PRIME TYPE AND LEXICAL RETRIEVAL IN HINDI-ENGLISH BILINGUALS

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Register No.: 13SLP030

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

University of Mysore, Mysore

May, 2015

CERTIFICATE

This is to certify that this dissertation entitled **"Prime Type and Lexical Retrieval in Hindi-English Bilinguals"** is a bonafide work in part fulfillment of the degree of Master of Science (Speech-Language Pathology) of the student (Registration No. 13SLP030). 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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May, 2015

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DECLARATION

This is to certify that this dissertation entitled **"Prime Type and Lexical Retrieval in Hindi-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 Sciences, 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.

Mysuru | Registration No: 13SLP030

May, 2015

Dedicated to

Maa, Paa, di, jijz

&

bhai

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ABSTRACT

Priming is an implicit memory effect in which exposure to one stimulus influences response to another stimulus. Masked priming is a paradigm wherein the participant is consciously unaware of the stimulus presented whereas an automatic processing is defined as the activation of a sequence of nodes in response to particular input. There has been much debate among the researchers on the effective prime type for lexical access in bilinguals. The present study aims at investigating the automatic processing in Hindi-English (L1-L2) neurotypical bilingual adults using masked translation priming in two language direction i.e., L1 to L2 (Hindi to English) and L2 to L1 (English to Hindi). Totally 30 neuro-typical participants between the age range of 20-30 years participated in the study. The Language Experience and Proficiency Questionnaire (LEAP- Q) was administered on the selected participants to determine their proficiency in both the languages. Using DMDX software, semantic categorization of living and non living items was carried out. The reaction time (RT) and the accuracy of responses for stimuli were measured and subjected to statistical analyses. The overall results reveal that the lexical retrieval using unmasked primes is faster than masked primes in Hindi-English bilingual adults in L1 to L2 direction i.e., when the prime is presented in Hindi and target in English language. Also, retrieval of living items from mental lexicon is faster compared to non living items.

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CHAPTER I

INTRODUCTION

Mental lexicon is a highly interactive system, in which words share the phonological, morphological, semantic and orthographical 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 in several terms 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). In the past decades, priming paradigms have been commonly used to understand the mental lexicon and word retrieval in bilinguals. Both automatic and conscious processing facilitates word recognition during priming tasks depending on the prime duration.

Spreading activation theory of semantic processing seems to be an effective explanatory construct which was developed for 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 link between the prime and target words (Collins and Loftus, 1975).This neural network model of semantic priming assumes that the presentation of a prime stimulus is treated as a learning event that creates a change in the connection weights among processing units that represent lexical knowledge (Becker, Moscovitch, Behrmann & Joordens, 1997; Joordens & Becker, 1997). These weight changes although subtle, were predicted to be long lasting, unlike the temporary change in state of activation assumed by spreading activation and related theories of 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 to identify or produce an item as a result of a specific prior encounter with the item (Tulving & Schacter, 1990). It is a non-conscious (implicit) form of human memory in which exposure to one stimulus influences the response to another stimulus. The most common interpretation of priming is that the cortical representations of the prime and target are interconnected or overlap in some way such that activating the representation of the prime automatically activates the representation of the target word. In a typical priming experiment, two words are presented successively. The first word refers to as prime and the second word as 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 is said to occur when prime facilitates the response to targets.

1.1.1 Types of Priming

There are various types of priming which have been widely used to understand the linguistic processing such as:

a) *Cross linguistic priming*: In cross linguistic studies, the effect of priming is observed across two or more languages. 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. ‘billi’ (cat in L1) – ‘dog’ (target) in L2.

b) *Semantic priming*: In semantic priming, the prime and the target are from the same semantic category and share some features. For example, the word dog is a semantic prime for wolf, because the two are both similar animals. Semantic priming is theorized to work because of spreading neural networks. When a person thinks of one item in a category, similar items are stimulated by the brain. Even if they are not words, morphemes can prime for complete words that include them. An example of this would be that the morpheme 'psych' can prime for the word 'psychology'.

c) *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. ‘billi’ (prime in L1) followed by target ‘cat’ in L2. 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.

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

e) *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’.

f) *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’.

g) *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.

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 duration of 200-250 milliseconds followed by SOA of approximately 50msec and then the target will be presented for duration of 2000 milliseconds. For example,

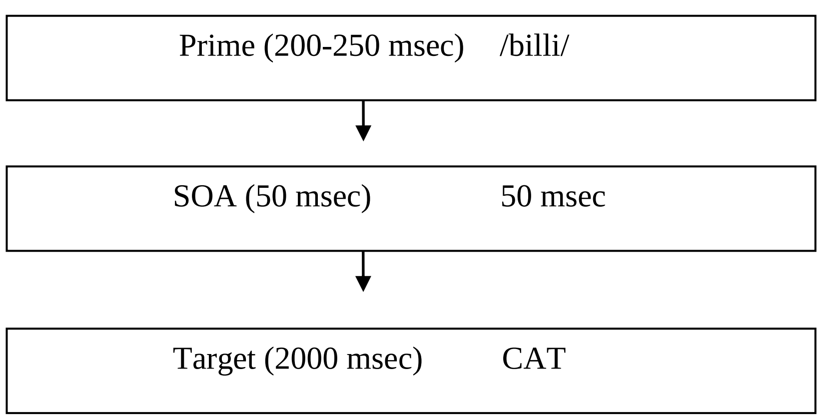

Figure 1.1 Sequence of presentation of prime and target in unmasked priming

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. For example, the prime /bekku/ would be presented for 250 ms followed by a SOA of 50 milliseconds. Finally target /CAT/ was presented for 2000 milliseconds.

i) *Masked priming:* Masked priming is a commonly used technique in the areas of psycholinguistics. It is developed by Forster and Davis (1984), usually involves a very short interval of SOA, with no intervening items 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 sometimes referred to as a 'sandwich' technique, because the prime is sandwiched between a forward pattern mask and the target stimulus, which acts as a backward mask. A crucial advantage of using masked primes is the fact that the combination of forward and backward masking of primes and brief exposure duration typically serve to prevent subjects from being aware of a prime's identity and often leaves subjects unaware even of the presence of the prime event.

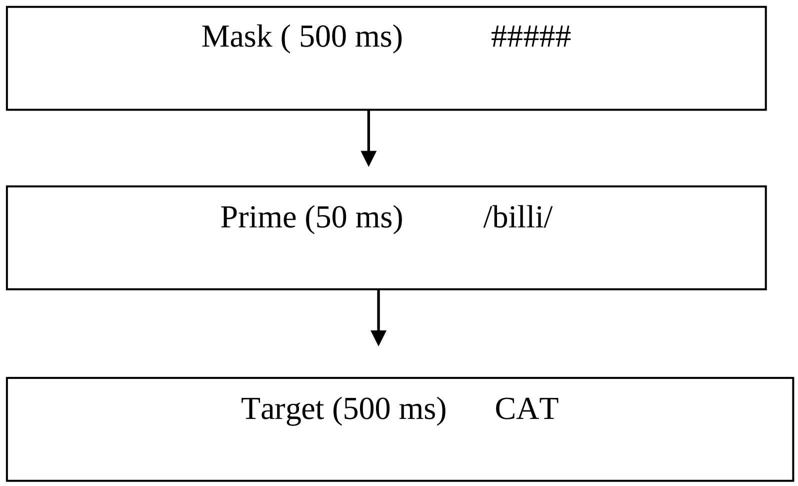

Figure 1.2 Sequence of presentation of prime and target in masked priming

Here, mask (###) is presented for 500 milliseconds, followed by a prime which could be either orthographically or semantically related to the target, presented in lower case for 50 milliseconds and finally target (CAT) in upper case is presented for 500 milliseconds.

Benefits 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) Nature of relationship between prime and target. E.g – if the prime and target are semantically related or syntactically related.
2) Order of presentation of prime and target i.e., if forward masking or backward masking 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 modality or auditory modality.
5) Temporal parameters 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 linking nodes and that prepares a node for activation, the basis for retrieval of its 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 for lexical retrieval is found 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.

1.3 Aim of the study

The aim of the study is to examine the effect of unmasked and masked priming on lexical retrieval in Hindi-English Bilingual Adults.

CHAPTER II

REVIEW OF LITERATURE

Language is the most powerful, permanent means of communication. With the help of language, humans can express their thoughts, desires, emotions and feelings. It also helps in storing knowledge, transmitting messages and experiences among humans. Thus, most of the activities in the world are carried out by language using one or a combination of communication modes and/or the language(s) used in the society the present scenario, the majority of the population is either bilingual or multilingual. Bilingualism is the alternate use of two or more languages by the same individual that has raised interest in researchers to understand its representation in the bilingual mind. It has always been fascinating to acknowledge the representation of mental lexicon among bilinguals. Much research has been carried out in regard to the idea of having a share or individual concept centre of two languages in a bilingual brain. A review of literature suggests that this area is still under investigation in order to understand the processing mechanism in bilinguals' brain.

2.1 Bilingual Mental Lexicon

Majority of the world's population 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. The two lexical systems may be connected through a common semantic system (compound bilingualism), or have their own distinctive semantic representations (coordinative bilingualism), or the less proficient language may be associated with the dominant language at the lexical level only and thus connected to the semantic representation indirectly (subordinative bilingualism).

2.2 Models of Bilingualism

Two major hypothesis tested in the models of bilingualism are: (1) do bilinguals think in two different languages or one language; and if one language, then do they translate the word to the other language; and (2) 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 form 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 assume 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.

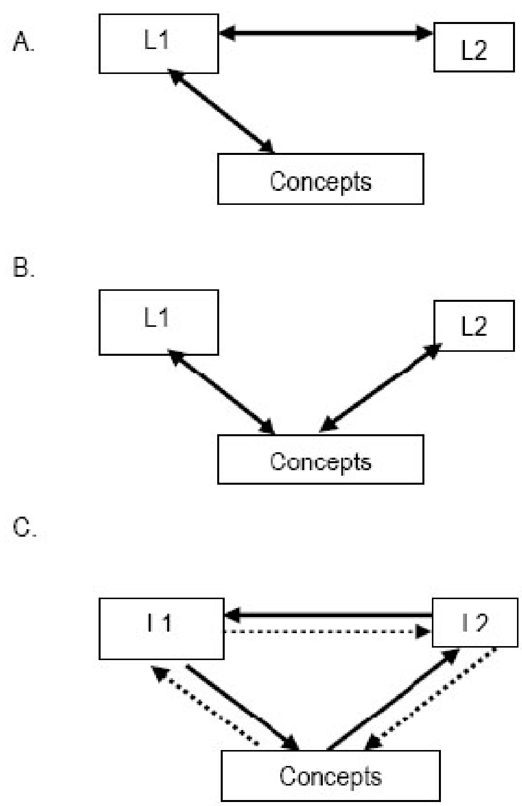

Figure 2.1 The hierarchical models. A: Word Association Model; B: Concept Mediation Model; C: Revised Hierarchical Model.

(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, although it speaks of an integrated lexicon, the division into two language nodes 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 in which a distinction is drawn between the representation of form and meaning, the translation equivalents of both the languages can either be directly connected via form–form connections (word association hypothesis), or indirectly connected via a shared semantic representation (concept mediation hypothesis). This shared semantic representation could either be localist (i.e. 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–form connections 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 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.

2.3.2 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 includes lexical decision, 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; 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; 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.

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.

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.

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

'Cognates' are usually referred to the translation equivalents that are identical or similar in their orthography across languages. These words will have same meaning Examples: the French/English pair "tigre/tiger" and the Spanish/English pair "limon/lemon". The cross-linguistic form overlap of cognates has been researched extensively by the researchers to investigate if words from different languages get co-activated during tasks like reading, listening, and speaking in bilinguals. Studies have found that cognate status influences the performance of individual on a number of lexical tasks. It has been concluded that cognate nouns are recognized more rapidly by bilingual adults in lexical decision tasks (Caramazza & Brones, 1979 ; de Groot & Nas, 1991). Also, translation of same is also faster than non cognates (de Groot, 1992a and de Groot 1992b). Priming across languages is greater for cognates than non-cognates (Cristoffanini, Kirsner & Milech,1986) and cognate status may interact with the level of language proficiency of the individuals (de Groot & Poot, 1997).

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 Priming effect in 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 tasksto 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. Tasks 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 Hindi -English languages

Bilingual context is characterized by linguistic diversity, different pattern of language acquisition and variations in language use across contexts. Language proficiency refers to the degree to which an individual exhibits control over the various aspects of language such as, phonology, morphology, semantics, syntax and metalinguistic knowledge. The present study conducted using Hindi-English bilinguals to check for lexical retrieval in each of the language using masked priming. Spread of bilingualism in English is more than Hindi, (the National language) i.e, 8% as second language, 3.15%, as third language whereas the same in Hindi is 6.15% and 2.16%. Further, among the bilinguals reported in census 1991, 70% are forced bilinguals in groups of people who speak languages that do not have script of its own (Mallikarjun, 1991). The census in India also reports a gradual increase in the population of bilinguals from 9.70% in 1961, 13.04% in 1971, 13.34% in 1981 and 19.44% in 1991. As bilingualism is very common, a thorough understanding of it is of paramount importance. English is alphabetic and linear, in that vowels and consonants are arranged sequentially. In contrast, Hindi, written in Devanagari, is an alpha- syllabary and non-linear writing system wherein vowels are placed around consonants making it a visually complex script. Additionally, the grapheme to phoneme mapping in English is opaque while Devanagari is transparent.

There are many languages like French-English which share common script for their orthography whereas; there are certain languages like Chinese–English and Hindi–English which require distinct scripts for both the languages. Research in this area in order to understand the mechanisms underlying reading in such bilinguals have been motivated by two hypotheses, namely the universal language hypothesis (Clarke, 1980; Goodman, 1973; Perfetti, Zhang, & Berent, 1992) and the language-specific hypothesis (Fiez, 2000; Gottardo, Yan, Siegel, & Wade, 2001; Holm & Dodd, 1996; Koda, 1994; Neville et al., 1998; Vaid, 2002; Vaid & Hull, 2002; Wang & Geva, 2003; Weinreich, 1953). According to the universal language system theory there is common cognitive and neuro-anatomical network for reading across languages.The visual forms that represent units of spoken language vary across writing systems. The language-specific hypothesis therefore suggests separate processing networks for different orthographies (Meschyan & Hernandez, 2006; Tan et al., 2003).

Hindi uses Devanagari which is an ancient writing system used widely in South Asia. According to the 2001 census survey of India, out of the one billion Indian population, 33% speak Hindi (Singh, Solanki, & Bhatnagar, 2008), which is approximately 330 million. An economic survey conducted by the Government of India in 2004 (UNDP report, 2004) reported a national literacy rate of 61% suggesting that about 200 million use the Devanagari script. The Devanagari script is derived from Brahmi, an abugida orthography (MacKenzie & Tanaka-Ishii, 2007). An abugida, also called alphasyllabary, is a segmental writing system in which consonant-vowel sequences are written as a unit i.e., vowel notations are obligatorily associated with and built into the consonants. The Devanagari script has both syllabic as well as alphabetic properties and hence called an alpha-syllabary. The Devanagari script differs from the Roman derived English script in many terms such as: grain size, transparency and orthographic representation (Padakannaya & Mohanty, 2004; Patel, 2004; Padakannaya & Joshi, 1995; Sproat & Padakannaya, 2008; Vaid & Gupta, 2002). The basic written unit in Devanagari script is called as akshara that stands for orthographic syllable consisting of consonant(s) with inherent vowel /a/ or consonant(s) with vowel diacritics or simply vowel in its full form. Though akshara stands for a syllable, it can be visually analyzed into constituent phonemes thus making it different from a syllabary such as Kana (Japanese syllabic writing scripts). English letters are designed with basic geometric shapes like vertical, horizontal, diagonal lines, circles and use several symmetrical shapes which can be written either in upper or lower case. Written English uses a number of diagraphs, such as ch, sh, th, ph, wh etc but they are not considered separate letters of that alphabet. Devanagari characters, on the other hand, have a complex spatial organization and are asymmetric, free flowing and have highly complicated shapes. English has a linear organization, in which vowels and consonants are written only in a linear left-to-right fashion, whereas, in Devanagari, the consonants are mostly written in a linear left-to-right order (कमल , 'kamal', meaning lotus) and vowel signs are positioned nonlinearly above (खेल , 'khel', meaning to play), below (खुल, 'khul', meaning 'to open') or to either side of the consonants (खाल, 'khal', meaning 'skin'). Also, for certain words in Devanagari, the vowel precedes the consonant in writing but follows it in speech (खिल , 'khil', meaning 'to blossom'). These qualities make reading in the Devanagari script complex and challenging. However, it is orthographically transparent with nearly perfect one to one correspondence between akshara and sound as opposed to English, which is irregular and opaque.

The nature of the lexical organization in Indian bilinguals is being studied with great interest in the recent past where in different offline and online methods 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.

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Sweety, Meera, Aishwarya and Jayashree (2009) have done a cross-language priming (translational and semantic) experiment on 18 healthy Malayalam-English bilingual adults with the aim of investigating the priming pattern in two languages groups i.e., monolinguals vs bilinguals. 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. Results revealed that priming effect was similar in both the language directions i.e., from Malayalam to English and English to Malayalam. Also, there was no significant difference between translation priming and semantic priming paradigm. Although, it was found that bilinguals were quicker and more accurate to judge the target words than the monolinguals.

The extent and limits of sub-conscious processing in Indian bilinguals is yet to be investigated. This automatic or sub-conscious processing can be extensively understood by using masked priming paradigms as explained earlier. With very few studies related to unmasked translational priming, the lexical organization and access in bilinguals is not clearly understood. The findings of masked priming experiments done across the world (e.g. Chinese, Spanish, Farsi, Arabic, Japanese, French, Greek and others) cannot be generalized for Indian languages due to a wide range of differences in the structure and script. This provides the necessity to conduct the present study with the aim of examining the effect of unmasked and masked priming on lexical retrieval in Hindi-English bilingual adults.

CHAPTER III

METHOD

The main aim of the present study was to investigate the effects of masked and unmasked priming on lexical retrieval on healthy bilingual adults who were native speakers of Hindi language and have learnt English language in a formal instruction context in schools.

Objectives of the study are:

- To investigate the implicit and explicit lexical retrieval mechanism using translation priming across Hindi-English neuro- typical bilingual adults.
- To study the effect of language direction on translation priming from Hindi to English and English to Hindi using lexical retrieval speed and accuracy measures.

3.1 Participants

Thirty Hindi-English neuro-typical (NT) bilingual adults between the age ranges of 20 to 30 years were selected for the study. Participants were divided into two groups with an age interval of 5 years (20-25 years; and 26-30 years) with each group consisting of 15 participants (consisting of both male and female).

3.1.1 Participant selection criteria

- All the thirty participants selected were native speakers of Hindi Language (L1) and have learnt English as their second language (L2).

- The participants were screened for visual acuity using Snellen chart (Snellen, 1862). They were also screened for any marked neurological and medical histories using WHO Ten Question Disability Screening Checklist (Singi, Kumar, Malhi & Kumar, 2007).
- Language proficiency of each participant in both Hindi and English languages was screened using Language Experience Proficiency Questionnaire (Ramya & Goswami, 2009).

Table 3.1
Demographic details and language proficiency of the participants

Participants	Age/gender	Education/ Occupation	Language Proficiency	
			Hindi	English
Participant 1	20 years/M	UG	Good	Good
Participant 2	21 years/M	UG	Good	Good
Participant 3	22 years/F	PG	Good	Good
Participant 4	20 years/F	UG	Good	Good
Participant 5	21 years/F	UG	Good	Good
Participant 6	22 years/F	UG	Good	Good
Participant 7	23 years/M	PG	Good	Good
Participant 8	24 years/M	PG	Good	Good
Participant 9	24 years/M	PG	Good	Good
Participant 10	23 years/ F	PG	Good	Good
Participant 11	23 years/F	UG	Good	Good
Participant 12	24 years/ F	PG	Good	Good
Participant 13	25 years/ M	PG	Good	Good
Participant 14	25 years/ M	PG	Good	Good

Participant 15	25 years/ M	PG	Good	Good
Participant 16	25 years/F	PG	Good	Good
Participant 17	25 years/F	PG	Good	Good
Participant 18	25 years/ F	PG	Good	Good
Participant 19	26 years/ M	PG	Good	Good
Participant 20	26 years/ M	IT sector	Good	Good
Participant 21	26 years/ M	IT sector	Good	Good
Participant 22	26 years/ F	PG	Good	Good
Participant 23	26 years/ F	PG	Good	Good
Participant 24	26 years/ F	IT sector	Good	Good
Participant 25	29 years/ M	IT sector	Good	Good
Participant 26	30 years/ M	UG	Good	Good
Participant 27	30 years/ M	PG	Good	Good
Participant 28	29 years/ F	PG	Good	Good
Participant 29	30 years/ F	PG	Good	Good
Participant 30	30 years/ F	UG	Good	Good

3.2 Study design

Cross-sectional and counterbalanced design was adopted in the following study to compare the effect of two different types of priming i.e. masked and unmasked priming on lexical retrieval.

3.3 Stimulus paradigm

Two paradigms were used in the study: Masked and Unmasked priming paradigms. 80 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 (*Lexical retrieval task*)

######## (500 ms)	कुत्ता (50 ms)	DOG (1000 ms)

Figure 3.1 Sequence of presentation of prime and target in masked priming (L1 to L2)

######## (500 ms)	cat (50 ms)	बिल्ली (1000 ms)

Figure 3.2 Sequence of presentation of prime and target in masked priming (L2 to L1)

पंखा (500 ms)	FAN (1000 ms)

Figure 3.3 Sequence of presentation of prime and target in unmasked priming (L1 to L2)

coin (500 ms)	सिक्का (1000 ms)

Figure 3.4 Sequence of presentation of prime and target in unmasked priming (L2 to L1)

3.4 Stimulus material

Stimulus material consisted of four word lists, two word lists in Hindi to English translation and two word lists in English to Hindi translation. In Hindi (L1) to English (L2) word lists, prime word was in Hindi and the target word was in English whereas in English (L2) to Hindi (L1) word lists, prime word was in English and target word was in Hindi. Each list consisted of 20 translation equivalent word pair. The word list included frequently occurring living and non- living items taken from Hindi- Kannada Common Vocabulary (CIIL common vocabulary series 1, 1973) and “With a little bit of help” – A manual and 634 cards for language training in Hindi (Karanth, Manjula, Geetha & Prema, 2010) . The details and example of test stimuli is given in Table 3.2 below.

Table 3.2
Details of the stimuli material

Number of Hindi-English word pairs		Number of English-Hindi word pairs	
Living	Non-living	Living	Non-living
20	20	20	20
Example:	Example:	Example:	Example:
कुत्ता- DOG	सिक्का-COIN	cat-बिल्ली	fan- पंखा

For masked condition, hash marks (##) were presented in Courier New font style with 48 point font size. For both masked and unmasked condition, English prime words were presented in lower case with Courier New font style and 36 point font size and Hindi prime words were presented in Mangal font style and 36 font size. English target words were presented in upper case with courier new font style and 48 point font size whereas Hindi target words were in Mangal font style and 48 point font size. All the stimuli items including hash marks, prime words, and target words were presented in bold font style. Practice session with 8 word pairs was given in both the language direction for both the conditions i.e., masked and unmasked to familiarize the participants with the task. Stimuli words in each list was randomized and presented on a computer screen using DMDX software.

3.5 Instrumentation

Stimuli were presented on a Samsung 14 inch laptop screen with Windows 8 operating system using DMDX software (Forster and Forster 2003). The timing of the stimulus presentation was controlled through the Windows based DMDX software by which the reaction times to visual stimuli (word-pairs) was measured. DMDX is free downloadable software which was created and programmed by Jonathan and Ken Forster in the Department of Psychology at the University of Arizona.

3.6 Procedure

The participants were tested individually in a quiet room. Semantic categorization task was used. All the participants were initially divided in two groups and they were subjected to two different tasks i.e. for Group 1, masked priming task and for Group 2 unmasked priming task. Each of the group was subjected two conditions i.e., Group 1 received the condition in which prime was first presented in L1 and target in L2, later the same group received another condition in which the prime was presented in L2 and target in L1. Similarly, the Group 2 was subjected to these two conditions i.e. first from L1 to L2 and later from L2 to L1.Participants were instructed for the task in which they were asked to press 'right' control key if the prime & target belongs to the living category and press 'left' control key if it belonged to non-living category. The responses were analyzed for reaction time and accuracy measures. For masked task, initially hash marks (##) were presented for 500 milliseconds followed by prime presentation for 50 msec. A time interval of 50 milliseconds also called as Stimulus Onset Asynchrony (SOA) was presented between prime and target during which screen was kept blank. SOA was then followed by presentation of target word for 500 msec.

For example,

Table 3.3
Details of the Response procedure for masked priming

Mask	Prime	Target	Subjects' response
####	बिल्ली	/kæt/	Right control key if target belongs to the living category
####	fan	पंखा	Left control key if target belongs to the non living category

For unmasked condition, prime was presented for 250 milliseconds followed by SOA of 50 milliseconds and then target was presented for 500 milliseconds.

For example,

Table 3.4
Details of the Response procedure for unmasked priming

Prime	Target	Subjects' response
बिल्ली	/kæt/	Right control key if target belongs to the living category
fan	पंखा	Left control key if target belongs to the non living category

Hash marks (##), primes and targets appeared on the centre line of the computer screen. All the primes used represented the translation (in orthographic form) of the targets selected. Each participant was given time duration of 2500 milliseconds to respond after the presentation of target. If the subject failed to respond to a target with in 2500 milliseconds then that item was recorded as error and was followed by next stimulus. The inter- trial interval was initiated followed by presentation of hash marks in masked condition and prime in unmasked condition. Participants were instructed to respond as quickly and as accurately as possible. A pilot study was conducted before finalizing the stimuli and the procedure.

3.6.1 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]

3.7. Scoring and Analysis

The stimuli were coded as '+ nn*' for living and '- n*' for non-living items and the responses were recorded in a similar manner. Correct responses were indicated by '+' sign followed by reaction time duration and incorrect responses were indicated by a '-' sign along with the reaction time measure. The responses were analyzed for reaction time. Each correct response was scored as '1' and incorrect/absent response as '0'. Ten practice trials were provided prior to the experimental task. Only correct responses on both types of priming tasks in two language directions were considered for further analysis. The reaction time scores for correct responses were considered and averaged to get average reaction time for a particular paradigm. For each of the paradigm, reaction time scores was calculated separately and later combined scores of all the paradigms were also calculated. All the scores obtained were tabulated and subjected to SPSS software version 16.0 for statistical analysis.

- [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.
- 'n'stands for numerical value, e.g. for living - + 22 and for non- living +2.

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 Hindi-English bilingual adults

(ii) The lexical retrieval speed and accuracy in L1 to L2 and L2 to L1 conditions in Hindi (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:

- 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 aim of the present study was to examine the effect of unmasked and masked priming on lexical retrieval in Hindi-English Bilingual Adults. The present study also attempted to investigate the effect of language direction, if any in lexical access in bilingual adults. The data was analyzed for reaction time (RT) and accuracy measures for neuro-typical bilingual adults.

The objectives of the study were:

- To compare the reaction time and accuracy measures for lexical access using masked and unmasked priming among neuro-typical Hindi-English bilingual adults across two language directions i.e., [prime word: Hindi (L1), target word: English (L2) and prime word: English (L2),target word: Hindi (L1)].
- To compare the performance between two priming types: masked and unmasked translation priming using semantic categorization task.

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

The data was statistically analyzed for reaction time and accuracy measures for the following priming conditions: Translation equivalents of Living (L) and Non living (NL) items in two language direction i.e., Hindi-English (L1-L2) and English-Hindi (L2-L1) for two priming conditions : masked (M) and unmasked (UM).

The data obtained was coded, analyzed and subjected to statistical analysis. For the statistical analysis, SPSS (Statistical Package for the Social Sciences) – Version 16.0 software was used. Test employed for the data analysis included both parametric and non-parametric test. Mixed ANOVA & Repeated measure ANOVA (parametric tests) and Wilcoxon Signed Ranked test and Mann Whitney U Test (non parametric tests) were used. Parametric test were being employed only if the data satisfied the normality condition and normality was tested using Shapiro-Wilk test of Normality.

The results obtained are discussed with reference to reaction time and accuracy measures under the following sections:

4.1 Performance of bilinguals on two priming types- Masked and unmasked.

4.2 Performance of bilinguals in two language directions.

4.3 Effect of age on performance

4.4 Effect of gender on performance.

4.1 Performance of bilinguals on two priming types- Masked and unmasked

a. **Reaction time:** the overall mean, median and standard deviation (SD) of the reaction time across two priming paradigms in two language directions were obtained using descriptive statistics.

Table 4.1
Performance of bilingual adults across two priming condition

Condition	**Reaction time**		**Mean (N=30)** *Maximum time = 2500msec*	**SD**	**Median**
	Maximum reaction time	**Minimum reaction time**			
ML1L2_L	1202.01	599.92	824.23	173.04	772.61
ML1L2_NL	1251.31	567.62	867.43	184.66	841.39
ML2L1_L	1449.52	614.74	832.21	1.81	804.87
ML2L1_NL	1388.42	643.47	904.17	186.95	856.60
UML1L2_L	1122.16	361.24	605.06	177.06	576.27
UML1L2_NL	1085.09	329.39	622.80	183.08	590.91
UML2L1_L	6494.98	417.51	866.19	1.08	615.55
UML2L1_NL	1320.53	398.76	662.52	229.60	628.52

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living)

Analysis of results shows that reaction time for unmasked priming is lower compared to masked priming in both language directions. However, in mean reaction time for L2-L1 living condition in masked priming condition was better than unmasked priming condition (Mean ML2L1L= 832.21, SD= 1.81; UML2L1L= 866.19, SD= 1.08). Results revealed that shortest reaction time was observed in unmasked paradigm in L1 to

L2 direction for living item (UML1L2_L) with Mean = 605.06 and SD= 177.06 and longest reaction time was observed in masked paradigm in L2 to L1 direction for non living item (UML2L1NL) with Mean= 904.17 and SD= 186.95. In general, the overall reaction time was observed to be lower for retrieval of living than non-living items irrespective of the priming condition and language direction except for one condition in which reaction time for living item is more compared to non living item across unmasked priming in L2 to L1 direction with (mean of UML2L1L= 866.19 and SD= 1.08) and (mean of UML2L1NL = 662.522 and SD= 229.60)

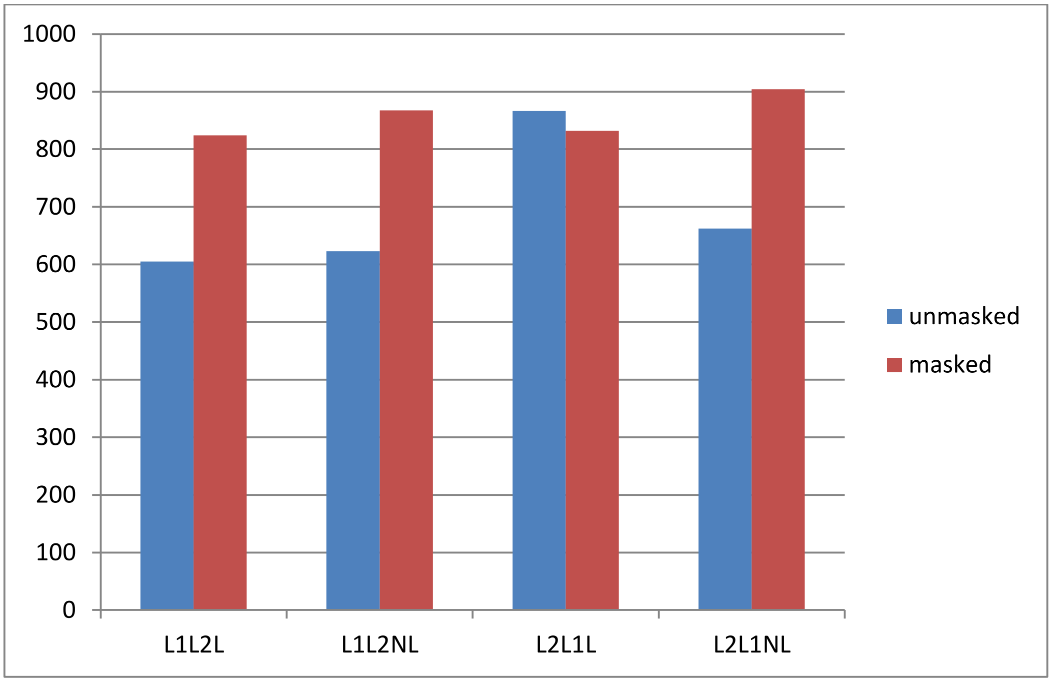

Figure 4.1 Mean reaction time for masked and unmasked paradigms

Further, Wilcoxon Signed Rank test was employed to compare between reaction time for two priming condition irrespective of age and gender and results reveals that there was a significant difference between two types of priming. Significance difference was present in both the language directions between both the priming conditions.

Table 4.2
Wilcoxon signed ranked test showing significant difference between masked and unmasked priming

Conditions	Z value	p value
UML1L2_L - ML1L2_L	4.700	0.000
UML1L2_NL - ML1L2_NL	4.679	0.000
UML2L1_L - ML2L1_L	3.383	0.001
UML2L1_NL - ML2L1_NL	4.371	0.000

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living)

b. Accuracy: the overall mean, median and standard deviation (SD) of the accuracy measures across two priming paradigms in two language directions for living and non living items were obtained using descriptive statistics.

Table 4.3

Performance on accuracy measures of bilingual adults across two priming condition

Conditions	Mean Max=10	SD	Median
AML1L2_L	9.26	0.83	9.00
AML1L2_NL	9.66	0.55	10.00
AML2L1_L	9.46	0.86	10.00
AML2L1_NL	9.73	0.58	10.00
AUML1L2_L	9.73	0.44	10.00
AUML1L2_NL	9.33	1.02	10.00
AUML2L1_L	9.50	0.90	10.00
AUML2L1_NL	9.83	0.37	10.00

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living)

Analysis of results shows that accuracy measures for unmasked priming is better compared to masked priming in both language directions but the difference is not highly significant. However, accuracy measures for L1-L2 non-living condition in masked priming paradigm was better than unmasked priming paradigm (Mean AML2L1L= 9.66, SD= 0.55; Mean AUML2L1L= 9.33, SD= 1.02). Results revealed that higher accurate measures were present in unmasked paradigm from L2 to L1 direction for non-living item (UML2L1NL) with Mean = 9.83 and SD= 0.37 and lower accurate measures were present in masked paradigm from L1 to L2 direction with living item (ML1L2 L) with Mean= 9.26 and SD= 0.83.

Further, Wilcoxon Signed Ranked test was employed to compare between accuracy measures for two priming conditions irrespective of age and gender and results reveals that there was no significant difference between two types of priming on accuracy measures. Significant difference was present only in one condition i.e., L1 to L2 direction for living item with ($|z|= 2.502$ and $p= .012$).

The results of the present study reveal that reaction time is shorter for lexical retrieval in unmasked priming condition compared to masked priming condition in both language direction (L1 to L2 and L2 to L1) for both living and non living lexicons. These findings are discussed with reference to the variables such as the nature of relationship between prime and target, order, format and modality of presentation of prime and target, as well as the temporal parameters such as the SOA and prime duration that are likely to have impact on priming phenomenon.

In the present study, prime and target were translation equivalent of each other in two languages (L1 and L2). 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). Baoguo, Lijuan, Peng and Susan (2014) reported that the priming effect of the translational equivalents did not significantly differ for abstract and concrete words both in lexical decision and semantic categorization tasks for bilinguals in both prime-target directions and therefore, the translation primes help for a better understanding of the organization of bilingual mental lexicon.

Both prime and target were presented in the visual mode using orthography of the two languages Hindi and English. Hindi uses Devanagri script for writing whereas, English uses Roman script. The Devanagari script differs from the Roman derived English script w.r.t. grain size, transparency and orthographic representation (Padakannaya & Mohanty, 2004; Patel, 2004; Padakannaya & Joshi, 1995; Sproat & Padakannaya, 2008; Vaid & Gupta, 2002). Hindi is considered to be orthographically transparent language with nearly perfect one to one correspondence between akshara and sound as opposed to English, which is irregular and opaque and this property can lead to asymmetrical results, i.e., significant in L1 to L2 but not vice versa in priming condition as observed in the present study. Besides the above, the script in Hindi being alpha-syllabary (vowels overlap with consonants), facilitates closure phenomenon during identification of word in Hindi language compared to English language.

For both the masked and unmasked conditions, SOA was kept as constant at 50 ms but prime duration was different for both types of priming. For masked priming, prime was presented for duration of 50 ms whereas for unmasked priming, prime was presented for 500 ms. Reaction time differences seen in unmasked and masked priming conditions 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). Here, since the prime duration for masked priming was less (50 ms), it involved unconscious processing for lexical retrieval of the word where as for unmasked priming, processing would have been strategic and conscious for lexical retrieval.

Studies have also accounted for results with better reaction time for masked priming compared to unmasked priming as in study conducted by Perea, Dunabeitia and Carreiras (2008), used the standard prime duration of 50 ms and tested simultaneous balanced Spanish-Basque bilinguals and found a significant symmetrical bidirectional masked cross-language associative/semantic priming effects. These results of the present study, however, are contradictory to Perea et al., study as there was no significant effect of masked priming in either L1 or L2.

Studies have accounted that masked priming may account for significant results depending on the relation between prime and target. Study conducted by Sanchez-Casas, Ferre, Demestre, Garcia-Chico & Garcia-Albea (2012) reported that masked priming produces significant results of priming only with strong associates between words but no evidence of priming effect was noticed with weak associates or only-semantic related word pairs. On the other hand, when the prime was presented unmasked, all the types of relations produced significant priming effects and they were not influenced by association strength. Therefore, based on the results of the present study, it can be attributed that masked priming did not show any significant effect because of the prime-target relation used in the study that are neither stronger co relates nor weak correlates but were translation equivalents.

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). Also, masked translation priming effects depend on the type of prime (cognates and non-cognates) and the task (lexical decision and semantic categorization) and thus a consistent pattern of effect cannot be established. In the present study, prime used are non-cognates which were employed to semantic categorization task and thus, these factors could have contributed to no significant effects for masked priming.

The reaction time obtained by the participants in the present study varied approximately from 329.39 ms to 6494.98 ms in unmasked priming condition and from 567.62 ms to 1449.52 ms in masked priming condition. The maximum reaction time that was controlled for the study was at 2500ms but reaction time obtained exceeded the set criteria which could be because of the response timings of any one individual which lead to this skewness for reaction time. As, there are no norms established to compare the obtained reaction time, it cannot be concluded whether the obtained reaction time is appropriate or not for the population selected, languages considered, task employed and paradigms designed. Hence, conclusive statements with respect to the speed of lexical retrieval in Hindi-English bilingual adults cannot be made based on the reaction time obtained through the paradigms of the study.

4.2 Performance of bilinguals in two language directions

a. **Reaction time**: the overall mean, median and standard deviation (SD) of the reaction time across two language directions i.e., (prime-Hindi and target- English;

prime- English and target - Hindi) in two priming conditions were obtained using descriptive statistics.

Figure 4.2 Mean reaction time for L1-L2 and L2-L1 language direction.

Table 4.1 and Figure 4.2 show that reaction time is better in L1 to L2 direction. That is when prime was presented in Hindi language and target in English language, reaction time was shorter compared to vice versa. Although the difference between reactions time across both language directions were not highly significant. It implies that the retrieval of the target in L2 is faster with the prime presented in L1, whereas, the reaction time is found to be longer in retrieving the target in L1 with L2 prime. Results revealed that shortest reaction time was present in unmasked paradigm in L1 to L2 direction for living item (UML1L2 L) with Mean = 605.06 and SD= 177.06 and longest reaction time was present in masked paradigm in L2 to L1 direction for non living item (UML2L1NL) with Mean= 904.17 and SD= 186.95. The overall reaction time is shorter for the retrieval of living items compared to non living items in both the language directions.

Further, Wilcoxon Signed Rank test was carried out for each of the language direction i.e., L1 to L2 and from L2 to L1 and a pair wise comparison were done between the two priming paradigm. On doing analysis of results obtained from Wilcoxon Signed Rank test, results revealed that there was no significant difference in reaction time between the language directions across both the priming paradigms i.e., Prime in Hindi and target in English or Prime in English and target in Hindi in both masked and unasked priming. But, there was significant difference present for one language direction across unmasked paradigm for living item (UML2L1 L- UML1L2 L) with |z| value- 2.581 and p value <.05. Thus, the effect of different priming condition for reaction time was not found to be significant between the two language directions.

b. Accuracy: the overall mean, median and standard deviation (SD) of the accuracy measures across two language direction across two priming paradigm were obtained using descriptive statistics.

Table 4.3 shows that accuracy measures for L2 to L1 direction is better than L1 to L2 in both the priming paradigms but the difference was not highly significant i.e., accuracy measures for prime in English (L2) and target in Hindi (L1) produces more accurate results but the difference is not highly significant. Also, in one condition i.e., in unmasked condition, accuracy measures were better when prime was presented in Hindi and target in English for living item (UML1L2L> UML2L1 L). Results revealed that most accurate measures were present in unmasked paradigm from L2 to L1 direction for non-living item (UML2L1NL) with Mean = 9.83 and SD= 0.37 and less accurate measures were present in masked paradigm from L1 to L2 direction with living item (ML1L2 L) with Mean= 9.26 and SD= 0.83.

Further, Wilcoxon Signed Ranked test was employed to compare between two parameters irrespective of age and gender and results reveals that there was no significant difference between two types of priming on accuracy measures. Significant difference was present only in one of the unmasked conditions between two language directions for non living item with ($|z|$= 2.491 and p= .013).

The results of the present study reveals that priming takes place better in L1 to L2 direction i.e., reaction time is shorter when prime is presented in Hindi (L1) and target in English (L2), between both priming paradigm for both living and non living category lexicons. The results of the present study are in favor of previous studies which have accounted for the similar findings (Altarriba, 1992; Kroll & Stewart, 1994; Fox, 1996; Keatley & de Gelder, 1992; Keatley, Spinks, & de Gelder, 1994; Kroll & Sholl, 1992).

These results can be explained through Hierarchical models proposed by Potter, von Eckardt & Feldman (1984) which includes word association model (WAM) (Potter et al., 1984) According to this model, words present in L2 lexicon is connected to its conceptual representation through L1 equivalent. Therefore, in order to access to the meaning of L2 word, there would be an automatic activation of corresponding L1 word. Thus, this model concludes that there is no direct connection between the concepts of word and its lexicon represented in second language. And as, there will be involvement of translation from L1 lexicon for L2 words, it will increase the reaction time for L2 word naming.

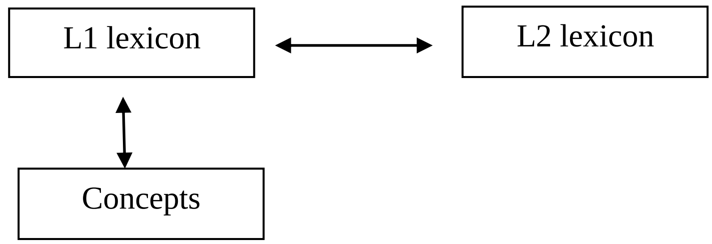

Figure 4.3 Word association model (Potter, 1984).

Further, these results are also supported by the sense model (Finkbeiner et al., 2004). This model is based on the concept that translation priming depends on the degree of overlap in the senses (features) associated with the prime and target i.e., Translation equivalents share one sense (typically, dominant sense), but may differ in the remaining senses. According to this model Priming from L1 to L2 is stronger because the L1 prime can activate a high proportion of the L2 target senses (features). However, priming from L2 to L1 is weaker because the L2 prime might activate only the dominant sense of the L1 target, and hence the ratio of primed to unprimed senses associated with the L1 target will be rather low, compared to that in the L1– L2 direction., The sense model claims the notion of asymmetrical lexical-semantic representations between L1 and L2 in bilingual memory, which in turn causes the translation asymmetry in lexical decision.

Researchers have also found that there is an automatic activation of L1 translated morpheme during the processing of L2 compound words irrespective of the scripts of L1 and L2. The activation of information for reading depends on the difference in the prime duration. 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.

Studies conducted regarding translational processing in bilinguals during visual word recognition have consistently accounted for asymmetric pattern of priming effects in the translation pairs i.e., semantic interference was only observed in L1-L2 direction and not vice versa (Kroll & Stewart, 1994).

Researchers have also found that 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 and this masked translation priming asymmetry is claimed to be task dependent.

For a long time, there has been a debate in the literature about the nature of the bilingual memory centered on whether two languages access one common or two separate conceptual systems (Francis, 1999, 2005). However, converging evidence from different experimental paradigms (e.g., speeded translation, semantic priming, masked priming and long-term priming) has confirmed that translation equivalents tap shared semantic representations in bilingual memory, even though experiments with cross-language semantic associates produced mixed findings that were difficult to interpret (e.g., Kirsner, Smith, Lockhart, King and Jain, 1984; Schwanenflugel and Rey, 1986; Williams, 1994).

That is, an asymmetrical pattern of cross-language priming is observed: L1 can prime L2, but L2 cannot prime L1. This might suggest that bilinguals are unable to effectively process L2 primes within such a short time.

In addition to these factors, greater proficiency and use of Hindi 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 neighborhood leading to more confusion due to increased competition created by neighborhood lexical items while on the other, the lexical items in L1 have less competition from the neighborhood leading to a better organization of L1. With increasing knowledge and proficiency in L2, the neighborhood of L2 becomes less dense and the representation would become more organized. 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.

In the present study, L1 to L2 condition has accounted for shorter reaction time compared to the vice versa condition which can be accounted for the fact of dominance and usage of L1 language in bilinguals. The participants of the study were screened for language dominance using LEAP-Q (Language Experience Proficiency Questionnaire (Ramya & Goswami, 2009) that revealed Hindi language being more dominant among them and also usage of Hindi language was more compared to English. All the participants reported that they were using English language only in their work set up and were predominantly using Hindi language in all other situations.

Results have also revealed that during the task of categorization between living and non living, reaction time was better for living items compared to non living items and these results show that the retrieval of lexicon belonging to living category is faster than that of non-living category which can be explained based on the presumption 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 facilitating 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 non-living category in English language.

The above results on the semantic categorization are probably influenced partly by the handedness of the participants. For the living and non living semantic categorization task , the participants were instructed to press the "right control key" for items under living category and "left control key" for non- living category. And as all the participants of the study were right handed users that probably lead them to make use of their right hand more often and at faster rate contributing to the present findings.

4.3. Effect of age on performance

a. **Reaction time:** Age range of 20-30 years was considered for the study and it was divided into two groups consisting of Group I in the age range of 20 to 25 years and Group II with 25 to 30 years. In each age range 15 participants, both male and females were there. The effect of age on lexical retrieval in adult bilinguals was studied. Table 4.4 depicts the reaction time of the two age groups.

Table 4.4
Reaction time for masked condition w.r.t age vs language

Conditions	20-25 years		25-30 years	
	Median	**SD**	**Median**	**SD**
ML1L2L	861.26	190.29	743.96	98.90
ML1L2NL	899.49	197.89	773.19	127.75
ML2L1L	851.67	2.02	719.19	1.23
ML2L1NL	925.44	218.03	810.73	111.95

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living)

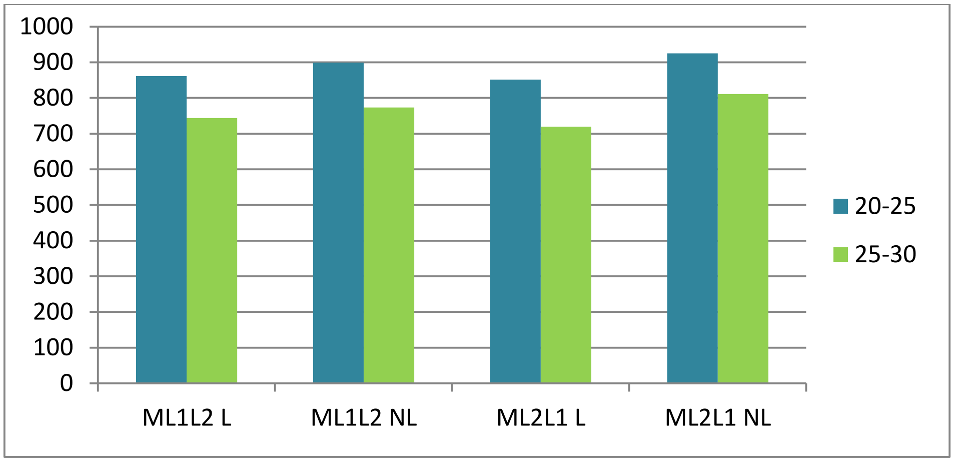

Figure 4.4 Mean reaction time for two age groups between masked condition and two language directions.

Table 4.5

Reaction time for unmasked condition w.r.t age vs language

Conditions	20-25 years		25-30 years	
	Median	**SD**	**Median**	**SD**
UMLIL2L	676.99	222.38	525.44	79.27
UML1L2NL	709.25	195.26	535.33	117.02
UML2L1L	771.12	212.03	578.64	1.52
UML2L1NL	790.64	260.25	488.22	140.44

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living)

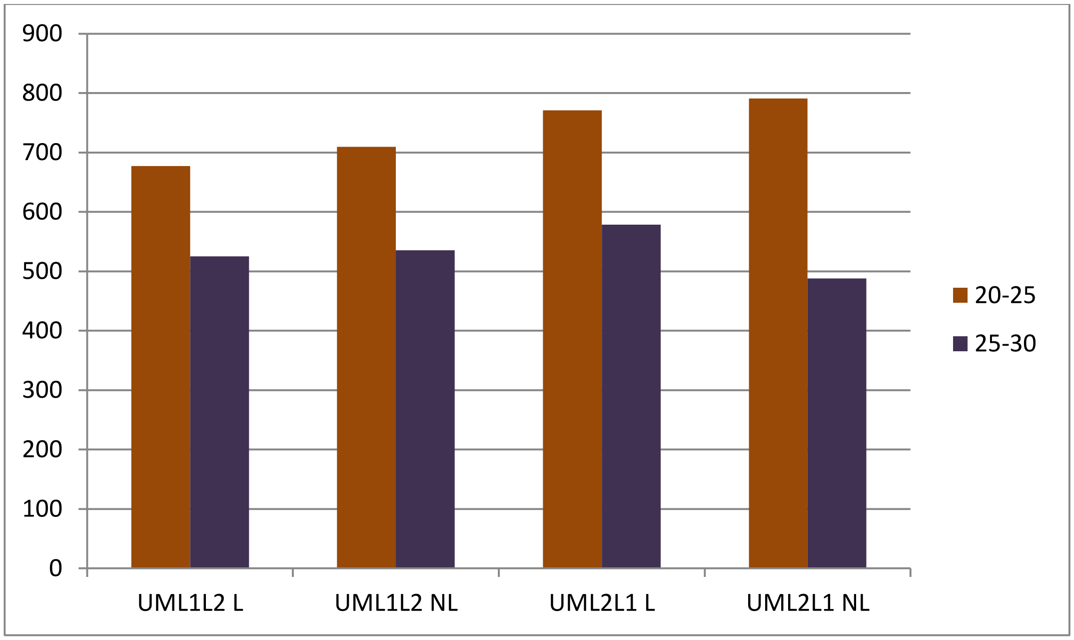

Figure 4.5 Mean reaction time for two age groups between unmasked condition and two language directions.

Table 4.6

Reaction time for age group- 20-25 years across two priming paradigm and two language direction.

Conditions	Z value	p value
UML1L2_L-ML1L2_L	3.29	0.001
UML1L2_NL-ML1L2_NL	3.23	0.001
UML2L1_L-ML2L1_L	2.61	0.009
UML2L1_NL-ML2L1_NL	2.84	0.005

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living)

Table 4.7
*Reaction time for age group- 25-30 years across two priming paradigm and two language directions***.**

Conditions	Z value	p value
UML1L2_L - ML1L2_L	3.408	0.001
UML1L2_NL - ML1L2_NL	3.408	0.001
UML2L1_L - ML2L1_L	2.215	0.027
UML2L1_NL - ML2L1_NL	3.294	0.001
UML2L1_L - UML1L2_L	2.215	0.027

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living.

The reaction time of participants in the age range of 25-30 years is shorter than the participants in the age range of 20-25 years in all the conditions conducted. As, both the groups met the criteria of normality that is $p < 0.05$ hence, mixed ANOVA was employed to see the significant difference between two ages (between effect), priming types , languages and domains (living v/s non living) and also the interaction effects among these parameters. Results revealed that there was no significant effect of two age groups, languages and domains. Also, the interaction effect was absent. Although, there was a significant effect found for absolute value of priming condition with $F (1, 28) = 8.858$, $p= 0.006$. Further, Wilcoxon Signed Rank test was carried out between the two age groups independently, to compare the reaction time for two priming condition and also for two language direction. And the results revealed that for both the age groups (20-25 years and 25-30 years), there was a significant difference for the reaction time between two priming condition but not between two language directions. Although in the age group of 25-30 years, there was a significant difference found across two language direction in one of the unmasked condition with living item (UML2L1 L- UML1L2L)

|z|= 2.215 and p= 0.027 but the difference was not highly significant. Further, Mann Whitney U test was performed to compare two age groups across two gender and results revealed that there was no significant difference found in the two age groups across gender.

b. Accuracy: Wilcoxon Signed Rank test was employed between the two age groups independently to compare the accuracy measures for two priming conditions in two language directions. Results revealed that there was no high significant difference across two priming conditions and two language directions in age group 20-25 years. Across priming condition, only in one condition significant difference was found but it was not highly significant (AUML1L2L-AML1L2L, |z| = 2.111 and p= .035) and similarly, between language direction in one condition (AML2L1L- AML1L2L, |z|= 2.121 and p=.034) significant difference was seen which was not highly significant. For age group 25-30 years, no significant difference was found between two priming condition but between two language directions, only in one condition difference was found which was not highly significant, AUML2L1 NL- AUML1L2NL |z= 2.157| and p value= .031.

Further, Mann Whitney U test was performed to compare between two age groups. And results revels that no significant difference across two priming conditions and two language direction. Although, difference was found in one condition with masked priming in L2 to L1 direction but it was not highly significant with (AML2L1L |z| = 2.042 and p= .041)

Also, Mann Whitney U test was performed to compare between two age groups with gender as a grouping variable. And results revels that no significant across two priming condition and two language direction.

4.4 Effect of gender on performance

a. Reaction time: based on gender two groups were made: males and females and each group consisted of 15 participants.

Table 4.8
Reaction time for masked condition w.r.t gender vs language

conditions	Males		Females	
	Mean	SD	Mean	SD
ML1L2L	794.07	154.87	854.39	189.96
ML1L2NL	858.50	188.06	876.36	187.33
ML2L1L	816.09	1.35	848.32	2.21
ML2L1NL	902.27	175.89	906.07	203.60

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living.

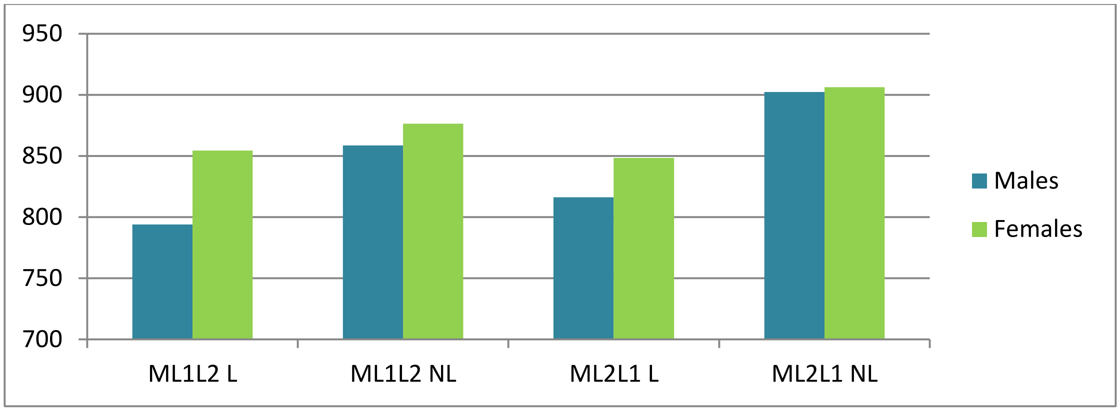

Figure 4.6 Mean reaction time for two gender groups between masked condition and two language directions

Table 4.9
Reaction time for unmasked condition w.r.t gender vs language

conditions	Males		Females	
	Mean	**SD**	**Mean**	**SD**
UMLIL2L	594.92	163.17	615.20	195.17
UML1L2NL	650.80	185.40	594.77	182.70
UML2L1L	1084.24	1.50	648.14	213.80
UML2L1NL	702.06	227.63	622.98	232.42

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living.

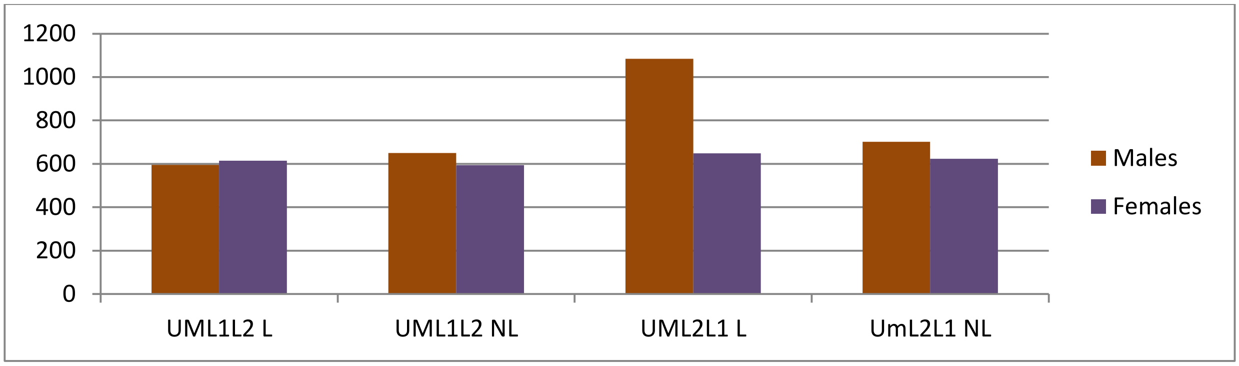

Figure 4.7 Mean reaction time for two gender groups between unmasked condition and two language directions.

The reaction time of male and female participants is variable. For masked condition, female participants have longer reaction time across both the language direction for both living and non living item. For unmasked paradigm female participants had shorter reaction except for one condition i.e., L1 to L2 direction for living item (UML1L2 L).

Male group met the criteria of normality that is $p < 0.05$ hence, Repeated measure ANOVA was employed to see the significant difference within group across priming conditions, languages and domains (living v/s non living) and also the interaction effects among these parameters. Results revealed that there was no significant effect priming condition, languages and domains within the group- males. Also, the interaction effect among these parameters was absent.

Further, Wilcoxon Signed rank test was employed for the male group to compare between the reaction time between two priming conditions for language directions. Results revealed that there was significant difference found between priming condition in three conditions: UML1L2L – ML1L2L $|z| = 3.237$ and $p = .001$, UML1L2NL-ML1L2NL $|z| = 3.181$ and $p = .001$ and UML2L1NL-ML2L1NL $|z|= 2.783$ and $p = .005$.

Also, there was significant difference found in one of the language direction across unmasked priming with living item, UML1L2L-UML2L1L |z|= 2.726 and p = .006.

For female group, Wilcoxon Signed Rank Test was performed as normality criteria were not met.

Table 4.10
Reaction time for female group across two priming condition and two language direction.

Parameters	|Z|	p value
UML1L2_L-ML1L2_L	3.408	0.001
UML1L2_NL-ML1L2_NL	3.408	0.001
UML2L1_L-ML2L1_L	3.010	0.003
UML2L1_NL-ML2L1_NL	3.351	0.001

(M= Masked, UM= unmasked, L1= Hindi, L2= English, L= Living, NL= non living.

Result revealed that there was a significant difference present for reaction time across priming conditions but not across two language direction. Further, Mann Whitney U test was performed to compare two age range, gender wise across various parameters. Results obtained for the group male when compared for two age group revealed that there was significant difference across two masked conditions with L2 to L1 language direction across both living and non living items i.e., ML2L1L |z| = 2.315, p = .021, ML2L1NL |z| = 1.967 , p= .049. Also, significant difference was found for two unmasked condition with both L2 to L1 as well as L1 to L2 language direction across non living items i.e., UML1L2NL |z|= 2.780, p= .005 and UML2L1NL |z| = 2.780, p= .005. Results obtained for the group female when compared for two age groups revealed no significant difference across two priming paradigm and two language directions.

b. Accuracy: Wilcoxon Signed Rank test was employed across the two gender groups independently to compare the accuracy measures for two priming condition in two language directions. Results revealed that there was no significant difference across two priming condition and two language directions in male group. For female group, significant difference is found for three conditions but the difference is not highly significant and those conditions are: Unmasked to masked paradigm in L1 to L2 direction for both living and non living item. i.e., (AUML1L2L-AML1L2L $|z| = 2.126$, $p = .033$; AUML1L2NL-AML1L2NL $|z| = 2.157$, $p = .031$). For language direction, in unmasked paradigm for non living conditioned showed significant results (AUML2L1NL- AUML1L2NL $|z| = 2.56$, $p = .010$).

Further, Mann Whitney U test was performed to compare between two gender groups. And results revels that no significant difference across two priming condition and two language direction. Also, Mann Whitney U test was performed to compare between two gender groups with age as a grouping variable. And results reveals that no significant across two priming condition in two language direction.

The overall results reveal that the lexical retrieval using unmasked primes is faster than masked primes in Hindi-English bilingual adults in L1 to L2 direction i.e., when the prime is presented in Hindi and target in English language. Also, retrieval of living items from mental lexicon is faster compared to non living items.

There was no effect of age and gender on lexical retrieval across both the priming conditions as well as for both the language directions.

CHAPTER V

SUMMARY AND CONCLUSION

Bilingualism is the alternate use of two or more languages by the same individual and in the present scenario, the majority of the population is either bilingual or multilingual so, it has become fascinating to acknowledge the representation of mental lexicon among bilinguals. Language representation in a bilingual brain is an unsolved problem though, various theories, models and studies have been put forth to examine the debated issues. Till date, language representation, lexical access and processing have been investigated using various electrophysiological methods, behavioral methods including priming. Priming is one of the behavioral methods that can be used to study the processing or lexical access in bilinguals. Various priming types are available which can be used to acknowledge the two main types of processing i.e., implicit and explicit depending on the visibility of prime. Cross language priming in bilinguals have shown that if sufficient processing time is given, the priming effect for lexical retrieval is found across languages (Schwanenugel & Rey, 1986, Grainger & Beauvillain, 1988; Fox, 1996). In view of scanty research in Indian context using priming paradigm across two languages, the present study was conducted to understand the mechanism of lexical retrieval in Hindi-English bilinguals.

The present study thus aimed to examine the effect of unmasked and masked priming on lexical retrieval in Hindi-English Bilingual Adults between the age ranges of 20-30 years. The present study also attempted to investigate the effect of language direction (Hindi to English or English to Hindi), if any in lexical access in bilingual adults. The parameters considered to compare the performance for two priming conditions in two languages were reaction time and accuracy.

Findings of the present study indicated that reaction time and accuracy measures for unmasked priming were better compared to masked priming in both language directions. This result could be explained by number of factors that are likely to have impact on priming phenomenon such as the nature of relationship between prime and target (translational equivalents), temporal parameters such as the SOA and prime duration. Here, prime duration for masked priming was taken as 50 msec and for unmasked priming as 500 msec contributing to involvement of strategic processes in the identification of the target in unmasked priming condition.

Findings of the study also indicated that priming takes place better in L1 to L2 direction i.e., reaction time is shorter when prime is presented in Hindi (L1) and target in English (L2), between both priming paradigm for both living and non living category lexicons. These results could be explained by number of models such as word association model (WAM) (Potter et al., 1984), sense model (Finkbeiner et al., 2004). These results can also be attributed to the fact of dominance and usage of L1 language in bilinguals. As, the individuals participated in the present study were screened for language dominance using LEAP-Q (Language Experience Proficiency Questionnaire (Ramya & Goswami, 2009) and results revealed that Hindi language was more dominant among them and also usage of Hindi language was more compared to English.

Findings also indicated that there was no significant effect of age and gender on priming condition in two language directions. Results have also revealed that reaction time was better for living items compared to non living items and these results show that the retrieval of lexicon belonging to living category is faster than that of non-living category which can be explained based on the presumption that the living and non-living categories vary in terms of semantic features (Masson, 1995). Also, these results can also be supported with the fact of hand dominancy effect as key for living items was present on right side.

The overall results reveal that the lexical retrieval using unmasked primes is faster than masked primes in Hindi-English bilingual adults in L1 to L2 direction i.e., when the prime is presented in Hindi and target in English language. Also, retrieval of living items from mental lexicon is faster compared to non living items.

Limitations

(i) Findings of the present study cannot be generalized as in the present study only adults proficient in both languages were considered. Results may vary for other age range groups such as elderly or adolescents and also for bilinguals with low proficiency in two languages.

(ii) Normative data for reaction time or accuracy measures was not available which could help in deciding whether the obtained reaction time is appropriate or not for the population selected, languages considered, task employed and paradigms designed.

(iii) Distribution of participants across gender in two age groups is not equal (age range 20-25 yrs= 7 males and 8 females ; age range 25-30 years= 8 males and 7 females).

Implications

I. Reaction time and accuracy measures obtained in the present study can be used as the reference for future studies.

II. Processing and lexical access is considered to be same in healthy and disordered population and thus, results obtained in present study can be used in a management program for adult language disordered cases by emphasizing more on L1 language and working on living items prior to non living items.

Future Direction

I. The word list used in the study can be developed as an online tool to gather data from larger sample to establish standard reference.

II. Further, this online tool could be used as an assessment tool for disordered population to check for their reaction time across implicit and explicit processing.

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APPENDIX I

English - Hindi Translation equivalents

Masked condition

Prime	Target	IPA
Fan	पंखा	/pʌnk^{h}a/
Camphor	कपूर	/kʌpur/
Artist	कलाकार	/kʌlakar/
Almond	बादाम	/baḏam/
Hunter	शिकारी	/ʃikari/
Bucket	बाल्टी	/balṭi/
Goat	बकरी	/bʌkri/
Nurse	नर्स	/nʌrs/
Flute	बासुरी	/basuri/
Wool	ऊन	/u:n/
Cobbler	मोची	/moʧi/
Cap	टोपी	/ṭopi/
Leopard	चीता	/ʧiṭa/
Net	जाल	/ʤal/
Cow	गाय	/ga:j/
scissors	कैंची	/kaiʧi/
physician	हकीम	/hʌkim/
crow	कौआ	/kaʒva/
Shirt	शर्ट	/ʃʌrṭ/
Mosquito	मच्छर	/mʌʧ^{h}ʌr/

Unmasked condition

Prime	Target	IPA
Cuckoo	कोयल	/kojʌl/
Monkey	बंदर	/bʌndʌr/
Jeep	जीप	/ʤip/
Pearl	मोती	/mot̪i/
Hen	मुर्गी	/murgi/
Flag	ध्वज	/dhuʌʤ/
Camel	ऊंट	/unt^h/
bottle	बोतल	/boṭʌl/
Rabbit	खरगोश	/k^{h}ʌrgoʃ/
Slippers	चप्पल	/ʧʌpʌl/
Beggar	भिक्षुक	/b^{h}ikʃuk/
Ticket	टिकट	/ṭikʌt/
Fish	मछली	/mʌʧ^{h}ʌli/
Thief	चोर	/ʧor/
Towel	तौलिया	/t̪olija/
Table	मेज़	/mɛʤ/
Potter	कुम्हार	/kumhar/
Brick	ईंट	/int/
Window	खिड़की	/k^{h}idki/
Writer	लेखक	/lek^{h}ʌk/

APPENDIX II

Hindi – English Translation equivalents

Masked condition

Prime	Target	IPA
कुत्ता	Dog	/kut̪t̪a/
बस	Bus	/bʌs/
सिक्का	Coin	/sikka/
शत्रु	Enemy	/ʃʌt̪ru/
शिशु	Baby	/ʃiʃu/
लौंग	Clove	/laung/
कालीन	Carpet	/kalin/
बहन	Sister	/bʌhʌn/
लाठी	Stick	/lat^{h}i/
चींटी	Ant	/ʧinṭi/
महात्मा	Saint	/mʌhat̪ma/
उल्लू	Owl	/ullu/
सुई	Needle	/sui/
सिपाही	Soldier	/sIpahi/
खाट	Bed	/k^{h}aṭ/
मोजे	socks	/moʤe/
कबूतर	Pigeon	/kʌbuṭar/
बर्फ	Snow	/bʌrf/
चुहा	Rat	/ʧuha/
चम्मच	Spoon	/ʧʌmʌʧ/

Unmasked condition

Prime	Target	IPA
मेंढक	Frog	/mɛnḍʌk/
नक्शा	Map	/nʌkʃa/
किसान	Farmer	/kIsan/
चूड़िया	Bangles	/ʧudIja/
महिला	Woman	/mʌhila/
नाव	Boat	/nav/
जेब	Pocket	/ʤɛb/
हिरण	Deer	/hirʌ/
मुकुट	Crown	/mukuṭ/
बतख	Duck	/bʌt̪ʌk^h/
तोता	Parrot	/t̪ot̪a/
पानी	Water	/pani/
साड़ी	Sari	/sari/
मित्र	Friend	/mit̪rʌ/
चाय	Tea	/ʧaj/
रोगी	Patient	/rogi/
चाकू	Knife	/ʧaku/
मकड़ी	Spider	/mʌkʌḍi/
रबर	Rubber	/rʌbʌr/
रानी	Queen	/rani/