PRIME TYPE AND LEXICAL RETRIEVAL IN KANNADA-ENGLISH BILINGUALS

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This Masters Dissertation is submitted in part fulfillment for the Degree of Master of Science in Speech-Language Pathology

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May, 2015

CERTIFICATE

This is to certify that this dissertation entitled **"Prime Type and Lexical Retrieval in Kannada-English Bilinguals"** is a bonafide work in part fulfillment of the degree of Master of Sciences (Speech-Language Pathology) of the student (Registration No. 13SLP017). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Prime Type and Lexical Retrieval in Kannada-English Bilinguals"** is the results of my own study under the guidance of Dr. K.S. Prema, Professor of Language Pathology, Department of Speech Language Science, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CHAPTER I

INTRODUCTION

Mental lexicon is a highly interactive system, in which words share the phonological, morphological, semantic and orthographic features. These features are co-activated during the presentation of the actual word. This phenomenon offers more challenges as well as interests in understanding the process of bilingual word recognition as there would be activation of the features of one or both the languages. Weinreich (1953) postulated three types of mental lexicon in bilinguals: compound, coordinate and subordinate. The bilinguals differ on several dimensions such as the number of underlying conceptual systems, the way in which the second language is accessed and the memory storage for two languages (separate or shared). It is well documented that both automatic and conscious processing facilitates word recognition during priming tasks depending on the prime duration. Therefore, in the past decades, priming paradigms have been generally used to understand the mental lexicon and word retrieval mechanism in bilinguals.

Spreading activation theory of semantic processing seems to be an effective explanatory construct which was developed to explain memory retrieval mechanism. According to the automatic spreading activation model, a prime activates the representations related to the target within a semantic network thus establishing a connection between prime and target words (Collins and Loftus, 1975). This neural network model of semantic priming assumes that the presentation of a prime stimulus facilitates a change in the connections and representation of lexical knowledge (Becker, Behrmann, Joordens, & Moscovitch, 1997; Joordens & Becker, 1997). These changes although insidious, were assumed to be long living, unlike the temporary change caused in the state of activation which has been assumed by spreading activation and other theories associated with semantic priming. Theorists have claimed that automatic spreading activation is the underlying mechanism in word retrieval within the memory network. They have investigated this hypothesis using different types of priming and varied task demands across languages in bilinguals.

1.1 Priming

Priming refers to the change in the ability of an individual to identify or produce an item as a result of a prior encounter with a specific item (Tulving & Schacter, 1990). It is a non-conscious (implicit) form of human memory in which exposure to previously presented stimulus influences the response to the following stimulus. The most common interpretation of priming is that the representation of the prime and target in the cortex are interconnected such that activation of the representation of the prime would automatically activate the representation of the target word. In a typical priming experiment, two words are presented successively. The first word refers to prime and the second word is the target to which response has to be made**.** The time duration between the prime and initiation of the target is called as Stimulus Onset Asynchrony (SOA). Priming effect is said to occur when prime facilitates the response to targets.

1.1.1 Types of Priming

Various types of priming which have been widely used to understand the linguistic processing are:

a) *Semantic priming*: In semantic priming, the prime and the target would belong to the same semantic category and share some features. For example, the word cat is a semantic prime for tiger, because the both are animals and present with nearly similar visual features. Semantic priming is theorized to work because of spreading neural networks. When a person thinks of one item in a category, similar items are primed (stimulated, activated) by the brain.

b) *Translation Priming:* In this type of priming, the prime word is presented in one language (L1 or L2) of a bilingual individual, followed by its translation in other language (L2 or L1). E.g. /bekkU/ (prime in Kannada language, L1) followed by target / cat/ in L2 (English language). In translation priming the presentation of a prime word automatically causes its lexical entry (Foster & Davis, 1984) to be activated which signifies short SOA's.

c) *Phonological Priming:* In Phonological priming, the prime and target are phonologically related to each other. For example, the word /kʌp/ (prime) is phonologically related to the word 'kæt' (target) since they share a common initial phoneme. This commonality would result in the prior activation of the target in the brain.

d) *Syntactic priming:* Here, the prime and the target are syntactically related to each other. E.g – a 'cat' (prime) followed by target 'a cat that's on a table'.

e) *Orthographic Priming:* This type of priming specifically influences visual word recognition as it involves use of orthography. Here, a visual prime is spelled similar to target word. Usually the prime and target words share all the same letters except for one. E.g. – ‘farm’ (prime) followed by target ‘barn’.

f) Repetition Priming: Here, the prime presented will be the same as the target stimuli. The influence of the initial presentation of the stimulus on responding to the same stimulus presented few milliseconds later is considered.

g) Cross linguistic priming: In cross linguistic studies, the effect of priming is observed across two or more languages. The influence of processing in one language on processing of the other language known by the individuals can be studied. Here, the prime and the target are presented in two different languages and their effects on each other for language processing are considered. E.g. ‘/bekkU/’ (prime in L1) – ‘dog’ (target) in L2. Cross linguistic priming can follow any of the above explained types of priming. Priming experiments are generally conducted using unmasked and masked paradigms for which all the above types of priming tasks are employed.

*h) Unmasked priming***:** Unmasked priming, is a type of prime which consists of presentation of both prime and target without any other interfering stimulus such as hash marks (###). Here, prime is presented for a duration of 200-250 milliseconds followed by SOA of approximately 50msec and then the target will be presented for a duration of 2000 msec. For example,

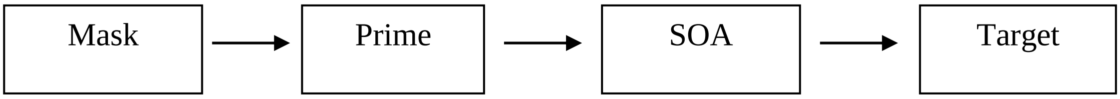
Figure 1

Sequence of presentation of prime and target in unmasked priming

Here, prime will be presented for a time window of approximately 200-250 milliseconds which is further followed by an SOA above 50 milliseconds. After this short interval, the target will be presented for around 2000 milliseconds or more depending on the task and participants.

i) Masked priming: Masked priming is a commonly used technique in the areas of psycholinguistics. This technique was developed by Forster and Davis (1984) which usually involves a very short interval of SOA, and no intervening items are displayed between prime and target. Furthermore, the prime is presented for a very short duration that participants are largely unaware of the nature of prime. Masked priming can be conducted in 2 ways- forward masking or backward masking. In Forward masking, the hash mark (##) will be preceding the prime which is then followed by the target so, the sequence of presentation will be- ### - prime – target. Backward masking is characterized by the hash (#) mark following the prime, which is then followed by the target so, here the sequence will be prime - ### - target. In forward masking, the mask is presented immediately prior to the prime which refers to a row of hash marks (###), the width varies to cover the prime completely. E.g. for 'ATTITUDE'- ########.This type of priming is referred to as a 'sandwich' technique by Foster and Davis (1984), since the prime is sandwiched between a pattern which acts like a mask and the target stimulus. The advantage of using masked primes is that the combination of masking (either forward or backward) the primes and brief exposure duration typically prevent individuals from being aware of a prime's identity and often leaves them unaware of the presence of the prime prior to the target.

Figure 2
Sequence of presentation of prime and target in masked priming



Here, mask (###) is presented for 500 milliseconds, followed by a prime which is presented in lower case for 50 milliseconds. A relatively short SOA is maintained between the prime and target; finally target word in upper case is presented for 500 milliseconds.

Advantages of masked priming paradigm. To assess automatic processing in isolation without the involvement of any strategic processes, conscious perception of the primes can be prevented by using masking techniques (Breitmeyer, 2007), which do not render the use of strategies (Henson, 2003; Merikle, Joordens, & Stolz, 1995), while typical priming effects still occur. Although masked priming had a smaller magnitude than unmasked priming (Kiefer, 2002; Kiefer & Spitzer, 2000), these subliminal masked priming effects demonstrate that semantic word meaning can be accessed automatically in an unconscious fashion (Adams & Kiefer, 2012; Kiefer & Martens, 2010; Kiefer & Brendel, 2006; Marcel, 1983). In the present study, two main types of priming i.e., masked and unmasked have been employed to understand the bilingual mental lexicon.

1.1.2 Variables

There are number of variables which can have a significant impact on priming phenomenon and hence should be kept under control. The variables are:

1) Relationship between prime and target. E.g. – if the prime and target are semantically related or syntactically related.
2) Order of presentation of the mask i.e., if forward masking, backward masking or a combination of forward and backward is used.
3) Format of presentation of prime and the target i.e., either orthographic or picture stimuli and if both are presented in same format or in cross format.
4) Modality of presentation of prime and target i.e., visual or auditory modality.
5) Time related factors such as SOA and prime duration.
6) Type of tasks employed. The priming effects differ among semantic categorization, lexical decision and naming tasks.

1.2 Need for the study

Priming is a form of sub threshold excitation that is transmitted across connections and related nodes and that prepares the appropriate node for activation which in turn forms the basis for retrieval of information (Burke, 2006). To ascertain only automatic activation spread, prevention of explicit processing of the prime and measurement of implicit effects is essential. This can be accomplished by visual masking of the prime. Presentation of prime words with masks interrupts the conscious processing of the prime.

Cross language priming in bilinguals have shown that if sufficient processing time is given, the priming effect is found for lexical retrieval across languages (Schwanenugel & Rey, 1986, Grainger & Beauvillain, 1988; Fox, 1996). The same has been found in Indian healthy bilingual adults and bilingual aphasics (Deema, 2005; Rajani, 2005; Mandira, 2009). Many psycholinguistic theories claim that the automatic mechanism of lexical retrieval is preserved in fluent aphasics. The extent and limits of sub-conscious processing in Indian bilinguals who generally are not strict bilinguals but variants of bilinguals by virtue of the ethno-cultural and linguistic dimension of India is yet to be investigated. In this line of research, the present study aims to examine the effect of unmasked and masked priming on lexical retrieval in Kannada-English Bilingual Adults.

CHAPTER II

REVIEW OF LITERATURE

With a rapid increase in the bilingual population across the world, the main focus of psycholinguistic research is on the representation of two languages in the bilingual brain. Mental lexicon is one of the tools for the researchers to understand the differences in the language representation between monolingual and bilinguals. Bilingual language storage, processing and access from the mental lexicon have been extensively investigated since 1980s. The activation of mental lexicon in bilinguals is commonly studied using reaction time measures. Lexical representation, lexical decision and variations in language direction are the core areas for understanding bilingual brain. These have been researched using various priming tasks, the details of which are reviewed and summarized in the following sections.

2.1 Bilingual Mental Lexicon

Majority of the population across the world is bilingual in the recent past (De Broot, 1993). Hence, an understanding of the mental lexicon of bilinguals has given way to the development of various models, hypotheses and experimental tasks. The major issue discussed in the models of bilingual language representation is the mapping of form or orthographic codes to meaning or semantic codes of the words in the lexicon. Weinreich (1953) proposed three ways of lexical connections in bilingual memory. Compound bilingualism wherein the two lexical systems of two different languages may be connected through a common semantic system, coordinative bilingualism wherein the two lexical systems have distinct semantic representations, or subordinate bilingualism where the less proficient language may be associated with the dominant language at the lexical level only and thus connected to the semantic representation indirectly.

2.2 Models of Bilingualism

Two major hypotheses are tested in the models of bilingualism.

(1) Do bilinguals think in two different languages or in each of the language? If in one language, do they translate the word to the other language? and

(2) If translated, is the translation automatic?

Explanation for these hypotheses has been given by the hierarchical models of bilingual word representation. Current research suggests that, at the lexical level, the two languages have distinct and separate representations. However, at the conceptual level, the two languages have shared or overlapping representations (De Groot, 1992; Kroll & Stewart, 1994; Potter, So, Von Eckardt, & Feldman, 1984). This class of representational models is referred to as hierarchical models.

2.2.1 Hierarchical Models

Hierarchical models of bilingual language processing presume separate lexical (word form) representations but shared conceptual (meaning) representations for the translational equivalents in the two languages of a bilingual. Hierarchical models proposed by Potter, von Eckardt & Feldman (1984) include word association model (Potter et al., 1984) which assumes that L2 word is connected to its conceptual representation only through its L1 equivalent. So, according to this model, if a bilingual needs to access the meaning of L2 word then first there would be an activation of corresponding L1 word. Only then, he or she can access the meaning of the word. The next hierarchical model is the concept mediation model (Potter et al., 1984) which proposed that L1 and L2 word forms are directly connected to their corresponding conceptual representations.

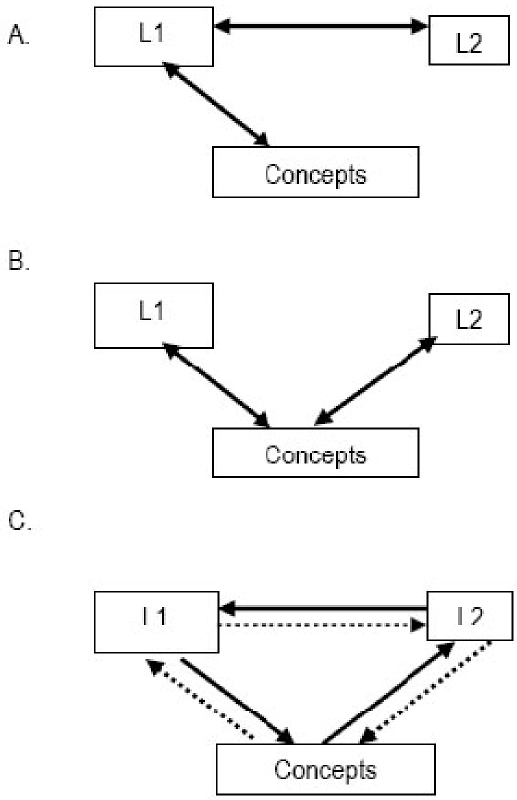


Figure 3. The hierarchical models. A: Word Association Model; B: Concept Mediation Model; C: Revised Hierarchical Model.
(Source: Menenti, 2006)

When Potter et al. tested these models on bilinguals they found that L1-L2 (forward) translation was faster than L2 picture naming since picture naming requires the retrieval of L1, L2 and the concepts whereas forward translation requires only L1 and L2 lexical retrieval. Later, Kroll and Stewart (1994) stated that the time taken during the translation from L2 to L1 is faster than L1 to L2 i.e. there is an asymmetry in the lexical and conceptual connections between L1 and L2. They posited that this asymmetry is because the concept mediation takes place only in L1-L2 translation. This view of Kroll and Stewart is known as the revised hierarchical model (RHM). Thus, RHM stands by two aspects: first, there are both lexical and concept mediated links between L1 and L2. The lexical link is stronger in L2-L1 and conceptual link is stronger in L1-L2 direction. Second, the connections between the lexical and conceptual links are dependent on the language proficiency. According to this model, both lexical and conceptual links are active in the bilingual memory, but the strength of the links differs as a function of fluency in L2 and relative dominance of L1 over L2. The conceptual asymmetry results from the evidence that L1 words are more likely to engage semantic processing than their L2 translation equivalents, given the assumption that the activated concepts are shared by both L1 and L2. After L2 proficiency is achieved, the lexical link from L2 to L1 remains but the conceptual links between L2 lexical items and the concepts are established. As L2 proficiency increases, direct access to concepts from L2 will be gradually established and backward translation should not differ from forward translation because of L2 conceptual mediation.

2.2.2 Connectionist Models

Another set of models called the connectionist models also attempt to explain the bilingual memory which include the following: BIA (Bilingual Interactive Activation) and BIA+.BIA (Dijkstra and van Heuven, 1998) is an extension of Interactive Activation model (McClelland and Rumelhart, 1981). The basic assumption of this model is the integrated lexicon and it is successful in extending effects observed in single language to bilinguals. According to the BIA model, when a string of letters is presented, the visual input will have an impact on particular features at each letter position. This activation of these related features will subsequently stimulate the processing of the letters that contain these features and at the same time inhibit the processing of the letters for which the features are not activated. The stimulated letters further excite words in both languages which contain the activated letter while all other words are inhibited. At the word level, words are inhibited depending on the features irrespective of the language to which they belong to. Word nodes activated in one language send activation on to the corresponding language node; also, activated language nodes send inhibitory feedback to all word nodes in the same and the other language. Thus, the main function of these language nodes is to compile activation from words in the language they represent and inhibit the active words of the other language. The activation of the language nodes reflects the amount of activity in each lexicon in bilinguals provided the features of the words in both the languages in the visual mode matched (Walter, van Heuven, Dijkstra &, 1998). Target word recognition in one language is influenced by the neighbourhood density and frequency of such orthographically similar words in the other language (Andrews, 1989, 1992; Carreiras, Perea & Grainger, 1997).

BIA was further extended as BIA+ (Dijkstra & van Heuven, 2002) which speaks of two processes within the lexico-semantic system in bilinguals: An automatic or bottom-up process which is essentially driven by stimulus input and involves modification of the level of activation and an intentional or top-down process that alters the response to the signals coming from the bilingual lexico-semantic system, but does not modify activation levels within the system. But, the main problem with the BIA model is that though it speaks of language nodes it does not speak how they came to form in the first place. Further, though it speaks of an integrated lexicon, the division into two language nodes somehow again questions this approach. Even though researchers have agreed upon the presence of a separate semantic or conceptual level in bilingual memory structure, there is no emphasis on such concept in BIA.

2.3 Representation of translation equivalents in Bilingual lexicon

A model of bilingual memory draws a distinction between the representation of form and meaning. It assumes that the translation equivalents of both the languages can either be directly connected through connections between the forms of two languages (word association hypothesis), or indirectly connected via a shared semantic representation between the two languages (concept mediation hypothesis). This shared semantic representation further could either be localist (a single node corresponding to the shared concept) or distributed across a set of semantic features or meaning units (deGroot, 1992), or both. In addition to these, a hierarchical model of bilingual processing has been put forth (Kroll & Sholl, 1992; Kroll & Stewart, 1994), where the level of L2 proficiency determines the degree to which bilinguals rely upon form to form connections or word association as opposed to concept mediation. Frenck-Mestre and Prince (1997) in contrast have demonstrated that L2 processing was independent of L1 translation links in less proficient speakers and also highlights concept mediation. Translational equivalent primes result in faster reaction times relative to unrelated primes (Keatley et al., 1994; Gollan et al., 1997; Jiang, 1999; Jiang & Forster, 2001; Basnight-Brown & Altarriba, 2007; Duyck & Warlop, 2009; Dunabeitia & Perera, 2010; Schoonbaert, 2011). Many translational priming studies suggest that translation equivalents have a shared representation (Keatly et al. 1994; Dunabeitia et al. 2010; Schaeffer, Paterson, & McGowan, 2014) and activation of shared representations facilitates automated processing (Schaeffer and Carl, 2013). Translation primes on the whole help for a better understanding of the organization of bilingual mental lexicon.

2.3.1 Sense Model

Translational priming effect depends on the task employed in the experiment. Most of the studies have shown that semantic categorization task had robust priming effect than lexical decision because the former task required access to semantic information (Grainger and Frenck-Mestre, 1998). In the same line of research, Finkbeiner Forster, Nicol and Nakamura (2004) also attempted to explain this task effect thorough another model of translational priming called Sense model. According to the Sense Model, translation priming also depends on the overlap of the senses or features associated with the prime and target and that the semantic categorization strengthens this overlap.

The Sense Model assumes that most words have different meanings according to the context in which they are used and that the range of senses that a word has will differ across languages. Translation equivalents typically share the dominant sense, but may differ in the remaining senses. Thus, translational priming depends on the representation of L1 and L2 at semantic level due to difference in the senses activated for L1 and L2. Translation priming also depends on the ratio of senses which prime and those that do not prime the senses associated with the target. In order to facilitate priming, it is essential to activate an ample proportion of the target senses. Priming from L1 to L2 has a stronger effect because the L1 prime can activate greater proportion of the L2 target senses. On the other hand, priming from L2 to L1 is weaker because the L2 prime might activate only the dominant sense of the L1 target, thus reducing the ratio of primed to unprimed senses associated with the L1 target compared to that in the L1 to L2 direction. This asymmetrical activation affects the degree of priming depending on the type of task selected; specifically more in a lexical decision task. Since no category information is available in lexical decision task, filtering effect with respect to the category will not be present. Hence, there will be no increase in the ratio of primed to unprimed senses in the L2–L1 direction because of which, no priming is observed. Whereas in semantic categorization task, the category which has been provided is assumed to act as a kind of filter and restricts the activation to just the category-relevant features of the target. Therefore, it increases the ratio of primed to the unprimed senses even in case of L2–L1 priming. This explanation is referred to as the Category Restriction Hypothesis (Finkbeiner, Forster, Nakamura & Nicol, 2004).

The sense model, in general, claims the idea of asymmetrical lexical and semantic representations between L1 and L2 in bilingual mental lexicon, which in turn causes the asymmetry in terms of translation during lexical decision. Wang & Forster (2010) conducted a study to investigate whether the translation effect occurred only to exemplars, ruling out the possibility of congruence effect, and the role of the category information in translation priming. Results obtained were in support of the assumptions of the sense model.However, the sense model claims translation symmetry in semantic categorization task with the assumption that the category serves as a filter to eliminate the representational asymmetry. Only Sense Model is able to provide an account for the priming asymmetry and its dependence on the task till date.

2.3.1.1. Translational processing in bilinguals during visual word recognition.

The studies in this regard have aimed to identify the way in which the words of both the languages in bilingual are connected to each other and also to their semantic representations (e.g., Potter, So, Von Eckhardt, & Feldman, 1984).One of the most interesting findings reported was a consistent asymmetric pattern of priming effects in the translation pairs; semantic interference was observed only in L1-L2 direction and not vice versa (Kroll & Stewart, 1994). The forward translation (L1 to L2) was semantically mediated and backward translation (L2 to L1) took place without any semantic mediation. Recent study conducted be Kroll, Van Hell, Tokowicz, & Green (2010) has suggested the existence of semantic mediation in backward translation and also found that backward translation task was easier than forward translation task. This result was interpreted as evidence showing asymmetry in the connections between translation equivalents; the existence of more efficient or stronger connections between L2 words and their L1 counterparts as compared to L1 words and their L2 translations.

2.4 Priming experiments on Bilinguals

Tasks commonly used to study the lexical retrieval from bilingual memory include lexical decision, lexical naming and semantic categorization. The time taken by the participant to make the decision or name the item or to categorize the item provides the measure of the dependent variable of interest, reaction time. The experimental manipulations with respect to the task infer the nature of the neural systems mechanisms that is responsible for retrieval from lexical memory. The particular manifestation for this involves presenting another word just prior to the target word. If the previously presented word has some similarity to the target word, then the reaction time to the target would be decreased. The assumption is that the processing of first word alters the nature of the processing for target word either by making the whole process faster or by eliminating the steps in the computation. On the other hand, the first word may also increase the reaction time to the target recognition.

The nature of the lexical organization in bilinguals is being studied with great interest in the recent past where in different offline and online methods are being used. Online methods are more effective to study the language processing in bilingual brains. Among the online tasks, priming (Meyer and Schvaneveldt, 1971) has been frequently used to study bilingual lexical organisation. During priming, the cortical representation for the previously presented word influences the representation of the target word. Hence, cross-language priming experiments would enable us to know the bilingual mental lexicon in an extensive manner. As per the language specific hypothesis of Bilingual Lexical Organization, bilinguals have two language-specific memory systems. In such case, no cross-language priming effects would be expected. In the view of language interdependent hypothesis of Bilingual Lexical Organization, bilinguals have a common and shared conceptual representation for both the languages. To support this, there should be an evidence for cross-language priming influence (facilitation) in terms of reaction time and accuracy. Among the various types of priming, research shows that translation priming task has been frequently used to study the lexical organisation in bilinguals.

As early as in 1986, Schwanenflugel and Rey investigated the representation of semantic information in the bilingual lexicon through a lexical decision task. The influence of cross-language was studied through a translation priming task with SOA being 300ms. Results showed that priming effect was seen in L1-L2 and L2-L1 directions which supported the language interdependent representation in bilinguals. Frenck and Pynte (1987) conducted a similar experiment in French-English bilinguals and they also observed facilitation due to priming across the languages. They suggested that this facilitation could be the result of conscious and strategic processing and not due to effortless automatic processing. Results from the studies where cross-language priming effects have been investigated across two orthographically dissimilar languages have shown facilitatory priming effects in both L1-L2 and L2-L1 directions. Gollan (1997) and Jiang (1999) have reported the same in Hebrew-English and Chinese-English bilinguals.

Among all the experiments, cross language priming is the one which is being widely used to understand the processing of languages in the bilingual brain (Chen and Ng, 1989; Jin, 1990; Smith,1991; De Groot and Nas, 1991; Altarriba, 1992; Sanchez-Casas, Davis, &Garca-Albea, 1992; Keatley and De Gelder, 1992; Gollan, Forster and Frost, 1997).Prema, Abhishek, and Prarthana (2010) have reported that in Indian bilinguals, lexical priming is one of the convenient tools to examine the lexical representation. Research is being done in this regard using priming paradigm and these studies have reported on the lexical representation in Indian bilinguals (Deema, 2005; Pravesh, 2009; Sweety, 2009). The lexical representation in brain damaged bilingual individuals has also been studied (Rajani, 2005; Mandira, 2013). The cross-language priming studies focus on investigating whether the two languages in the mental lexicon of bilinguals are shared or separated. The priming effects are studied using various prime-target relations, script, and prime duration. The most important factor that affects the processing in bilinguals is the duration for which the prime is presented in cross-language priming experiments. Prime duration is related to the degree of awareness of the prime which in turn influences the recognition of the target. Kouider and Dupoux (2004) suggested that at least partial awareness of the prime is required in semantic priming tasks. The cross-language priming studies have shown that longer prime duration uses conscious processing strategies and shorter prime durations utilize automatic processing. More recently, shorter prime durations (around 50 ms) is being used in most of the cross-language priming experiments (in

Hebrew- English bilinguals by Gollan, 1997; in Chinese-English bilinguals by Jiang, 2001).

Recently, YeongKo and Wang (2014) conducted two masked priming lexical decision experiments with different prime durations to study how the Korean-English bilinguals read compound words. Compound words served as the target which was preceded by constituent visual primes. One of the experiments had within-language prime-target pairs and the other had cross-language prime (L2)-target (L1) pairs with different prime durations (36, 48 and 100 ms). Within-language priming experiment showed that Korean compound words are processed depending on the morpheme unit rather than the syllable form. Cross-language priming experiment revealed that there is a cross-language activation of L1 (Korean) morphemic information while reading the L2 (English) compound words. They concluded that bilingual readers are more sensitive to morphological information than form information while reading compound words in both Korean and English. Authors also suggest that there is an automatic L1 translated morpheme activation during the processing of L2 compound words irrespective of the scripts of L1 and L2. The difference in the prime duration accounted for the type of information activated for reading. At lesser prime durations (36 and 48 ms), phonological and morphological information of L1 are activated regardless of semantic relatedness whereas at greater prime duration (100 ms), semantic information constrains the morphological activation of L1 while reading complex words in L2.Therefore, prime duration is an important factor to be considered in priming experiments.

The lexical organization in Indian bilinguals depends on the language structure. Indian languages are semi- syllabic and are non-alphabetic in nature. The mental lexicon of Indian bilinguals for Indian languages has also been studied using priming tasks by various researchers to understand the representation of non-alphabetic languages (Deema & Prema, 2005; Brajesh, Parvesh & Akanksha, 2009; Sweety, Meera, Aishwarya, Jayashree, 2009).

2.4.1 Unmasked versus masked priming

Most researchers have found differences between masked and unmasked priming qualitatively. For masked priming, the effects are often assumed to reflect savings in the encoding of the target stimulus, whereas for unmasked priming, it has been suggested that the effects reflect the familiarity of the prime–target compound cue. In contrast, few researchers have claimed that masked and unmasked priming reflect essentially the same core processes. According to the diffusion model (Ratcliff, 1978), masked related primes facilitate the processing of the target compared to masked unrelated primes, and unmasked priming affects primarily the quality of the lexical information. Alternatively, in Bodner and Masson's (2001, 2003) view both masked and unmasked primes would form an episodic trace independent of the visibility and the awareness of the prime.

Sanchez-Casas, Ferre, Demestre, Garcia-Chico & Garcia-Albea (2012) did a study with the aim of investigating the pattern of semantic priming effects, using masked and unmasked conditions in a lexical decision task. They also manipulated the type of semantic relation and associative strength between words. The results showed that the masked priming effects were seen with strong associates, but no evidence of such priming effects was found with weak associates or only-semantic related word pairs. When the prime was presented in unmasked condition, all types of semantic relations between the words produced significant priming effects and they were not influenced by the association strengths.Study done by Ulrich, Hoenig, Gron

& Kiefer (2013) investigated the neural correlates of semantic priming under masked and unmasked prime presentation conditions. They concluded that masked primes were not consciously perceived, and both priming conditions showed reliable priming effects, although effects were smaller in the masked than in the unmasked condition. In ERP studies (Kiefer & Spitzer, 2000; Kiefer, 2002; Kiefer & Brendel, 2006; Kiefer & Martens, 2010; Martens, Ansorge, & Kiefer, 2011) that are ideal to capture fast-decaying unconscious processes because of their high temporal resolution, masked and unmasked priming modulated the N400 ERP component, an index of semantic processing. On comparing the configuration of priming effects in the masked and unmasked conditions, the underlying neural generators seem to be similar.

2.4.2 Masked Priming Paradigm

Visual word recognition effects are hampered by strategic, mnemonic, or attentional processes in any kind of judgment task (lexical decision and/or semantic categorization) and hence Forster and Davis (1984) introduced masked priming paradigm to overcome this limitation. This would enhance the identification of some of the short-lived purely visual word recognition effects. Masked priming paradigm includes the presentation of certain pattern (e.g. hash marks) for 500 ms, followed by brief presentation of prime in lower case for approximately 30-60 ms which is further followed by the target in upper case. The participant is supposed to perform the judgment task on the target words. The presentation of prime is rapid so as to prevent the awareness of the existence of the prime by the participant. This will avoid the processing being conscious or involvement of any attention-related cognitive processes since masked primes have been found to be processed from the visual percept or sub-lexical levels of word processing (Forster, Davis, Schoknecht & Carter, 1987).The words that overlapped orthographically failed to show reliable priming when the prime was visible (Colombo, 1986; Martin & Jensen, 1988), but reliable facilitation effects were obtained when the prime was masked (Forster et al., 1987). This finding suggests that the masked priming technique taps very early processes in the perception of a word that are no longer apparent if processing of the prime is carried through to completion, producing conscious perception of the prime. An equally strong reason is that one can be more confident that the observed priming effects do not result from a conscious perception of the relationship between the prime and the target, as proposed in retrospective accounts of priming (Neely, Keefe, & Ross, 1989). In this account, the recognition of the target word is unaltered by the prime, but the subsequent recognition of a conceptual link between the target and the earlier prime has a direct effect on the response to a target.

2.4.2.1 Visibility of the prime.

The level of awareness of the prime has to be tested to confirm the automatic activation or processing. An effective tool to measure the presence and extent of the prime awareness is the 'd' measure. 'd' measure is a sensitivity measure which is based on signal detection theory (Greenwald, Abrams, Naccache, Dehaene, 2003). Here, participants are asked to perform the same tasks with same stimuli but on primes instead of targets. If the mean'd' value is zero, it indicates zero visibility of the primes. If the mean'd' value is more than zero (positive value), it indicates increased prime visibility. Participants tend to strategically process the prime as its visibility increases thus retrieving the target from their explicit memory.

2.4.3 Masked priming effects on visual word recognition in bilinguals

In order to explore the automatic cross-language interconnections in different processing levels of bilingual lexicon, numerous studies have used masked priming paradigm. The bilingual participants would be aware of only the presence of the target and not the prime because of its rapid presentation which in turn prevents the strategic processing related to the involvement of both the languages known by the bilinguals in the task. Hence, there would be an evidence of language non-selective lexical activation when there is a change of language between prime-target pairs. One of the first studies in this regard was done by Bijeljac-Babic, Biardeau and Grainger (1997) in French-English bilinguals. They suggested that the lexical competition among orthographic neighbors takes place similarly within English and across both the languages and also words form one language becomes automatically co-activated while processing the other.

Automatic cross-language activation effects have been obtained with words which overlap exclusively at semantic level (non-cognate translation) and even for the words of two languages with distant semantic relationship (cross-language associates). Studies with respect to non-cognate translation priming have suggested that semantic overlap is sufficient to trigger the co-activation in both the languages and translation equivalents automatically activate each other. Hartsuiker (2009) examined unbalanced but proficient Dutch-English bilinguals in whom he found significant masked associative/semantic priming effects only when the prime duration was more than 50 ms (100 ms or 250 ms). On the other hand, Perea, Dunabeitia and Carreiras (2008) used the standard prime duration of 50 ms and tested simultaneous balanced Spanish-Basque bilinguals. They found a significant symmetrical bidirectional masked cross-language associative/semantic priming effects.

2.4.4 Masked translation priming

Masked translation priming effect is a facilitation obtained during processing of words and subsequent recognition of targets when it is preceded by translation equivalent prime rather than prime being semantically related or unrelated in the non-target language. This facilitatory effect has been measured in terms of reaction time and accuracy. Explanation for this facilitation has been given in two ways. One view says that, the prime gets effectively processed at semantic level than activating the target word (Dijkstra & van Heuven, 2002; Kroll & Tokowich, 2005). Another view claims that the prime creates a direct link between the conceptual representations in both the languages (Jiang & Forster, 2001). Gollan, Forster and Frost (1997) found a significant masked translation priming effect in forward translation direction for both cognates and non-cognates. These results did not hold the same for backward translation direction in Hebrew-English bilinguals. Similar results were found by Dunabeitia, Perea and Carreiras (2010), Kim and Davis (2003), Voga and Grainger (2007) in Basque-Spanish, Korean-English and Greek-French bilinguals respectively.

2.4.4.1. Processing involved in Masked Priming

Masked semantic priming speculates access to the word meaning (Carr & Dagenbach, 1990; Kiefer, 2002; Kiefer & Spitzer, 2000). It indicates a facilitatory response to a target word, when it is preceded by a semantically related masked prime word (e.g., key-lock). The left middle temporal gyrus is responsible for semantic processing of words and the left fusiform gyrus actively participate in the processing of orthographic features of the words. The experiments done using masked translational priming taps both lexical as well as semantic levels of representation thus leading to automatic activation. This automatic activation of translation equivalents in bilingual visual word recognition depends on L1 dominance and not on L2 competence (Lopez, 2013). With the premise that priming is mediated by different processes in the brain, different forms of priming activate distinct brain regions. The expected visuo-motor response during priming tasks activate occipito-parietal areas (Wolbers et al., 2006) which is known to be involved in visual form processing (ventral pathway) as well as in object grasping and motor preparation (dorsal pathway). Semantic priming depends on anterior temporal areas (ventral pathways) supporting semantic integration (Kiefer & Pulvermüller, 2012; Nobre & McCarthy, 1995).

2.4.5 Factors influencing masked translational priming

There can be many factors that influence the priming effect in bilingual translational priming experiments. The response to the prime depends on the extent to which the orthography of the two languages known by the bilingual individuals is similar or different; age of acquisition and proficiency in first and second languages; task employed in the priming paradigm; and also attention allocation and reading proficiency of the bilingual participants selected for the study.

2.4.5.1 Cognate nature of the lexicon in languages

Cognateness of the bilingual lexicon refers to the phonological and orthographical match between the translational equivalents. Non-cognates are those translational equivalents which have different phonological (sound pattern) and orthographical (spelling) features. On the other hand, cognates are the translational equivalents which share similar sound patterns and spelling properties between the two languages known by the bilinguals. Because of this significant difference, priming effects in cognate which share phonological and orthographical representations and non-cognate translation equivalents which share only semantic representation are also likely to vary.

Studies on non-cognate translation priming.

Masked non-cognate translation priming effect was always found to be asymmetric (faster recognition in forward translation than in backward translation) but, the facilitation is dependent on the experimental settings particularly on the type of task (lexical decision versus semantic categorization). Previously conducted unmasked priming experiments failed to provide adequate evidence on this activation of shared semantic representation in bilinguals (significant effects were obtained by Chen & Ng, 1989; Cristoffanini, Kirsner, & Milech,1986; Jin & Fischler, 1987; Kerkman, 1984 and non-significant effects reported by Kirsner, Brown, Abrol, Chadha, & Sharma, 1980; Kirsner et al., 1984). Recent studies have used masked priming paradigm and have revealed the presence of automatic activation of translation equivalents (Zhang, Van Heuven & Conklin, 2011). Zhang et al investigated Chinese-English bilinguals using masked priming paradigm and showed that L1 (Chinese) translation of L2 (English) primes and targets were activated automatically. Priming effect of masked non-cognate translation was significant in semantic categorization task in both the directions (Grainger and Frenck-Mestre, 1998). The same has been supported by recent researchers (Finkbeiner, Nicol, Forster and Nakamura, 2004; Wang & Forster, 2010). On the whole, masked translation priming effects depend on the type of prime (cognates and non-cognates) and the task (lexical decision and semantic categorization). However, a consistent pattern of effect across different languages is yet to be examined.

Studies on cognate translation priming.

Use of varying degrees of cognate translation equivalents (non-identical to completely identical cognates) in priming experiments have shown a positive effect on visual word recognition in bilinguals. This is said to be dependent on the extent of ortho-phonological overlap of the languages (Cristoffanini et al, 1986). It is not necessary that cognates should always lead to an effective and faster processing (Dijkstra, Miwa, Brummelhuis, Sappelli, and Baayen, 2010). Dikstra et al showed that there was an interference caused by the identical cognates leading to larger inhibition rather than activation in Dutch-English bilinguals on performing a lexical decision task.

2.4.5.2 First and second languages

Researchers have found the effect of priming to be asymmetrical across the languages known by bilinguals. These effects are smaller or absent in L2-L1 priming than in L1-L2 priming (Altarriba, 1992; Fox, 1996; Keatley & de Gelder, 1992; Keatley, Spinks, & de Gelder, 1994; Kroll & Sholl, 1992). Many of the earlier experiments have reported priming asymmetries when cross-language prime-target pairs were used. This masked translation priming asymmetry is claimed to be task dependent. Finkbeiner, Forster, Nakamura, and Nicol (2004) suggest that the extent of asymmetry is decreased in semantic categorization tasks compared to lexical decision because of the category filling mechanism (Category Restriction Hypothesis) that restricts the features considered in categorization tasks to dominant, category-relevant features. This claim of Sense model was not well supported by Xia and Andrews (2014) wherein they suggest that there would be a pre-activation of the conceptual features of the target word category. This pre-activation provides feedback to lexical forms that would compensate for the weaker connections between lexical and conceptual connections of L2 words in Chinese-English Bilinguals. Baoguo, Huixia, Yiwen and Susan (2014) also suggest that the Sense model do not adequately explain the asymmetry seen in the cross-language translation priming. Instead they found that the Revised Hierarchical model (Kroll and Stewart, 1994) and the BIA+ model (Dijkstra and van Heuven, 2002) better explain the translation priming asymmetries in cross-language studies.

The priming asymmetry for different language directions in Chinese-English Bilinguals is discussed in two fold explanations (Xiaowei, Ping, Youyi, Xiaoping and Hua, 2011). On the one hand, lexical items in L2 have denser neighbourhood leading to more confusion due to increased competition by neighbourhood lexical items while on the other, the lexical items in L1 have less competition from the neighbourhood leading to a better organization of L1. With increasing knowledge and proficiency in L2, the neighbourhood of L2 becomes less dense and the representation would become more organised.

2.4.5.3 Task employed (Lexical decision task versus semantic categorization task)

Majority of the priming experiments is done using a Lexical decision or Semantic categorization or naming task. Both these tasks differ in their relative sensitivity to the semantic variables. To successfully perform a semantic categorization task, the retrieval of semantic information is essential; whereas on the other hand lexical decision does not require this retrieval (Balota & Chumbley, 1984; Shelton & Martin, 1992). The Sense model assumes an asymmetrical translational priming effect in lexical decision task and translation priming symmetry in semantic categorization task in bilingual memory. In the latter task, the symmetry is brought about by the category which serves as the filter to eliminate the representational symmetry.

Graniger and Frenck-Mestre (1998) conducted a masked translational priming experiment using non-cognate translational equivalents. Further, they evaluated the effectiveness of two different tasks (Lexical decision and semantic categorization) which are generally used in priming experiments. The study included twelve native speakers of English with French as L2 with high proficiency. A total of 60 non-cognate translation equivalents in English and French were selected as prime (French) and target (English) in the translation prime condition. The masking paradigm included both forward and backward masking with four different prime durations: 0 ms, 14 ms, 29 ms and 43 ms. The participants were tested on both lexical decision task where they had to indicate whether the string of letters presented was an English word or not and in the semantic categorization task and that if the items presented belonged to the designated category. Results revealed no significant difference in the reaction times on semantic categorization and lexical decision task. But the interaction effect between the task and priming showed a robust translational priming effect on semantic categorization task. Significant effects of priming were observed from 29 ms prime duration onwards and the effect was more robust in 43 ms prime duration.

The priming effects seen in the above studies are hypothesized to be mediated by the semantic representations shared by the translational equivalents and not by form or orthographic representations in the bilingual memory. One can expect a more robust priming effect in a semantic categorization task because it requires an access to semantic information. The top-down semantic feedback explains this disparity in the performance on lexical decision and semantic categorization tasks.

The translational priming effects were seen at 29 ms prime duration in semantic categorization task whereas the effects took a longer time in lexical decision task in which the effects emerged from 43 ms onwards. The authors conclude that robust translational priming effects can be seen on semantic categorization rather than on lexical decision and naming tasks because of the relative access to the semantic information.

Two experiments conducted by Sarmiento (2011) showed that non-cognate translation equivalents in Spanish facilitated visual word recognition of words in English in a Semantic categorization task and not during Lexical decision. These findings supported Grainger and Frenck-Mestre (1998) hypothesis which says that non-cognate primes can provide a facilitatory effect on semantic categorization task. This implies that the mental lexicons of each language in bilinguals are interconnected through meanings and not through forms.

2.4.6. Cross-script Priming in Kannada-English languages

Kannada is one of the major Dravidian languages in Southern part of India. It is considered to be the state language of Karnataka state and is spoken by around 20 million people. Kannada is one of the earliest documented inscriptions (Halmidi) dated 450 A.D. The literacy tradition of Kannada dates back to 1,200 years (Kavirajamarga in nineteenth century). The language has influentially undergone many changes in its morphological and orthographical structure (Rajapurohit, 1982). The following features differentiate Kannada from English:

(a) Phonetic arrangement of the script

(b) Inherent /a/ in consonants

(c) Short and long vowels

(d) Existence of retroflex consonants

(e) Differentiation between /la/ and /ḷa/; /na/ and /ṇa/

(f) Many of the nasals are hardly used

Kannada script (like Korean) is a mixture of syllabic and alphabetic principles. It is taught syllabically whereas English orthography is morphophonological (sequence of phonemes and its constituent morphemes are decoded simultaneously). English language is being taught to speak, read and write at a younger age in India and henceforth everyone in India is at least bilingual. English Bilingualism has now become an integral part in the modern multilingual Indian linguistic context. Since Kannada is a semi-syllabic language, visual representation of orthographic features has a unique relation with word recognition due to factors such as automaticity and inflectional morphology (Purushothama, 1986; Bhat, 2012, 2013).

Kannada and English being non-cognate language pair have shown significant priming effects in Johnson & Premas' study in 2005. Priming effects were found to be larger in L1-L2 direction which may be due to the stronger conceptual connections from L1 to concept store (Revised Hierarchical Model). The difference in the scripts has reduced the orthographic competition resulting in priming effect thus supporting the shared representation view of bilingual lexicon. Johnson concluded that this orthographic distance between Kannada and English did not negatively influence the priming effect but showed a clear evidence of semantic mediation in bilinguals.

Sweety, Meera, Aishwarya and Jayashree (2009) have done a cross-language priming (translational and semantic) experiment on 18 healthy Malayalam-English bilingual adults aimed at examining their lexical organization. They used a total of

126 word targets including translational equivalent word pairs, semantically related and semantically unrelated word pairs which were presented in both language directions. They did not find any difference with respect to the priming effects in either of the language directions, relatedness of the prime and target words and the two types of priming paradigm incorporated. But they have reported that the performance of bilinguals is better than monolinguals in terms of lexical decision which supports the assumption of revised hierarchical model (Kroll and Stewart, 1994).

CHAPTER III

METHOD

The aim of the study was to examine lexical retrieval in Kannada-English Bilingual Adults by employing priming paradigm. Since there is differential effect of unmasked and masked priming on lexical retrieval as reported in the literature, the study was designed using similar paradigm.

The primary objective of the study was to investigate lexical retrieval in Kannada-English Bilingual Adults residing in Karnataka state with Kannada as their native language.

The secondary objectives of the study are to examine:

- The explicit and implicit lexical retrieval mechanisms in neurotypical Kannada-English bilingual adults
- The lexical retrieval speed and accuracy in L1 to L2 and L2 to L1 conditions in Kannada (L1)-English (L2) bilingual adults.

The study was designed using cross-sectional and counterbalanced design.

3.1 Participants

A total of 30 neurotypical Kannada-English bilingual adults in the age range of 20-30 years who are native speakers of Kannada language and have learnt English language in a formal instruction context in schools of Mysore city were included in the study. The participants were divided into five groups (M=3; F=3) with two years interval and were selected as per the criteria listed below:

- Native language being Kannada (L1)

- Second language being English (L2) learnt in a formal instruction context in schools of Mysore city for a minimum of 12 years.
- Normal or corrected normal visual abilities with no known neurological, reading or learning disorder. All the participants were screened for any disability as per the WHO Ten Question Disability Screening Checklist (Singi, Kumar, Malhi & Kumar, 2007).
- Good proficiency in both the languages which was informally screened using few domains of Language Experience Proficiency Questionnaire (Maitreyee, 2009).

Table 1
Demographic details and language proficiency of the participants.

Participant number	Age/ Gender	Education/ Occupation	Language Proficiency	
			Kannada	English
01	21 Years/ F	UG	Good	Good
02	22 Years/ F	UG	Good	Good
03	22 Years/ F	UG	Good	Good
04	21 Years/ M	UG	Good	Good
05	22 Years/ M	UG	Good	Good
06	22 Years/ M	UG	Good	Good
07	23 Years/ F	PG	Good	Good
08	23 Years/ F	PG	Good	Good
09	23 Years/ F	PG	Good	Good
10	24 Years/ M	PG	Good	Fair
11	24 Years/ M	PG	Good	Good
12	25 Years/ M	PG	Good	Good

13	24 Years/ F	PG	Good	Good
14	25 Years/ F	PG	Good	Fair
15	25 Years/ F	PG	Good	Good
16	26 Years/ M	PG	Good	Good
17	26 Years/ M	PG	Good	Fair
18	27 Years/ M	PG	Good	Good
19	26 Years/ F	PG	Good	Good
20	26 Years/ F	PG	Good	Good
21	27 Years/ F	PG	Good	Good
22	26 Years/ M	PG	Good	Good
23	26 Years/ M	PG	Good	Fair
24	27 Years/ M	PG	Good	Good
25	28 Years/ F	PG	Good	Good
26	28 Years/ F	PG	Good	Good
27	29 Years/ F	PG	Good	Good
28	29 Years/ M	PG	Good	Fair
29	30 Years/ M	PG	Good	Good
30	30 Years/ M	PG	Good	Good

3.2 Stimulus Material

Stimulus material consisted of two word lists (Annexure 1):

List 1: Kannada (L1) to English (L2)

The prime was presented in Kannada and the target word in English language.

List 2: English (L2) to Kannada (L2)

The prime was presented in English and the target appeared in Kannada language.

A total of 40 word pairs were selected in which each list included 20 word pairs. List 1 had 20 word pairs in Kannada-English and list 2 had 20 word pairs in English-Kannada. Each word pair had a prime in one language and its translation equivalent target word in another language. The word pairs selected were the names of 20 living items and 20 non-living items which were included in each of the lists. The word pairs were selected from AIISH Research Fund Project 3.47 (Prema, 2009).

Table 2. *Details of the stimuli material*

Number of Kannada-English word pairs		Number of English-Kannada word pairs	
Living	Non-living	Living	Non-living
10	10	10	10
Example: ಬೆಕ್ಕು- Cat	Example: ಪುಸ್ತಕ- Book	Example: Snake - ಹಾವು	Example: Knife- ಚಾಕು

10 word pairs of both L1-L2 and L2-L1 apart from the test stimuli were also developed to give practice trials in order to familiarize with the task and response mode before the presentation of the test stimuli using word pairs.

3.2.1 Paradigms

Two paradigms were used in the study: Masked and Unmasked priming paradigms. 40 word pairs were presented separately under masked and unmasked conditions. For masked condition, the prime was presented for a brief duration following hash marks (#####) and then the target word was presented. On the other hand, in unmasked condition the prime was not followed by hash marks and was presented for a relatively longer duration. Then, the target word was presented. The stimulus set in the masked paradigm was: '##### – prime – target' and 'prime – target' in unmasked condition. Both paradigms had L1-L2 and L2-L1 word pairs as prime and targets respectively. The task of the participant was to categorize the target word as living or non-living under both the conditions.

Figure 4
Masked priming (L1 to L2)

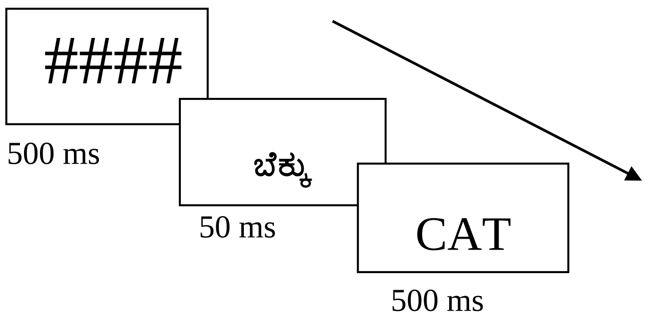
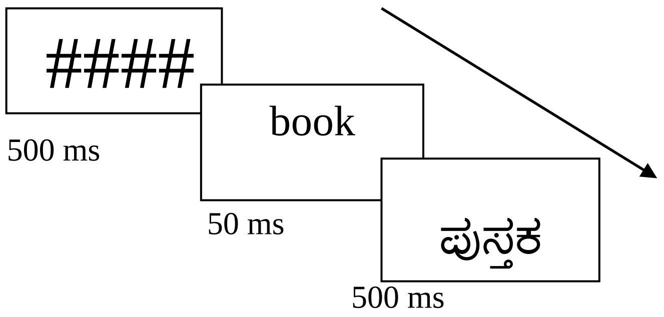


Figure 5
Masked priming (L2 to L1)



Duration of stimulus presentation in masked priming tasks: The mask (hash marks) was presented for 500 milliseconds which were followed by the prime for a brief period (50 milliseconds); then the target word was presented for 500 milliseconds. The inter stimulus interval (interval between the prime termination and target onset) was 50 milliseconds. The SOA was maintained for 100 ms. Hence, the total time for the presentation of one set of stimulus was 1100 milliseconds with a response time of 2500 milliseconds for each stimulus (Annexure II).

Figure 6
Unmasked priming (L1 to L2)

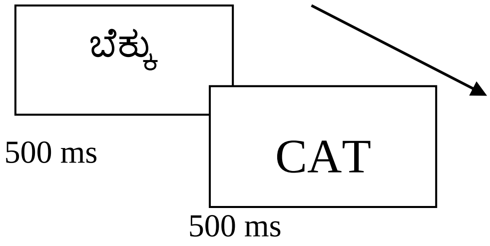
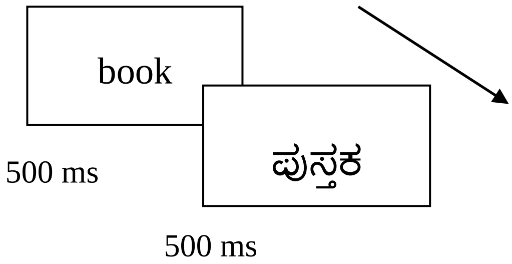


Figure 7
Unmasked priming (L2 to L1)



Duration of stimulus presentation in unmasked priming tasks: The prime is presented for 500 milliseconds followed by an inter stimulus interval of 50 milliseconds; then the target word was presented for 500 milliseconds. The SOA was maintained for 550 ms. Hence, the total time for the presentation of one set of stimulus was 1050 milliseconds with a response time of 2500 milliseconds for each stimulus (Annexure II).

3.3 Instrumentation

A Dell Vostro laptop of 15.6 inch screen was used to present the stimuli. The timing of the stimulus presentation was controlled through the Windows based DMDX software (Forster and Forster, 2003) by which the reaction times to visual stimuli (word-pairs) was measured. DMDX is freely downloadable software which was created and programmed by Jonathan and Ken Forster in the Department of Psychology at the University of Arizona.

3.4 Procedure

The participants were made to sit comfortably in a quiet room and were tested individually. The stimulus material including the two list of word pairs were presented in black color Courier New font for English words (lower case for primes and upper case for target words; Albeiro, 2011) and Tunga for Kannada words over a white 15.6 inch screen of the laptop. The font size of the prime was 36 and the target was 48. The primes and targets are presented in different cases to minimize the visual overlap in orthographic representation (Forster and Davis, 1984).In the masked priming paradigm, the forward mask (#####) was presented for 500 milliseconds followed by the prime in L1 (in L1 to L2 condition) or L2 (in L2 to L1 condition) which was presented for a brief period of 50 milliseconds. Then, the target appeared for 500 milliseconds in L2 or L1 (in contrast to the prime language) following the prime. Inter stimulus interval (time between the termination of the prime and onset of the target) was 50 milliseconds followed by the presentation of the target word. Hence, stimulus onset asynchrony (time between the onset of the prime and onset of the target) was 100 milliseconds. In unmasked priming, the prime and target were successively presented for 500 milliseconds with inter stimulus interval of 50 milliseconds. Hence, SOA in unmasked priming would be 550 milliseconds. Once the target appeared on the screen, the participants were instructed to press ‘Right Control key’ if the word belonged to living category and ‘Left Control key’ if the word was a member of non-living category as quick as possible. They were asked to use both their hands to facilitate the selection of the appropriate keys. The responses were interpreted and the reaction times were automatically measured and saved by the software.

The participants were made to perform the semantic categorization task in both masked and unmasked conditions. First, the participants were made to categorize the word pairs as living or non-living under masked condition. Later, they were subjected to unmasked paradigm condition. Masked priming paradigm was conducted prior to the unmasked in order to rule out the possibilities of being aware of the prime. A gap of one week was maintained between masked and unmasked paradigms so as to do away with the familiarity of the word pairs. Semantic categorization of the word pairs was done under four different conditions as mentioned in Figure 4, 5, 6, and 7 by all the participants. Reaction time for correctly responding to the target words of each participant was recorded automatically by the software when the participants responded by pressing the Right and Left Control keys.

3.5 Estimate of the visibility of the prime

Following the experiment, the participants were asked about their level of awareness of the prime and to categorize the prime instead of the target stimuli (visibility test to calculate 'd' measure)[1].

3.6 Scoring and analysis

The stimuli were coded as '+' for living and '-' for non-living items. The responses were also recorded similarly. Correct responses were indicated by '+' sign

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- [1]'d' measure is a sensitivity measure based on signal detection theory (Greenwald et al, 2003). Here, participants are asked to perform the same tasks with same stimuli but on primes instead of targets. If the mean 'd' value is zero, it indicates zero visibility of the primes. If the mean 'd' value is more than zero (positive value), it indicates increased prime visibility.

and incorrect categorization was indicated by a '-' sign along with the reaction time measure. All the responses on both types of priming tasks in two language directions were considered for further analysis. The reaction time measures and accuracy for all the responses were considered and tabulated. These reaction time and codes for accuracy (1 for correct response and 0 for incorrect response) were subjected to statistical analysis using SPSS respectively.

The data was analyzed statistically to address the following research questions posed in the study:

(i) The effect of masked and unmasked priming paradigms on lexical retrieval mechanisms in neurotypical Kannada-English bilingual adults

(ii) The lexical retrieval speed and accuracy in L1 to L2 and L2 to L1 conditions in Kannada (L1)-English (L2) bilingual adults.

(iii) Effect of age and gender on lexical retrieval using masked and unmasked priming paradigms.

The data was subjected to following statistical procedures:

- Descriptive statistics to compute mean, median and standard deviation
- Parametric tests such as repeated measure ANOVA and mixed ANOVA and
- Non-parametric tests such as Wilcoxon signed rank test and Mann Whitney test.

CHAPTER IV

RESULTS AND DISCUSSION

The primary objective of the study was to investigate lexical retrieval in Kannada-English Bilingual Adults residing in Karnataka state with Kannada as their native language.

The secondary objectives of the study are to examine:

- The explicit and implicit lexical retrieval mechanisms in neurotypical Kannada-English bilingual adults using unmasked and masked priming paradigms.
- The lexical retrieval speed and accuracy in L1 to L2 and L2 to L1 conditions in Kannada (L1)-English (L2) bilingual adults.

The study was designed using cross-sectional and counterbalanced design.

The dependent variables considered in the study were reaction time and accuracy. The independent variables were the priming paradigms (unmasked and masked) and language directions (L1 to L2 and L2 to L1) used in the paradigms. The results of the study are discussed under the following sections:

(a) Reaction time for semantic categorization in L1 & L2

(b) Accuracy of semantic categorization in L1 & L2

For statistical analysis, SPSS (Statistical Package for the Social Sciences) – Version 17.0 software was used. Descriptive statistics, parametric and non-parametric tests were used to derive statistical values. Descriptive statistics was employed to calculate the mean and standard deviations of the reaction time. When the data satisfied the normality condition, parametric tests were conducted. Non-parametric tests were employed whenever the data did not satisfy the normality condition. Normality was tested using Shapiro-Wilk test of Normality. The normality was observed for the reaction time of all the participants, both for gender and age. In the present study, parametric tests such as repeated measure ANOVA, paired t-test and independent two sample t-test were used to analyze the data. Non-parametric tests such as Wilcoxon signed rank test and Mann-Whitney U test were used to analyze the data which did not satisfy normality condition.

A total of four conditions were employed in the study to examine the objectives. Reaction time and accuracy for all these four conditions was analyzed and then compared to examine the objectives of the study. Following is the list of the conditions considered:

1. Unmasked priming: Prime in L1 and target in L2 (UML1L2)
2. Unmasked priming: Prime in L2 and target in L2 (UML2L1)
3. Masked priming: Prime in L1 and target in L2 (ML1L2)
4. Masked priming: Prime in L2 and target in L2 (ML2L1)

Table 3
Mean, Median and SD for reaction time

Conditions	Min	Max	Mean (N=30)	SD
UMLIL2L	325.42	1384.93	608.75	212.89
UML1L2NL	420.00	1569.60	711.08	280.06
UML2L1L	366.72	1349.43	698.95	244.46
UML2L1NL	372.88	1700.87	786.34	290.61
ML1L2L	456.49	1039.57	707.12	167.40
ML1L2NL	497.38	1348.28	786.10	192.38
ML2L1L	443.07	1234.39	713.38	175.75
ML2L1NL	471.54	1584.38	820.40	244.82

UML1L2: Unmasked priming in L1-L2 condition; UML2L1: Unmasked priming in L2-L1 condition;
ML1L2: Masked priming in L1-L2 condition; ML2L1: Masked priming in L2-L1 condition;
L: Living items; NL: Non-living items.

Objective 1:

To study the lexical retrieval using unmasked and masked priming paradigms.

To compare the reaction time measure for the unmasked and masked conditions, Mann- Whitney U test was performed. Table 5 and Figure 2 indicate that the reaction time is shorter in unmasked priming than masked priming in all the four conditions under study. The mean reaction time is observed to be 608.75 ms. (SD=212.89) for categorizing the target in unmasked L1-L2 direction for living things (UML1L2L) and the 786.34 ms. (SD=290.61) to categorize the non-living things in L2-L1 direction in unmasked condition (UML2L1NL). In general, the overall reaction time is observed to be shorter for the retrieval and categorization of living than non-living items in both conditions.

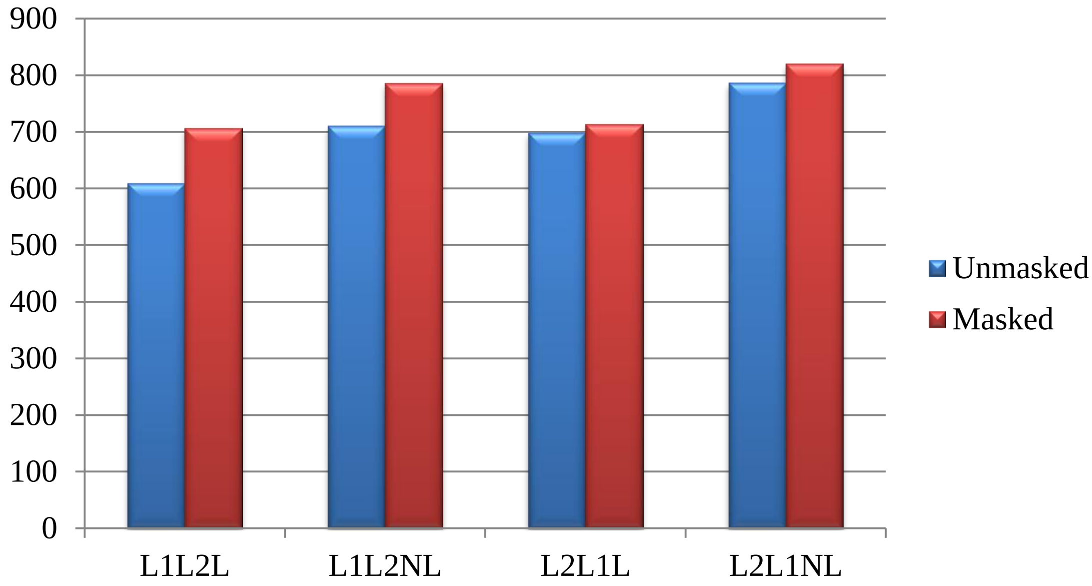

Figure 8. Mean reaction time for unmasked and masked paradigms

Wilcoxon signed rank test was done to examine the significant difference between the two paradigms in both language directions. Significant difference was observed between unmasked and masked priming for both living and non-living items in L1 to L2 direction (Z=3.22; p<0.05 and Z=2.417; p<0.05). There is no significant difference found for unmasked and masked conditions in L2 to L1 direction (UML2L1L versus ML2L1L: Z=0.689; p>0.05 and UML2L1NL versus ML2L1NL: Z=0.895; p>0.05).

Objective 2:

To examine the lexical retrieval in both language directions (L1 to L2 and L2 to L1).

Table 5 and Figure 3 indicate that the reaction time is shorter in L1 to L2 direction which implies that the identification of the target in L2 is faster when the prime is presented in L1. The reaction time is longer for categorizing the target in L1 with L2 prime. Faster identification of the targets in L1 to L2 direction has been observed in both unmasked and masked conditions. Shorter reaction time (608.75ms; SD=212.89) is observed in categorizing the living items in unmasked condition and the longer reaction time (786.34; SD=290.61) is noted for categorizing non-living items in masked condition in L1 to L2 direction. The overall reaction time is shorter for the categorization of living than non-living items in both language directions.

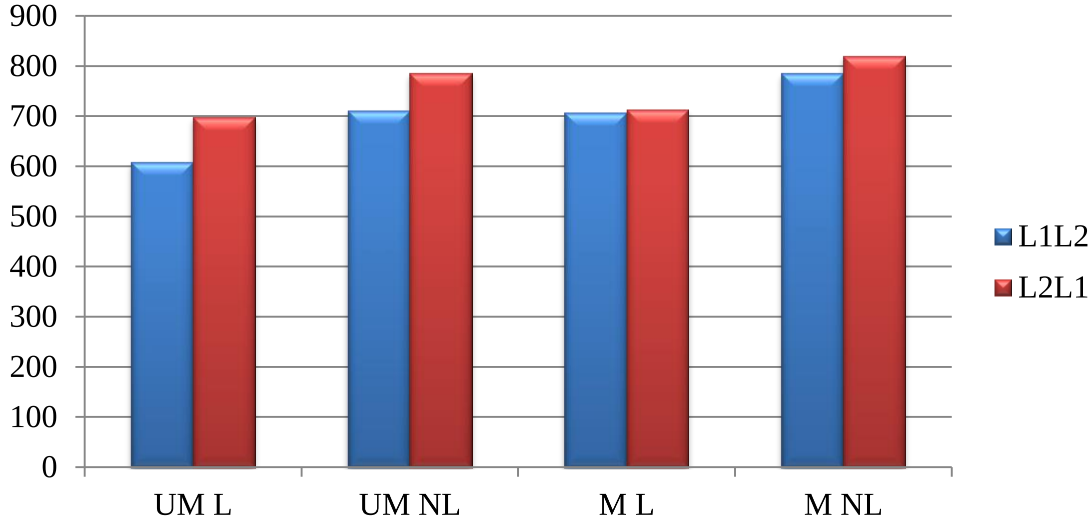

Figure 9. Mean reaction time across language directions

Wilcoxon signed rank test was done to examine the significant difference between the two language directions. Significant difference between L1-L2 and L2-L1 for both living and non-living items in unmasked priming condition ($Z=3.198$; $p<0.05$ and $Z=2.314$; $p<0.05$) was observed. There is no significant difference found in L1-L2 and L2-L1 for living and non-living items under masked priming condition ($Z=0.195$; $p>0.05$ and $Z=1.429$; $p<0.05$).

Accuracy was analyzed with respect to correct and incorrect responses. While programming the stimuli, it was planned to get scores for accuracy with the help of DMDX software that saved the correct responses as ‘+’ and incorrect responses as ‘-’ which were then coded as ‘1’ and ‘0’ respectively. The coded mean values of all correct and incorrect responses were analyzed. Percentage of accuracy in responding to all the experimental conditions varied from 89% to 96%.

Further, the reaction times were examined in relation to age and gender. The entire age range was divided into two groups of 20-25 years and 25-30 years. The effect of age on lexical retrieval in adult bilinguals was studied. Table 4 depicts the reaction time of the two age groups.

Table 4
Reaction time vs. age

Paradigms	20-25 years		25-30 years	
	Mean	**SD**	**Mean**	**SD**
UMLIL2L	502.70	149.08	623.14	246.30
UML1L2NL	606.04	214.70	683.67	320.53
UML2L1L	555.43	173.68	737.28	262.06
UML2L1NL	616.08	311.62	837.29	258.53
ML1L2L	639.84	173.83	757.67	157.76
ML1L2NL	680.76	162.73	808.26	210.58
ML2L1L	660.77	144.66	699.31	195.89
ML2L1NL	749.74	229.02	775.94	264.54

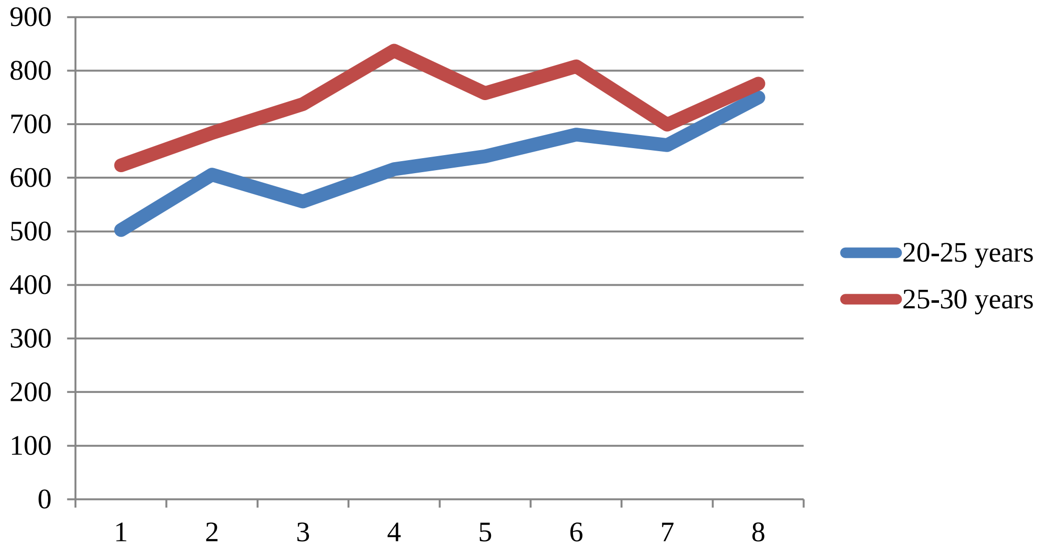

Figure 10. Trend of reaction time across age groups in all the 8 priming conditions

The reaction time of participants in the age range of 20-25 years is shorter than those in the age range of 25-30 years in all the conditions. Since the parameters under masked priming paradigm satisfied normality condition in both the age groups, parametric test (repeated measure ANOVA) was performed to examine the difference between L1 to L2 and L2 to L1 in masked priming paradigm. To test the effects among the parameters under unmasked priming paradigm which did not satisfy the normality condition, non-parametric test (Mann- Whitney U test) was performed. Both the measures revealed no significant effect ($p<0.05$) of age on both the experimental paradigms in either of the language directions.

Table 5
Reaction time vs. gender

Paradigms	**Males**		**Females**	
	Mean	**SD**	**Mean**	**SD**
UMLIL2L	636.27	256.54	577.31	152.23
UML1L2NL	710.69	294.41	711.52	273.78
UML2L1L	686.50	246.71	713.19	250.34
UML2L1NL	792.99	310.68	778.74	277.32
ML1L2L	730.27	180.87	680.67	152.83
ML1L2NL	777.36	221.54	796.08	160.39
ML2L1L	707.80	197.90	719.77	153.74
ML2L1NL	832.17	286.63	806.94	196.32

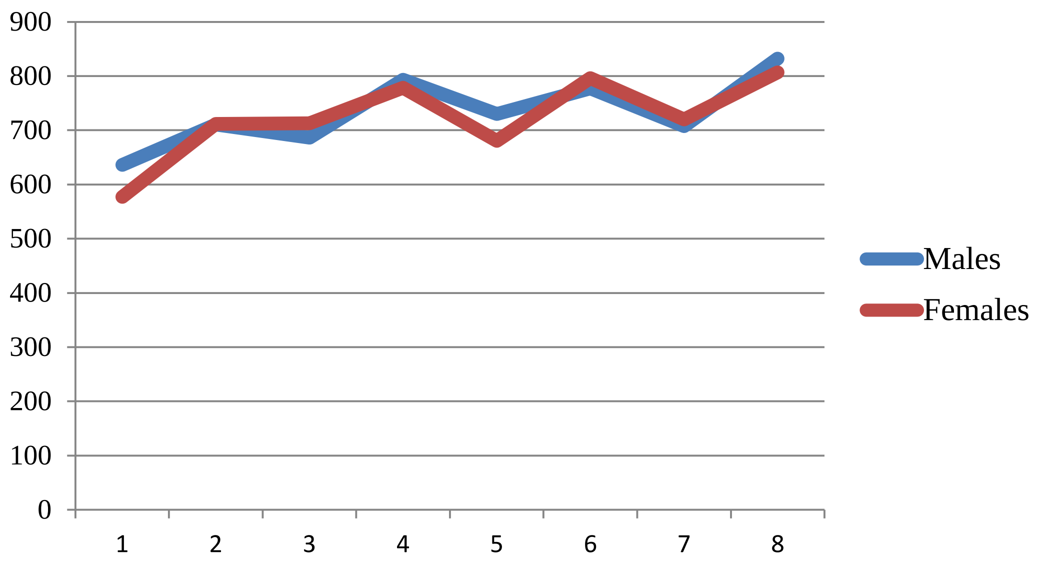

Figure 11. Trend of reaction time vs. gender in all the 8 priming conditions

The reaction time of male and female participants for lexical categorization is variable. Mann -Whitney U test was performed to see the significant difference between the genders. There was no significant difference between the gender on the experimental paradigms (unmasked and masked) in both the language directions.

Further, to study the differences in lexical retrieval for pairs of cross-lingual stimuli, Wilcoxon signed-rank test was performed. The Z-values showed statistically significant difference ($p<0.05$) as indicated in Table 8 which indicates a significant difference ($p<0.05$). Wilcoxon signed rank test suggested that for the category of living, there is a significant difference between the unmasked and masked conditions in L1-L2 direction (UML1L2L versus ML1L2L and UML1L2NL versus MLIL2NL). Further, for non-living category also there is a significant difference between unmasked and masked condition in L1-L2 direction (UML2L1L versus UML1L2L and UML2L1NL versus UML1L2NL).

Table 6
Pair-wise comparisons

Pairs	Z-value	Level of significance (p)
UML1L2L versus ML1L2L	3.322	.001
UML1L2NL versus MLIL2NL	2.417	.016
UML2L1L versus UML1L2L	3.198	.001
UML2L1NL versus UML1L2NL	2.314	.021

The above findings suggest that there is a significant difference between the masked and unmasked priming conditions for both living and non-living items only in L1 to L2 direction ($p>0.05$). In case of language directions, there is a significant difference between L1 to L2 and L2 to L1 for both living and non-living only in unmasked priming condition ($p>0.05$).

Visibility of the prime was tested subjectively for all the participants in masked priming paradigm. The participants were asked whether they were aware of the prime after the completion of the task. As per the self-reports by the participants, 28 out of 30 participants reported that they could sense the presence of prime but could not categorize the prime. Among the 28, 14 reported that they could just perceive the presence of prime and reported the prime to be a distractor and the other 14 were able to read and categorize the prime. Awareness of the prime was present for most of the participants in L1 to L2 direction; and the degree of awareness was higher in L1 to L2 than in L2 to L1 direction. Among all, only two participants were unaware of the prime in the masked priming tasks in either language directions. This asymmetry in the participants' reports on the presence of prime in the two language could be attributed to nature of the orthography of the two languages (Kannada and

English), proficiency in the languages, besides the attentional processes required to perform the task.

The results of the present study are in support with the Revised Hierarchical Model and not the Category Restriction view of bilingual language processing. RHM posits that there is a link between the lexicon and concepts of L1 and L2 which is supported by the occurrence of translational priming effect. Further, RHM emphasizes the influence of first language proficiency in bilinguals which is also supported by the finding that priming effect has taken place only in L1 to L2 direction. Since the priming effect in both the language directions is not seen in the semantic categorization task, the category restriction hypothesis not supported by the results of the study. This suggests that category restriction hypotheses might get influenced by factors such as language proficiency and usage because the participants in the study had good proficiency in L1 compared to L2.

Besides the above, the findings of the present study are also not in consensus with the BIA model. The visual features of Kannada and English words have inhibited the activation of related features with respect to language dominance. There is activation of related features in L2 and retrieval of specific feature thus inhibiting the others when the prime was presented in L1. There is no evidence of activation of L1 related features when the prime was presented in L2.

The primary objective of the study was to examine the lexical retrieval in Kannada-English bilingual adults. As shown in Table 6, there are no significant differences in the reaction time in retrieving the lexicon between Kannada and

English languages and also between the living and non-living categories in masked condition, both being longer. However, there is a significant difference in terms of reaction time in retrieving the lexicon between the languages and between the categories in unmasked condition. The results show that the retrieval of lexicon belonging to living category is faster than that of non-living category. This can be explained based on the premise that the living and non-living categories vary in terms of semantic features (Masson, 1995). The utility of the knowledge of these semantic features depends on the task. For example, in semantic categorization task, the lexicon is categorized as living or non-living based on the shared features. In contrast, distinctive features of the lexicon play a role in picture-naming tasks. Grondin, Lupker and McRae (2009) showed that shared features had a facilitatory effect in making decisions in a visual word recognition task conducted on young adults. Though distinctive features are helpful in the discrimination among similar features thus facilitate accurate categorization, shared features are assumed to have a stronger representation since they are shared across many concepts. In support to this, Cree and McRae (2003); Randall, Moss, Rodd, Greer & Tyler (2004) have reported differences in the distribution of semantic features of living and non-living category in English language. Semantic features of living things are comparatively slower in activating the semantic representations because of their lesser number of distinctive features and strong co-activation of shared features. On the other hand, the distinctive features of non-living things activate the semantic representations at a faster rate. Majority of the researchers (Tyler & Moss, 2001; Randall et al., 2004) provide support for a feature based representation of conceptual knowledge.

In the Indian context, Prarthana & Prema (2013) investigated the semantic features in living and non-living category in Kannada language. They found that living category had relatively lesser number of distinctive features than non-living category. This could have an impact on the results obtained in the present study with regard to the performance variations for living and non-living categories under unmasked condition in L1-L2 direction. The participants could retrieve the lexicon belonging to the living category than the non-living category since the representation of shared features is stronger than distinct features. The language which is used by the bilinguals to conceptualize the living and non-living things also has an effect on the time taken to categorize the stimuli. The findings of the present study emphasize the inter-relation between the usage of the language and concept representation rather than the relation between shared or distinctive semantic features and concept representation.

The reaction time obtained by the participants in the present study varied approximately from 325 ms to 1700 ms (SD=290ms) in unmasked and from 440 ms to 1580 ms (SD=245ms) in masked priming conditions. The maximum reaction time that could have been obtained was 2500ms. Since there are no norms established to compare the obtained reaction time, except the mean range, no remarks can be made on the reaction time measure for the population selected, languages considered, task employed and paradigms designed. Also with respect to the speed of lexical retrieval in Kannada-English bilingual adults, based on the reaction time procured in the study the results are discussed, however, in the absence of reference norms.

Further, the study aimed at examining the differences in terms of explicit and implicit processing in healthy adult bilinguals by incorporating unmasked and masked priming conditions. The results revealed that there is a significant difference between unmasked and masked priming. But, this difference is seen only in L1-L2 direction and not in the other language direction. Reaction time differences seen in unmasked and masked priming paradigms is based on the prime duration or awareness of the prime. The visibility of the prime reflects the type of processing taking place in the bilingual brain. If the prime duration is more, strategic processes contribute to the identification of the target and if the prime duration is less, then the target is identified by automatic or unconscious processing strategies (Kouider and Dupoux, 2004). The present study incorporated 50 ms of prime duration in masked priming and the prime was visible for 500 ms duration in unmasked priming tasks (Gollan, 1997; Jiang, 2001). YeongKo and Wang (2014) have suggested that at shorter prime durations (36 and 48 ms), the phonological and morphological information contributes to the identification of the target and at longer prime durations (100 ms), semantic activation helps in reading Korean words. Hence, the identification of targets in the masked priming task where the prime duration was shorter in the present study is not based on the semantic activation. The target recognition might be due to the features of the language since Kannada is a syllabic language (like Korean). The word recognition ability is based on the orthographic structure of the language (Leslie and Shannon, 1981). Letter recognition efficiency is found to determine the ability to recognize the word and the speed of reading (Jackson and McClelland, 1979).

Many cross-linguistic priming experiments that have been done in alphabetic languages report the reaction time to be shorter in masked conditions. The conscious attention paid on the prime in unmasked priming condition hinders the identification of the target presented later (Raymond, 1992). This can be explained in terms of the SOA maintained between the initiation of the prime and initiation of the target. Many priming experiments have shown that larger the SOA, more is the contribution of strategic processes in lexical retrieval and vice versa. In the masked priming condition, participants would have paid lesser attention towards the prime; but which appeared far before than the target (Naccache, Blandin and Dehaene, 2002). This would have interfered in categorizing the target thus leading to longer reaction times in masked priming condition as observed in the present study. In contrast, longer SOA employed in unmasked priming conditions has facilitated in categorizing the target lexicon without any interference thereby lengthening the reaction time.

The prime duration (being 500 ms in unmasked and 50 ms in masked) in the present study might have allowed the strategic processing to act upon categorizing the lexicon. The prime duration assumed in the study is based on the experiments done in English languages which in turn depend on the orthographic features. Language pairs which have different scripts such as Dutch-English and French-English have demonstrated masked priming effects at a relatively longer duration of around 100 ms to 250 ms (Hartsniker, 2009). This might be due to the relatedness in the script of cognate languages which would confound the reader between the prime and target. In contrast, languages with dissimilar scripts such as Hebrew-English and Korean-English also have demonstrated masked priming effects at 50 ms prime duration. Whereas, skilled readers in Kannada could sense the prime even at 50 ms of presentation which indicates the robust effect of orthographic structure on visual word recognition in Kannada-English bilinguals. Hence, the prime duration at which strategic processing begins in case of Kannada language is not known. Longer prime duration in unmasked priming conditions would have led the participants to use their strategic processing for categorizing the lexicon thus leading to shorter reaction time. The 50 ms prime duration in masked priming condition is also not efficient in masking the prime since 28 among 30 participants were able to sense the presence of prime. Therefore, a normative range of prime duration (presumably less than 50 ms) which contributes to explicit and implicit processing needs to be explored.

Subsequently, the study investigated the effect of language directions in lexical retrieval. Automaticity and orthography in reading Kannada words has contributed to the faster reaction times for identification of targets in L2 (English) when the prime was presented in L1 (Kannada). Automaticity in word reading refers to the simultaneous or parallel word reading strategy based on the visual structure of the words. Highly skilled readers process the words automatically and are less affected by conceptual information. They can read words even if they are presented for a brief duration. Hence, the knowledge of the rules of orthography is an important factor in word recognition (Purushothama, 1986). Unlike English, factors such as word frequency, class, imageability and/or concreteness do not influence the speed of reading words in Kannada by skilled Kannada readers (Karanth, Mathew and Kurien, 2004).

Another orthographic feature of Kannada which might have contributed to increased L1 prime awareness is stemming. Stemming is a term used in linguistic morphology and refers to a process that groups morphologically related words into the same class and thus used in retrieving information to improve the recall rate. The role of stemming especially in highly inflected languages like Kannada improves the effectiveness of retrieval (Larkey and Connell, 2003; Majumder, Mitra, Parui, Kole, Mitra, and Datta, 2007; Dolamic and Savoy, 2010). The morphology of Kannada is rich and complex than English and the assumption of derivational morphology is violated in Kannada. Bhat (2013) found that the distance of inflectional morphological variants from the lemma is more than that of the derivational morphological variants. Inflectional stemming in Kannada is largely dependent upon the accuracy of the morpheme segmentation process. As noted in Bhat (2013), the morpheme segmentation is better for nouns than for verbs. Hence, the faster lexical retrieval in L1 to L2 language directions may also be due to the nouns in selected as stimuli Kannada which acted as primes in priming tasks.

Since there was visibility of the prime in masked priming tasks, the stipulated prime duration of 50 ms could have contributed to strategic processing of primes thus leading to longer reaction times. The participants were not informed regarding the presence of the prime in masked priming tasks. But since the participants could sense the presence of prime due to automaticity and orthographical features of Kannada prime, they would have used their strategic processing to recognize the target word. The visibility of the prime without prior information of its presence would have interfered with the target identification thus leading to increased reaction times in masked priming tasks.

In addition to these factors, greater proficiency and use of Kannada language over English might have resulted in the language direction variations. The priming asymmetry for different language directions in Chinese-English Bilinguals is discussed in two fold explanations (Xiaowei, Ping, Youyi, Xiaoping and Hua, 2011). On the one hand, lexical items in L2 have denser neighbourhood leading to more confusion due to increased competition by neighbourhood lexical items while on the other, the lexical items in L1 have less competition from the neighbourhood leading to a better organization of L1. With increasing knowledge and proficiency in L2, the neighbourhood of L2 becomes less dense and the representation would become more organised. Jevoor and Prema (2013) suggested that reaction time and accuracy parameters in identifying semantic relationship between word pairs reflect the language proficiency. In the present study, faster reaction times in L1 to L2 direction can be attributed to the increased L1 proficiency of the participants.

The results reveal that the lexical retrieval using unmasked primes is faster than masked primes in Kannada-English bilingual adults in L1 to L2 direction i.e., when the prime is presented in Kannada and target in English language. Longer reaction time in masked priming task could be attributed to the prime duration, its visibility and thus causing interference in categorizing the target lexicon. Prime duration in the present study was 50 ms for all the masked priming tasks even which resulted in strategic processing of the orthographic forms of the primes in Kannada. Faster lexical retrieval in L1 to L2 direction can be attributed to the proficiency or use of the language and orthographical features of Kannada language.

To summarize, the lexical organization in bilinguals is being widely studied with the help of priming experiments. In the Indian context, the same has been examined through various priming paradigms as discussed earlier. Priming experiments conducted in Indian context have tapped on the explicit or the conscious lexical retrieval mechanisms in bilinguals. With this background review, the present study was conducted with an aim of examining both explicit and implicit mechanisms in the lexical retrieval by incorporating two types of priming paradigm namely unmasked and masked translational priming respectively. Unmasked priming task examines the explicit mechanism in the lexical retrieval since there would be enough time to strategically process the prime in order to decide, categorize and/or name the target word. On the other hand, masked priming task does not provide more time to strategically process the prime. Thus, the target would be identified through automatic or implicit processing mechanism. These two types of priming were incorporated in the present study to examine the lexical retrieval mechanisms in Kannada-English bilinguals. A total of 30 bilinguals with Kannada as native language and English as second language participated in the study. The two priming paradigms were counterbalanced across two language directions for all the participants. The presentation of the stimuli, computation of reaction time and accuracy in identifying the target word was done through DMDX software. The reaction time was found to be lower for identifying the target words in unmasked condition compared to masked condition. The lexical retrieval was found to be faster in L1-L2 direction than in L2-L1 direction which supports the assumption of the revised hierarchical model. Longer reaction time in masked condition is due to the interference caused by the prime and its orthographic nature even though the prime was presented for a very brief duration of 50ms. Hence, for a language with orthographic feature such as Kannada (transparent features with phoneme-grapheme correspondence), the findings of the present study suggests that the prime duration could be kept below 50ms in order to examine the implicit processing mechanism in lexical retrieval.

CHAPTER V

SUMMARY AND CONCLUSION

The understanding of bilingual language representation, processing and retrieval are the major areas of current research in Psycholinguistics and Neurolinguisitics. The mental lexicon in bilinguals is well explored through priming experiments since 1980s. Various modifications of the priming paradigms have taken place as per the researchers' topic of interest. These priming experiments in bilinguals have highlighted the effect of language proficiency, prime duration, task employed and orthography on bilingual word recognition and processing. Hence in a developing nation like India where there is a rapid increase in bilingual population, it would be interesting to explore and understand the language representations in Indian bilinguals. Indian languages differ from that of English and other languages with respect to the orthographical features and the way in which words are processed (top-down). Hence, a mere generalization of the findings from the studies in western context cannot be made. The present study aimed at exploring the nature of lexical retrieval in Kannada-English bilinguals using a priming paradigm.

The objectives of the study were:

(i) To examine the implicit and explicit lexical retrieval mechanisms in Kannada-English bilingual adults and

(ii) To examine the lexical retrieval speed and accuracy in both the language directions (Kannada to English and English to Kannada).

A total of 30 adults in the age range between 20 and 30 years with Kannada as their native language (L1) and English as their second language (L2) were selected.

There were two experimental paradigms: Unmasked and masked priming paradigms. These two paradigms were conducted in four conditions i.e., both unmasked and masked priming were conducted in both the language directions. Thus, the four conditions are as follows:

1. Unmasked priming (L1 to L2)
2. Unmasked priming (L2 to L1)
3. Masked priming (L1 to L2)
4. Masked priming (L2 to L1)

Two separate set of stimuli for both the paradigms was selected. In the unmasked priming, the prime and target appeared for 500ms with 50 ms gap in between whereas in the masked priming, the mask (hash marks) appeared first for 500 ms, then the prime was displayed for a brief duration of 50 ms followed by the target word which appeared for 500 ms. The presentation of the stimuli was done using DMDX software. The task of the participants was to categorize the target words which appeared on the screen as living or non-living thing. They were instructed to press ‘right control key’ if the target word belonged to living category and ‘left control key’ if the target word belonged to the non-living category. The reaction time and accuracy in this semantic categorization task were measured and analyzed.

The data obtained was analyzed using SPSS (version 17) software. The mean and standard deviation of the reaction time and accuracy were calculated. Parametric and non-parametric tests were used to compare the reaction time and accuracy in unmasked and masked priming conditions across two languages. Further to explore the significant difference in the performance between the conditions and languages, paired t-test was carried out. Mann-Whitney U test was carried out to find the significance effects between age and gender.

Results of the present study revealed the following:

(a) The mean reaction time and percentage of accuracy of Kannada-English bilingual adults in semantic categorization task was better in unmasked condition than in masked condition.
(b) Participants reported of prime visibility during masked priming task.
(c) The reaction time for categorizing living items was shorter than non-living items.
(d) The reaction time was shorter during lexical retrieval in L1 to L2 direction than in L2 to L1 direction.

The results of the present study are in support with the Revised Hierarchical Model of bilingual language processing. RHM posits that there is a link between the lexicon and concepts of L1 and L2 which is supported by the occurrence of translational priming effect. Further, RHM emphasizes the influence of first language proficiency in bilinguals which is also supported by the finding that priming effect has taken place only in L1 to L2 direction. Since the priming effect in both the language directions is not seen in the semantic categorization task, the category restriction hypothesis is not supported by the results of the study. Because the participants in the study had good proficiency in L1 compared to L2, it is plausible that language proficiency and usage might have its influence on the category restriction hypotheses and therefore, the results are not supportive of the hypothesis. Besides the above, the findings of the present study are also not in consensus with the BIA model. The visual features of Kannada and English words have inhibited the activation of related features with respect to language dominance. There is activation of related features in L2 and retrieval of specific feature thus inhibiting the others when the prime was presented in L1. There is no evidence of activation of L1 related features when the prime was presented in L2.

The findings obtained in the present study can be attributed to longer prime duration in masked priming tasks which interfered in categorizing the target thus leading to a longer reaction time. The processing nature and orthographic structure of Kannada language also contributes to the prime visibility and faster lexical retrieval in L1 to L2 direction. In addition to these, there is also an effect of L1 dominance, high proficiency and/or greater usage in the selected Kannada-English bilinguals. To conclude, the lexical retrieval in Kannada-English bilinguals during visual word recognition using masked priming tasks depends on the prime duration, orthographical structure and type of processing the orthography of Kannada and English languages.

5.1 Clinical implications

The present study has provided an understanding of the mental lexicon in Kannada-English bilinguals based on their performance in priming tasks. The study supports the revised hierarchical model of bilingualism by evidencing the lexical and conceptual links between L1 and L2; and also the L1 proficiency effect on the speed of lexical retrieval. Further, the study helps to

- To compare lexical retrieval in both the language directions in healthy bilingual adults.
- To demonstrate the feasibility of using appropriate priming strategies to facilitate lexical retrieval in bilinguals.

- To facilitate automatic activation and make use of the residual implicit memory abilities in bilinguals with brain damage wherein explicit processing abilities are affected.

5.2 Limitations of the study

- All the bilingual participants selected were not balanced or equally proficient in both the languages. They differed in terms of the usage of the languages (greater usage of Kannada language).
- Norms for prime duration and SOA to be maintained in priming paradigms has not been established in Indian scenario. The prime duration and SOA used in the study are based on alphabetical languages which might not hold good for Indian languages which are not alphabetic in nature.

5.3 Future directions

- The prime duration used in the masked priming duration can be reduced to examine the masked priming effect since there was prime visibility at 50 ms. Thus, the duration of the prime at which strategic process operate can be explored.
- Lexical retrieval in balanced bilinguals can be investigated.
- Other types of priming can also be employed (Repetition priming) to explore the language representation.
- Influence of language and their writing systems on visual word recognition in bilinguals can be investigated.

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ANNEXURE I

List of word pairs used in Masked and Unmasked L1-L2 priming task

Prime	Target
ಬೆಕ್ಕು	*CAT*
ಸೂಜಿ	*NEEDLE*
ಪುಸ್ತಕ	*BOOK*
ಕೋಳಿ	*HEN*
ಅಕ್ಕಿ	RICE
ನರಿ	FOX
ಮರ	TREE
ಬೆಳ್ಳಿ	SILVER
ನದಿ	RIVER
ಕಾಗೆ	CROW
ಕೊಠಡಿ	ROOM
ಮೇಕೆ	SHEEP
ಒಂಟೆ	CAMEL
ಶಾಲೆ	SCHOOL
ಮಗು	CHILD
ಹಣ	MONEY
ಗೂಬೆ	OWL
ಕೋಟೆ	FORT
ಹಂಸ	SWAN
ಘಂಟೆ	BELL
ಬಲೆ	NET
ಹಕ್ಕಿ	BIRD
ನವಿಲು	PEACOCK
ಕತ್ತರಿ	SCISSORS

Italicized words were considered as practice items.

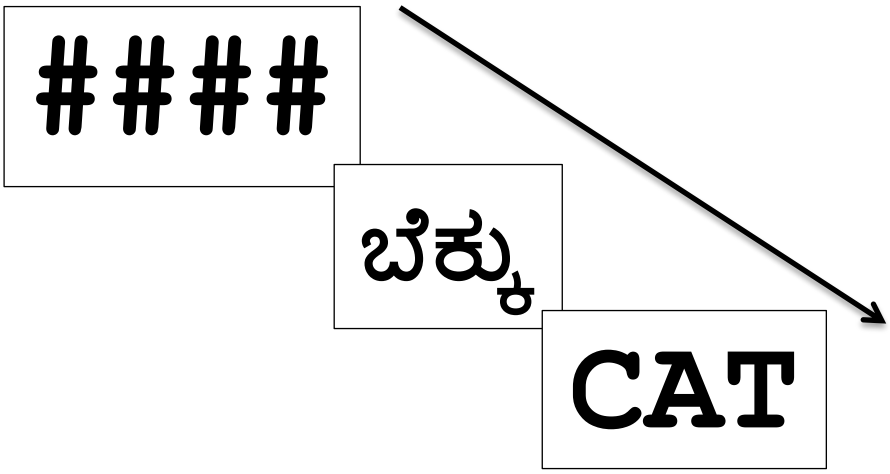
List of word pairs used in Masked and Unmasked L2-L1 priming task (UML2L1)

Prime	Target
KNIFE	ಚಾಕು
MONKEY	ಕೋತಿ
PRESIDENT	ಅಧ್ಯಕ್ಷ
PLATE	ತಟ್ಟೆ
SCORPION	ಚೇಳು
SAND	ಮರಳು
PEACOCK	ನವಿಲು
OIL	ಎಣ್ಣೆ
SNAKE	ಹಾವು
ORNAMENT	ಒಡವೆ
BIRD	ಹಕ್ಕಿ
WEAPON	ಅಸ್ತ್ರ
CHARIOT	ರಥ
CHILD	ಮಗು
WOOD	ಸೌದೆ
CAVE	ಗುಹೆ
SWAN	ಹಂಸ
FLOWER	ಪುಷ್ಪ
SATELLITE	ಉಪಗ್ರಹ
SHEEP	ಮೇಕೆ

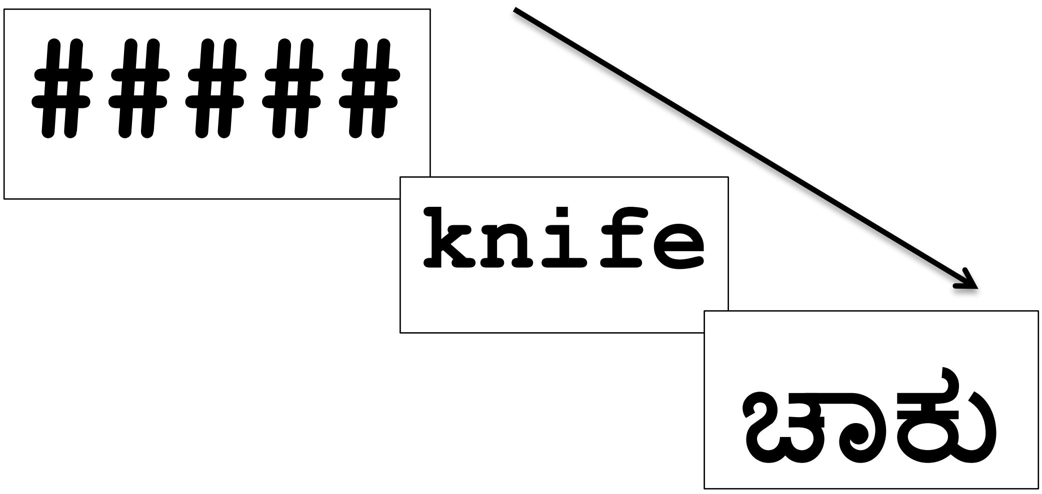
ANNEXURE II

Depiction of the exact nature of the stimuli used

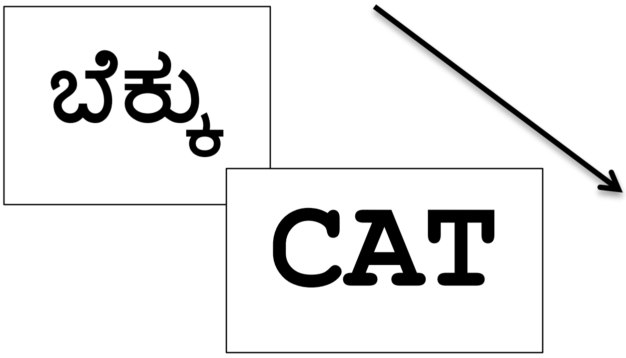
Masked priming (L1 to L2)



Masked priming (L2 to L1)



Unmasked priming (L1 to L2)



Unmasked priming (L2 to L1)