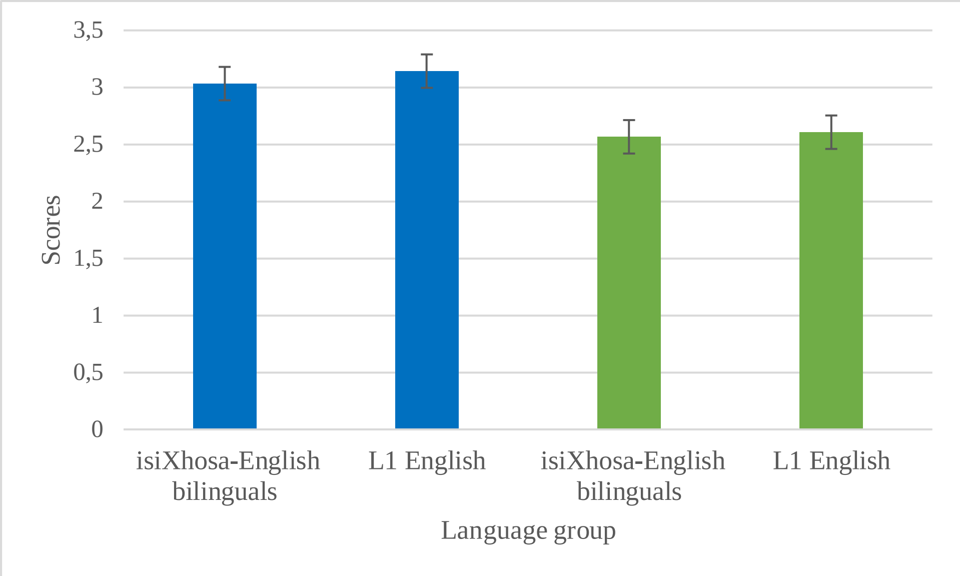


Figure 22: Triads 1 (blue) and 2 (green) predicted pair scores of isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

The same was found for triads 3 and 4 (see figure 23). The predicted pair chips in triad 3 can be characterised as blue and the predicted pair chips in triad 4 can be characterised as green. No significant difference was found between the two groups for triad 3, t (56) = -1.026, p = 0.309, indicating that the isiXhosa-English bilingual participants were equally likely to select the predicted pairs compared to the L1 English participants. For triad 4, both groups scored fairly low with regards to selecting the predicted pairs although, as seen in figure 23, the L1 English participants have a marginally higher score compared to the isiXhosa-English bilingual participants. This difference however, was not statistically significant, t (56) = -1.517, p = 0.135.

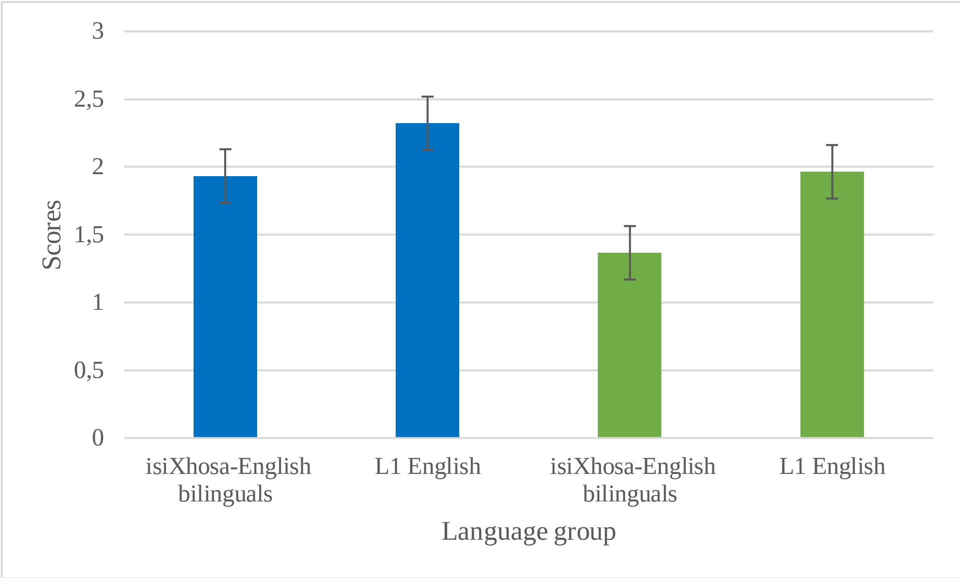


Figure 23: Triads 3 (blue) and 4 (green) predicted pair scores of isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

In contrast to the above, a significant difference was found for triad 5, t (56) = -2.297, p = 0.005. The predicted pair chips in triad 5 can be characterised as "grue". These results reveal that the L1 English participants selected the predicted pairs more frequently than the isiXhosa-English bilingual participants. An inspection of the means showed that the isiXhosa-English bilinguals and the L1 English participants selected other colour chips more times than selecting the predicted pair chips for triad 6. As with triad 5, the predicted pair chips can be characterised as "grue". However, no significant difference was found, t (56) = -0.173, p = 0.863. Therefore both groups were similar on this triad. Figure 24 illustrates the predicted pair scores for triads 5 and 6 between the two language groups.

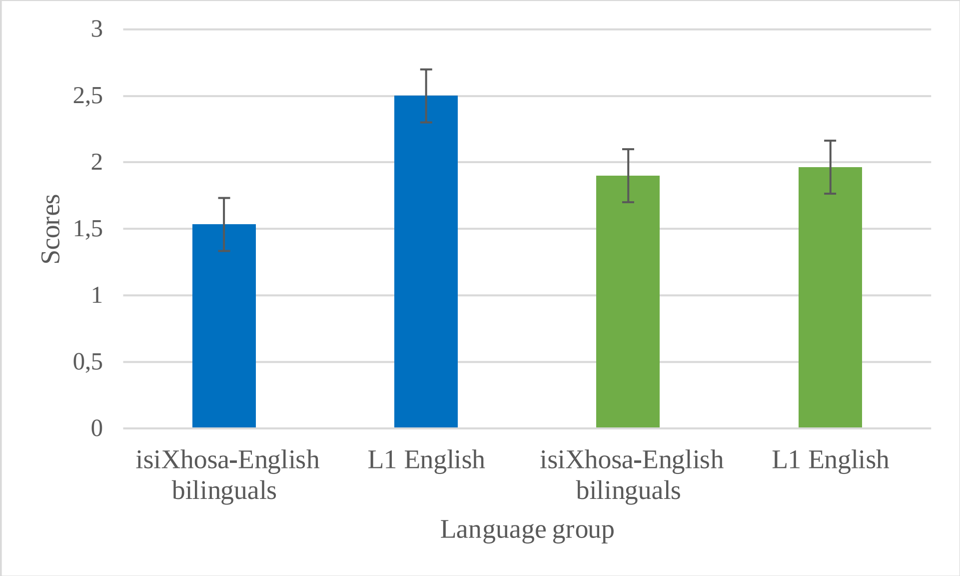


Figure 24: Triads 5 (blue) and 6 (green) predicted pair scores of isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

The results of an independent *t*-test revealed no significant difference between the groups, *t* (56) 0.295, $p = 0.769$, for triad 7. The predicted pair chips in this triad can be characterised as blue. This result suggests that both language groups did not select more than around 1 predicted pair. Similarly, no significant difference was found between the two groups for triad 8, *t* (56) = 0.943, $p = 0.350$. For this triad, the predicted pair chips can be characterised as green. Interestingly, the isiXhosa-English bilingual participants' average predicted pair score was marginally higher, but not robustly so, than the L1 English participants'. These results are illustrated in figure 25.

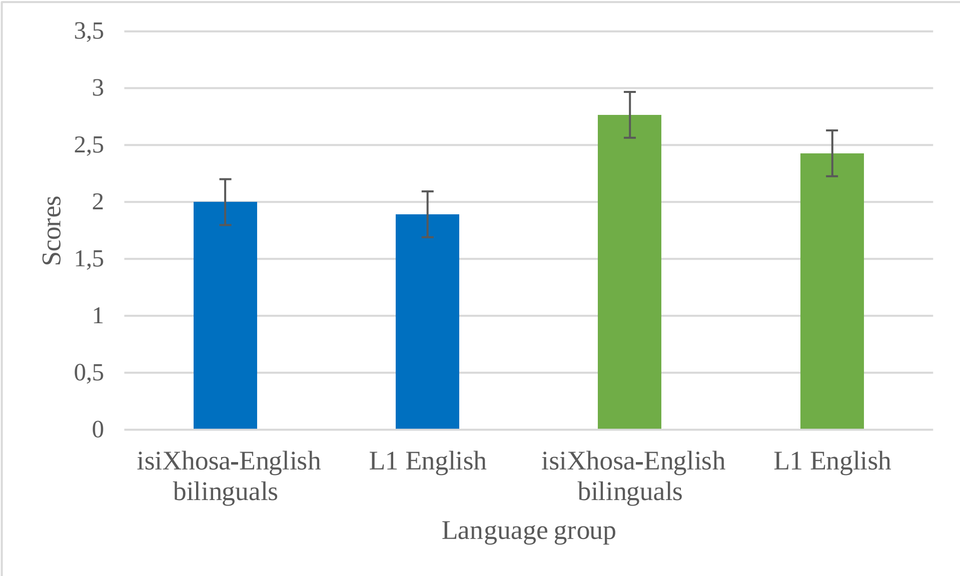


Figure 25: Triads 7 (blue) and 8 (green) predicted pair scores of isiXhosa-English bilinguals and L1 English speakers. Standard error of the mean represented by error bars.

5.2.2 Examining the influence of English language experience on similarity judgements of colour among isiXhosa-English bilinguals

The following step of the analysis was to assess whether L2 English experience had any effects on similarity judgements of colour, specifically of blue and green, within the isiXhosa-English bilinguals. As explained in section 5.1, the isiXhosa-English bilinguals were divided into two groups depending on their English language experience (see table 7 in section 5.1). Firstly, independent *t*-tests were run in order to see whether any differences occurred between group 1 (English-dominant) and group 2 with regards to the predicted pair scores for each triad.

For triad 1, group 1 (m = 3.14, SD = 1.15) attained similar predicted pair scores to group 2 (m = 2.77, SD = 1.30). A *t*-test showed no significant difference between the two groups, t (28) = 0.765, p = 0.450. Subsequently, for triad 2, group 1 (m = 2.42, SD = 1.24) attained similar predicted pair scores to group 2 (m = 2.88, SD = 0.78). No significant difference was found, t (28) = -1.019, p = 0.317.

Similar to the above, for triad 3, group 2 (m = 2.11, SD = 1.61) showed to have similar predicted pair scores compared to group 1 (m = 1.85, SD = 1.38). Analysis of the predicted pair scores of triad 3 also revealed no significant difference between the two groups, t (28) = -0.437, p =

0.665. For triad 4, an inspection of the means revealed that group 1 (m = 1.47, SD = 1.25) selected the predicted pairs more frequently than group 2 (m = 1.11, SD = 1.69). Again, no significant difference was found for the predicted pair scores of triad 4, *t* (28) = 0.659, *p* = 0.515.

Subsequently, it was revealed that group 1 (m = 1.57, SD = 1.24) had a marginally higher score than group 2 (m = 1.44, SD = 1.33) for triad 5. However, a *t*-test showed no significant difference between the two groups, *t* (28) = 0.250, *p* = 0.804. For triad 6, an inspection of the means revealed that group 1 (m = 1.90, SD = 1.22) selected the predicted pairs more frequently than group 2 (m = 1.88, SD = 1.05). A *t* test showed, however, that there were no statistically significant differences between the two groups, *t* (28) = 0.034, *p* = 0.973.

For triad 7, an inspection of the means revealed that group 2 (m = 2.55, SD = 0.72) selected the predicted pairs more frequently than group 1 (m = 1.76, SD = 1.37). However, there were no statistically significant difference between the two groups, *t* (28) = -1.626, *p* = 0.115. Lastly, group 2 (m = 3.33, SD = 1.11) selected the predicted pairs more frequently compared to group 1 (m = 2.52, SD = 1.20) for triad 8. A *t*-test showed, however, that these differences were not significant, *t* (28) = -1.716, *p* = 0.097.

In order to further analyse whether English language experience had any effects on similarity judgements of colour, several multiple linear regression analyses were run.

The independent variables (English proficiency, frequency of English use, and age of acquisition of English) were inputted into a multiple regression analysis, with the dependent variable as the predicted pair scores for triad 1. The general regression was not significant, *F* = -0.007, *p* = 0.157, *MSE* = 1.138, R^2 = 0.179. None of the L2 English variables showed significant effects on the predictive pair scores (see table 13), although AoA exhibited a trend (*p* = .065). Specifically, this result suggests that participants who learnt English later in life were more likely to behave like L1 English speakers (which goes somewhat against expectations). Figures 26, 27, and 28 show the relationship between English background variables and predictive pairs for triad 1. No visible outliers seem to skew the results in either way.

Table 13: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 1 predicted pairs as the dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.038	0.177	0.861	0.699	1.430
Eng frequency of use	0.326	1.572	0.128	0.734	1.363
AoA of English	0.369	1.926	0.065	0.862	1.160

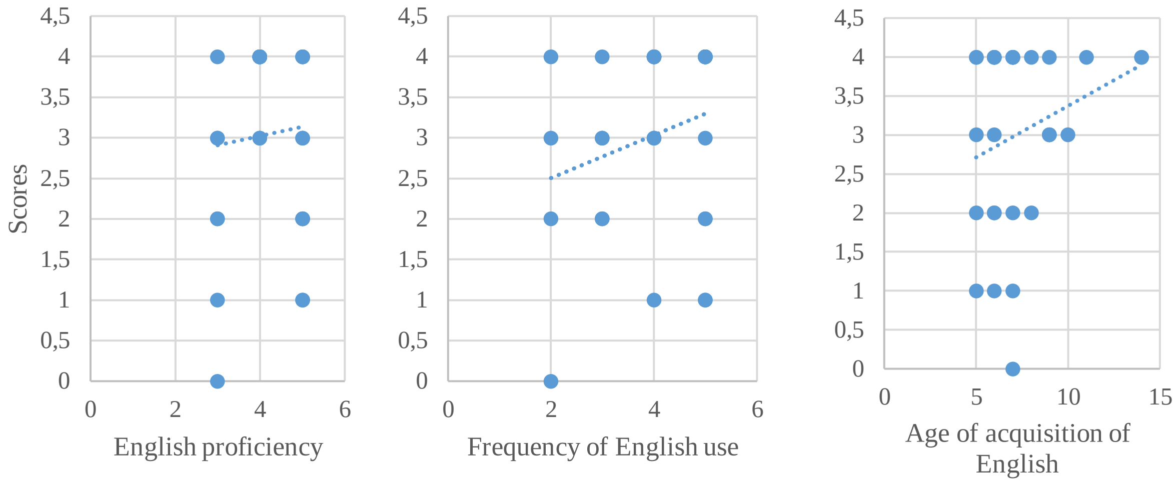


Figure 26: L2 English proficiency and predicted pair scores for triad 1.

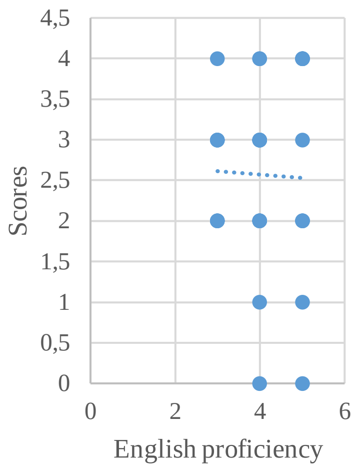
Figure 27: L2 English use and predicted pair scores.

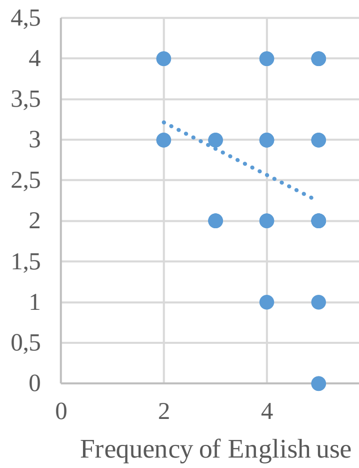
Figure 28: Age of acquisition of L2 English and predicted pair scores.

The predicted pair scores for triad 2 were then analysed, and, as above, no significant effects were found, $F = 2.049$, $p = 0.344$, $MSE = 1.126$, $R^2 = 0.118$. None of the L2 English variables showed a significant effect on the predicted pair scores (see table 14), except for a trend for frequency of use of English. The relationship between the predicted pair scores for triad 2 and the L2 English variables are illustrated in Figures 29, 30, and 31. No visible outliers seem to skew the results in either way.

Table 14: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 2 predicted pairs as the dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.161	0.730	0.472	0.699	1.430
Eng frequency of use	-0.400	-1.858	0.074	0.734	1.363
AoA of English	-0.035	-0.178	0.860	0.862	1.160





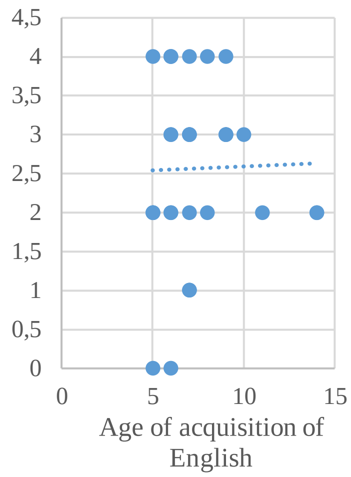


Figure 29: L2 English proficiency and predicted pair scores for triad 2.

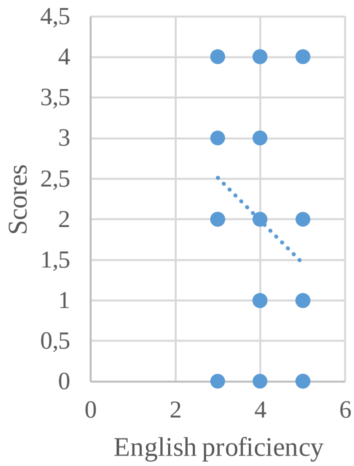
Figure 30: L2 English use and predicted pair scores.

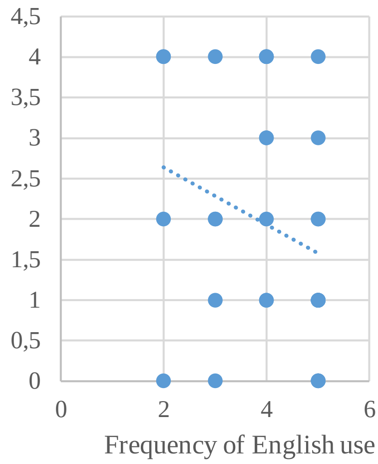
Figure 31: Age of acquisition of L2 English and predicted pair scores.

Next, the predicted pair scores for triad 3 were analysed and no significant effect was found, $F = 3.299$, $p = 0.150$, $MSE = 1.372$, $R^2 = 0.182$. It was found that none of the L2 English variables had a significant effect on the predicted pair scores (see table 15). The relationship between the predicted pair scores for triad 3 and the L2 English variables are illustrated in figures 32, 33, and 34.

Table 15: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 3 predicted pairs as the dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	-0.280	-1.322	0.198	0.699	1.430
Eng frequency of use	-0.212	-1.026	0.314	0.734	1.363
AoA of English	-0.311	-1.629	0.115	0.862	1.160





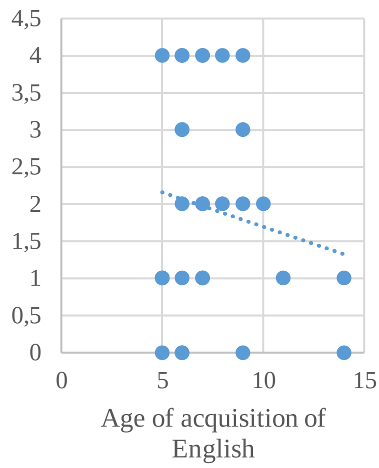


Figure 32: L2 English proficiency and predicted pair scores for triad 3.

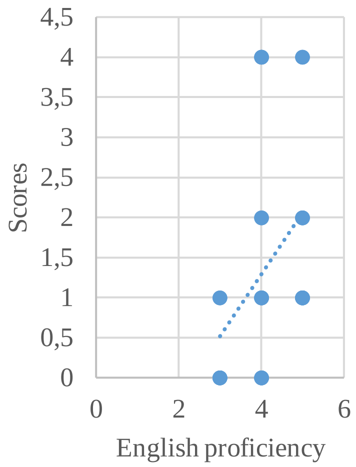
Figure 33: L2 English use and predicted pair scores.

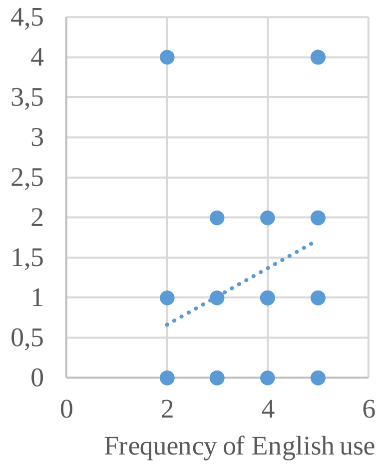
Figure 34: Age of acquisition and predicted pair scores.

Subsequently, the predicted pair scores for triad 4 were analysed, and, as above, the overall regression was not significant, F = -1.922, p = 0.070, MSE = 1.272, R^2 = 0.234. These results suggest, in the instance of a significant outcome, only 23.4% of the variation in the isiXhosa-English bilingual participants' predicted pair scores for triad 4 would have been accounted for by the L2 English variables, leaving the remaining 76.6% unexplained. However, it was revealed that English proficiency in fact had a small, significant effect on the predicted pair scores for triad 4 (see table 16). The Tolerance values and the VIF shows that multicollinearity was not an issue. Figures 35, 36, and 37 illustrate the relationship between the predicted pair scores for triad 4 and the L2 English variables. No visible outliers seem to skew the results in either way.

Table 16: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 4 predicted pairs as the dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.449	2.187	0.038	0.699	1.430
Eng frequency of use	0.118	0.588	0.562	0.734	1.363
AoA of English	0.235	1.272	0.215	0.862	1.160





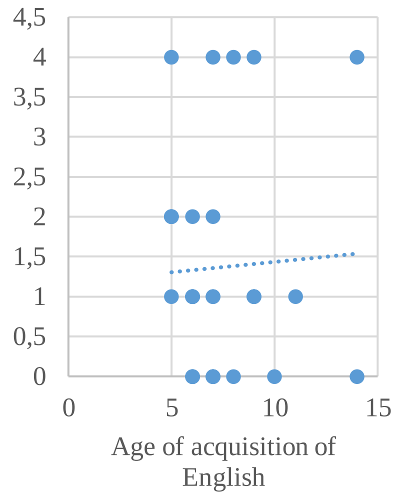


Figure 35: L2 English proficiency and predicted pair scores for triad 4.

Figure 36: L2 English use and predicted pair scores.

Figure 37: Age of acquisition of L2 English and predicted pair scores.

Similarly, no significant effect was found for the predicted pair scores for triad 5, $F = 0.537$, $p = 0.325$, $MSE = 1.239$, $R^2 = 0.123$. It was also revealed that none of the L2 English variables had a significant effect (see table 17). Figures 38, 39, and 40 illustrate the relationship between the predicted pair scores for triad 5 and the L2 English variables.

Table 17: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 5 predicted pairs as the dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.089	-1.132	0.268	0.699	1.430
Eng frequency of use	-0.083	1.803	0.083	0.734	1.363
AoA of English	0.135	0.584	0.565	0.862	1.160

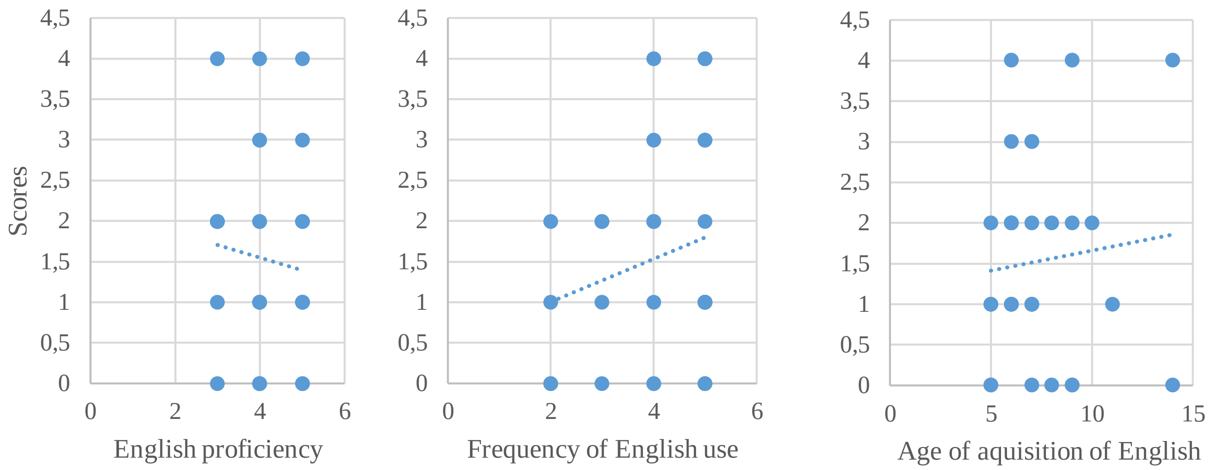


Figure 38: L2 English proficiency and predicted pair scores for triad 5.

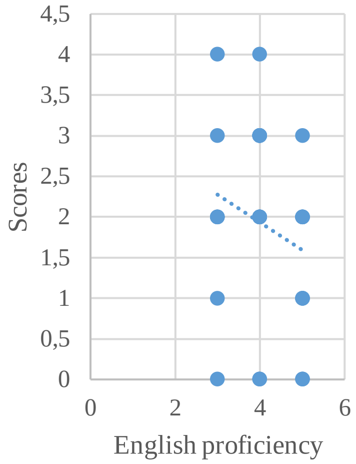
Figure 39: L2 English use and predicted scores.

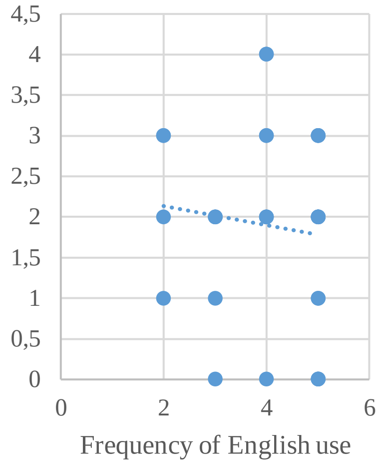
Figure 40: Age of acquisition of L2 English and predicted pair scores.

The predicted pair scores for triad 6 were then analysed. As above, no significant effect was found, F (0.601) = 2.354, p = 0.620, MSE = 1.180, R^2 = 0.065. Correspondingly, the L2 English variables showed no significant effect (see table 18). The relationship between the predicted pair scores for triad 6 and the L2 English variables are illustrated in figures 41, 42, and 43.

Table 18: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 6 predicted pairs as the dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.089	0.383	0.705	0.699	1.430
Eng frequency of use	-0.083	-0.365	0.718	0.734	1.363
AoA of English	0.135	0.646	0.524	0.862	1.160





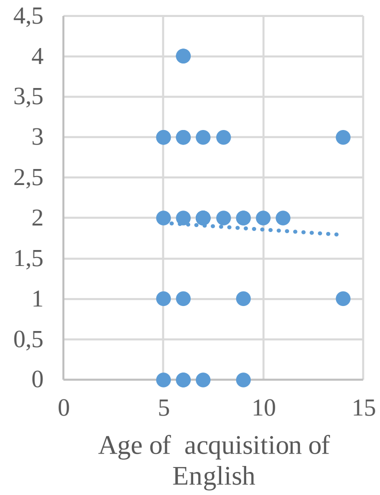


Figure 41: L2 English proficiency and predicted pair scores for triad 6.

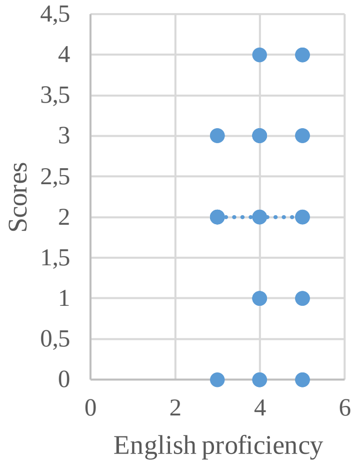
Figure 42: L2 English use and predicted pair scores.

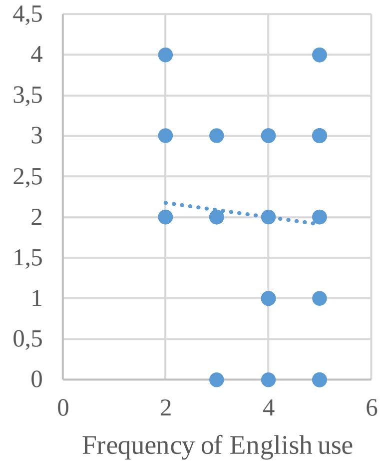
Figure 43: Age of acquisition of L2 English and predicted pair scores.

Similar to the above, the predicted pair scores for triad 7 were analysed and it was found that no significant effect occurred, F = 0.648, p = 0.890, MSE = 1.314, R^2 = 0.023. As indicated in table 19, no significant effects were shown for any of the L2 English variables on the predictive pair scores. The relationship between the predicted pair scores for triad 7 and the L2 English variables are illustrated in figures 44, 45, and 46.

Table 19: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 7 predicted pairs as the dependent variable

Independent variables	Standardised coefficient	t	p	Tolerance	VIF
Eng proficiency	0.089	0.383	0.705	0.699	1.430
Eng frequency of use	-0.083	-0.365	0.718	0.734	1.363
AoA of English	0.135	0.646	0.524	0.862	1.160





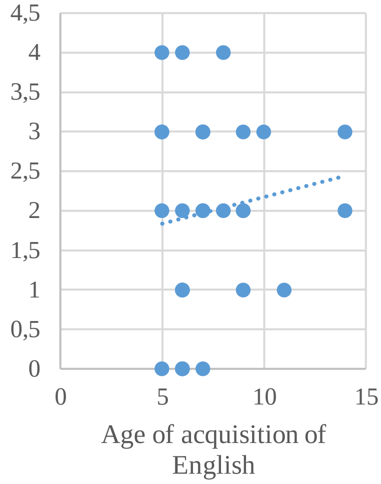


Figure 44: L2 English proficiency and predicted pair scores for triad 7.

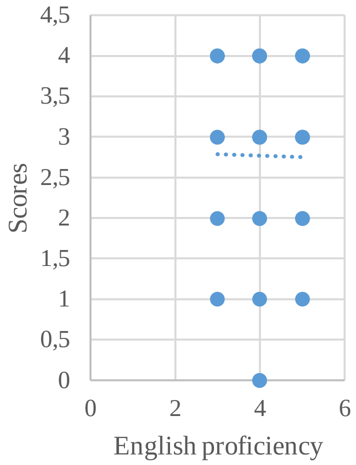
Figure 45: L2 English use and predicted pair scores.

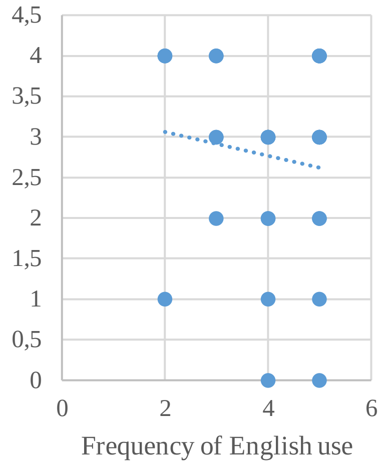
Figure 46: Age of acquisition of L2 English and predicted pair scores.

Lastly, analysis was done on the predicted pair scores for triad 8. Again, no significant effect was found, F = 0.430, p = 0.284, MSE = 1.202, R^2 = 0.133. Correspondingly, none of the L2 English variables had a significant effect on the predicted pair scores (see table 20). Figures 47, 48, and 49 illustrate the relationship between the predicted pair scores for triad 8 and the L2 English variables.

Table 20: Summary of coefficients, significance values, diagnostics for multicollinearity with triad 8 predicted pairs as the dependent variable

Independent variables	**Standardised coefficient**	**t**	**p**	**Tolerance**	**VIF**
Eng proficiency	0.174	0.796	0.433	0.699	1.430
Eng frequency of use	-0.116	-0.544	0.591	0.734	1.363
AoA of English	0.361	1.838	0.078	0.862	1.160





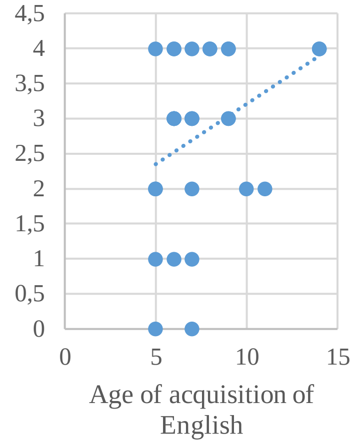


Figure 47: L2 English proficiency and predicted pair scores for triad 8.

Figure 48: L2 English use and predicted pair scores.

Figure 49: Age of acquisition and predicted pair scores.

6. Discussion

This chapter will provide a discussion of the findings of this study, which examined memory accuracy and similarity judgments of green-blue colour space in tow languages (i.e., isiXhosa and English) with varying colour categorisation patterns. The discussion will relate the results at a general level to the literature discussed in previous chapters, and specifically to the research questions asked in the current thesis. To reiterate, these questions were as follows:

1) Do English speakers and isiXhosa speakers differ in memory accuracy of the green-blue colour space?

2) Do English speakers and isiXhosa speakers differ in judgements of the above colour space?

3) To what extent does the English language experience among isiXhosa speakers modulate memory accuracy and similarity judgements?
   In other words, do isiXhosa speakers shift towards similar behaviour as monolingual English speakers?

In response to these questions, it was predicted that, first, isiXhosa and English speakers will differ in their memory and judgements of the green-blue colour space and, second, that the isiXhosa speakers will vary in their colour behaviour at least in part as a function of their English language experience. In what follows, each of these issues will be discussed.

6.2 Memory accuracy

The results of the memory experiment showed a significant difference for overall memory accuracy for green-blue colour space. The L1 isiXhosa speakers showed lower recognition memory accuracy compared to L1 English speakers, such that the L1 English speakers tended to select the specific colour chips of blue and green more accurately compared to the isiXhosa-English bilinguals.

Roberson, Davies and Davidoff (2000:403) found that recognition memory performance of Berinmo speakers tended to be higher for colours specific to Berinmo than those specific to English. Similarly, Himba memory recognition was also revealed to be more accurate for Himba-specific colours (Roberson *et al.*, 2005:391) In a similar fashion, in the current study, the L1 English speakers achieved higher accuracy for the English-specific *blue* and *green* colours under examination.

Wolff and Holmes (2011:256) propose the view, *language as meddler*, which suggests that language effects come about in instances where non-linguistic codes are concurrent with linguistic codes throughout the decision-making process (Wolff & and Holmes, 2011:256). In light of Whorfian effects, the findings mentioned above suggest that naming patterns of a language may influence memory performance, since English has two distinct terms for blue and green, unlike isiXhosa. The findings of the current study also provide evidence from a language that has not yet been examined with regards to non-verbal behaviour, thereby contributing to our understanding of the role language plays in the cognition of colour.

When interpreting the current findings, it is also important to remember that the analysis of the individual blue and green chips showed significant differences for only two out of the four colour chips under examination. For one green colour, a significant difference was shown, such that the L1 English speakers' memory accuracy was higher than that of the isiXhosa-English bilinguals'. Similarly, for one blue colour, the results indicated that the L1 English speakers had a significantly higher score. However, for the other two chips, no significant differences were revealed, indicating that the isiXhosa-English bilingual speakers performed similarly to the L1 English speakers. The null effects found for these other two chips may, however, be considered to serve an important function: had it been found that the groups under scrutiny differed on all four chips, this could have been a general problem, as it could potentially suggest that there was a group difference in general recognition memory (for unknown reasons). Since this was not the case, these null effects thus function as a control measure to ensure compatibility between the groups in this regard.

An important question, then, is whether there was something about these specific blue and green colours, and not the other two, that made them less susceptible to group differences. Previous research (Parshotam, 2018:25-32) showed that isiXhosa-English bilingual speakers frequently selected colour chips in the green region, specifically GY-region, as prototypes for their language-specific term *luhlaza*. One of the frequently selected prototype chips was the green chip under examination, for which no group differences were found. It was also evident that although boundaries were positioned across blue and green regions of colour space, the green region remained dominant in the placement for *luhlaza*. This offers a potential explanation for the null effect that was found for the one green colour as both languages name this chip for green and *luhlaza*, respectively. However, for the blue colour under examination, isiXhosa-English bilinguals did not name the specific chip as a prototype for *luhlaza*. In the elicitation task used by Parshotam (2018), terms for blue (s*ibhakabhaka* "the sky" and *zuba* "blue") mainly appeared in the lists of those participants who were more proficient in English, but these occurrences were very limited in number. Nonetheless, this suggested that the isiXhosa speakers shifted to some extent towards colour naming patterns of their L2 English (Parshotam, 2018:38). The null effect obtained for the one blue colour chip in the current study could then possibly be a result of the participants' experience with English.

In other words, the fact that only half of the memory stimuli elicited cross linguistic differences may be attributed to, on the one hand, the green-like properties of *luhlaza* and, on the other, the bilingual participants' English experience. There is, of course, also the possibility that the other half of the colour chips have some sort of light properties that render them perceptually more salient, and thus less likely to be subject to language effects. This question is open to future research.

A conclusion can be made that speakers of the two languages differed in their memory accuracy for blue-green colour space, but not to a large extent, which is evident in the finding that only 50% of the stimuli was language specific.

6.3 Effects of L2 English background on memory accuracy for colour

Seeing that learning a new language can change conceptual and cognitive patterns, the researcher decided to assess specific language background variables which could exert an influence on the bilingual speakers' colour categorisation behaviour. At least five different variables (language proficiency, age of acquisition, bilingual language mode, language contact, and context of acquisition) are recognised in the literature as having exerted an influence on L2 speakers' cognitive restructuring (Bylund & Athanasopoulos, 2014:969-977; Pavlenko, 2005:438). Therefore, in the current study, the isiXhosa-English bilinguals were put into two groups depending on their English language experience. This was done in order to see whether any effects on memory accuracy for blue and green occurred as a result of English language experience. Since bilingual language mode and context of acquisition were constant in the participant group, the variables of proficiency, contact, and age of acquisition were used for this group division.

However, results showed that, overall, both of the groups had similarly high accuracy scores for blue and green colours which indicated no significant influence of overall English experience. When analysed in a multiple regression analysis, age of acquisition of English was the only background variable shown to significantly influence overall memory accuracy within the isiXhosa-English bilingual group. This finding could be in line with the suggestion that cognitive behaviour of an L2 speaker may be influenced by the acquisition age (Bylund & Athanasopoulos, 2014:974). In other words, the earlier in life participants learnt English, the more likely they were to achieve a higher accuracy score and portray memory accuracy patterns adapted to that of L1 English speakers.

Athanasopoulos (2009) revealed no effects of language background variables for Greek-English bilingual participants' colour categorisation. Similarly, as mentioned above, the current study found little to no significant effects of L2 English background variables on memory accuracy in the isiXhosa-English bilinguals. In contrast, previous research (Athanasopoulos *et al*., 2011:14) found effects of language contact on colour cognition, such that Japanese-English bilinguals who had more frequent contact with English (L2) were less likely to distinguish between within-category and cross-category blue stimuli pairs compared to L1 Japanese speakers. A possible reason for these contrasting findings is that there are several types of language contact and various ways of measuring this variable, such as ratings for general frequency of use or estimation of usage in hours (Bylund & Athanasopoulos, 2015:126).

The current study made use of self-reports (for language contact and language proficiency), which have shown to be quite troublesome, and may not always yield reliable data. Previous studies have also been unsuccessful in showing an effect of proficiency on cognitive behaviour (Athanasopoulos, 2009, Bylund & Athanasopoulos, 2014). Bylund and Athanasopoulos (2015:126) suggest that it is vital to use more extensive measures when assessing the language contact variable as each subset (e.g., spoken, written, active) could influence language skills in their own regard. These varied findings could then indicate that background variables such as the ones mentioned above, are not always forthcoming in colour cognition as well as other domains.

In examining the language background variables, it can be inferred that English language experience did only to a limited extent influence the memory accuracy among the isiXhosa-English bilinguals, but no effects of proficiency and contact were shown. It is also worth keeping in mind that the low incidence of L2 English variables effects in the current study could be because the isiXhosa-English bilinguals were not diverse enough with regards to their level of English proficiency, frequency of use, and age of acquisition. A sample that exhibits a greater variation in this regard might increase the potential of revealing significant effects.

6.4 Similarity judgement

In general, the results of the similarity judgements experiment showed that both language groups performed fairly similar with regards to selecting the predicted pairs of the 8 triads. In comparing group performance for memory and pairs, it can be see that for memory, 50% of the stimuli yielded language-specific effects, whereas for predicted pairs, such effects were only found for 12.5% of the stimuli. The significant difference for the similarity judgements was documented for triad 5, where the boundary was central. The L1 English participants chose the predicted pairs (two green colour chips) more often than the isiXhosa-English bilingual participants. This finding could be due to the fact that the blue-green boundary is present in English basic colour terms but not in isiXhosa, suggesting that the isiXhosa-English bilinguals did not show preference for the green or blue stimuli in this specific triad.

Overall, the isiXhosa-English bilinguals had a higher score when selecting within-category stimuli than cross-category stimuli. Current accounts of CP suggest that judging stimuli of different categories is easier than stimuli belonging to the same category (Ozgen, 2004:95). The L1 English participants tended to select those stimuli pairs belonging to the same category in English to be more similar since English distinguishes between blue and green regions of colour space. This demonstrates the proposal of CP as it shows that the colour categories available in English had an influence on the way in which the English participants judged colour. Moreover, it provides support for the fact that language influences the cognition of colour to a certain extent.

Roberson *et* al. (2005) predicted that the Himba speakers would judge within-category stimuli to be more similar than cross-category stimuli. The results revealed that the English speakers selected predicted pairs more frequently than the Himba speakers. The Himba participants, similar to Berinmo and English, judged within-category pairs to be more similar. More specifically, the Himba participants judged stimuli which was in the same category in Himba to be more similar (Roberson *et al*., 2005:396-398). Similar findings were found by Winawer *et al*., (2007) who examined colour discriminations in L1 English speakers and L1 Russian speakers. The results showed that when presented with cross-category stimuli, the Russian participants performed quicker than when presented with within-category stimuli as Russian speakers distinguish between light and dark blue. The English participants did not show any CP effects as they do not distinguish between the two shades of blue.

As mentioned above, predicted pairs yielded considerably fewer language-group differences than for memory. This indicates that the participants relied more on their knowledge of their respective languages during the memory task than the similarity judgment task. The fewer differences found for the predicted pairs show that the isiXhosa-English bilingual participants judged the colour stimuli of blue and green in a similar way to the L1 English participants even though these two languages vary in the way that they categorise these two regions. A possible reason for the difference could be that in memory tasks, the participants depend on language to commit facts to memory as the stimuli has to be retained in memory for a duration of time before making a selection. In judgment tasks, these effects do not occur as the stimuli are present each time a judgment must be made.

Similar patterns have been documented for a different perceptual domain, namely motion. Bylund and Athanasopoulos (2013:292) examined grammatical aspect effects on motion events in L1 speakers of Swedish and L1 speakers of English. The participants were asked to complete a memory triads-matching task where they viewed three video clips, individually, on a monitor and were instructed to judge whether the third clip (target) was similar to the first or the second clip. The results showed that the Swedish participants matched the target video with a certain alternate (which showed a motion endpoint) more frequently that the English speakers. For the online triads-matching task, the same procedure was followed as in the memory task, but all three clips were viewed all together. The results of this iteration of the task revealed, in contrast, no significant differences between the two language groups (Bylund & Athanasopoulos, 2013:298).

The findings of the similarity judgements showed that the L1 English speakers and the isiXhosa-English bilinguals tended to judge blue-green colour space quite similarly.

6.5 Effects of L2 English background on similarity judgements of colour

Overall, no significant differences were found within the isiXhosa-English bilinguals when they were split into two groups depending on degree of English language experience. Instead, both groups performed similarly when selecting predicted pairs of the respective triads. As mentioned with the lack of effects found between the two groups for memory accuracy, the problem could possibly reside in the two groups not being sufficiently distinct.

Only two triads showed somewhat significant effects of L2 English language experience in the multiple regression analyses. For triad 1, consisting of blue within-category stimuli, no significant effects of L2 English variables were revealed. However, age of acquisition of English showed a trend, suggesting that those participants who learnt English at a later stage in their lives were more likely to behave like English speakers (figure 28). For triad 4, consisting of cross-category stimuli (2 green chips, 1 blue chip), a significant effect was revealed for proficiency of English (figure 35), suggesting that those participants who were more proficient in English tended to select the predicted pairs (i.e., the 2 green chips) more frequently, thus behaving like English speakers. Languages such as isiXhosa would supposedly not show any preference for cross-category stimuli as, in isiXhosa the stimuli would belong to a single category. This finding could then demonstrate the proposal that the higher the proficiency in the L2, the more likely the chances of cognitive restructuring in the L2 speaker (Bylund & Athanasopoulos, 2014:969).

Although scarcely, the findings show that the isiXhosa-English bilinguals' experience with language influenced them to produce patterns of judgement in line with L1 English speakers.

6.6 The term *luhlaza* and its effects on cognition

It can be deduced from the results of both the experiments that in some instances the isiXhosa-English bilinguals and L1 English speakers differed significantly in their memory accuracy and judgements of blue-green colour space. As mentioned above, one possible reason for this could be the multilingual context of South Africa where most individuals of a certain education level are also proficient in English as L2, because the language of instruction at school, university, and the workplace, more times than not, is English (de Wet, 2002). Thus, the L1 isiXhosa speakers' prolonged immersion in English could influence them to adapt their colour categorisation patterns to be more similar to those of L1 speakers of their L2, English.

In relation to the presence of English in the participants' daily lives, the current findings provide an important impetus for further considering the status of the *luhlaza* term. As previously mentioned, this term can be modified (e.g., *sibhakabhaka* "the sky"), indicating that even when in isiXhosa language mode, speakers still have awareness of the distinction. This resonates with previous research, suggesting that *luhlaza* may be undergoing some sort of change (Davies & Corbett, 1994), and that *luhlaza* is not “grue” but instead, “green or blue” (Davies & Corbett, 1994; Parshotam, 2018). Thus, with this insight, that *luhlaza* is in fact not really “grue”, one might think then that robust effects on cognition of the green-blue colour space may not be obtained, or even that isiXhosa speakers may be equal to English speakers with regards to their judgment of blue and green.

Clearly, this was not the case, but it must also be acknowledged that the cross-linguistic differences that were revealed here are limited. Since *luhlaza* is not a purely “grue” term, isiXhosa speakers are likely more accurate at remembering and distinguishing the blue-green colour space compared to speakers of a genuine grue-term language. That said, isiXhosa speakers cannot be compared to monolingual speakers of a grue-term language, who are stricter with their colour recognition and distinctions.

In light of these findings and interpretations, I propose that *luhlaza* could potentially move towards describing green colour space more than blue colour space, as it has been shown that speakers of isiXhosa tend to name colour chips in the green region more frequently than in the blue region (Parshotam, 2018). An additional term for the blue region of colour space could potentially form either within the isiXhosa language or through borrowing from another language, such as English. That said, with the extent of English contact in the context of South Africa, future generations of isiXhosa speakers may reveal an even greater cognitive shift in their L2 colour behaviour by distinguishing more explicitly between green and blue.

7. Conclusion

This final chapter provides a summary of the results yielded from the main experiments of the study, in section 7.1, which is followed by section 7.2 where the limitations/shortcomings of the current study are discussed. The contribution of the current study is explained and suggestions for future research are provided in section 7.3.

7.1 Summary of results

The current study examined whether cross-linguistic differences modulate memory accuracy and similarity judgements of the green-blue colour space among speakers of isiXhosa and English. It also aimed to examine whether their experience with the English language influenced isiXhosa speakers to behave more like L1 speakers of English on these measures. This was accomplished by examining speakers of two languages which vary in their categorisation of colour.

On the whole, the results of the memory and judgement experiments revealed certain differences, but also – and crucially, to a greater extent – similarities between the two language groups. The isiXhosa-English bilinguals demonstrated recognition memory accuracy patterns similar to that of L1 English speakers, although the L1 English participants tended to achieve higher memory accuracy scores overall. For the similarity judgements experiment, the two language groups selected predicted pairs in a similar manner for the majority of the triads. While it is assumed that the participants' English language experience has had an effect on the studies behaviour, direct effects of English language experiential variables could not be found.

7.2 Study limitations

7.2.1 Language background questionnaire

The background questionnaire utilised in this current study included sections where participants were asked to self-rate their language proficiency and frequency of use of their languages. A possible limitation of this could be that the participants guess or incorrectly rate the language background variables. A potential alternative to this would be to make use of a language proficiency test which could obtain more accurate and detailed results about the participants’ language proficiency, and relying on validated questionnaires could also help overcome this problem. Taking into consideration that these instruments (proficiency tests and questionnaires) are often time-consuming and have not necessarily been normed on South African populations, a study with a larger scope than the current one should attempt to utilise these types of instruments.

7.2.2 Similarity judgements experiment

The number of stimuli used in this experiment was quite limited resulting in a small set of triads being created. This was not deemed as an issue however, a more diverse set of triads would allow for more extensive results to be obtained.

7.2.3 Sample size

The sample sizes in the current study were in accordance with previous research, and thus acceptable, but still possibly of limited statistical power for revealing more subtle effects in the data. In order to retest the current findings and obtain a greater statistical power, larger sample sizes would be needed.

7.3 Contribution of the study and potential avenues for future research

The current study aimed to make a contribution to bilingual cognition research. This was accomplished by extending and adapting colour categorisation methodology mainly used in the Western and/or monolinguals contexts, to the multilingual context of South Africa. Southern Bantu languages such as isiXhosa offer an excellent opportunity to study colour categorisation as they encode colour space differently from languages such as English. Furthermore, the current study is, to the best of my knowledge, one of the first to explore bilingualism-specific effects on non-verbal cognitive processes such as colour memory and similarity judgements in a Bantu language spoken in South Africa. Likewise, while it was not a primary aim of the thesis, it is potentially also the first one to offer behavioural colour data on South African English, which surprisingly has not been documented before. This study may thus have taken some few first steps in the exploration of colour cognition and multilingualism, but these should by no means be the last steps.

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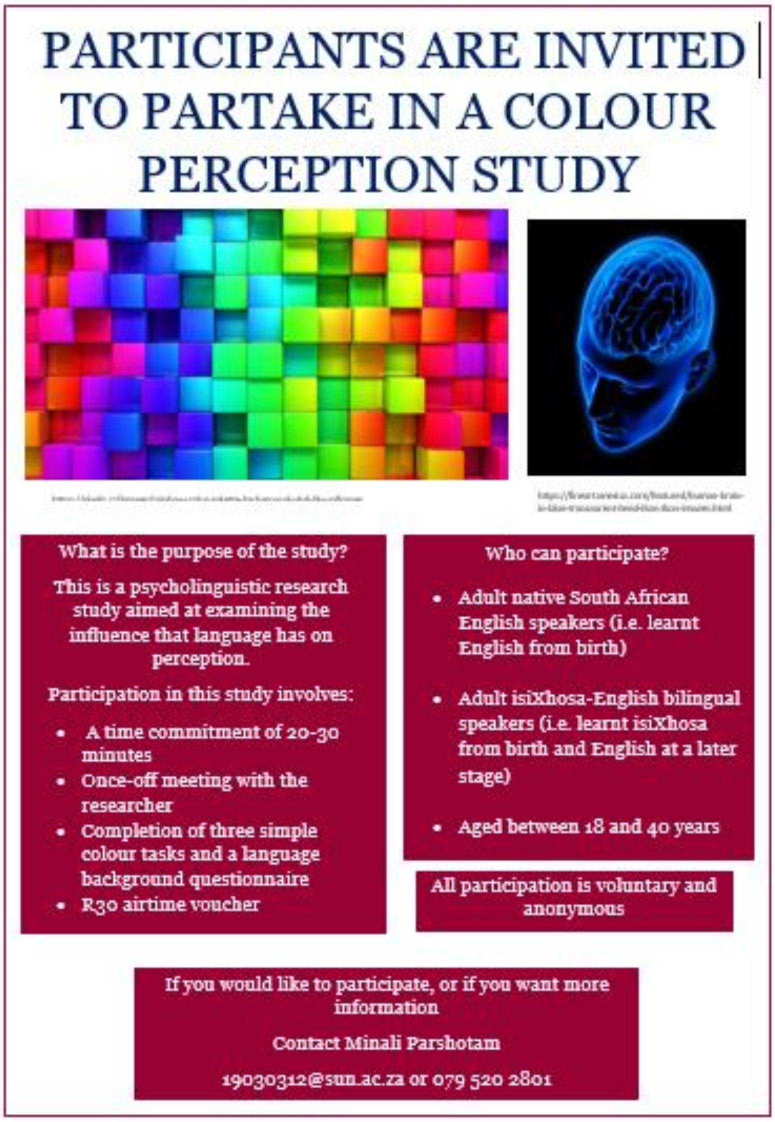
9. APPENDICES

9.1 Appendix A: Recruitment flyer



9.2 Appendix B: Recruitment email

Dear Prospective Participant

My name is Minali Parshotam. I am a Master's student in the Department of General Linguistics at Stellenbosch University. I would like to invite you to participate in my colour perception research study which is aimed at examining the influence that language has on perception.

You are eligible to participate in this psycholinguistic study if you are an adult native South African English speaker (i.e. learnt English from birth) or an adult isiXhosa-English bilingual speaker (i.e. learnt isiXhosa from birth and English at a later stage), aged between 18 and 40 years.

Your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever.

If you are willing to participate in this study, you will be asked to complete three simple colour tasks and a language background questionnaire.

All instructions will be given in English. Your participation will take between 20-30 minutes and you will be required to complete the tasks in person with the researcher.

Participants will receive an airtime voucher worth R30 for their contribution to this study.

If you have any questions or would like to know more about this study, please do not hesitate to contact the researcher Minali Parshotam at 19030312@sun.ac.za or on 079 520 2801.

Kind regards,

Minali Parshotam

9.3 Appendix C: Consent form 1

This form was used for the pre-experimental study.

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

CONSENT TO PARTICIPATE IN RESEARCH

Dear Prospective Participant

My name is Minali Parshotam. I am a Master's student in the Department of General Linguistics at Stellenbosch University. I would like to invite you to participate in my research study. The results of this study will contribute towards the thesis for my Master's degree. You are eligible to participate in this psycholinguistic study if you are an adult native South African English speaker (i.e. learnt English from birth), aged between 18 and 40 years.

Please take some time to read the information presented here, which will explain the details of this project. Your participation in this research study is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

<u>Purpose of this study</u>

This study is aimed at examining the influence that language has on perception.

<u>Procedures</u>

If you are willing to participate in this study, you will be asked to complete the following tasks:

Firstly, you will be asked to complete a colour discrimination task. This will entail you describing patterns depicted on a number of cards. Secondly, you will be asked to complete an elicitation task which will entail you writing down colour terms. Thirdly, you will be asked to complete a naming task which will entail you selecting best exemplars for the terms you previously provided. You will then be asked to complete a mapping task which will entail you grouping coloured chips together. Lastly, you will be asked to fill out a language background questionnaire which will ask basic questions about you and your language background.

All instructions will be given in English. Your participation will take between 20-30 minutes and you will be required to complete these tasks in person with the researcher.

Potential risks/discomfort

Participation in this study does not hold any risk for you and you will not experience any discomfort.

Potential benefits to subjects and/or society

This research will contribute towards a better understanding of the relationship between language and thought through the examination of colour representation.

Compensation

Participants will not be remunerated in any form for their participation.

RIGHTS OF RESEARCH PARTICIPANTS:

You have the right withdraw your consent at any time and withdraw from participating without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

Confidentiality of participants

Your information provided to the researcher during this study will be kept anonymous as each participant will receive a unique participant code. The data collected will be kept in a secure, locked cupboard and all electronic data will be stored on the researcher's password protected laptop.

This study does not require any other personal details apart from the participants' age, gender, place of birth, and language background. The only other details given are those required by the consent form.

If you have any questions or would like to know more about this study, please do not hesitate to contact the researcher Minali Parshotam at 19030312@sun.ac.za or on 079 520 2801 and/or the Supervisor Professor Emanuel Bylund at mbylund@sun.ac.za.

DECLARATION BY PARTICIPANT

I have read the attached information leaflet and it is written in a language with which I am fluent and comfortable. I was given a chance to ask questions and all my questions have been adequately answered. I understand that taking part in this study is voluntary. I may choose to leave the study at any time and will not be penalised or prejudiced in any way. All issues related to privacy and the confidentiality and use of the information I provide have been explained to my satisfaction.

I hereby consent to participate in this research study.

____

Name of participant

____________________________________ __________________________

Signature of participant **Date**

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to ________________._________________________

They were encouraged and given ample time to ask me any questions. This conversation was conducted in English.

______________________________________ ______________

Signature of Investigator **Date**

9.4 Appendix D: Consent form 2

This form was used for the main experiments. It states that no compensation will be provided.

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

CONSENT TO PARTICIPATE IN RESEARCH

Dear Prospective Participant

My name is Minali Parshotam. I am a Master's student in the Department of General Linguistics at Stellenbosch University. I would like to invite you to participate in my research study. The results of this study will contribute towards the thesis for my Master's degree. You are eligible to participate in this psycholinguistic study if you are an adult native South African English speaker (i.e. learnt English from birth) or an adult isiXhosa-English bilingual speaker (i.e. learnt isiXhosa from birth and English at a later stage), aged between 18 and 40 years.

Please take some time to read the information presented here, which will explain the details of this project. Your participation in this research study is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

<u>Purpose of this study</u>

This study is aimed at examining the influence that language has on perception

<u>Procedures</u>

If you're willing to participate in this study, you will be asked to complete the following tasks:

Firstly, you will be asked to complete a colour discrimination task. This will entail you describing patterns depicted on a number of cards. Secondly, you will be asked to complete a memory task. For this task, you will be asked to remember a number of coloured chips. Thirdly, you will be asked to complete a similarity judgement task. For this task, you will be asked to rate the similarity of different coloured chips. Lastly, you will be asked to fill out a language background questionnaire which will ask basic questions about you and your language background.

All instructions will be given in English. Your participation will take between 20-30 minutes and you will be required to complete these tasks in person with the researcher.

Potential risks/discomfort

Participation in this study does not hold any risk for you and you will not experience any discomfort.

Potential benefits to subjects and/or society

This research will contribute towards a better understanding of the relationship between language and thought through the examination of colour representation.

Compensation

Participants will not be remunerated in any form for their participation.

RIGHTS OF RESEARCH PARTICIPANTS:

You have the right withdraw your consent at any time and withdraw from participating without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

Confidentiality of participants

Your information provided to the researcher during this study will be kept anonymous as each participant will receive a unique participant code. The data collected will be kept in a secure, locked cupboard and all electronic data will be stored on the researcher's password protected laptop.

This study does not require any other personal details apart from the participants' age, gender, place of birth, and language background. The only other details given are those required by the consent form.

If you have any questions or would like to know more about this study, please do not hesitate to contact the researcher Minali Parshotam at 19030312@sun.ac.za or on 079 520 2801 and/or the Supervisor Professor Emanuel Bylund at mbylund@sun.ac.za.

DECLARATION BY PARTICIPANT

I have read the attached information leaflet and it is written in a language with which I am fluent and comfortable. I was given a chance to ask questions and all my questions have been adequately answered. I understand that taking part in this study is voluntary. I may choose to leave the study at any time and will not be penalised or prejudiced in any way. All issues related to privacy and the confidentiality and use of the information I provide have been explained to my satisfaction.

I hereby consent to participate in this research study.

____

Name of participant

____ ______________________________

Signature of participant **Date**

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to __________________.____________________________

They were encouraged and given ample time to ask me any questions. This conversation was conducted in English.

____ _______________

Signature of Investigator **Date**

9.5 Appendix E: Consent form 3

This form was used for the main experiments. It states that compensation will be provided.

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

CONSENT TO PARTICIPATE IN RESEARCH

Dear Prospective Participant

My name is Minali Parshotam. I am a Master's student in the Department of General Linguistics at Stellenbosch University. I would like to invite you to participate in my research study. The results of this study will contribute towards the thesis for my Master's degree. You are eligible to participate in this psycholinguistic study if you are an adult native South African English speaker (i.e. learnt English from birth) or an adult isiXhosa-English bilingual speaker (i.e. learnt isiXhosa from birth and English at a later stage), aged between 18 and 40 years.

Please take some time to read the information presented here, which will explain the details of this project. Your participation in this research study is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

Purpose of this study

This study is aimed at examining the influence that language has on perception.

Procedures

If you are willing to participate in this study, you will be asked to complete the following tasks:

Firstly, you will be asked to complete a colour discrimination task. This will entail you describing patterns depicted on a number of cards. Secondly, you will be asked to complete a memory task. For this task, you will be asked to remember a number of coloured chips. Thirdly, you will be asked to complete a similarity judgement task. For this task, you will be asked to rate the similarity of different coloured chips. Lastly, you will be asked to fill out a language background questionnaire which will ask basic questions about you and your language background.

All instructions will be given in English. Your participation will take between 20-30 minutes and you will be required to complete these tasks in person with the researcher.

Potential risks/discomfort

Participation in this study does not hold any risk for you and you will not experience any discomfort.

Potential benefits to subjects and/or society

This research will contribute towards a better understanding of the relationship between language and thought through the examination of colour representation.

Compensation

Participants will receive an airtime voucher worth R30 for their contribution to this study.

RIGHTS OF RESEARCH PARTICIPANTS:

You have the right withdraw your consent at any time and withdraw from participating without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

Confidentiality of participants

Your information provided to the researcher during this study will be kept anonymous as each participant will receive a unique participant code. The data collected will be kept in a secure, locked cupboard and all electronic data will be stored on the researcher's password protected laptop.

This study does not require any other personal details apart from the participants' age, gender, place of birth, and language background. The only other details given are those required by the consent form.

If you have any questions or would like to know more about this study, please do not hesitate to contact the researcher Minali Parshotam at 19030312@sun.ac.za or on 079 520 2801 and/or the Supervisor Professor Emanuel Bylund at mbylund@sun.ac.za.

DECLARATION BY PARTICIPANT

I have read the attached information leaflet and it is written in a language with which I am fluent and comfortable. I was given a chance to ask questions and all my questions have been adequately answered. I understand that taking part in this study is voluntary. I may choose to leave the study at any time and will not be penalised or prejudiced in any way. All issues related to privacy and the confidentiality and use of the information I provide have been explained to my satisfaction.

I hereby consent to participate in this research study.

____

Name of participant

____________________________________ __________________________

Signature of participant **Date**

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to ____________________.______________________________

They were encouraged and given ample time to ask me any questions. This conversation was conducted in English.

______________________________________ ______________

Signature of Investigator **Date**

9.6 Appendix F: Language background questionnaire

Language background questionnaire

Please complete the following questionnaire regarding a few basic questions about you and your language background.

Participant code: ______________

Age: __________

Gender: __________

Where were you born? ____

A. Please specify the languages which you speak and rate your proficiency in each of them, using the following self-rated scale:

1	2	3	4	5
Poor				Excellent

Language(s)	Proficiency (1-5)
1.	
2.	
3.	
4.	

B. Please specify how frequently you use each language on a daily basis, using the scale below:

1	2	3	4	5
Seldom				Most often

Language(s)	Frequency of use (1-5)	Hours per week
1.		
2.		
3.		
4.		

C. Please specify which language(s) you learnt first (i.e. as a baby):

____

D. If you speak language(s) other than the one(s) you learnt first, please specify the language(s), where you learnt them, and at what age you learnt them.

Language(s)	Formal (e.g. school, university)	Informal (e.g. home, playground)	Age of acquisition
1.			
2.			
3.			
4.			

E. Do you have any difficulties with colour perception?

____