CROSS-LINGUISTIC PRIMING IN KANNADA-ENGLISH BILINGUAL NONFLUENT APHASIA

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CERTIFICATE

This is to certify that this dissertation entitled **"Cross-Linguistic Priming in Kannada-English Bilingual Nonfluent Aphasia"** is a bonafide work in part fulfilment for the degree of Master of Sciences (Speech-Language Pathology) of the student (Registration No. 11SLP015). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **““Cross-Linguistic Priming in Kannada-English Bilingual Nonfluent Aphasia””** is the results of my own study under the guidance of Dr. Jayashree C Shanbal, Lecturer in Speech Language Pathology, Department of Speech Language Pathology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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May, 2013

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CHAPTER 1: Introduction

Language processing in a bilingual brain has always been an epicentre of various researches in the field of psycholinguistics. The idea of having a shared or individual concept centre of two languages have gathered wide popularity in different schools of thought in studies related to bilingual brain. However, the fascination still remains for the difference in case of a multilingual brain and a brain damaged individual, do the languages known by the individuals hold a shared or different representation in the brain.

Most of the researches are highlighted to understand the normal language processing in neurotypical individuals. Various psycholinguistic models and hypothesis were proposed such as the Language Specific Hypothesis (de Bot & Schreuder, 1993; Djikstra & van Heuven, 1998; Schulpen et al., 2003) and Language Independent Hypothesis (Paradis & Lebrun, 1983) and models such as the Word Association Model (Potter, von Eckhardt and Feldman, 1984) and Revised Hierarchical Model (RHM) (Kroll & Stewart, 1994). The efficacy and the supremacy of these models are strengthened studying the language processing in bilingual brain damaged or pathological conditions.

Various experiments are carried out to understand the process of lexical representation and decision and directional variances which are core parameters of language processing in bilingual population. This can be studied through priming experiments, more precisely through cross-linguistic priming paradigms. Lexical decision tasks (LDT) are used frequently in translation priming paradigms to understand the bilingual lexical organization. Semantically related or transitional equivalent primes along with unrelated word prime aids in explaining the bilingual representation of L1 and L2 better (Kiran & Lebel, 2007).

With ample amount of research in bilingual neurotypical individuals, there is a specific trait that has been successfully established about the lexical processing of two different languages, i.e presence of symmetrical priming effects in both the direction (Duyck and Brysbaert, 2002) or absence of priming effect from L2 to L1 (Altarriba, 1992) which depends highly on the proficiency and usage of the languages. But there is a lack of such specific trait in individuals with Bilingual Aphasia (Kiran and Lebel, 2007). These asymmetries were explained on the basis of the Bilingual Interactive Activation (BIA) Model, proposed by Djikstra and van Heuven (1998) which postulates that the integration of bilingual individual's lexicon occurs across languages.

The processing in a bilingual individual with aphasia can be reflected upon his/her performances in online and offline tasks. In recent year, online studies have gained a lot of popularity as it projects about the automatic processing. Prema, Abhishek and Prarathana (2010) have reported that lexical priming is the most convenient tool to observe the lexical representation in a bilingual brain. Different types of prime have shown different level of activation in human cortex, some have more automatic access and some are more controlled. It has also been reported that language proficiency acts as one of the most important variable in the cerebral organisation of a bilingual cortex. With proficiency literature has suggested that the involvement of the non dominant hemisphere also increases. In case of balanced bilinguals the representation of the second language should mimic that of the first language (Faust, Azdi, & Vardi, 2012; De Groot, 1992). The lexical activation or access that is observed in bilingual anterior aphasia have differed view among the authors. Few believe that there is a lack of automatic priming and limited effect of priming on lexical activation (Milberg, Blumstein, Katz, Gershberg, & Brown, 1995) whereas another school of thoughts believe the presence of priming mechanism in individuals with anterior aphasics, and believe that the lexical activation takes place but at a higher latency (Prather, Zurif, & Love, 1992).

Hence, it is essential for Speech-language pathologists and researchers to know the mechanism of linguistic processing in bilingual aphasic, as the performance is highly dependent upon the severity, pathology and the proficiency of the individual. The interaction between the two languages Kannada and English, how one facilitates the lexical processing of another can be an important marker or variable in Aphasiology therapy. Also, the various priming conditions that are being used by speech language pathologist may show vivid results in different aphasic syndrome. So, which priming condition elicits maximum and best response from the anterior aphasics can be highlighted during the rehabilitation.

Each and every language spoken in multilingual India has a unique phonological and orthographical representation. So, the process of lexical access or concept representation stands to be a very strong field in cognitive research especially in cross-linguistic studies. Experiments using cross linguistic semantic and translation priming have provided with ample information related to the lexical selection in normal bilinguals. These data have tentatively suggested that priming effects interact with language proficiency. But it could be interesting to understand the mechanism or influence of two or more languages in an individual with brain damage such as aphasia.

The insight into the nature of cross linguistic priming in language deficit population is still very sparse. It would be interesting to know if language deficiency also plays an important variable on priming effect. For instance, recent studies have suggested that individuals with Broca's aphasia have showed reduced levels of lexical activation (Utman, Blumstein, & Sullivan, 2001) and are unable to effectively integrate lexical activation (Milberg, Blumstein, Giaovanello, & Misurski, 2003) and anterior aphasics have shown traits of priming effect the level of activation is very slow (Prather, Zurif, & Love, 1992). It has been suggested that the priming effect is atypical in individuals with Aphasia; they do not follow any specific trait as observed in normal individuals (Kiran & Lebel, 2007; Sebastian, 2005). Therefore, the study of the priming effect on brain damage particularly non fluent aphasic as they have relatively spared comprehension and have shown traits of priming effect will provide a greater insight about the bilingual representation and restoration of the lexical information in L1 and/or L2.

Hence, the primary aim of the present study was to investigate the effect of cross linguistic semantic and translation priming in non fluent Kannada-English (K-E) bilingual aphasia. The objectives of the study included the following,

Objectives of the study

- To study the effect of language proficiency on semantic and translation priming in normal K-E bilinguals

- To study the effect of language direction on semantic and translation priming from Kannada to English and English to Kannada in normal K-E bilinguals
- To study any difference of response priming on lexical decision task between normal K-E bilinguals and K-E bilingual individuals with non-fluent aphasia.

CHAPTER 2: Review of literature

Language processing in a bilingual brain has always been an epicentre of various researches in the field of psycholinguistics. The idea of having a shared or individual concept centre of two languages have gathered wide popularity in different schools of thought in studies related to bilingual brain. However, the fascination still remains for the difference in case of a multilingual brain and a brain damaged individual, do the languages known by the individuals hold a shared or different representation in the brain? In order to understand the processing mechanisms in brain damaged bilinguals individuals a vast literature was reviewed in terms of chaining the links right from the definitions of bilingualism to bilingual aphasias.

2.1 Defining bilingualism

Bilingualism is the alternate use of two or more languages by the same individual. Bloomfiled (1933) defined bilingualism as the native like control of two languages. Diebold (1961) defined bilingualism as simply passive knowledge of written language or any contact with a second language and the ability to use it in the environment of the native language. ASHA (2004) defined bilingualism as "The use of at least two languages by an individual". The notion of 'use' means that the bilingual individual has the capacity to access either of the language, or has a minimal competence in both languages or making the individual depend on the dominant or stronger language to process the non dominant language (Mackey, 1962;Weinreich, 1953).

Thirumalai and Chengappa (1985) have described bilingualism as

a. If the language is the property of the group, bilingualism is the property of an individual.
b. An individual's` use of two languages presupposes the existence of two different language communities; it need necessarily presuppose the existence of a bilingual community.
c. Bilingualism is not a phenomenon of language but a characteristic of its use.
d. Bilingualism is viewed as contact between culture and social groups. Viewed in this manner, bilingualism is defined as the ability, on the part of the individual to express himself in a second language, adhering faithfully to concepts and structures which are appropriate to this purpose, instead of paraphrasing something expressed in his nature of language
e. Bilingualism is viewed as something relative since the point at which the speaker of a second language becomes bilingual is entirely arbitrary or impossible to determine.

Bilingualism is broadly classified as (a) simultaneous bilingualism and (b) sequential bilingualism (ASHA, 2004), the course and use of second language (L2) acquisition is what distinguishes both.

Simultaneous bilingualism occurs when an individual has had equal opportunity, use and stimulation of both the language, usually related to bi-language learning in young children. The performance and proficiency is par in both the languages.

Sequential bilingualism occurs when an individual has had significant and evocative exposure to a second language, after the first language is well established, usually after the age of 3 years. This kind is usually seen as English (L2) learning in school after the well established first language (L1) performance.

However, the language representation in these types of bilinguals has not been explained, the classification is strictly related to the course of language learning and the proficiency. Weinreich (1953) had classified bilingualism according to the representation of first (L1) and second (L2) language in the mental lexicon as compound, coordinated and subordinate bilinguals.

a) *Compound bilingual*: In a compound bilingual the two languages are organized as a single system or one concept area. They would have learnt the two languages concurrently before their sixth year. The individuals are hypothesized to have one semantic system for two codes (languages).

b) *Coordinated bilingual*: A coordinated bilingual would learn the second language after 13 years old age (Kirstein & de Vincesnz, 1974). According to Weinreich (1953), the languages are represented as individual semantic system i.e. two languages have two separate mental lexicon.

c) *Subordinate bilingual*: A subordinate bilingual mediates through L1 to learn L2 (thinks in L1 and translates to L2).

This served as an epicentre for various researches. The central and pertinent question which remained in the limelight is whether bilingual speakers have two separate lexicons, one for each language, or one large bilingual lexicon. In other words, there were always questions on whether the bilinguals have two mental dictionaries to recognize the words in a language or do they have a single integrated mental dictionary? Another question which came up was whether there are separate conceptual and lexical levels in the memory of a bilingual. Researchers more or less agreed on the presence of a shared conceptual level but specific lexical representations for each language (Paradis & Lebrun, 1983; de Bot & Schreuder, 1993; Djikstra & van Heuven, 1998; Schulpen et al., 2003).

2.2. Language representation and processing in a bilingual brain

The basic question in the neuropsychology of bilingualism still circulates around the cerebral representation and organization of the two languages, which is much more challenging in case of multilinguals. Various hypothesis and theories have been put forth to ease the enigma of a bilingual cortex. Bilingual lexical organization is broadly discussed in terms of two major theoretical viewpoints. The Language Specific Hypothesis (de Bot & Schreuder, 1993; Djikstra & van Heuven, 1998; Schulpen et al., 2003) proposes that the lexical knowledge of the bilingual may be represented in two language specific memory systems, one for each of the two languages. Whereas, the Language Independent Hypothesis (Paradis & Lebrun, 1983) suggests that bilinguals share a common conceptual representation for two languages (L1 and L2) or even more. Based on this hypothesis various bilingual lexical access models have been proposed. Few cited lexical access models which have been designed by various researchers to understand the lexical processing in bilinguals are explained in the subsequent sections.

Word association model

Von Eckhardt and Feldman (1984) projected that the second language (L2) words gain access to concepts only through first language (L1) mediation. Figure. 2.1 show that there is a direct L1-L2 lexical link, where L1 has the only connection with the concept area, whereas L2 has no direct relationship with the concept area. Thus, it supports the ideas of language independent hypothesis (Paradis & Lebrun, 1983). This model has gained in good citation in understanding the second language (L2) learning in low proficient individuals. For e.g. Book learning of a second language.

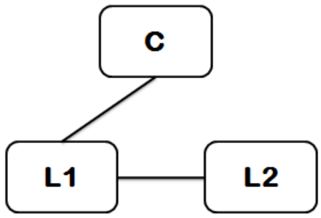

Figure.2.1. Word association model (Von Eckhardt & Feldman, 1984)

Concept mediation model

The Concept Mediation model (Potter et al, 1984) showed that L1 and L2 words directly access concepts and that the two language representations operate as separate systems, each of them connect directly to the a modal conceptual system. Figure 2.2 shows that there is no direct relationship with the two language centre; they are independent of each other. This model explains the high proficiency of L2, the learning of L2 from birth.

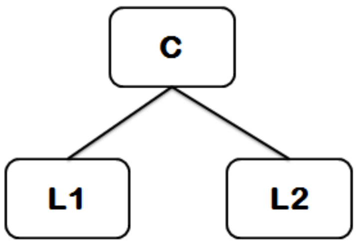

Figure.2.2. The Concept Mediation model (Potter et al, 1984)

Mixed model

De Groot (1992), tried to answer the dependency of each language on one another. According to De Groot (1992), there is a link between the two languages even though the proficiency of the individual shifts from low to high, mediation between the languages are maintained (see Fig.2.3). Also, it very well explains how translation priming effect can persist in both the directions.

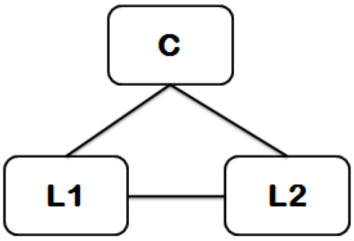

Figure 2.3. The Mixed model (De Groot, 1992)

Revised hierarchical model

The Revised Hierarchical Model (RHM) (Kroll & Stewart, 1994) (see Fig. 2.4) originated from studies that found asymmetrical translation and semantic priming effects which supported both the word association and concept mediation models. According to this model, in low proficient bilinguals, L1 consists of a lexical store which is more developed than that of L2, and L1 has a very strong link to the conceptual system. L2 consists of a well-developed lexical store and has a weaker link to the conceptual system. Kroll and Stewart (1994) from their experiments on translation tasks found that the link between the lexical stores of L1 and L2 may be asymmetrical i.e., stronger link from L2 to L1 as the results revealed the translation from L2 to L1 was faster than from L1 to L2 (Sholl, Shankaranarayanan, & Kroll, 1995).

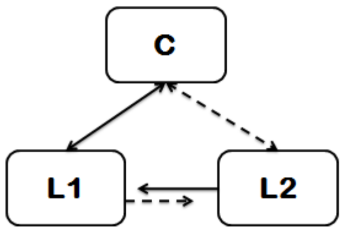

Figure.2.4. The Revised Hierarchical Model (Kroll & Stewart, 1994)

Heridia (2008) studied the performance of L1 and L2 representation in Spanish-English bilinguals in a repetition task. The individuals were expected to memorize words from each language, where few of the words were repeated irrespective of the language. The findings of the study indicated equal effect of repetition of L1 and L2 i.e. better retrieval of words which were repeated irrespective of the language. Glanzer and Duarte (1971) interpreted this finding as evidence for shared representations but there are many studies which challenge the efficacy of RHM. There is strong evidence against strong lexical connection between L2 and L1 words. This finding was established from masked priming studies, where a prime is presented before the target for such a short duration (typically 50-80ms) that is not perceived consciously but still shows a priming effect. The effect of L1 prime to L2 targets is evident but effect of L2 on L1 was vague (Jiang & Foster, 2001, studied on Chinese- English Bilinguals; Gollan, Foster & Frost, 1997). They also concluded that effect of masked priming is seen most when prime and target share same alphabet or script unless bilinguals are balanced.

Also there are evidence against separate lexicons and selective access. RHM supports two separate lexicons such as L1 and L2. There are many studies in recent years, which have established good evidence against it. Spivey and Marian (1999) investigated using a “visual word paradigm” in Russian- English bilingual to see the effect of L2 and L1 on each other. They used eye tracking to highlight the competition effect in word selection. They postulated that when a stimulus set contained similar words (similar sounding) there was eye shift between similar word irrespective of L1 and L2 as the distracting word. It highlights the fact that the competition effect was effective across language and doest believe in two different lexicons or access.

RHM fails to justify the weak connection between L2 and the concept mediation centre. De Groot (1994) presented evidence against this belief and stated that L2 to L1 translation requires or depends a lot on concept centre (i.e. semantics and the context). La Heij, Hoogandu, Kerling and Van der Velden (1996) supported this concept by studying the L2 to L1 translation. La Heij et al., (1996) found that L2 translation to L1 was faster when a semantically associated cue was provided (e.g. target “chair”, cue “table”) which is indicative thatL2 requires or depends on concept mediation centre.

2.3 Priming and language processing-bilingual lexical organization

Experiments and tasks to study the bilingual representation and language processing have been broadly classified as (a) offline studies and (b) online studies.

a) Offline studies: these studies require a more conscious effort from the individual, mostly requires tasks such as problem solving (e.g. what does the sentence mean. “Is an ostrich a bird”?). These tasks require analysis and depend highly upon memory and associations.
   E.g. sentence picture naming, categorization, word generation etc.

b) Online studies: These studies highlights majorly on the temporal aspects and the automatic process required during lexical processing. It tries to pinpoint the unconscious level of integration and interaction that takes place for in language processing. E.g. priming studies, word monitoring studies etc.

Online tasks are more widely used in collaboration with neuro imaging studies to understand the language processing. Recent literature have suggested the importance of priming experiments and its association with neuro imaging studies, to highlight anatomical correlates of language processing.

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). Priming works on paradigm of mental chronometry which was proposed by Posner (1978), variations in behavioural response times are assumed to reflect dynamic variations in the “activation” of memorized concept by a semantically related contextual prime word or stimulus. Priming represents an example of implicit or non declarative memory (Graf & Schacter, 1985) an unconscious influence of past experience on current performance or behaviour. So, priming most importantly highlights the working of implicit and non declarative memory.

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 language. Here the prime and target is presented in two different languages and their effect on each other for language processing is considered. E.g. Among the pairs *perro (*Spanish for dog, prime) - CAT (target). These studies are extremely informative to understand the bilingual representation of the language in the cortex.

b) Semantic priming

It is also known as associative priming, i.e. to observe the effect of a semantically related word to elicit/ recognize the target e.g. *bread* as prime for *butter*. The priming effect arises at a very short stimulus onset asynchrony (SOA) or time elapsed between prime and target of a few ten millisecond (Perea & Rossa, 2002; Rastle, Davis, Marslen-Wilson., & Tyler, 2000) Semantic priming can also be classified as:

- Semantically related
- Semantically unrelated

Semantic priming studies have reported that the reaction time is shorter for related word pairs than for unrelated word pair (e.g. *tree* and *bread*) (Meyer & Schvaneveldt, 1971). Semantically related priming can be further classified according to the type of semantic relation and on association strength (Brunel, 2004) as semantically related (step 1 priming) and semantically distant (step 2 priming).

- *Step 1 priming* corresponds to direct association between the target and the prime in the memory *(e.g., tiger-stripes).* It is reported to arise at a short stimulus onset asynchrony (SOAs) (Li et al., 1999; Perea & Gotor, 1997, Perea , Gotor & Nacher, 1997; Hodgson, 1991; den Heyer, Braind & Smith, 1985).

- *Step 2 priming* corresponds to an indirect association through a common associate (e.g., [*lion (tiger) - stripes*]. Step 2 priming is reported to be weaker than Step 1 priming (Kiefer, Ahlegian, & Spitzer, 2005; Hill et al., 2002; Chwilla, Kolk, & Mulder, 2000; McNamara, 1992). Step 2 priming requires a longer SOA than Step 1 priming (Arnott, Chenery, Copland, Murdoch, & Silburn, 2003; Hill et al., 2002; Bennet & McEvoy, 1999).

c) Translational priming:

In this priming, prime word is presented in one of the language (L1 or L2) of a bilingual individual, followed by its translation of the same word in other language (L2 or L1) E.g., word pairs can be presented as either *gato* (prime)- cat (target) or cat (prime)-*gato* (target), *Gato* is the Spanish translation of cat. Translation priming the presentation of a prime word automatically causes its lexical entry (Foster & Davis, 1984) to be activated which signifies short SOAs.

d) Phonological priming

It refers to phenomenon of identification of a word is made easier by the prior exposure to a word that is phonologically related than to phonologically unrelated word e.g.; *cry* (prime) – *try* (target).

e) Syntactic priming

The prime and target words are syntactically related e.g., *runs* (prime) - *run* (target).

Usually non words are used are used in a priming study to minimize the expectancy generated by two stimulus which are related. But the non lexical processing has gained a lot of interest among researchers. Masson and Issak (1999) studied non lexical priming i.e. priming effect for Non words. The processing of non words and semantically related words were used for a masked priming task in native English speakers. They reported that processing of a non word have reported to require higher processing time than semantically unrelated words. Neely, 1991 reported that there will be higher confusion to code a non word which is similar morphologically and phonologically similar to the target. Thus the processing of non words is usually slower.

The various types of priming have been used in literature to understand the language processing in bilingual brain. Each studies have reported the effect of various prime on the lexical access tested under various paradigms such as lexical decision task, judgement task etc. Various experiments are carried out to understand the process of lexical representation and decision and directional variances in bilingual population. This can be understood through cross linguistic priming experiments. Lexical decision tasks (LDT) are used frequently in translation priming paradigms to understand the bilingual lexical organization. Semantically related or translation equivalent primes along with unrelated word prime aids in explaining the bilingual representation of L1 and L2 better (Kiran & Lebel, 2007)

Many cross-language priming experiments have been conducted in the past decades. By and large, these experiments have shown effects of both translation priming and semantic priming across languages, and have observed at least the following two interesting patterns:(i) facilitation for translation equivalents is usually larger than that for semantically related words (Basnight-Brown & Altarriba, 2007); and (ii) priming effects in the L1–L2 direction (from first language primes to second language targets) are often larger than those in the L2–L1 direction, and this pattern has been referred to as the *priming asymmetry* (Dimitropoulou, Duñabeitia & Carreiras, 2011; Jiang, 1999; Jiang & Forster, 2001).

Keatly, Spinks, and De Gelder (1994) carried out semantic priming experiment on Chinese-English and French-Dutch bilinguals at various SOAs. The authors reported that cross linguistic semantic priming occurred at an early SOA of 250ms only when primes where presented in L1 i.e. Chinese and French. They reported stronger connections from L1 to L2 than from L2 to L1, and suggested that this asymmetric cross language priming supports the language specific model of the bilingual brain.

Altarriba (1992) reported absence of priming effects from L2 to L1 in typical population on lexical decision task. Duyck and Brysbaert, (2002) on the other hand, revealed symmetrical priming effects for both the directions. Schwanenfluegel and Rey (1986) studied the influence of cross language semantic and translation priming in lexical decision in early Spanish-English bilinguals (300ms SOA). Results depicted a robust priming effect in both L1-L2 direction as well as L2-L1. Therefore, Tzelgov and Ezra, (1992) suggested that this asymmetry across individuals is not systematic and does not show a specific trend.

According to Snodgrass (1993), this asymmetry can be attributed to the difference between “recall” (L1- L2) and “recognition” (L2- L1). Recalling from native language is much faster and easier for an unbalanced bilingual, especially in the younger years. Kroll and Stewart (1990) also acknowledged that L1 primes are more likely to activate the conceptual representation than L2 primes supported by the Distributed representation model (DRM) (de Groot et al, 1991, 1992).

Although it is widely accepted that cross-language priming effects are factual, the exact nature of this phenomenon has not been studied systematically against important bilingual factors such as the participant's L2 learning history and language use habits, age of acquisition, and similarity distances between the bilingual's two languages (Altarriba & Basnight-Brown, 2007). Grosjean (1998) argued that while studying bilingual representation and the interaction between L1 and L2, researchers need to carefully consider factors such as the nature of the bilingual participant including bilingual proficiency, learning history, the nature of experimental tasks such as task characteristics (e.g., bilingual speech mode) and modality of testing (comprehension vs. production), and stimulus properties such as word length, frequency, and type (e.g. cognates vs. noncognates, abstract vs. concrete words; Van Hell & De Groot, 1998).

Marked asymmetry in lexical decision was observed for Chinese- English neurotypical bilinguals also showed better L1 to L2 priming effects than vice- versa (Jiang & Forster, 2001). Schoonbaert, Duyck. & Brysbaert. (2009) investigated cross-language priming effects with unique non cognate translation pairs. Unbalanced Dutch-English neurotypical were taken for lexical decision task. The results revealed significant translation priming from L1 to L2 and from L2 to L1 using two different stimulus onset asynchronies (SOAs) (250 and 100 msec) although translation priming from L1 to L2 was significantly stronger than priming from L2 to L1. Cheng and Ng (1989), studied semantic and translation priming effects in Chinese-English neurotypical with a lexical decision task. They reported robust priming effect for translation equivalent than semantically related in crosslinguitic presention of prime and target.

Researchers have observed a number of interesting patterns from the priming effects of both translation equivalents and semantically related word pairs across languages. Zhao and Li (2011) implemented a self-organizing neural network model, DevLex–II, to simulate these two types of priming effects across Chinese and English. Specifically, the model incorporates a computational mechanism for simulating spreading activation based on the distance between bilingual words in the semantic space. The model also considers additional factors that modulate priming effects, such as the initial activation level of the prime words and the degree to which the target word can be recognized. The model specifically answers the directional effect on priming (L1 to L2 versus L2 to L1). The findings of the study revealed clear asymmetry in the direction effect irrespective of the type bilinguals (late onset v/s early onset). They also studied the difference in the processing of types of priming (translation versus semantic priming) as depicted in Figure 2.5

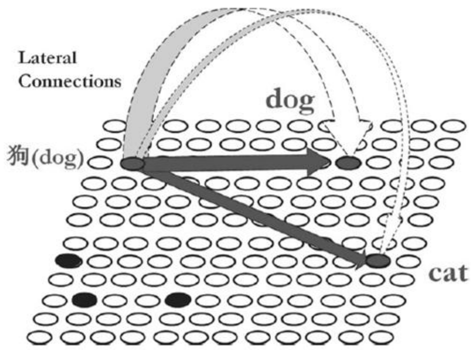

Figure.2.5 Processing of semantic and translation priming (Zhao & Li, 2011)

Zhao and Li (2011) explained the effect with the help of spreading activation model. Figure 4.5 illustrates the two paths of activation spreading from the prime word to the target word. A shaded dot on the map represents the Best Matching Unit (most active nodes) of a word. The dashed arrows indicate the spreading activation via the lateral connections and the solid arrows the spreading activation within the semantic map. Both translation priming [狗 – *dog*] and semantic priming [狗 – *cat*] are depicted in the above figure 4.5. The lateral connection between semantically related cross-language word pairs is weaker (narrower) than that between translation equivalents.

A number of theoretical frameworks of the bilingual mental lexicon have been proposed in the literature, including the Bilingual Dual-Coding theory (Pavio & Desrochers, 1980), the Distributed Feature model (De Groot, 1992), the Revised Hierarchical model (Kroll & Stewart, 1994), and more recently, the Sense model (Finkbeiner, Foster, Nicol & Nakamura, 2004; Segalowitz & de Almeida, 2002). Most of these models have been designed to account for bilingual lexical processing at a conceptual level although they are based on specific experimental findings from a variety of paradigms including priming. In recent years, there has also been interest in building models that can be computationally implemented or verified (Li & Farkas, 2002; Thomas & Van Heuven, 2005).

The Bilingual Interactive Activation (BIA) model (Dijkstra & Van Heuven, 1998, 2002) is one example in computational modelling of bilingual language processing. However, the BIA model belongs to a class of "permanent "or "stationary" models because mechanisms of learning and adaptation for representation are missing in these models. Learning mechanisms are crucial, for example, in accounting for cross-language priming effects from bilinguals with different levels of L2 proficiency or different histories of learning, and such mechanisms have been incorporated into several models in the past (Li & Farkas, 2002; Zhao & Li, 2010 & Thomas & Van Heuven, 2005).

The pattern of language processing would be much clearer if areas related to lexical selection were evident. This can be still speculated with the help of lexical representation studies in brain damaged population. So the effect of priming in individuals with aphasia will be different from that of Neurotypical.

2.4. Bilingual lexical organisation in aphasia

Effect of priming and the lexical processing is best understood when studied on a disordered population especially the brain damaged such as adult aphasia, where the processing is disrupted because of the pathological condition. The understanding will facilitate in exploring effects of priming in bilinguals and strengthen understanding of the cortical representation of languages.

Sebastian (2007) studied effect of crosslinguistic priming on individuals with bilingual (Kannada-English) aphasia. They studied the reaction time and error rates across four priming conditions- translation equivalent (TE), semantically related (SR), semantically unrelated (SU) and Non word (NW) in two language directions. They observed that priming effect was observed mostly for SR and TE in Kannada-English as well Kannada-English language directions. Whereas this effect was not observed in individuals with aphasia, the priming effect was seen more in the Kannada-English direction. Overall asymmetrical priming effect was observed for normal individuals and a symmetrical priming pattern was observed in bilingual aphasics.

Abhishek and Prema (2012) studied the automatic and volitional mechanism of lexical retrieval in individuals with Aphasia. They compared the responses on the basis of lexical decision task for automatic (SOA of 300ms) and judgement task for volitional mechanism (SOA of 1000ms) in two individuals with Broca`s Aphasia and Wernicke`s Aphasia and three Anomic aphasia. Broca`s aphasia showed better volitional mechanism than automatic whereas individuals with Wernicke`s aphasia showed better performance for automatic task than volition. It was reported that only individuals with Anomic aphasia showed better volitional as well as judgement mechanism.

Abhishek and Prema (in preparatory stage) have studied the lexical organisation in Broca`s and anomic aphasia. Lexical decision task was carried out from Translation equivalent, semantically related and unrelated word primes. Results revealed that there was no significant difference between the performance of Broca`s and Anomic aphasia. The lexical automatic activation mechanism was unimpaired in Broca`s aphasia. The responses were present but at a higher reaction time, which was explained on the basis of comprehension of the stimulus and processing. As the priming conditions were compared, in Kannada-English direction performance for Translation equivalent was better and for English-Kannada direction, semantically related word prime yielded better response. The pattern was justified with proficiency of the individuals were L1 was more dominant, the performance was better in L1-L2 direction.

On the other hand, Kiran and Lebel (2007) examined lexical representation in early Spanish-English bilingual aphasia using an unmasked semantic and translation priming paradigm. Results from the experiments revealed that the accuracy of response was equal across the four priming conditions (SR, SU, TE and NW) for English targets. In contrast, it was reported that for Spanish targets SR and TE had higher accuracy rates than unrelated words. The subtle difference if any present between TE and SR suggested that these words are processed in a similar way in the cortex. Asymmetrical priming was observed in neurotypical individuals but bilingual individuals with aphasia were more indicative of asymetrical priming across priming conditions. Kiran and Lebel (2007) reported that the complexity of semantic priming and lexical access in bilingual Broca’s aphasia, priming effects were highly dependent upon complex interaction between language proficiency, language impairment and usage. This was reported to be the reason why individuals with bilingual aphasia showed an irregular trait.

Prather, Zurif, Love & Bronwell (1997) studied the semantic processing in anterior and posterior aphasic. They studied priming effect in one individual with Broca`s aphasia and Wernicke`s aphasia. They studied different SOAs at which the population showed least error rates. They reported that priming effect in Broca`s aphasia was present but the speed of activation was slower, they showed less erroneous responses at a SOA of 1200ms. They also concluded that the error pattern observed for both group is different, posterior aphasics show more inhibitory deficit and anterior show more facilitatory deficit in lexical processing

The first neurotypical study using brain imaging was reported by Klein, Zatorre, Milner, Meyer and Evans, 1994. They studied the cerebral representation of L1 and L2 in English-French bilinguals. PET revealed activation of left putamen during word generation task for L2 (less known language). Similar study was done by the Klein et al (1999) on Chinese (L1)-English (L2) bilinguals. It was shown that for both the languages same cortical structures (left inferior frontal, dorsolateral, frontal, temporal and parietal cortices and right cerebellum) were activated irrespective of L2 being learned in the later part of the life.

Kotz (2001) studied word recognition in early fluent Spanish- English bilinguals using lexical decision task. The reaction time and event related potentials (ERP`s) were compared and studied for words and non words in either Spanish or English. Results showed that there was symmetrical priming in L1 and L2 and that word recognition is equivalent in early fluent bilinguals. Hernandez et al., (2000) used f MRI to investigate the cortical activation during a naming task for six early Spanish (L1) - English (L2) bilinguals. Results revealed no difference found in the area of representation and intensity of activation between the two languages. They concluded their finding highlighting that the cortical representation of both L1 and L2 is similar and there was no evidence that naming processing for each language was different.

Marian, Spivey and Hirsch (2003) studied the area of activation in bilingual cortex during lexical access through an eye tracking study, they reported that although the same general structures are active for both languages (Russian and English), differences within these general structures are present across languages and across levels of processing. For example, different centres of activation were associated with first versus second language processing within the left Inferior Frontal Gyrus, but not within the Superior Temporal Gyrus. They suggested parallel activation (as found with eye tracking) and shared cortical structures (as found with f MRI) may be characteristic of early stages of language processing (such as phonetic processing), but the two languages may be using separate structures at later stages of processing (such as lexical processing). So, the representation changes from a unitary language centre to a more specific and defined lexicon of each language as the proficiency of the individual increases or becomes more balanced.

Phillips, Segalowitz, Brien and Yamasaki (2004) investigated individual differences in second language (L2) proficiency by looking at the efficiency or automaticity of semantic priming using behavioural and event-related brain potential (ERP) measures. In Experiment 1, 37 unbalanced English-French bilinguals made living/non-living judgments to English and French nouns in lists blocked by language. Sixty critical words were each presented twice, once primed by a semantic associate in the preceding trial (e.g. ADULT, CHILD) and once unprimed (e.g. RABBIT, CHILD). Measures of response time (RT) and intra-individual variability in response time (coefficient of variation, CV) were obtained. The CV provided an index of processing efficiency that has been related to automaticity. Participants performed faster and with lower CVs (i.e. with greater efficiency) in L1 than L2, and the more highly proficient bilinguals had lower CVs than the less proficient bilinguals.

Experiment 2 replicated these results with 29 participants and provided an electrical brain activity measure of processing efficiency using the N400 ERP. Participants with high proficiency in L2 showed significant N400 and RT priming effects in both their L1 and in their L2. The low L2 proficient subjects manifested significant RT priming effects in L1 and L2 and a significant ERP priming effect in L1. However, they did not manifest a significant ERP priming effect in L2. But the confusion remained that in these participants' response times were facilitated by related primes in L2 while the N400 effect was absent. The researchers justified that the ERP and RT measures reflected different stages or aspects of cognitive processing. There is controversy concerning the extent to which the N400 is sensitive to automatic priming processes (Deacon et al., 2000; Kiefer, 2002; Kutas & Hillyard, 1989), or later post-lexical/integrative processes (Brown & Hagoort, 1993; Chwilla et al., 1995; Chwilla, Kolk, & Mulder, 2000; Holcomb, 1993).

The processing in a bilingual individual with aphasia can be reflected upon his/her performances in online and offline tasks. In recent year, online studies have gained a lot of popularity as it projects about the automatic processing. Prema, Abhishek and Prarthana (2010) have reported that lexical priming is the most convenient tool to observe the lexical representation in a bilingual brain. Different types of prime have shown different level of activation in human cortex, some have more automatic access and some are more controlled. For controlled access, the time required for the processing of these words longer such as for semantically unrelated occur at a higher SOAs (Arnott, Chenery, Copland, Murdoch, & Silburn, 2003; Hill et al., 2002; Bennet & McEvoy, 1999).

Language proficiency and use act as one of the most important variable in the cerebral organisation of a bilingual cortex. With proficiency literature has suggested that the involvement of the non dominant hemisphere also increases. In case of balanced bilingual the representation of the second language should mimic that of the first language (Faust, Azdi, & Vardi, 2012; De Groot, 1992). The lexical activation or access that is observed in bilingual anterior aphasia have differed view among the authors. Few believe that there is a lack of automatic priming and limited effect of priming on lexical activation (Milberg, Blumstein, Katz, Gershberg, & Brown, 1995) whereas another school of thoughts believe the presence of priming mechanism in individuals with anterior aphasics, and believe that the lexical activation takes place but at a higher latency (Prather, Zurif, & Love, 1992).

Hence, it is essential for us to know the mechanism of linguistic processing in bilingual aphasic, as the performance is highly dependent upon the severity, pathology and the proficiency of the individual. The interaction between the two languages Kannada and English, how one facilitates the lexical processing of another can be an important marker or variable in Aphasiology therapy. Also, the various priming condition that are being used by speech language pathologist may show vivid results in different aphasic syndrome. So, which priming condition elicits maximum and best response from the anterior aphasics can be highlighted during the rehabilitation.

Each and every language spoken in multilingual India has a unique phonological and orthographical representation. So, the process of lexical access or concept representation stands to be a very strong field in cognitive research especially in cross-linguistic studies. Experiments using cross linguistic semantic and translation priming have provided with ample information related to the lexical selection in normal bilinguals. These data have tentatively suggested that priming effects interact with language proficiency. But it could be interesting to understand the mechanism or influence of two or more languages in an individual with brain damage such as aphasia.

The insight into the nature of cross linguistic priming in language deficit population is still very sparse. It would be interesting to know if language deficiency also plays an important variable on priming effect. For instance, recent studies have suggested that individuals with Broca's aphasia have showed reduced levels of lexical activation (Utman, Blumstein, & Sullivan, 2001) and are unable to effectively integrate lexical activation (Milberg, Blumstein, Giaovanello, & Misurski, 2003) and anterior aphasics have shown traits of priming effect the level of activation is very slow (Prather, Zurif, & Love, 1992). It has been suggested that the priming effect is atypical in individuals with Aphasia; they do not follow any specific trait as observed in normal individuals (Kiran & Lebel, 2007; Sebastian, 2005). Therefore, the study of the priming effect on brain damage particularly non fluent aphasic as they have relatively spared comprehension and have shown traits of priming effect will provide a greater insight about the bilingual representation and restoration of the lexical information in L1 and/or L2.

Hence, the primary aim of the present study was to investigate the effect of cross linguistic semantic and translation priming in non fluent Kannada-English (K-E) bilingual aphasia. The objectives of the study included the following,

Objectives of the study

- To study the effect of language proficiency on semantic and translation priming in normal K-E bilinguals
- To study the effect of language direction on semantic and translation priming from Kannada to English and English to Kannada in normal K-E bilinguals
- To study any difference of response priming on lexical decision task between normal K-E bilinguals and K-E bilingual individuals with non-fluent aphasia.

CHAPTER 3: Method

The primary aim of the present study was to investigate the effect of cross-linguistic semantic and translation priming in non fluent Kannada-English (K-E) bilingual aphasia.

Objectives of the study were as follows:

- To study the effect of language proficiency on semantic and translation priming in normal K-E bilinguals
- To study the effect of language direction on semantic and translation priming from Kannada to English and English to Kannada in normal K-E bilinguals
- To study any difference of response priming on lexical decision task between normal K-E bilinguals and K-E bilingual individuals with non-fluent aphasia

A two group comparison research design was used to compare the clinical group i.e. individuals with non fluent aphasia (N=5) and control (neurotypical) group i.e. the neurotypical individuals (N=10).

3.1 Participants

Participants were classified into two groups- The clinical group and the control group.

Clinical group: In the initial phase of the study a total of seven individuals (five with Broca's aphasia and two with Conduction aphasia) were considered for the study. Two individuals with Conduction aphasia were unable to follow the instructions of the testing, hence they were not included in the study. A total of five individuals with Kannada-English bilingual non fluent aphasia (NFA) (Broca's aphasia) who were in the age range of 25 to 85 years participated in the study.

Control group: Ten neurotypical (NT) individual were selected for the study. Each of the clinical group individuals were age, gender and educational background matched with two individuals each in the control group.

Participant selection criteria

All the participants spoke Kannada as their native language, with a minimum qualification of twelve standards. An informed consent was taken from all the participants with prior information on the purpose of the study and maintenance of confidentiality.

Clinical group-The following participation criteria was considered for the selection of individuals in the clinical group,

- Diagnosis by a neurologist of a stroke in the left hemisphere confirmed by a CT/MRI scan,
- Onset of stroke at least nine months prior to participation in the study,
- Right-handed prior to stroke,
- Bilingual speakers of Kannada and English

- Adequate hearing, vision, and comprehension to engage fully in testing and treatment, and stable health status.
- The diagnosis of aphasia was determined by administration of the Kannada adaptation of Western Aphasia Battery (Kertesz, 1982; adapted by Shyamala,Vijayashree & Ravi, 2008).
- The language proficiency, performance and usage for each of the selected language were assessed by Bilingual Aphasic Test in Kannada-English (Paradis & Rangamani, 1989).

Control group

- Participants selected had normal or corrected normal vision and no known reading or learning disorder. All the participants were screened for any marked neurological and medical histories according to the WHO Ten question disability screening checklist (cited in Singhi, Kumar, Malhi & Kumar, 2007).
- The Language proficiency questionnaire: An adaptation of LEAP-Q in Indian context (Maitreyee, 2009), was used to define the proficiency of each language, its usage and performance.

Language profile of the participants

Participant 1 was 84 years/ male, with 80 years of language experience (usage) in Kannada, and 74 years of language experience in English. He is a retired teacher and a past rotary club member. Participant had an attack of stroke due to unstable blood pressure at the age of 80 years. CT scan and MRI reports revealed lesion in the left MCA territory. Participant was diagnosed with Broca`s aphasia, with an Aphasia Quotient of 23.6. He attended speech therapy for 6 months post stroke. Post morbidly he majorly relies on his L2 (English) for his daily conversation. Frequent code shifting/ language shift was observed from Kannada to English. He comprehends spoken English and Kannada sentences, also written forms of the languages. Performance in English is better in second language as highlighted on the Bilingual aphasia test (Kannada-English). Premorbidly person was right handed and post morbidly is ambidextrous.

Participant 2 was 34yrs/male, with 30 years of language experience (usage) in Kannada, and 25years of language experience in English. He was a bank accountant and mostly used English as his preferred language. Participant had a left cerebral vascular accident (CVA) at the age of 32. CT scan and MRI reports reveal infarct in the distribution of the anterior division of the left middle cerebral artery. Participant was diagnosed with Broca`s aphasia, with an Aphasia Quotient (AQ) of 22.75. He is undergoing speech therapy since 1 year post stroke. Post morbidly he majorly relies on his L1 (Kannada) for his daily conversation. He comprehends spoken English and Kannada sentences, also written forms of the languages. Performance in Kannada (L1) was better than the English (L2) as highlighted on the Bilingual aphasia test (Kannada-English). Premorbidly person was right handed and post morbidly predominant left hand usage

Participant 3 was 42 year male, with 36years of language experience (usage) in Kannada, and 10 years of language experience in English. He was a teacher and mostly used Kannada in both his work and social environment as his preferred language. Participant had an ischemic stroke at the age of 40 years. CT scan and MRI reports revealed infarct in the left middle cerebral artery. Participant was diagnosed with Broca`s aphasia, with an Aphasia Quotient (AQ) of 19.5. He is undergoing speech therapy since 4 months. Post morbidly he majorly relies on his L1 (Kannada) for his daily conversation. He comprehends spoken Kannada sentences and also written forms of the language. He comprehends simple sentences in English and identifies very common words and reads them. Performance in Kannada (L1) was better than the English (L2) as highlighted on the Bilingual aphasia test (Kannada-English). Premorbidly person was right handed and post morbidly predominant left hand usage.

Participant 4 was 68 years/male, with 64years of language experience (usage) in Kannada, and 58 years of language experience in English. He is a retired army officer. Participant had an ischemic stroke at the age of 67. CT scan and MRI reports showed lesion in the left middle cerebral artery territory. Participant was diagnosed with Broca`s aphasia, with an Aphasia Quotient (AQ) of 21.0 He is undergoing speech therapy since 3 months. Post morbidly he majorly relies on his L2 (English) for his daily conversation. Frequent language shifts and code switches are evident in his speech. He comprehends spoken Kannada and English sentences and also written forms of the languages. Performance in English (L2) was better than Kannada (L1) as highlighted on the Bilingual aphasia test (Kannada-English). Premorbidly person was right handed and post morbidly predominant left hand usage.

Participant 5 was 28yrs/male, with 26years of language experience (usage) in Kannada, and 20 years of language experience in English. He was a software engineer. Participant had a stroke at the age of 25 due to persisting hypertension. CT scan and MRI reports reveal infarct in the left middle cerebral artery. participant has good recovery pattern and was presently diagnosed with Broca`s aphasia, with an

Aphasia Quotient (AQ) of 22.5. He is undergoing speech therapy since 2 months. Post morbidly he majorly relies on his L1 (Kannada) for his daily conversation. He comprehends spoken Kannada and English sentences and also written forms of the languages. Eqiperformance in Kannada (L1) and English (L2) as highlighted in Bilingual aphasia test (Kannada-English). Premorbidly person was right handed and post morbidly uses mixed laterality.

Two individuals with conduction aphasia were selected for the study, but the individuals could not comprehend the instruction. So the data was not considered for these two participants. The experimental group only consisted of individuals with Broca`s Aphasia.

The educational and proficiency ratio is depicted in Table 3.1. The proficiency ratio was calculated by rating the performance of the client in both the languages. Each participant was compared with two neuro typical individuals who were age, gender and education years matched in both the languages.

Table 3.1

Details of participants

Individual with aphasia (Demographic data)	Age matched neuro-typical	Age/ gender	Education/ Occupation
Participant 1 84 years/M B.Sc, B.Ed	Participant 1a Participant 1b	84 years/M 82 years/M	B.Sc,B.Ed /Teacher B.Sc / Teacher
Participant 2 34 years/M B.Com	Participant 2a Participant 2b	35 years/M 32.8 years/M	B.Com /Accountant B.Com/ Surveyor
Participant 3 42years/M BA	Participant 3a Participant 3b	40 years/M 42 Years/M	BA/ Service BA/ Librarian
Participant 4 68 years/M	Participant 4a Participant 4b	67 years/M 68 years/M	BA/ Teacher B Sc/ Service

BA			
Participant 5	Participant 5a	29 years/M	B.E /Service
28 years/M	Participant 5a	28 years/M	BSc /Service
B.E, MBA			

3.2 Stimulus Material

Stimulus material consisted of two word lists- list 1: Kannada to English and the list 2: English to Kannada. In the List 1, prime word was in Kannada and the target in English and in the List 2, prime was given in English and target in Kannada. A total of 50 word pairs were compiled under two language direction related list (K-E & E-K). Each list would consist of 10 translation equivalent word pairs, 10 semantically related word pairs, 10 semantically distant word pairs, 10 semantically unrelated word pairs, and 10 non words pairs in which the target would be non words making a total of 50 word pairs.

The word list included frequently occurring words and non-cognates only. The word list was be adapted from relative frequency of phonemes and morphemes in Kannada (Ranganatha, 1982) which enclosed words weighted according to its frequency of occurrence and usage. The selected words were then subjected to a familiarity rating by 5 native speakers of Kannada. The native speakers rated the words as closely related, distant related and unrelated. According to the familiarity rating, the words were grouped under the main variables in the word list (semantically related, distant related and unrelated). The words which had more than one translation equivalent were not considered for the study. Only non cognates & commonly used words were included.

All the non words selected were pronounceable and orthographically regular. English non-words and Kannada non-words were generated by changing one or more phonemes of real Kannada or English words. The place of articulation of the phoneme changed was maintained and was substituted with phoneme with similar feature. The details and example of test stimuli is given in table 3.2 below.

Table 3.2
Details of test stimuli

	Total number	Kannada – English		English – Kannada	
Conditions		Prime	Target	Prime	Target
Translation Equivalent	10	/mukʰa/	Face	Rice	/akki/
Semantically related prime words	10	/tamma/	sister	Door	/kIʈakI/
Semantically unrelated prime	10	/se:bu/	flower	Water	/maga:/
Non words	10	/hattu/	/len/	Flower	/hIvu/
Semantically distant words	10	/Mugu/	perfume	owl	/tʃandra/

Practice session with 5 word pairs was given in both the language directions to familiarize the participants with the instructions and task. Stimuli words in each list was randomized and presented using the DMDX software.

3.4 Instrumentation

A 14 inch screen, Dell Inspiron laptop was used to carry out the experiment. The stimulus presentation was through DMDX software. DMDX software is a Win 32-based display system used to measure reaction times to visual and auditory stimuli and accuracy rates. It was programmed by Jonathan Forster at the University of Arizona

3.5 Procedure

The participants were tested individually in a quiet room. All the prime and targets in the two language directions was presented consecutively on the centre line of the computer monitor. The participants were instructed for a lexical decision task. The stimuli appeared in black on a white background. Stimulus presentation was controlled by DMDX software (Forster & Forster, 2003). DMDX is a display system used to measure reaction time to visual and auditory stimuli. In the presented task, participants were expected to press 'shift-right' key for correct response and 'shift-left' key for incorrect response. The responses were analysed for reaction time and accuracy measures. For both the groups, each prime was presented for 2000 ms which was followed by a 150 ms gap between the prime and the target, during which the screen was kept blank. The target word then appeared and remained on the screen for 2000 ms or till the subject responded. If the subject failed to respond to a target within 2000ms, that item was recorded as an error and was followed by the next stimulus. The inter-trial interval was initiated followed by presentation of the subsequent prime. Participants were instructed that they will be shown words on the computer screen and that they are required to decide , as quickly and as accurately as possible whether or not the second word was a translation equivalent or not. These temporal values for this study have been employed after a pilot study on two individuals with Broca`s aphasia prior to the main study.

3.6 Scoring and Analysis

Each correct response was scored '1' and incorrect/absent response was scored '0'. The data was coded and tabulated and then subjected for statistical analysis using Statistical Package for Social Sciences (SPSS), version 20. The data was statistically analysed for reaction time and accuracy measures for the following priming conditions: Semantically related (SR), semantically unrelated (SU), semantically distant (SeD), Non word (NW) and Translation equivalent (TE) and between two language directions Kannada-English (K-E) and English-Kannada (E-K).

The data was analysed statistically to address the three research questions posed in the study-

(i) Effect of language direction on semantic and translation priming from Kannada to English and English to Kannada in normal K-E bilinguals

(ii) Difference of response priming on lexical decision task between normal K-E bilinguals and K-E bilingual individuals with aphasia.

The data was analysed using the following statistical procedures:

- The Man Whitney test was done to compare the performance between individuals with NFA and Neurotypical (NT) individuals.

- The Wilcoxon signed rank test was carried out to observe the effect of priming direction on reaction time and accuracy measures in individuals with NFA and Neurotypical (NT) individuals.
- The Friedman test was carried out to detect any significant difference across the five priming tasks between the two directions (K-E and E-K) condition.
- The Wilcoxon signed rank test was carried out to compare between the five priming task under each direction (K-E and E-K).

CHAPTER 4: Results

The primary aim of the present study was to study the effect of cross linguistic priming on lexical access in individuals with bilingual non-fluent aphasia. The present study also attempted to investigate the effect of language direction, if any in lexical access in bilingual non-fluent aphasia. The data was analyzed for reaction time (RT) and accuracy measures for individuals with non fluent aphasia (NFA) and neurotypical individuals (NT).

The objectives included:

- To compare the reaction time and accuracy measures between individuals with Non fluent aphasia (NFA) and Neurotypical (NT) individuals.
- To observe the effect of direction (prime word: Kannada, Target word: English and Prime Word: English, Target Word: Kannada) on lexical access in individuals with NFA and NT individuals.
- To compare the performance between five priming conditions in two priming directions (Kannada to English and English to Kannada) for NT individuals and individuals with NFA.

The data was statistically analysed for reaction time and accuracy measures for the following priming conditions: Semantically related (SR), semantically unrelated (SU), semantically distant (SD), Non word (NW) and Translation equivalent

(TE) and between two language directions Kannada-English (K-E) and English-Kannada (E-K).

The results of the study are explained in the following sections,

4.1 Performance of individuals with NFA across priming conditions and language directions

4.2 Performance of NT individuals across priming conditions and language directions

4.3 Comparison of performance of individuals with NFA and NT individuals across priming conditions

4.4 Comparison of performance of individuals with NFA and NT individuals between language directions

4.5 Descriptive analysis of performance of individuals with NFA in comparison to NT individuals

4.1 Performance of individuals with NFA across priming conditions and between language directions

The data was analysed for individuals with NFA on RT and accuracy measures for different priming conditions and language directions.

4.1.1. Performance of individuals with NFA across priming conditions on RT and accuracy measures

The overall mean, median and standard deviation (SD) of the reaction time and accuracy measures were extracted for the Non fluent aphasic population across the five priming task and under two direction (K-E and E-K). Table 4.1 shows the performance of individuals with non fluent aphasia across five priming conditions and between two language directions for RT measure.

Table 4.1

Performance of individuals with NFA across five priming conditions and between two language directions for RT (n=5)

NFA (RT in ms)				
Conditions	Kannada-English (K-E)		English-Kannada (E-K)	
	Median	SD	Median	SD
SR	2643.26	210.28	2732.19	245.89
SU	2381.40	434.10	2500.32	644.44
SeD	2849.72	410.20	2900.28	563.09
TE	2310.90	304.58	2132.13	455.47
NW	2876.89	296.57	2900.74	369.630

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word.

Analysis of results in Table 4.1 shows that individuals with NFA showed longer reaction time in both directions for NW (Median K-E=2876.89, SD=296.57,Median E-K= 2900.74,SD=396.63) than SeD (Median K-E =2849.72,SD=410.20, Median E-K= 2900.28,SD=563.09). Individuals with NFA showed shorter reaction for SU (Median K-E=2381.40, SD=434.10, Median E-K=2500.32, SD=644.44) and SR (Median K-E=2643.26, SD=210.28, Median E-K=2732.19,SD=245.89) than SeD (Median K-E =2849.72,SD=410.20, Median E-K= 2900.28,SD=563.09). Results revealed that individuals with NFA showed shortest reaction time for TE (Median K-E=2310.90, SD=304.58, Median E-K= 2132.13, SD=455.47) in both the directions (Fig 4.1). Further Friedman’s test results revealed that there was a significant difference in the reaction time of the Non Fluent Aphasics,

χ^2 (5) = 16.00, p<0.05 between the priming tasks, in Kannada-English direction and χ^2 (4) = 10.080, p<0.05 between the priming tasks, in English- Kannada direction.

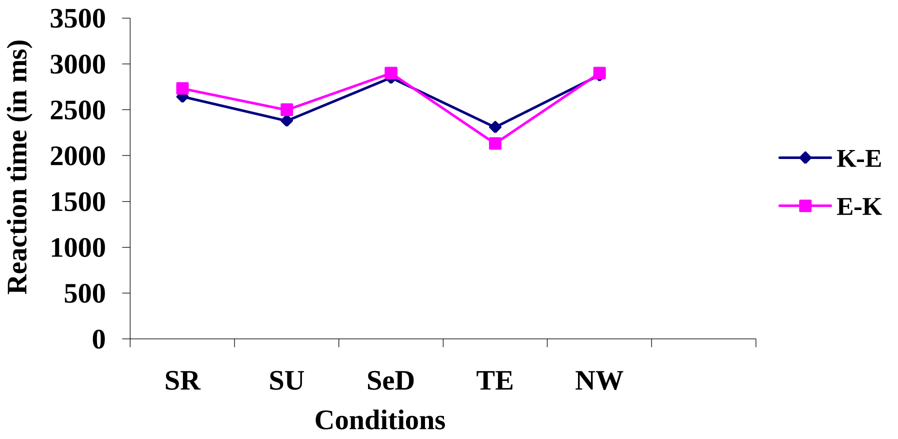

Figure 4.1. Performance of NFA across priming conditions for reaction time

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word.

The results revealed that individuals with NFA showed longest reaction time for NW followed by SeD, SR, SU and shortest reaction time for TE (Fig 4.1). Table 4.2 shows the performance of individuals with NFA across five priming conditions and between two language directions for accuracy measure.

Table 4.2

Performance of individuals with non fluent aphasia across five priming conditions and between two language directions for accuracy (n=5)

	NFA (accuracy)			
Conditions	Kannada-English (K-E)		English-Kannada (E-K)	
	Mean	SD	Mean	SD
SR	7.60	0.548	8.00	0.707
SU	6.20	1.095	6.00	0.548
SD	6.20	1.483	7.00	0.548
TE	7.60	0.894	9.00	0.894

NW	5.60	0.548	5.00	0.837

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

Analysis of results in Table 4.2 revealed that individuals with NFA showed higher accuracy scores for TE (K-E, Mean=7.60, SD=0.86) (E-K, Mean=9.00, SD=0.89) in both the directions than SR (K-E, Mean=7.60,SD=0.54) (E-K, Mean=8.00, SD=0.70). SR showed better accuracy for SR (K-E, Mean =7.60, SD= 0.54) (E-K, Mean=8.00, SD=0.70) than SeD (K-E, Mean=6.20, SD=1.09) (E-K, Mean=7.00, SD=0.54) and SU (K-E, Mean=6.20, SD=0.54) (E-K, Mean=6.00, SD=0.54). It was highlighted in the results that NW (K-E, Mean=5.60, SD= 0.54) (E-K, Mean=5.00, SD=0.837) showed lowest accuracy rates when compared across the five priming conditions (Fig. 4.2 Further Friedman's test results revealed that there was a significant difference in the accuracy measures of the Non Fluent Aphasics, χ^2 (5) = 12.444, $p<0.05$ between the priming tasks, in Kannada-English direction and χ^2 (4) = 19.033, $p<0.05$ between the priming tasks, in English- Kannada direction. Analysis of results revealed accuracy of TE was highest in both the directions followed by SR, SeD, and SU and lowest for NW (Fig 4.2).

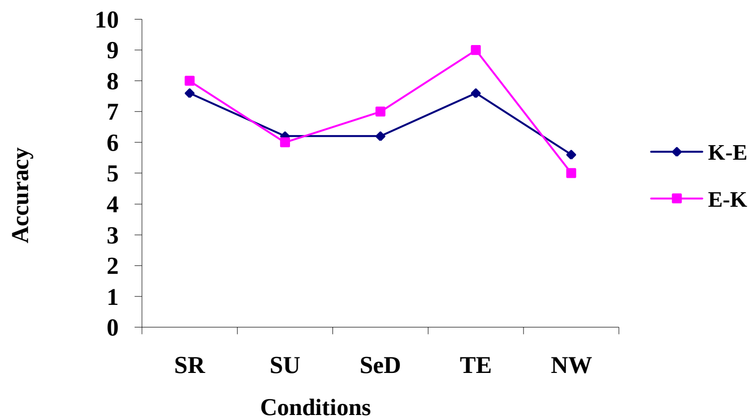

*Figure 4.2.*Performance of NFA across priming conditions for accuracy measures
Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

4.1.2. Performance of individuals with NFA between language directions on RT and accuracy measures

Wilcoxin Signed Rank test was carried out separately for each of the directions and a pair wise comparison was done between the priming tasks.

Kannada-English Direction

Analysis of results on Wilcoxin Signed Rank test revealed that individuals with non fluent aphasic showed no significant difference in the reaction time between the priming conditions. Individuals with Non fluent aphasia had very less variability in their reaction time irrespective of the priming pattern. Thus, the effect of different priming conditions for RT measure was not found to be significant.

Analysis of results on Wilcoxin Signed Rank test revealed that individuals with non fluent aphasic showed lower accuracy scores for NW (Mean= 5.60, SD= 0.54) than SR (Mean=7.60, SD=0.54) with a significance of, $|z|=2.060$, $p< 0.05$. Table 4.2 revealed higher accuracy scores for TE (Mean=7.60, SD=0.86) than SeD (Mean=6.20, SD=1.095), with a significant difference of,$|z| =2.121$, $p<0.05$. Results also showed higher accuracy for TE (Mean=7.60, SD=0.86) than NW (Mean=5.60, SD=0.54). There was a significant difference between TE and NW, $|z|=2.041$, $p<0.05$.

English to Kannada direction

Analysis of results on Wilcoxin Signed Rank test revealed that individuals with non fluent aphasic showed no significant difference in the reaction time between the priming conditions. Individuals with non fluent aphasia had very less variability in their reaction time irrespective of the priming pattern. Thus, the effect of different priming conditions on RT was not found to be significant.

Analysis of results on Wilcoxin Signed Rank test revealed that individuals with non fluent aphasic showed higher accuracy of response for SR (Mean=8.00, SD=0.707) than SU (Mean=6.00, SD=0.548). There was a significant difference between SR and SU, $|z|=2.070$, $p<0.05$. Also, SR (Mean=8.00, SD=0.707) had higher accuracy of response than SeD (Mean=7.00, SD=0.548), with a significance of, $|z|= 2.070$, $p<0.05$. Results revealed higher accuracy for TE (Mean =9.00, SD =0.89) than SU (Mean=6.00, SD= 0.548), with a significant difference of, $|z| = 2.041$, $p<0.05$. Also, higher accuracy for TE (Mean =9.00, SD =0.89) than SeD (Mean=7.00, SD=0.548) was also reported, with a significant difference of, $|z|= 2.060$, $p<0.05$. The accuracy of response was poorer for NW (Mean=5.00, SD=0.837) when compared to TE (Mean =9.00, SD =0.89), there was significant difference of, $|z|= 2.032$, $p<0.05$.

Overall individuals with NFA showed faster processing time and higher accuracy of responses for TE words in both the direction (K-E and E-K). Individuals with NFA showed longer processing time and higher error rates for non words and semantically distant words in both the direction. It was observed from the results for different priming conditions that longest processing time was taken for NW followed by SeD, SR, SU and TE. There was no significant difference observed for reaction time and accuracy measure between the priming conditions in two separate language directions.

4.2. Performance of NT individuals on RT and accuracy measures.

The data was analysed for individuals with NT on RT and accuracy measures for different priming conditions and language directions.

4.2.1. Performance of NT individuals in priming conditions on RT and accuracy measures

The overall mean, median and standard deviation (SD) of the reaction time and accuracy measures were extracted for neurotypical individuals across the five priming conditions and under two directions (K-E and E-K). Table 4.3 shows the performance of NT individuals across five priming conditions and between two language directions for RT.

Table 4.3

Performance of NT individuals across five priming conditions and between two language directions-RT

NT (RT in ms)				
	Kannada-English (K-E)		English-Kannada (E-K)	
Conditions	SD	Median	SD	Median
SR	489.90	859.33	456.26	993.55
SU	344.70	860.06	327.29	989.77
SeD	518.07	994.46	410.27	1090.44
TE	324.73	767.48	287.45	905.62
NW	566.78	920.36	510.12	1023.20

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

Analysis of results (Table 4.3) for performance of the NT individuals across priming conditions showed longer reaction times in both the directions for SeD (Median K-E=994.46, SD=344.70), (Median E-K=1090.44, SD=327.29) than NW (Median K-E=920.36, SD=566.78) (Median E-K=1023.20, SD=510.12). NT individuals showed shorter reaction time in both the directions for SR (Median E-K=993.55, SD=456.26) (Median K-E=859.33, SD=489.90) and SU (Median E-K=989.77, SD=327.29) (Median K-E=860.06, SD=410.27) than SeD (Median K-E=994.46, SD=344.70), (Median E-K=1090.44, SD=327.29). The results revealed that the shortest reaction time was observed for TE (Median K-E=767.48, SD=324.73) (Median E-K=905.63, SD=287.45) in both the directions.). Further Friedman's test results revealed that there was a significant difference in reaction time of the neurotypical population χ^2 (4) = 32.640, $p<0.05$ between the priming tasks, in Kannada-English direction and χ^2 (4) = 26.640, $p<0.05$ between the priming tasks, in English- Kannada direction. In both the directions (K-E, E-K) there was a significant difference observed among the priming tasks (SR, SU, SeD, TE and NW).

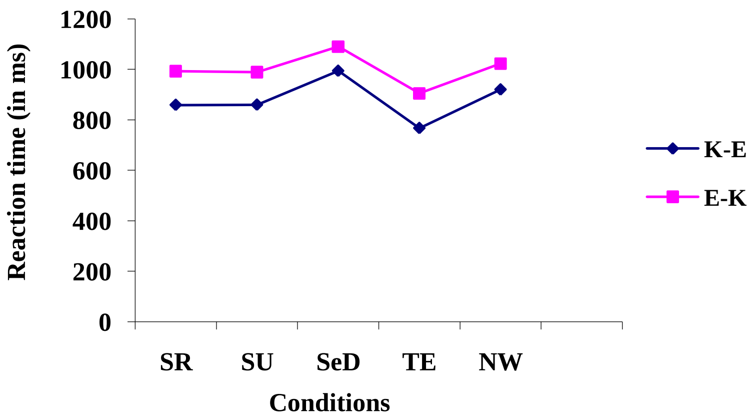

Figure 4.3. Performance of NT on reaction time measures for priming conditions

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

The results revealed that individuals with NT showed longest reaction time for SeD followed by NW, SR, SU and shortest reaction time for TE (Fig 4.3). Table 4.4 shows the performance of individuals with NT across five priming conditions and between two language directions for accuracy measure.

Table 4.4
Performance of NT individuals across five priming conditions and between two language directions for accuracy measures

NT-accuracy				
Conditions	Kannada-English (K-E)		English-Kannada (E-K)	
	Mean	SD	Mean	SD
SR	9.80	0.422	9.50	0.527
SU	10.00	0.000	9.70	0.675
SeD	9.00	1.054	9.00	1.054
TE	9.90	0.316	10.00	0.000
NW	9.80	0.422	9.30	0.823

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

Analysis of results (Table 4.4) revealed that the neurotypical individuals showed highest accuracy score for SU in K-E (Mean=10.00, SD=0.0), whereas highest accuracy score in E-K direction was observed for TE (Mean=10.00, SD= 0.0). SR primes (K-E, Mean=9.80, SD=0.42) (E-K, Mean=9.50, SD=0.52) secured better accuracy scores than SeD primes (K-E, Mean= 9.00, SD=1.05) (E-K, Mean=9.00, SD=1.54). Performance of neurotypical individuals was better for NW (K-E, Mean=9.80, SD=0.42) (E-K, Mean=9.30, SD=0.82) than SeD (K-E, Mean=.9.00, SD=1.05) (E-K, Mean=9.00, SD=1.54).). Further Friedman's test results revealed that there was a significant difference in the accuracy scores of the NT individuals χ^2 (4) = 17.580, p<0.05 between the priming tasks, in Kannada-English direction and χ^2 (4) = 13.067, p<0.05 between the priming tasks, in English- Kannada direction. In both the directions (K-E, E-K) there was a significant difference observed among the priming tasks (SR, SU, SeD, TE and NW).

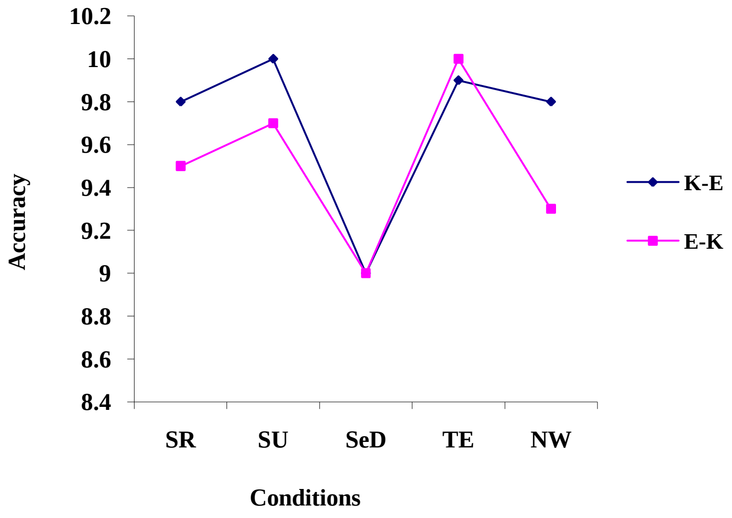

Figure 4.4. Performance of NT on accuracy measures for priming conditions

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

It was observed from Fig 4.4 that the accuracy levels were higher for TE, followed by SU, SR, NW, and SeD.

4.2.2. Direction effects on the priming conditions in NT individuals on RT and accuracy measures

Wilcoxin Signed Rank test was carried out separately for each of the directions and a pair wise comparison was done between the priming tasks. The results are explained under the following subsections.

Kannada-English Direction

Analysis of results on Wilcoxin Signed Rank test revealed that neurotypical individuals showed longer reaction time on SeD K-E (Median K-E=994.46, SD=344.70)than SR K-E (Median K-E=859.33, SD=489.90 with a significance of $|z| = 2.803$, $p < 0.05$. Results in Table 4.1 also showed longer reaction for NW K-E (Median=920.36) than SR K-E (Median K-E=859.33, SD=489.90) with a significant difference, $|z| = 2.599$, $p < 0.05$. NT individuals showed a longer reaction time for SeD K-E (Median K-E=994.46, SD=344.70), than SU K-E (Median K-E=860.06, SD=410.27) (Table 4.1). A significant difference was observed between SeD K-E (Median K-E=994.46, SD=344.70), and SU K-E (Median K-E=860.06, SD=410.27), with a significance, $|z| = 2.803$, $p<0.05$. NW K-E (Median= 920.36) showed longer reaction time when compared with TE K-E (Median K-E=767.48, SD=324.73) .A significant difference was observed between the NW K-E and TE K-E, $|z| = 2.803$, $p < 0.05$).

Analysis of results on Wilcoxin Signed Rank test revealed that neurotypical individuals showed shorter reaction time on TE K-E (Median K-E=767.48 ,SD=324.73) than SR K-E (Median K-E=859.33, SD=489.90) (Table 4.1). A significant difference was observed between the TE K-E and SR K-E ($|z| = 2.803$, $p < 0.05$. NT individuals showed shorter reaction time for TE K-E (Median =767.48) than SU K-E (Median K-E=860.06, SD=410.27), with a statistical significance of, $|z| = 2.599$, $p < 0.05$. Again, TE K-E (Median K-E=767.48, SD=324.73) showed a shorter reaction time than SeD K-E (Median K-E=994.46, SD=344.70), a significant difference was observed between TE-EK and SD K-E, $|z| = 2.803$, $p < 0.05$.

Analysis of results on Wilcoxin Signed Rank test revealed that neurotypical individuals revealed higher accuracy score for SR (Mean= 9.80, SD=0.42) primes than SeD (Mean=9.00, SD=1.05) (Table 4.8). A significant difference was observed between SR and SD,|z|= 2.271, p< 0.05. The accuracy level for SU (Mean=10.0, SD=0.00) prime was higher than SeD (Mean=9.00, SD=1.05), with a significance of, |z|= 2.232, p<0.05. The results revealed the higher accuracy for TE (Mean=9.90, SD=0.316) than SeD (Mean=9.00, SD=1.05). There was a significant difference observed between TE and SD,|z|= 2.251, p<0.05. The results showed, higher accuracy measure for NW (Mean= 9.80, SD=0.422) than SeD (Mean=9.00, SD=1.05) with a significance of,|z|= 2.060, p<0.05.

English to Kannada direction

Analysis of results on Wilcoxin Signed Rank test revealed that neurotypical individuals showed longer reaction time on NW E-K (Median= 1023.2) than SR E-K (Median= 993.55) (Table 4.1). A significant difference observed between NW E-K and SR E-K,| z |= 2.59, p< 0.05. Results from Table 4.1, SeD E-K (Median= 1090.44) showed longer reaction time than SU K-E (Median= 989.77). A significant difference of,| z |= 2.803, p<0.05. NT individuals showed longer reaction time on NW E-K (Median = 1023.2) than TE E-K (Median=905.62) (Table 4.1).A Significant difference observed between the two conditions,|z|= 2.803, p< 0.05.

Analysis of results on Wilcoxin Signed Rank test revealed that neurotypical individuals showed shorter reaction time TE E-K (Median= 905.62) than SR E-K (Median= 993.55) (Table 4.1) with a significant difference of |z|= 2.59, p< 0.05. TE E-K (Median= 905.62) showed shorter reaction time than SU E-K (Median= 989.77) with a significant difference of |z|= 2.599, p< 0.05. Table 4.1 revealed TE E-K

(Median= 905.62) also showed a shorter reaction time than SeD E-K (1090.44), with a significance of,|z|= 2.803, p<0.05.

Analysis of results on Wilcoxin Signed Rank test revealed that neurotypical individuals revealed higher accuracy score for TE (Mean=10.00, SD=0.00) (Table 4.8) than SR (Mean=9.50, SD=0. 527). There was a significant difference between TE and SR,| z |=2.236, p<0.05. Better accuracy scores was reported for TE (Mean=10.00, SD=0.00) than SeD (Mean=9.00, SD=1.05) with a significant difference of, |z| = 2.232, p<0.05. Results showed lower accuracy measures for NW (Mean=9.30, SD=0.82) than TE (Mean=10.00, SD=0.00). There was a significant difference between NW and TW of,|z|= 2.070, p<0.05.

Overall, the findings indicate that the neurotypical individuals showed longer processing speed and higher error rates for SeD and NW conditions irrespective of the direction of the presentation of the prime words from Kannada to English or English to Kannada. Also, shorter processing speed and lower error rates was observed in neurotypical individuals for TE words irrespective of the direction of presentation of the prime.

4.3.Comparison of performance of individuals with NFA and NT individuals across priming conditions

The performance of individuals with NFA and NT individuals on RT and accuracy measures were compared. An overall analysis of results revealed that individuals with NFA showed longer reaction time and higher error rates than compared to NT individuals across all the priming conditions and in both the directions (K-E and E-K). Table 4.5 shows performance of NT and individuals with

NFA-RT and Fig 4.5 shows the 95% confidence interval for reaction time measure across five priming task and two language directions.

Table 4.5

Performance of NT and individuals with NFA-RT

	Neurotypical (in ms) (N=10)		Non Fluent Aphasics (in ms) (N=5)	
	Median	SD	Median	SD
		Kannada-English		
SR	859.33	489.90	2643.26	210.28
SU	860.06	344.70	2381.40	434.10
SeD	994.46	518.07	2849.72	410.20
TE	767.48	324.73	2310.90	304.58
NW	920.36	566.78	2876.89	296.57
		English-Kannada		
SR	993.55	456.26	2732.19	245.89
SU	989.77	327.29	2500.32	644.44
SeD	1090.44	410.27	2900.28	563.09
TE	905.62	287.45	2132.13	455.47
NW	859.33	489.90	2900.74	369.630

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

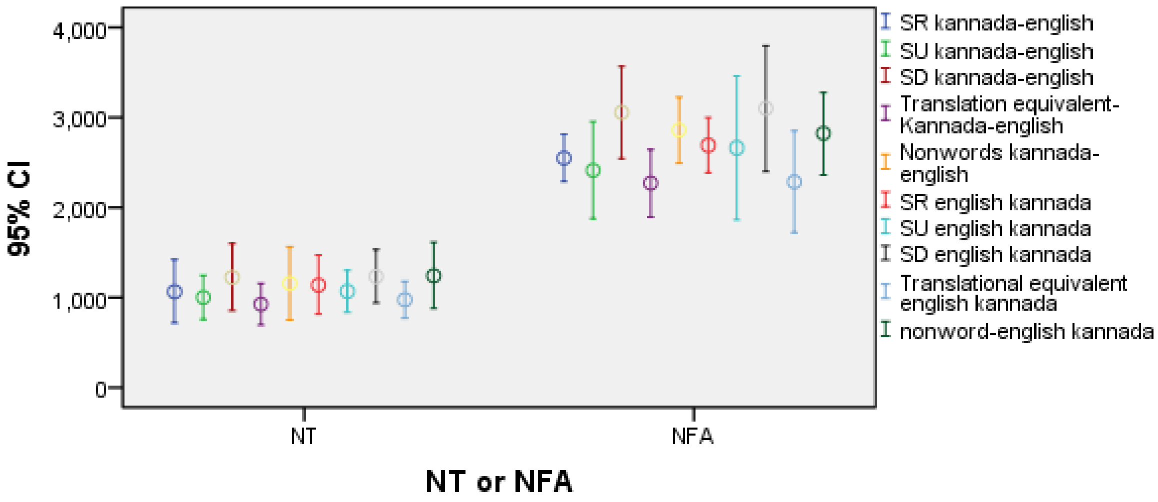

Figure 4.5. Error bar graphs for individuals with NFA and NT across priming conditions for reaction time.

Note: SR-Semantically related, SU- Semantically unrelated, SD- Semantically distant, TE- Translation Equivalent, NW- Non word

Table 4.6 shows performance of NT and individuals with NFA for accuracy and Fig 4.6 shows the 95% confidence interval for accuracy measures across five priming task and two language directions.

Table 4.6
Performance of NT and individuals with NFA-Accuracy.

	Neurotypical (N=10)		**Non Fluent Aphasics (N=5)**	
	Median	SD	Median	SD
	Kannada-English			
SR	9.80	0.422	7.60	0.548
SU	10.00	0.000	6.20	1.095
SeD	9.00	1.054	6.20	1.483
TE	9.90	0.316	7.60	0.894
NW	9.80	0.422	5.60	0.548
	English-Kannada			
SR	9.50	0.527	8.00	0.707
SU	9.70	0.675	6.40	0.548
SeD	9.00	1.054	6.60	0.548
TE	10.00	0.000	8.60	0.894
NW	9.30	.823	5.20	0.837

Note: SR-Semantically related, SU- Semantically unrelated, SeD- Semantically distant, TE- Translation Equivalent, NW- Non word

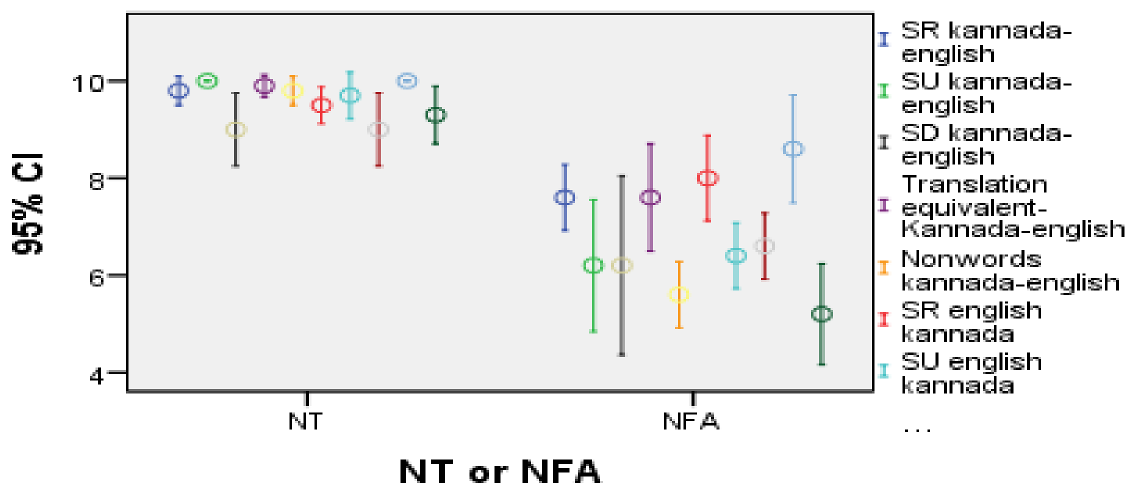

Figure 4.5. Error bar graphs for individuals with NFA and NT across priming conditions for accuracy.
Note: SR-Semantically related, SU- Semantically unrelated, SD- Semantically distant, TE- Translation Equivalent, NW- Non word

The Man Whitney Test was done to compare the performance of both the groups for the priming task. Analysis of results revealed that there is a significant difference between the performance of Non fluent aphasics (NFA) and Neurotypical (NT) group for reaction time and accuracy measures. The performance of the group will be compared and discussed under following subheadings for RT and Accuracy measures:

Non words (NW)

Analysis of results revealed for NW, individuals with NFA (Median K-E= 2876.89, Median E-K=2900.74) have shown longer reaction time measures in both the language directions than NT (Median K-E=920.36, Median E-K=859.33) (Table 4.5). There was a significant difference between reaction of NW in individuals with NFA and NT in K-E direction, $|z| = 3.062$, $p < 0.02$. In E-K direction there was a significant difference between the reaction time of individuals with NFA and NT, $|z| = 3.062$, $p < 0.02$.

Analysis of results revealed for NW, individuals with NFA (Mean K-E= 5.60), (Mean E-K=5) have shown higher error rates in both the language directions than NT individuals (Mean K-E= 9.80, Median E-K= 9.30) (Table 4.10). There was a significant difference between accuracy of response for NW in individuals with NFA and NT in K-E direction, $|z| = 3.342$, $p < 0.02$. In E-K direction there was a significant difference in the accuracy of response of individuals with NFA and NT, $|z| = 3.138$, $p < 0.02$.

Semantically distant (SeD)

Analysis of results revealed for SeD, individuals with NFA (Median K-E=2849.72, Median E-K=2900.28) have shown longer reaction time measures in both the language directions than NT (Median K-E=994.46, Median E-K=1090.44) (Table 4.5). There was a significant difference between reaction of SeD in individuals with NFA and NT in K-E direction, $|z| = 3.062$, $p < 0.02$. In E-K direction there was a significant difference between the reaction time of individuals with NFA and NT, $|z| = 3.062$, $p < 0.02$.

Analysis of results revealed for SeD, individuals with NFA (Mean K-E= 6.20), (Mean E-K= 7.00) have shown higher error rates in both the language directions than NT individuals (Mean K-E= 9.00, Mean E-K= 9.00) (Table 4.10). There was a significant difference between accuracy of response for SD in individuals with NFA and NT in K-E direction, $|z| = 2.806$, $p < 0.02$. In E-K direction there was a significant difference in the accuracy of response of individuals with NFA and NT, $|z| = 2.947$, $p < 0.02$

Semantically related (SR)

Analysis of results revealed for SR, individuals with NFA (Median K-E=2643.26, Median E-K=2732.19) have shown longer reaction time measures in both the language directions than NT (Median K-E=859.33, Median E-K=993.55). There was a significant difference between reaction of SR in individuals with NFA and NT in K-E direction, $|z| = 3.062$, $p < 0.02$. In E-K direction there was a significant difference between the reaction time of individuals with NFA and NT, $|z| = 3.062$, $p < 0.02$.

Analysis of results revealed for SR, individuals with NFA (Mean K-E= 7.60), (Mean E-K=8) have shown higher error rates in both the language directions than NT individuals (Mean K-E= 9.80, Median E-K= 9.50). There was a significant difference between accuracy of response for SeD in individuals with NFA and NT in K-E direction, $|z| = 3.342$, $p < 0.02$. In E-K direction there was a significant difference in the accuracy of response of individuals with NFA and NT, $|z| = 3.342$, $p < 0.02$.

Semantically unrelated (SU)

Analysis of results revealed for SU, individuals with NFA (Median K-E=2643.26, Median E-K=2500.32) have shown longer reaction time measures in both the language directions than NT (Median K-E=860.06, Median E-K=989.77). There was a significant difference between reaction of SU in individuals with NFA and NT in K-E direction, $|z| = 3.062$, $p < 0.02$. In E-K direction there was a significant difference between the reaction time of individuals with NFA and NT, $|z| = 3.062$, $p < 0.02$.

Analysis of results revealed for SU, individuals with NFA (Mean K-E= 6.20), (Mean E-K=6) have shown higher error rates in both the language directions than NT individuals (Mean K-E= 10.00, Median E-K= 9.70). There was a significant difference between accuracy of response for SU in individuals with NFA and NT in K-E direction, $|z| = 3.664$, $p < 0.02$. In E-K direction there was a significant difference in the accuracy of response of individuals with NFA and NT, $|z| = 3.339$, $p < 0.02$.

Translational equivalent (TE)

Analysis of results revealed for TE, individuals with NFA (Median K-E=2310.90, Median E-K=2132.13) have shown longer reaction time measures in both the language directions than NT (Median K-E=767.48, Median E-K=905.62). There was a significant difference between reaction of TE in individuals with NFA and NT in K-E direction,| z |= 3.062, p< 0.02. In E-K direction there was a significant difference between the reaction time of individuals with NFA and NT,| z |= 3.062, p< 0.02.

Analysis of results revealed for TE, individuals with NFA (Mean K-E= 7.60), (Mean E-K=9) have shown higher error rates in both the language directions than NT individuals (Mean K-E= 9.90, Median E-K= 10.00) (Table 4.10). There was a significant difference between accuracy of response for SeD in individuals with NFA and NT in K-E direction,| z | =3.405, p< 0.02. In E-K direction there was a significant difference in the accuracy of response of individuals with NFA and NT,| z |= 3.693, p< 0.02

4.4.Comparison of performance of individuals with NFA and NT individuals between language directions.

The Wilcoxin Signed Rank test was done; analysis of results reveals no significant effect of direction in the performance of reaction time and accuracy measures in individuals with NFA as well as NT group. Analysis of results revealed no significant difference in the reaction time of the neurotypical population when compared in two directions, TE English- Kannada and TE Kannada-English (|z|= 1.172, p>0.05), NW English- Kannada and NW Kannada-English (|z|= 1.784, p> 0.05), SR English- Kannada and SR Kannada- English (|z|= 1.214, p>0.05), SU English- Kannada and SU Kannada-English (|z |= 0.405, p< 0.05) ,SeD English- Kannada and SeD Kannada-English (|z |= 0.135, p< 0.05) .

Analysis of results revealed no significant difference in the accuracy of response in neurotypical population when compared in two directions, TE English-Kannada and TE Kannada-English ($|z| = 1.00$, $p > 0.05$), NW English- Kannada and NW Kannada-English ($|z| = 1.89$, $p > 0.05$), SR English- Kannada and SR Kannada-English ($|z| = 1.732$, $p > 0.05$), SU English- Kannada and SU Kannada-English ($|z| = 1.342$, $p < 0.05$) ,SeD English-Kannada and SeD Kannada-English ($|z| = 1.00$, $p < 0.05$).

Analysis of results reveals no significant difference in the reaction time of the non fluent aphasic group (NFA) primarily between two direction across priming task, TE English- Kannada and TE Kannada-English ($|z| = 0.405$, $p > 0.05$), NW English-Kannada and NW Kannada-English ($|z| = 0.674$, $p > 0.05$), SR English- Kannada and SR Kannada- English ($|z| = 1.214$, $p > 0.05$), SU English- Kannada and SU Kannada-English ($|z| = 0.405$, $p < 0.05$) ,SeD English-Kannada and SeD Kannada-English ($|z| = 0.135$, $p < 0.05$).

Analysis of results reveals no significant difference in the reaction time of the non fluent aphasic group (NFA) primarily between two direction across priming task, TE English- Kannada and TE Kannada-English ($|z| = 1.512$, $p > 0.05$), NW English-Kannada and NW Kannada-English ($|z| = 0.816$, $p > 0.05$), SR English- Kannada and SR Kannada- English ($|z| = 1.00$, $p > 0.05$), SU English- Kannada and SU Kannada-English ($|z| = 0.378$, $p < 0.05$) ,SeD English-Kannada and SeD Kannada-English ($|z| = 0.378$, $p < 0.05$).

Overall, the results highlighted that there was no significant effect of directionality of prime presentation (K-E or E-K) on accuracy of response and reaction time. Both the groups NT and NFA have signified a symmetrical effect of priming in two different directions (K-E and E-K). It was highlighted from the results that the error rates and processing time for individuals with NFA were much higher than NT individuals. Overall performance on accuracy measures and RT measure of individuals with NFA was better for TE prime in both the language directions. In semantic priming it was observed that the error rate and processing time for stronger semantic association prime i.e. SR had lower error rates than weaker association prime i.e. SU and SeD. The individuals with NFA showed least error rate and shorter reaction time in TE followed by SR, SeD, and SU and highest error rate and slower processing in NW.

4.5. Descriptive analysis of performance of individuals with NFA in comparison to NT individuals

A Descriptive (qualitative) analysis of each individual with NFA was done in order to compare the performance across priming conditions and between the two language directions. The analyses of results are explained in the following sections:

Participant 1: 84 Years/Male individual with bilingual NFA, showed better performance in English (L2) than compared to Kannada (L1) on Bilingual aphasia test. It was observed that accuracy and RT measures for TE was higher and shorter in E-K direction (Mean RT=1972.38, Accuracy=9.00 than K-E direction (Mean RT=2360.85, Accuracy=7.00). It was observed that for K-E direction SR words showed higher accuracy level (Accuracy=8.00) than TE (Accuracy=7.00).Poorest performance was observed for non words (K-E Mean=2381.02, Accuracy=4.00) (E-K Mean=3266.6, Accuracy=6.00) and SeD (K-E Mean= 2701.73, Accuracy=7.00) (E-K

Mean=3779.04, Accuracy=4) words in both the direction. It was highly deviant from the age matched NT individuals who showed similar accuracy and RT measures in both the directions and the RT across the priming condition were significantly shorter than NFA. For e.g. in NT (E-K), Mean RT= 869.3, Accuracy= 10 whereas for NFA (E-K), Mean RT=2360.85, Accuracy=7, implicating that the RT and accuracy measures of NFA individuals were both considerably delayed and inaccurate than NT individuals.

Participant 2: 34 Years/Male individual with bilingual NFA, showed better performance in Kannada (L1) than compared to English (L2) on Bilingual aphasia test. It was observed from the results that the individual showed strongest priming effect for TE in K-E direction (Mean RT=1982.34, Accuracy=8.00) and SR in E-K direction (Mean RT=3092.10, Accuracy=7.00) than other conditions. Poorest performance was observed for NW in K-E (Mean RT=2836.4, Accuracy=5.00) and E-K (Mean RT=3266.1, Accuracy=5.00) directions. It was also observed that the overall RT was longer for E-K direction than K-E. it was significantly observed from the data that the RT and Accuracy measures were much longer and error rates were higher for NFA than NT individuals. For e.g.in condition SU prime, NT (E-K), Mean RT= 972.69 ms, Accuracy= 10 whereas for NFA (E-K), Mean RT=3689.56 ms, Accuracy=6.

Participant 3: 42 Years/Male individual with bilingual NFA, showed better performance in Kannada (L1) than compared to English (L2) on Bilingual aphasia test. It was observed from the results that the individual showed strongest priming effect for TE in K-E direction (Mean RT=1989.42, Accuracy=9.00) and E-K direction (Mean RT=2132.13, Accuracy=7.00) than other conditions. Poorest performance was observed for NW in K-E (Mean RT=2431.02, Accuracy=6.00) and SeD E-K (Mean RT=3008.49, Accuracy=6.00) directions. It was also observed that the overall RT was longer for E-K direction than K-E. It was significantly observed from the data that the RT and Accuracy measures were much longer and error rates were higher for NFA than NT individuals. For e.g.in condition SR prime, NT (E-K), Mean RT= 1108.3, Accuracy= 9 whereas for NFA (E-K), Mean RT=2681.33, Accuracy=8.

Participant 4: 68 Years/Male individual with bilingual NFA, showed better performance in English (L2) than compared to Kannada (L1) on Bilingual aphasia test. It was observed from the results that the individual showed strongest priming effect for TE in K-E direction (Mean RT=2716.13, Accuracy=7.00) and E-K direction (Mean RT=2100.43, Accuracy=9.00) than other conditions. Poorest performance was observed for NW in K-E (Mean RT=2900.86, Accuracy=6.00) and E-K (Mean RT=2989.16, Accuracy=5.00) directions. It was significantly observed from the data that the RT and Accuracy measures were much longer and error rates were higher for NFA than NT individuals. For e.g.in condition SeD prime, NT (E-K), Mean RT= 1132.49, Accuracy= 9 whereas for NFA (E-K), Mean RT=2900.28, Accuracy=7.

Participant 5: 28 Years/Male individual with bilingual NFA, performed similarly for English (L2) and Kannada (L1) on Bilingual aphasia test. It was observed from the results that the individual showed strongest priming effect for TE in K-E direction (Mean RT=2310.49, Accuracy=9.00) and E-K direction (Mean RT=2132.4, Accuracy=9.00) than other conditions. Poorest performance was observed for NW in K-E (Mean RT=2876.89, Accuracy=6.00) and E-K (Mean RT=2900.79, Accuracy=6.00) directions. It was significantly observed from the data that the RT and Accuracy measures were much longer and error rates were higher for NFA than NT individuals. For e.g.in condition SU prime, NT (E-K), Mean RT= 706.32, Accuracy= 10 whereas for NFA (E-K), Mean RT=2416.6, Accuracy=7.

Overall it was observed that there was an irregular pattern of priming on two language directions in individuals with NFA mimicking the pattern of proficiency. It was also evident that the processing time was higher for NFA individuals than NT. The error rates were higher in NFA than the NT across priming conditions and language directions. Priming effects were observed for both NFA and NT groups. A symmetrical pattern was observed in both NFA and NT in terms of the direction effects from K-E and E-K.

CHAPTER 5: Discussion

The aim of the present study was to investigate the effect of cross linguistic semantic and translation priming in non fluent Kannada-English (K-E) bilingual aphasia. Performance of Individuals with bilingual aphasia was compared with neurotypical individuals on reaction time and accuracy measures. The experiment was carried out across five priming conditions- Semantically Related (SR), Semantically unrelated (SU), Semantically Distant (SeD), Translation Equivalent (TE) and

Nonwords (NW) in two language directions, Kannada- English and English-Kannada. The objectives of the experiment were to study:

- The difference in the performance on response priming on lexical decision task between neurotypical K-E bilinguals and K-E bilingual individuals with non-fluent aphasia.
- The effect of language direction on semantic and translation priming from Kannada to English and English to Kannada in K-E bilingual individuals with non fluent aphasia and neurotypical K-E bilinguals.
- The effect of language proficiency on semantic and translation priming in K-E bilingual individuals with non fluent aphasia and neurotypical K-E bilinguals.

The results of the present study are discussed in terms of:

5.1 Performance of individuals with non fluent aphasia (NFA) on RT and accuracy measures for priming conditions and language directions.

5.2 Comparison of priming effect on the performance between individuals with NFA and NT individuals.

5.3 Comparison of direction effect on the performance between individuals with NFA and NT individuals.

5.1 Performance of individuals with non fluent aphasia (NFA) on RT and accuracy measures for priming conditions and language directions.

The results of the present study revealed that the speed and accuracy of the lexical processing in K-E bilingual individuals with NFA was poor (longer RT and lesser accuracy) in comparison to the NT K-E bilinguals (see Figures 4.5 and 4.6). Longer processing speed in individuals with NFA could be attributed to the slower speed of activation involving a lexical activation task. This could be attributed to the damage in individuals with NFA in the anterior cortex which is responsible for facilitation of lexical nodes (Prather, Zurif, Love & Bronwell, 1997). Whereas the other areas related to processing is relatively spared, such as the posterior cortex which is speculated to be responsible for inhibition of selected lexical nodes. This processing disruption where facilitation of semantic nodes is affected and inhibition of the lexical items are more, results in erroneous selection of lexicon or higher error rates (Prather, Zurif, Love & Bronwell, 1997). It can also be speculated that the higher reaction time in Broca`s aphasia can be because of the involvement of the non dominant hemisphere in the process of lexical selection as part of post morbid cerebral re-organisation.

Various studies have reported the presence of automatic access to lexical/ semantic knowledge in individuals with non fluent aphasia. Individuals with Broca’s aphasia are reported to show inconsistent lexical priming effect but not absent (Abhishek & Prema 2012; Prather, Zurif, Love & Brownell 1997). This primary disturbance in the lexical activation of Broca’s aphasia was considered to be related to the speed of activation. Individuals with Broca`s aphasia prime when sufficient time is allowed for activation to spread among associates. The individuals with Broca’s aphasia showed reliable automatic priming but only at a long inter stimulus interval of 1500 msec. Automatic priming is mainly tapped at short SOAs, whereas controlled priming mechanisms are responsible for priming effects observed at long SOAs (De Groot, 1984; Neely, 1977, 1991).

Priming effects obtained with very short SOAs are usually assumed to rely more on automatic priming mechanisms, such as the automatic spreading of activation between related nodes in the semantic lexicon (Collins & Loftus, 1975), than on controlled priming mechanisms (Neely, 1991).That is, this subject retained the ability to access lexical information automatically if allowed sufficient time to do so. Swiney et al (1989), reported that individuals with Broca`s aphasia demonstrate a slower than normal rise time in lexical activation. This can be the related reason how individuals with NFA showed shorter reaction time and an inconsistent priming effect than NT bilinguals.

The results of the present study also indicated that across priming conditions within the NFA group, longer RT and poorer accuracy of responses was observed for NW. On the other hand, shorter RT and lesser error rates were observed for TE. Similar findings were observed in NT individuals as well. However, the overall performance of individuals with NFA was poorer (longer RT and fewer accurate responses) in comparison to NT individuals across all priming conditions. This can be because of the higher activation level required by the individuals with NFA (Broca`s aphasia) who showed priming effect but at a longer latency. The process of activation is slower or impaired in anterior aphasics. Prather et al. (1997) reported inhibition deficits in posterior aphasics and facilitatory deficits in anterior aphasics, which defined the delayed response in Broca`s aphasia and circumlocutions and paraphasic errors in Wernicke`s Aphasia.

Individuals with NFA performed better on TE priming in terms of shorter reaction time and higher accuracy than SeD priming which revealed longer RT and poorer accuracy rate (see Table 4.5). This could be because SeD priming in individuals with NFA shows weaker association than TE priming which is often observed in bilinguals. Semantically distant priming is considered as Step 2 priming (within semantically related priming) which requires longer SOA to activate a response. These findings are in support of various other studies reported in literature which explain the differences in processing of SeD and TE priming in a bilingual cortex (Kiefer, Ahlegian, & Spitzer, 2005; Hill et al., 2002; Chwilla, Kolk, & Mulder, 2000; McNamara, 1992). Step 2 priming requires a longer SOA than Step 1 priming (Arnott, Chenery, Copland, Murdoch, & Silburn, 2003; Hill et al., 2002; Bennet & McEvoy, 1999). This can also be explained on the basis of the direct access or direct lexical access that takes place for TE (Zhao & Li, 2011), when compared to SeD. Figure 2.4.shows that for SeD priming to take place, spreading activation has to follow a longer and multiple routes to pinpoint an association between the prime and the target. This could lead to either a longer processing time or make the lexical selection more vulnerable to errors when compared to TE priming which show stronger lateral connections and fewer routes for associations to take place (Zhao & Li, 2011).

Similar findings were observed in NT bilingual individuals across semantic priming conditions (SR, SeD and SU). Better response priming was observed for SR compared to SU and SeD, as explained earlier the weaker association seen in SU and SeD (step 2 priming) have been shown to occur at higher SOAs and is weaker than step 1 priming i.e. SR primes in neurotypical individuals (Kiefer, Ahlegian, & Spitzer, 2005; Hill et al., 2002; Chwilla, Kolk, & Mulder, 2000; McNamara, 1992). Step 2 priming requires a longer SOA than Step 1 priming (Arnott, Chenery, Copland, Murdoch, & Silburn, 2003; Hill et al., 2002; Bennet & McEvoy, 1999).

On comparison of the different semantic primes used, lexical access for SR was faster than SU and SeD. Most of the priming effect is explained using the spreading activation model (Collins and Loftus, 1975), which explains that related features or words gets activated with the presentation of the prime. The process of facilitation is faster than inhibition and selection. In case of SU and SeD words, the process of inhibition is much more than SR words. The relationship between the prime and the target is concrete in SR wherein the selection process is direct and faster. Also, selection of SR could be more automatic due to which lesser time and greater accuracy is expected in SR primes in comparison to SU and SeD which may require greater controlled selection with longer SOAs (Arnott, Chenery, Copland, Murdoch, & Silburn, 2003; Hill et al., 2002; Bennet & McEvoy, 1999).

. Philips, Segalowitz , O`Brian and Yamasaki (2004) reported that on electrophysiological measure such as the N400 showed robust amplitude in SU words than SR (Brown & Hagoort, 1993; Connolly, Phillips, & Forbes, 1995; Kutas & Van Petten, 1988). SR words have high association, so the selection could be more automatic in nature, whereas SU words may require more controlled word selection. N400 peak becomes more robust when semantic association from the prime is very less or minimal and shows a shorter peak when the semantic context is well maintained. Thus, the RT taken for SR words is primed faster than SU.

The results highlighted that across the five priming condition, better response was corresponding to TE and SR conditions in both individuals with NFA and NT. The priming effect for TE is much more robust than SR words in NFA as well as NT. This finding can be speculated in terms of the self-organizing neural network model proposed by Zhao and Li (2011). Translation equivalent primes seem to have stronger lateral connections with fewer nodes and routes when compared to semantically related primes (see Figure 2.5). These stronger connections and minimal routes facilitate faster processing and fewer errors in lexical selection when compared to SR priming condition. The phenomenon could also be explained using the spreading activation model (Collins & Loftus, 1975) where, the nodes activated for semantically related words are higher than compared to a translation equivalent, thus, the time required for the lexical processing, competition and selection takes longer time than direct selection as in the case of TE priming condition. The findings of the present study are in consonance with the findings of a study by Cheng and Ng (1989). They studied similar effects in Chinese-English bilingual speakers and reported that the lexical decision responses were facilitated to a greater extent when primed for translation equivalent than semantically related conditions on crosslinguistic presentation of prime and target. Both SR and TE are early appearing or they react on short SOAs. In translation priming the presentation of a prime word automatically causes its lexical entry (Foster & Davis, 1984) to be activated which signifies short SOAs. Also, reported for SR priming where SOA is very short (Perea & Rossa, 2002; Rastle, Davis, Marslen-Wilson, & Tyler, 2000).

For non words or non lexical priming, individuals with NFA required a longer processing time. As the morphological and phonological structure of the non words generated were very closely related to the target real word, which could give rise to the higher competition between the facilitated words. This could be explained by the fact that process of inhibition is more competitive, hence requiring longer time in case of nonwords with similar morphological structures as other words during priming (Masson & Isaac, 1999). This type of priming is considered as masked priming, and have reported to require higher processing time than semantically unrelated words

(Plaut, McClelland, Seidenberg, & Patterson, 1996; Seidenberg & McClelland,1989; Van Orden, Pennington, & Stone, 1990). It is explained as the number of generation of neighbourhood is more in case of non words with similar morphological structure as target, the process of inhibition takes a longer time. According to the Cohort Model (Marslen-Wilson & Welsh, 1978) the dependency on word prediction after the processing of first few phonemes might give rise to faulty selection of words, which was evident in the accuracy of responses.

Overall for both accuracy and RT it was observed that the performance was better for TE priming condition followed by SR, SU, and poorer performance observed for NW and SD priming condition.

5.2 Comparison of priming effect on the performance between individuals with NFA and NT individuals.

The results of the present study revealed that individuals with NFA showed better performance in TE word prime and poorest in NW and SeD. NT bilinguals performed better in TE prime and poorest for SeD word prime. For TE and SR word prime the lexical activation for individuals with NFA was much slower than NT bilinguals (see Tables 4.5 and 4.6). TE and SR prime have emerged as the strongest conditions to elicit a priming effect in both NT individuals and individuals with NFA. Sebestian (2005) studied TE and SR priming effect, reported slower activation of lexical knowledge of individuals with Kannada-English bilingual aphasia than NT. This result was again replicated by Kiran and Lebel (2007), who studied priming effect in Spanish-English bilingual aphasia. They also concluded that the level of activation is much faster in NT bilinguals than individuals with NFA. as the anterior cortex is responsible for facilitation of the lexical route, the disruption in NFA causes activation of these nodes at a very higher level, this causes at delayed latency of the priming effect to emerge.

For weak association semantic primes i.e., SU and SD, it was observed that the performance of the NFA individuals was much poorer than NT bilinguals in both reaction time taken and accuracy of response. The finding can be explained through the spreading activation of lexical entries which gets highlighted with presentation of prime. But this effect of lexical spreading, facilitation and inhibition of competing words is inconsistent and slower in individuals with Broca`s Aphasia (Prather et al, 1992, 1997; Swinney et al., 1989).

The results also highlight the processing of NW to be poorest of all the priming condition in individuals with Non fluent aphasia. There was a significant difference in the error rates and reaction time between the performance of NFA individuals and NT bilinguals. The RT and accuracy of response was better in NT bilinguals than NFA bilinguals. This could be because processing of non words as discussed above requires much more cognitive decoding than other primes. As the non words considered for this study was generated similar to the target word with only a subtle change in the phonological/ morphological structure, thus, the lexical processing in NFA individuals was delayed or even absent than compared to NT individuals. Sebestian (2005) reported similar finding in individuals with K-E bilingual aphasia and Kiran and Lebel (2007) in individuals with S-E bilingual aphasia.

5.3 Comparison of performance of NT and NFA, under the direction effect - RT and accuracy

Results in Table 4.3 revealed that the processing time required by non fluent aphasics was significantly higher than neurotypical individuals across all the five priming conditions for both K-E and E-K priming. The results of this finding have been supportive of the findings by Sebestian (2005) also reported that the facilitation and inhibition process during lexical access and selection is of much longer duration for NFA then compared to NT. Kiren and Lebel (2007) have also suggested similar finding in individuals with aphasia and neurotypical, as they studied Spanish- English bilinguals. For instance, recent studies have suggested that patients with Broca's aphasia show reduced lexical activation levels (Utman, Blumstein, & Sullivan, 2001) and are unable to adequately integrate lexical activation (Milberg, Blumstein, Giaovanello, & Misurski, 2003). Therefore, some of these fundamental changes in language processing abilities as a consequence of brain damage may also underlie the longer reaction and higher error rates that were observed in the patients with bilingual aphasia.

The results of the present study are suggestive of bi-directional priming (equal priming effect) also referred as symmetrical priming for Kannada-English and English- Kannada in both individuals with aphasia and neurotypical individuals. It was deduced from the results that there was no statistical significance in the performance of both groups between the two language directions. The symmetrical priming effect can be explained through the mixed model (De Groot, 1992). The model highlights dependency of each language on one another. According to De Groot (1992), there is a link between the two languages even though the proficiency of the individual shifts from low to high, mediation between the languages are maintained (see Fig.2.3). As observed in participant 1 who had high proficiency in both Kannada and English, but postmorbidly have shown better scores on English, but in the results it was observed that the priming effect was similar in both the languages.

Another reason for this finding can be the effect of proficiency. As the subjects selected in the present study were balanced bilinguals, the representation and processing of the both the languages is expected to be similar. Grosjean (1998) pinpointed bilingual proficiency, and learning history as important factors while studying bilingual representation and the interaction between L1 and L2. This is supportive of the study by Faust, Azdi and Vardi (2012) who studied semantic processing in Hebrew-English speaking dominant and balanced bilinguals. According to this tachioscopic experiment, in dominant bilinguals, the representation of native language is bilateral i.e. both right and left hemispheres are responsible for the processing. But this pattern was not replicated in the non native language; i.e. only left hemisphere involvement was reported. On a contrary they reported that in balanced bilinguals, the interaction between the two hemispheres is evident. They concluded that as the proficiency increases the language representation on the non native language which mimics that of native language. Samani and Saharifian (1997) investigated the facilitatory effects of cross language priming in Persian-English bilinguals at an SOA of 300ms. Results revealed no significant difference in facilitation of prime either in L1 or L2. They concluded that bilinguals have a common representational system.

The finding is supportive of many ERP studies which have indicated a common cortical representation of L1 and L2 (Kotz, 2001). Klein et al (1999) too reported that for both L1 and L2 same cortical structures (left inferior frontal, dorsolateral, frontal, temporal and parietal cortices and right cerebellum) were activated irrespective of L2 being learned in the later part of the life. Thus, indicating a common representation in the cortex and the supporting similar finding of similar priming effect on L1 and L2.

In individuals with aphasia, the absence of directional priming effect have been reported by Kiran and Lebel (2007) they explained that the complexity of semantic priming and lexical access in bilingual Broca's aphasia the priming effects are highly dependent upon complex interaction between language proficiency, language impairment and usage. Cross linguistic semantic priming in bilingual aphasia is inherently more complicated than semantic priming in monolingual aphasia. However, some assumptions that account for impaired priming effects in monolingual aphasia may also be applicable for interpreting priming in bilingual aphasia. For instance, recent studies have suggested that patients with Broca's aphasia show reduced lexical activation levels (Utman, Blumstein, & Sullivan, 2001) and are unable to adequately integrate lexical activation (Milberg, Blumstein, Giaovanello, & Misurski, 2003). Therefore, some of these fundamental changes in language processing abilities as a consequence of brain damage may also underlie the abnormal priming effects that were observed in the patients with bilingual aphasia.

Summary and Conclusion

Language representation in a bilingual brain has always been an enigma. Various model and theories have been speculated to explain whether bilinguals share a common mental lexicon for two languages or they have individual mental lexicon representing each language. The language representation, lexical access and processing have been investigated using priming task in collaboration with various electrophysiological studies, but priming studies still remains as the basic tool to investigate the lexical processing mechanism in human cortex. Various priming conditions are reported to trigger different routes and level of processing, this information gives a vivid idea about the nature of processing of different words and areas involved, but to understand the representation of the language in bilinguals it is mandatory to understand the processing first in brain damaged population.

The present study thus aimed to investigate the effect of priming in bilingual non fluent aphasia. The study was carried out in two language directions, Kannada-

English (K-E) and English-Kannada (E-K) and under five priming conditions, semantically related (SR), semantically unrelated (SU), semantically distant (SeD), Translation equivalent (TE) and Non word (NW).

In the present study, the group with NFA included individuals with Broca's aphasia only. Findings of the present study indicated that there was delayed or reduced activation level in individuals with non-fluent aphasia which included Broca`s aphasia. It was observed that individuals with Broca`s aphasia showed longer reaction time and poorer accuracy rates than the neurotypical individuals. Longer processing speed in individuals with NFA could be attributed to the slower speed of activation involving a lexical activation task. This could be attributed to the damage in individuals with NFA in the anterior cortex. The anterior cortex is considered to be responsible for activation or initiation of lexical nodes and the posterior cortex is responsible for inhibition (Abhishek & Prema 2012; Prather, Zurif, Love & Bronwell 1997). A damage in the anterior cortex with intact posterior cortex which is often seen in non-fluent aphasias can lead to relative increase in the inhibition process with decreased lexical activation. This may lead to poorer accuracy and increased processing time for lexical activation in non fluent aphasias. Whereas the other areas related to processing is relatively spared, such as the posterior cortex which is speculated to be responsible for inhibition of selected lexical nodes. This processing disruption where facilitation of semantic nodes is affected and inhibition of the lexical items are more, results in erroneous selection of lexicon or higher error rates (Prather et al., 1997). It can also be speculated that the longer reaction time in Broca`s aphasia can be because of the involvement of the non dominant hemisphere in the process of lexical selection as part of post morbid cerebral re-organisation.

Findings of the present study also indicated different priming effect for the priming conditions. For TE and SR the priming effect was more robust than SeD, SU and NW. This can be explained on the basis of the direct access or direct lexical access that takes place for TE (Zhao & Li, 2011), when compared to SeD. For SeD priming to take place, spreading activation has to follow a longer and multiple routes to pinpoint an association between the prime and the target. This could lead to either a longer processing time or make the lexical selection more vulnerable to errors when compared to TE priming which show stronger lateral connections and fewer routes for associations to take place (Zhao & Li, 2011). The NFA showed poorest performance for non words, this can be because the non words were generated keeping the morphological and phonological structure of the target words similar. To process such words requires a higher cognitive effort, as the process of inhibition is more and the competition between the words also is more, hence requiring longer time and poor accuracy levels.

The finding of the present study also revealed the absence of any specific priming effect, i.e. have shown bi directional priming effect from both the direction Kannada-English and English-Kannada in both individuals with Broca`s aphasia and neurotypical individuals. This can be explained on the basis of the linguistic organisation of the bilingual brain, as the subjects selected for the study had premorbidly high proficiency in both Kannada and English, the representation of the language is speculated to be similar in both, i.e. similar areas were activated for both the languages. This finding was also seen in Hebrew-English speaking neurotypical individuals (Faust, Azdi & Vardi, 2012).

To conclude, this priming experiment have explained that priming effect is highly dependent on the proficiency of languages, anatomical/functional correlates and the type of priming used. It is evident from the study that individuals with non-fluent aphasia (Broca`s aphasia) respond to priming, but the longer reaction time taken implies the higher facilitation threshold or lower activation. The priming effect is very much present in Broca`s aphasia, which appeared at an SOA of 1000 ms, used in the study. The bi directional priming effect in Broca`s aphasic speculate a common cerebral representation of two languages, which are activated at an equal level under priming directions (K-E or E-K).

Implications of the study

The present study highlights on the lexical activation in individuals with non fluent aphasia such as the Broca`s aphasia. The findings of the present study are indicative of theoretical implications in terms of the performance of individuals with NFA and NT individuals. The mechanism of priming effects in Kannada-English bilingual individuals with NFA was found to be similar in NT bilingual individuals. This finding adds on to the existing literature on priming effects in Populations such the Broca's aphasia. A few explanations to decreased lexical activation in non-fluent aphasias such as Broca's aphasia was explained by Prather et al. (1997) in terms of activation controlled by anterior cortex and inhibition controlled by the posterior cortex. These reports are found to have implications in terms of understand the comprehension abilities in Broca's aphasia versus Wernicke's aphasia. These may also facilitate an understanding in Speech-Language Pathologists while assessing individuals with aphasia and exploring issues related to activation and inhibition.

Inclusion of lexical related tasks in assessment could become a part of the comprehensive assessment of aphasia.

The present study also opens scope for further research in exploring lexical activation and direction effects in various other aphasias such as fluent aphasia or the sub-cortical aphasias in other languages. Priming effects and lexical selection is present in the individuals with NFA but they show a slower activation level. This information justifies the requirement of adequate and adjusted inter stimulus intervals in therapy for individuals with Broca`s aphasia. The finding also illustrates the need to work upon the facilitation of the lexical unit during rehabilitation of individuals with non-fluent aphasia such as Broca`s Aphasia. Translational equivalent and semantically related cues could yield better responses as interpreted from the study. Hence, these cues may be used in the initial stages of the management program followed by the other cues. It also highlights that in case of a high proficient individual with bilingual aphasia, the cues provided can be irrespective of a single language use, as the priming effect was observed for both directions (K-E and E-K), and it implies that the lexical activation can be facilitated from either of the languages. The findings from the present study implicate that it can be simply understood that bilingual individuals with non-fluent aphasia should be treated as a bilingual individual.

Limitation of the study

- The generalization of the findings could not be done as the sample size in the pathological group was small and included only the Broca's aphasia. And other types of non-fluent aphasias such as Conduction aphasia could not be considered for further testing as the two individuals considered for the study did not understand the instructions. The experimental paradigm can be used with other types of aphasias in order to draw conclusions on different other types of aphasias.

- The present study could not associate more on proficiency and cerebral organization of language as low proficient bilinguals were not considered in the present study.

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APPENDIX I

ENGLISH-KANNADA

Semantically related (SR)		
Prime	**Target**	**IPA**
Green	ಎಲೆ	/ele/
Pen	ಪುಸ್ತಕ	/pustaka/
water	ಮೀನು	/minu/
Umbrella	ಮಳೆ	/maḷɛ/
Nail	ಬೆರಳು	/beraḷu/
Broom	ಕಸ	/kasa:/
Table	ಕುರ್ಚಿ	/kUrtʃi/
Key	ಬೀಗ	/biga:/
Cat	ಇಲಿ	/iḷi/
Door	ಕಿಟಕಿ	/kiṭaki/
Semantically Distant (SeD)		
Sugar	ಉಪ್ಪು	/uppu/
Food	ದೋಸೆ	/dosɛ/
Four	ಐದು	/aiḏu/
Music	ಕಿವಿ	/kivi/
Circle	ಚಪಾತಿ	/tʃapaṭi/
Hot	ತಣ್ಣಗೆ	/tannagɛ/
Owl	ಚಂದ್ರ	/tʃandra/
Ear	ಮೂಗು	/mugu/
Elephant	ದೊಡ್ಡ	/doḍḍa/
Sister	ತಮ್ಮ	/ṭamma/
Semantically Unrelated (SU)		
Tiger	ಬಟಾಣಿ	/baṭani/
Money	ಮಲಗು	/malagu/
Chair	ಬಟ್ಟೆ	/baṭṭe/
Flower	ಅಜ್ಜಿ	/adzi/
Hair	ಕೆಲಸ	/kelasa/

Pillow	ಕತ್ತೆ	⁄kaṭṭe/
Egg	ಮೊಲ	⁄mola/
Clock	ನೀರು	⁄ni:ru/
Needle	ಕೆಂಪು	⁄kempu/
Translational Equivalent (TE)		
Rice	ಅಕ್ಕಿ	/akki/
Hand	ಕೈ	/kaj/
Slipper	ಚಪ್ಪಲಿ	/tʃappali/
Butterfly	ಚಿಟ್ಟೆ	/tʃiṭṭɛ/
Spectacles	ಕನ್ನಡಕ	/kannadaka/
Elephant	ಆನೆ	/a:ne/
Lips	ತುಟಿ	/tuṭi/
Rabbit	ಮೊಲ	/ mola/
Spoon	ಚಮಚ	/tʃamatʃa:/
Pumpkin	ಕುಂಬಳಕಾಯಿ	/Kumbalaka:i/
Nonwords (NW)		
Flower	ಬೂವು	/buwu/
Book	ಮುಸ್ತಕ	/musṭaka/
Red	ಗೆಂಪು	/gempu/
Crow	ಗಾಗೆ	/ga:gɛ/
Clock	ಕರಿಯಾರ	/karija:ra/
Door	ಮಾಗಿಲು	/Ma:gilu/
Butter	ಪೆಣ್ಣೆ	/peɲɲe/
Hair	ಗೂದಲು	/gudalu/
Water	ದೀರು	/di:ru/
Fish	ದೀನು	/dinu/

KANNADA-ENGLISH

Prime	IPA	Target
Semantically related (SR)		
Prime	**IPA**	**Target**
ಕೂದಲು	/kudalu/	Black
ಚಪಾತಿ	/tʃapati/	Curry
ಅಮ್ಮ	/amma/	Woman
ಬಳೆ	/balɛ/	Hand
ಹಿಂದೆ	/hindɛ/	Front
ಕೈ	/kaj/	Watch
ಬಾಗಿಲು	/ba:gilu/	Open
ಬಿಸಿ	/biʃi/	Fever
ಈರುಳ್ಳಿ	/irUli/	Tears
ಬೆಕ್ಕು	/bɛkku/	Milk
Semantically Distant (SeD)		
ಮಾವು	/ma:u/	Jam
ನೀರು	/ni:ru/	Vessel
ಮೊಸರು	/mosarU/	Cold
ಸೇಬು	/sebu/	Flower
ಬಳೆ	/ba:lɛ/	Green
ಕೂದಲು	/kuda:lu/	White
ಮೂಗು	/mu:gu/	Perfume
ವಿಮಾನ	/vima:na/	Train
ಕಾಲು	/ka:ḷu/	Pain
ಹುಡುಗಿ	/hudugI/	Skirt
Semantically Unrelated (SU)		
ಮಾತ್ರೆ	/matrɛ/	Hair
ಸ್ನಾನ	/ʃnana/	Pillow
ಪುಸ್ತಕ	/pustaka/	Egg
ಸೀರೆ	/ʃirɛ/	Tomato
ಹುಡುಗ	/huduga:/	Soup
ಸೂರ್ಯ	/ʃurja:/	Fish
ಮಗ	/maga:/	Plate

ಮೊಟ್ಟೆ	/moṭṭɛ/	Moon
ಎಲೆ	/ele/	Tiger
ಕಣ್ಣು	/kaŋŋu/	Money
	Translational equivalent (TE)	
ಒಂದು	/ond̲u/	One
ಮೇಲೆ	/mɛlɛ/	Up
ಇಲ್ಲ	/illa/	No
ಹೆಸರು	/hesa:ru/	Name
ಕೈ	./kaj/	Hand
ಬೇಕು	/beku/	Cat
ಮನೆ	/manɛ/	Home
ರುಪಾಯಿ	/rupa:ji	Money
ಮುಖ	/muk^{h}a:/	Face
ಕೆಂಪು	/kɛmpu/	Red
	Nonwords (NW)	
ಹತ್ತು	/haṭṭu/	len
ಅಕ್ಕ	/akka/	Dister
ಅಂಗಡಿ	/aŋgaḍi/	dzop
ಎಲೆ	/ele/	teaf
ಕತ್ತೆ	/kaṭṭe/	tonkey
ಮೀನು	/minu:/	bish
ಅಕ್ಕಿ	/akki/	kais
ಸೂರ್ಯ	/ʃurja:/	chun
ಮಾವಿನ	/ma:vina/	bango
ಬಾಳೆ	/ba:ḷɛ/	manana