Cross Language Priming in Bilingual Aphasics

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Abstract

The present study aimed to determine whether cross language semantic and translation priming was present in bilingual aphasics and normals in a pair-wise lexical decision task. The stimuli were designed to induce automatic processing (relatedness proportion of 0.3 and non word ratio of 0.5) in two conditions - prime presented in Kannada (L1) and target in English (L2) and prime in English (L2) and target in Kannada (L1), presented with a 250 ms SOA and a stimulus set. Results revealed that significant semantic priming and translation priming was present in aphasics and normals when the prime was presented in (L1) and target in (L2). However, significant semantic and translation priming was present only for normals when the prime was presented in (L2) and target in (L1). This suggests that lexical processing of primes was slower in aphasics compared to normals. In addition, priming was greater in L1-L2 condition than L2-L1 condition for both aphasics and normals. This asymmetry is explained on the basis of the revised hierarchical model and the sense model.

Introduction

The issue of language processing in human beings has remained an enigma despite decades of research. The challenge posed by bilingual individuals is much more intricate and therefore has interested linguists, neurolinguists, psycholinguists and speech language pathologists as well. Since majority of the world's population is comprised of bilinguals (De Bot, 1992), a host of studies on bilinguals is documented in the recent past.

Among these studies the nature of bilingual's lexical organization has been widely investigated. Many research paradigms are employed to determine whether each language is represented in a specific, separate language store or whether both languages share a common store. Priming paradigms, among which the experimental paradigms of semantic and translation priming, are widely used to explore the structure of bilingual lexicon since these paradigms facilitate study of automatic processing that is crucial to an understanding of language processing.

Numerous models have been proposed to explain semantic representation and access of lexical items between two languages (L1 and L2). The word association model (Potter et al., 1984) assumes that the second language words (L2) gain access to concepts only through first language mediation (L1) whereas the Concept Mediation Model (Potter et al., 1984) assumes that second language words directly access concepts. The revised hierarchical model proposed by Kroll and Stewart (1990, 1994) includes connections between both L1 and L2 and the central concept. However, the links differ in their strengths as a function of proficiency in L1 relative to L2. Therefore, L1 presumably has a larger lexicon than L2. Finally, de Groot (1992) proposed the mixed model which combines the word association and

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concept mediation models. This model assumes that the lexicons of a bilingual are directly connected to each other as well as indirectly connected by way of a shared semantic representation. Several variables are found to influence the bilingual lexical processing and these include language proficiency, structural similarity between languages, word frequency, etc.

Majority of the studies have been conducted on normal healthy individuals to understand the organization of languages. However, individuals with bilingual aphasia provide opportunity to observe the way in which multiple languages interact and offer a plan to study the neuropsychological organization of multiple languages with respect to one another. Studies carried out on lexical organization in bilingual aphasics provide evidence for cross linguistic links that exist between the cognate lexicons of the two languages in comparison to non cognates. Stadie et al., (1995) studied cross language picture naming in German (L1), French (L2) and English (L3), in a highly educated German patient. There was no difference between oral and written picture naming in any of the languages, but German naming was generally much better preserved indicating that German words were activated to a greater extent than French and English words. In addition they found that naming was better for cognates compared to non cognates in all the three languages. The authors interpreted the results with a mixed model (De Groot, 1994) which proposes that identical items in different languages i.e. cognate words are represented in a single system but that nonidentical elements would be treated in different systems.

Lalor and Kirsner (2001) investigated the speed and accuracy of word recognition on cognates relative to non-cognates during word reading and lexical decision tasks in a 63 year old multilingual man with mixed aphasia. There were no differences in response speed. For word reading there was a greater advantage for low-frequency cognates in Italian (the relatively weaker language post-morbidly) that had high-frequency English translations. This indicated facilitation from the stronger to weaker language. Results were interpreted to support a single-system model of bilingual lexical organization in which words are organized by morphology within a unified system.

Majority of the studies carried out in bilingual aphasia have been done in orthographically/structurally similar languages and have utilized offline tasks which really do not tap the automatic processing during lexical processing. Offline tasks are influenced by memory and attentional demands and thus can mask a patient's strength and weakness in any single area including subcomponents of the language domain. So far only one study (Lalor & Kirsner, 2001) used online tasks to assess lexical organization, but this was a case study. To date there are no documented reports in bilingual aphasia using priming tasks. Priming studies in aphasia would help us to understand the organization, relationship and processing between the lexicons of a bilingual individual.

Therefore the present study focuses on lexical organization in bilingual adult aphasics and matched normal controls using semantic and translation priming paradigm. The SOA (250 ms) and the stimulus set (nonword ratio of 0.50 and relatedness ratio of 0.3) were designed to induce automatic processing. Further, the results of this experiment would provide guidelines for treatment methods for bilingual individuals with aphasia.

Method

Aphasia in bilinguals is highly intriguing to researchers since it offers a very potential source of data to understand language representation as well as language loss in cerebral hemispheres. The present study is designed to study lexical processing in bilingual aphasics by employing priming task.

Objectives of the study:

1. To study cross-language priming in bilingual aphasics in comparison to matched normal controls.
2. To investigate whether cross-language translation and semantic priming is present in bilingual aphasics and normals in a pair-wise lexical decision task presented with a 250 ms SOA and a stimulus set designed to induce automatic processing when
   a. The prime is presented in the subject's first language (Kannada) and the target is presented in the subject's second language (English).
   b. The prime is presented in the subject's second language (English) and the target is presented in the subject's first language (Kannada)

Subjects

Five aphasics and five normal adults matched on the basis of age, gender, educational level and language proficiency served as subjects. Subjects were bilinguals, had Kannada as their first language and learnt English as second language at 10 years of age. All subjects demonstrated sufficient visual acuity (aided or unaided) to read stimulus words presented white on black, such as those used in the experiments. Normal subjects had no history of neurological, communicative or sensory impairment. Persons with a history of neurological disorder other than that precipitating the diagnosis of aphasia in the aphasic subject group were excluded.

Table 1: Demographic details of aphasic subjects

Parameters	A1	A2	A3	A4	A5
Age	43	78	62	52	63
Gender	Male	Male	Male	Male	Male
Education Level	B.E	H.S	G	G	Diploma
Occupation	Engineer	Retired	Retired	G.J	Retired
Time post onset	2 yrs	1 yr 8mts	3yrs 4 mts.	1 yr 6 mts	1 yr
Handedness	Right	Right	Right	Right	Right
Lesion Description	Left MCA infract	Ischemic infract in left hemisphere	Left MCA infract	Left MCA infract	Left infraction in frontal & temporal area
WAB scores in Kannada					
Spontaneous speech	18	1 17	18	18	17
Auditory comprehension	9.8	9.5	9.3	10	10
Repetition	8	8	9	9	9.6
Naming	7.1	6.4	7.4	7	6
Aphasia quotient in Kannada	85.8	81.8	87.4	88	85.2
Aphasia type in Kannada	Anomia	Anomia	Anomia	Anomia	Anomia
WAB scores in English					
Spontaneous speech	17	18	18	18	17
Auditory comprehension	9.7	9.5	8.95	10	10
Repetition	8	8	8	9	9.5
Naming	7.4	6.8	7.5	7	7
Aphasia quotient in English	84.2	84.5	84.9	88	87
Aphasia type in English	Anomia	Anomia	Anomia	Anomia	Anomia

B.E= Bachelor in Engineering, H.S=High School, G=Graduation, G.J=Government Job

All the aphasic subjects had a history of left cerebro-vascular accident confirmed by neurological examination. The diagnosis of aphasia subtype was determined by their performance on the Western Aphasia Battery (WAB, Kertez, 1982; see Appendix-A for details of the test) in Kannada and English. All aphasic subjects were a minimum of six months post-onset at the time of testing. Table 1 show the demographic details of aphasic and Table 2 show the demographic details of the normal subjects.

Table 2: Demographic details of normal subjects

Parameter	N1	N2	N3	N4	N5
Age	43	78	62	52	63
Gender	Male	Male	Male	Male	Male
Education Level	B.E	H.S	G	G	Diploma
Occupation	Engineer	Retired	Retired	G.J	Retired
Handedness	Right	Right	Right	Right	Right

B.E= Bachelor in Engineering, H.S=High School, G=graduation, G.J=Government Job

The questionnaire from Part A of Bilingual Aphasia Test (BAT, Paradis & Libben, 1987; Paradis & Rangamani, 1989) and Australian second language proficiency rating scale (ASLPR, Ingram 1985) were used to get information on language history of all the subjects. ASLPR is a scale that rates the proficiency of bilinguals in all four language skills (listening, speaking, reading and writing) on nine points. ASLPR was used to match aphasics and normal controls for language use. All subjects were proficient in English and Kannada. Tables 3a and 3b show the description of language usage by aphasics and normal subjects.

Table 3a: Description of language usage by aphasic subjects

Language usage	**A1**	**A2**	**A3**	**A4**	**A5**
Native language (L1)	Kannada	Kannada	Kannada	Kannada	Kannada
Second language (L2)	English	English	English	English	English
Other languages known	H	KoH	H	H/T	H/T
Language of Education	K/E	K/E	K/E	K/E	K/E
Age of learning L2	10 years	7 years	10 years	10 years	10 years
Years of Education in English	12 years	8 years	11 years	11 years	9 years
Language used at home	K/E	K/E	K	K	K
Language used at work/outside	K/E	K/E	K/E	K/E	K/E
Premorbid proficiency of L1&L2 (for aphasics)	L1=L2	L1=L2	L1=L2	L1=L2	L1=L2
Post morbid proficiency of L1 & L2	L1=L2	L1=L2	L1=L2	L1=L2	L1>L2

Short version of Bilingual Aphasia Test, Kannada-English version was administered to compare different language skills in subjects' two languages. This gave a clear picture of effect of aphasia on the two languages. BAT results revealed parallel recovery in both the languages.

Table 3b: Description of language usage by normal subjects

Language usage	N1	N2	N3	N4	N5
Native language (L1)	Kannada	Kannada	Kannada	Kannada	Kannada
Second language (L2)	English	English	English	English	English
Other languages known	H	H	H/Te	H	H
Language of Education	K/E	K/E	K/E	K/E	K/E
Age of learning L2	10 years	10 years	10 years	10 years	11 years
Years of Education in English	12 years	6 years	11 years	11 years	14 years
Language used at home	K	K	K	K	K
Language used at work/outside	K/E	K/E	K/E	K/E	K/E
Premorbid proficiency of L1&L2 (for aphasics)	L1=L2	L1=L2	L1=L2	L1=L2	L1=L2
Post morbid proficiency of L1 & L2	L1=L2	L1=L2	L1=L2	L1=L2	L1=L2

H=Hindi, Ko=Konkani, Te=Telugu, Ta=Tamil

Stimulus material:

Translation equivalent word pairs, semantically related word pairs and semantically unrelated word pairs formed the stimulus material. All the stimuli were non cognates*. Two base lists of one hundred and twenty five cross language prime-target containing seventy five non-repeated word targets and fifty non-repeated nonword targets were made. In the first list the prime was in Kannada and the target was in English and in the second list prime was in English and target was in Kannada.

Table 4: Example of stimulus material used in the experiment

Stimulus material	Kannada – English		English - Kannada	
Prime-target pairs	Prime	Target	Prime	Target
Translation Equivalents	su:dzi	Needle	water	ni:ru
Related words	pennu	Book	roof	nela
Unrelated words	a:ne	Plane	shelf	ha:vu

Words were selected from textbooks, dictionaries and Coltheart and Karanth (1984) word list. Attempt was made to include only frequently occurring words. Part of the non words were selected from Coltheart and Karanth word list and the rest were formed by substituting, transposing and/or adding one or two letters of words not selected for word targets. Nonwords were pronounceable and orthographically regular.

Out of the seventy five word targets, twenty five were preceded by translation equivalent prime, twenty five were preceded by related prime and twenty five were preceded by unrelated prime. These seventy five prime-target pairs were the critical prime target pairs and were included in the statistical analysis. Twenty five filler prime-target pairs were also

* Cognates are words with the same meaning and a similar form in two languages that share a common parent language or have a history of borrowing due to contact between each other. Example: The French/English pair 'tigre/tiger'. Since Kannada and English are orthographically and structurally different, cognate words are not present in Kannada and English.

made in each list. These filler targets were used to achieve the relatedness proportion of 0.3 and nonword ratio of 0.5 and were not included in the statistical analysis. The fifty nonwords were preceded by word primes. Table 4 shows the example of stimulus material used in the experiment.

To counterbalance target items across the different priming conditions three additional lists were made from each base list in the two language-order condition (i.e. Kannada-English and English-Kannada). These additional lists were formed by making new primes for the targets. Prime type was alternated across each list such that each word target appeared equally in the translation equivalent, related and unrelated priming condition. The final list consisted of three hundred word targets and 50 nonword targets in each language-order condition. Stimulus lists were counterbalanced across subjects such that each subject received hundred prime-target word pairs (25 translation equivalent word pairs, 25 related word pairs, 25 unrelated word pairs and 25 filler prime-target word pairs) and fifty nonword target. The final list in the two language-order condition was given to five Speech Language Pathologists to judge the relatedness between prime-target word pairs. They were also requested to indicate the most frequently occurring words in day to day conversation. The words that were judged as not so frequently occurring (for e.g. ba:TaTa) were eliminated from the list.

In the two language-order conditions i.e. Kannada-English and English-Kannada each list was subdivided into 5 blocks consisting of 20 word targets (5 translation equivalents, 5 related, 5 unrelated and 5 filler prime-target word pairs) and 10 nonword targets in each list. The relatedness proportion of 0.3 and nonword ratio of 0.5 was kept constant in all the blocks in each language-order condition. Prior to each experimental session (i.e. for each individual subject) the order of items within each of these blocks was randomized and then the order of the 5 blocks was randomized. Scrambling the stimuli in this manner decreased the likelihood of extraneous serial effects such as practice or fatigue.

A practice block of 18 prime-target trials containing 12 word targets and 6 nonword targets were made in two language order condition. Primes and targets for the practice blocks were words not used in the experiment. Out of the 12 word targets, 4 were preceded by translation equivalents, 4 preceded by related prime and 4 were preceded by unrelated prime.

Procedure:

All subjects were tested individually in a room. All prime-targets in the two language-order condition were presented consecutively on the centre line of a computer monitor. Words were displayed on white letters on black background on the monitor. Stimulus presentation was controlled by DMDX* software. Subjects responded by pressing the right arrow key for a 'yes' response and the left arrow key for a 'no' response on the key board. All subjects responded by pressing the keys with the index and middle finger of their right hand. Reaction times were recorded to the nearest millisecond and stored in the computer. The error rates were also noted down for each of the trial.

Each prime was presented for 200 ms. This was followed by a 50 ms interstimulus interval (ISI) during which the screen was blank. The target word then appeared and remained on the screen for 4000 ms or until the subject responded, whichever occurred first. The subsequent prime appeared 2000ms (inter-trial interval) after the previous target was

* DMDX software was developed by Kenneth I. Forster and Jonathan C. Forster at Monash University and at the University of Arizona. DMDX is a Win 32-based display system used to measure reaction times to visual and auditory stimuli. Detailed information regarding this software is available at the following website: www.u.arizona.edu/~kforster/dmdx/dmdx.htm

cleared from the screen. If a subject failed to respond to a target within 4000 ms that item was recorded as an error, the inter-trial interval was initiated, followed by presentation of the subsequent prime.

Subjects were read instructions describing the task. Subjects were told that they would see pairs of letter strings on the computer screen and that they were required to decide quickly and as accurately as possible whether or not the second letter string was a word or not (i.e. in Kannada-English condition they had to respond to the English target and in the English-Kannada condition they had to respond to the Kannada target). Two minutes break was given after each block and five minutes break after each language condition was over. The entire session took around 25-30 minutes. The reaction times of all the critical targets were subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS).

Results and Discussion

The aim of this study was to determine whether cross language translation and semantic priming was present in bilingual aphasics and normals in a pair-wise lexical decision task presented with a 250 ms SOA and a stimulus set designed to induce automatic processing (relatedness proportion of 0.3 and non word ration of 0.5) in two conditions-prime presented in Kannada (L1) and target in English (L2) and prime in English (L2) and target in Kannada (L1). Reaction time and error rate data were analyzed for aphasics and normals. Mean reaction time (RT), mean standard deviation (SD) and mean percentage error rates (ER) in each of the language order (Kannada-English and English-Kannada) and prime type is given in Table 5. Difference between the mean reaction times between the prime types in the two language-order condition (priming effect) is given in Table 6.

All reaction times below 200 ms and above 2000 ms were considered as outliers and eliminated from the analysis before the mean values for reaction times were calculated (Ulrich & Miller, 1994). The reaction times for incorrect responses were also eliminated from the analysis. This elimination did not change the general pattern of results. For the aphasic subjects, 2% of the data was eliminated and for normals this accounted to less than 0.5%.

Table 5: Mean Reaction Time (RT), SD and Mean Percentage Error Rate (ER) in each of the Language-Order and Prime type Condition

	PRIME TYPE											
Subject groups	Translation Equivalent			Related			Unrelated			Overall		
	RT	SD	ER	RT	SD	ER	RT	SD	ER	RT	SD	ER
Kannada – English (L1-L2)												
Normals	692.70	81.25	1.74	742.40	84.07	2.13	806.55	93.94	2.29	747.2	86.42	2.05
Aphasics	832.26	158.34	12.05	861.16	150.47	14.27	915.79	158.00	14.71	871.72	155.90	13.82
English - Kannada (L2-L1)												
Normals	803.05	149.32	1.82	831.71	82.95	2.21	871.08	104.80	2.65	835.28	112.35	2.26
Aphasics	901.97	212.20	14.93	931.12	184.08	15.62	941.12	184.08	16.45	924.87	196.29	15.66

Table 6: Priming effect in milliseconds

Subject Groups	TP	SP	Overall
Kannada-English (L1-L2)			
Normals	+ 113.85*	+ 64.1*	+ 177.9
Aphasics	+ 77.5*	+ 54.6*	+ 132.1
English-Kannada (L2-L1)			
Normals	+ 68*	+ 40*	+ 108
Aphasics	+ 40	+ 10	+ 50

TP=Translation priming; SP=Semantic priming; TP= Unrelated minus translation equivalent; SP=Unrelated minus related * indicates significance at 0.05 level

a) Reaction Time Analysis:

Reaction time analysis was done in order to determine whether translation priming and semantic priming was present in aphasics and normals. Reaction time data was subjected to Analysis of Variance (ANOVA) after the outliers were removed.

i) Normal Subjects:

A 2 (language order: Kannada-English and English- Kannada) × 3 (prime type: translation equivalent, related and unrelated) ANOVA was performed on the reaction time data of normal subjects. The main effect of language order was significant [F (1,744) = 119.73, P < 0.001]. This analysis indicates that 81.66 ms difference between the 753 ms mean RT in Kannada-English condition and 835 ms mean RT in English-Kannada condition was statistically significant. The main effect for prime type was also significant [F (2, 744) = 49.577, P < 0.001]. A Tukey Post-Hoc analysis for Kannada-English and English-Kannada condition combined revealed a significant difference between translation equivalents and unrelated word pairs (P < 0.005), between related word pairs and unrelated word pairs (P< 0.005) and between translation equivalents and related word pairs (P < 0.005). The language-order by prime type interaction was not significant. [F (2, 744) = 3.74, p= 0.064].

A separate one way ANOVA was performed for each of the prime type condition in order to determine whether facilitation (i.e. the priming effect) was significant for Kannada-English and English-Kannada condition. This analysis yielded a main effect for priming in Kannada- English condition [F (2,372) = 54.808, p < 0.001). A Tukey Post-Hoc analysis revealed that the + 113.85 ms facilitation for translation equivalents word pairs was significant (p < 0.005) and the +45 ms facilitation for related word pairs was significant (p < 0.005). Main effect was also present for priming in English-Kannada condition [F (2, 372) = 10.891, p< 0.001). A Tukey Post-Hoc analysis revealed that the +68 ms facilitation for translation equivalent word pairs was significant (p< 0.005) and the +40 ms facilitation for related word pairs was significant (p< 0.005).

A Paired t test was done to check whether there was any significant difference in the magnitude of translation and semantic priming between Kannada-English and English-Kannada condition. This revealed that the magnitude of translation and semantic priming was significantly greater in Kannada-English condition (P<0.005).

1. **Aphasic Subjects**

A 2 (language order: Kannada-English and English-Kannada) ×3 (prime type: translation equivalent, related and unrelated) ANOVA was performed on the reaction time data of aphasic subjects. The main effect of language order was significant [F (1,740) = 16.72, p< 0.001]. This analysis indicated that the 53 ms difference between 871 ms mean RT in Kannada-English condition and 924 ms mean RT in English-Kannada condition was statistically significant. The main effect for relatedness was also significant (2,740) = 6.730, p< 0.001]. A Tukey Post-Hoc analysis for Kannada-English and English-Kannada condition combined revealed a significant difference between translation equivalent word pairs and unrelated word pairs (p < 0.005) and between related word pairs and unrelated word pairs (p< 0.005). The language order by relatedness interaction was not significant. [F (2,740) = 1.161, p = .314].

A separate one way ANOVA was performed for each of the relatedness condition in order to determine whether the facilitation (i.e. the priming effect) was significant in Kannada-English and English-Kannada condition individually. This analysis yielded a main effect for priming in Kannada-English condition [F (2,371) = 8.108, p< 0.001]. Tukey Post-Hoc analysis revealed that the + 77.5 ms facilitation for translation equivalent word pairs was significant (p< 0.005) and the 54.6 ms facilitation for related word pairs was significant (p< 0.005). The main effect for priming in English-Kannada condition was not significant [F (2,369) = 1.33, p =.264].

A Paired 't' was done to check whether there was any significant difference in the magnitude of translation and semantic priming between Kannada-English and English-Kannada condition. This revealed that the magnitude of translation and semantic priming was significantly greater in Kannada-English condition (P<0.005).

b) Error Analysis:

Error analysis was carried out in order to determine whether there were differences in the error rate in each of the language order and prime type condition for normals and aphasics. Error data was analyzed using ANOVA.

i) Normal Subjects:

The total percentage of errors produced by normals was 2.15% (2.05% in Kannada-English condition and 2.26% in English-Kannada condition). Normal subjects made 2.05 % overall error in Kannada-English condition and 2.26 % overall error in English-Kannada condition.

A 2 (language order: Kannada-English and English-Kannada) × 3 (prime type: translation equivalent, related and unrelated) ANOVA was performed on the error data of normal subjects. The main effect for language order and prime type was not significant [F (1,744) = 0.808, p = 0.369; F (2,744) = 4.316, p = 0.06]. The interaction effect was also not significant [F (2,744) = .234, p = 0.791].

ii) Aphasic Subjects

Aphasic subjects made13. 82 % overall error in Kannada – English condition and 15.6 % in English – Kannada condition. The total percentage of errors produced by aphasics was 14.7% (13.8% in Kannada - English condition and 15.6% in English - Kannada condition).

A 2 (language order: Kannada-English and English-Kannada) ×3 (prime type: translation equivalent, related and unrelated) ANOVA was performed on the error data of aphasic subjects. The main effect for language order was significant [F

(1,744) = 4.32, p<0.05]. This analysis indicated that number of errors the aphasics subjects made in English-Kannada condition was significantly greater than Kannada-English condition. The main effect for relatedness was not significant [F (2,744) = 1.68, p = .18]. The interaction effect was also not significant [F (2,744)= .23, p = .79].

c) Comparison between normals and aphasics:

i) Reaction Time

An independent 't' test was performed in order to check whether differences were present in the reaction times between normals and aphasics in the two language order condition (Kannada-English & English-Kannada) across translation equivalents, semantically related and semantically unrelated word pairs. This indicated that there was highly significant difference (p <0.001) between normals and aphasics and that normals responded significantly faster in two language order condition across translation equivalents, semantically related and semantically unrelated word pairs. The 't' values df's and significance level for reaction time is given in Table 7. Figure 1 & 2 shows the graph of the mean reaction time across different prime types in normals and aphasic in the two language order condition.

Table 7:'t' values, df's and significance level of RT between normals and aphasics

Condition	t value	df	significance
Kannada - English			
TE	9.14	248	0.000
R	6.45	248	0.000
UR	6.06	247	0.000
English - Kannada			
TE	4.26	248	0.000
R	5.31	247	0.000
UR	3.68	246	0.000

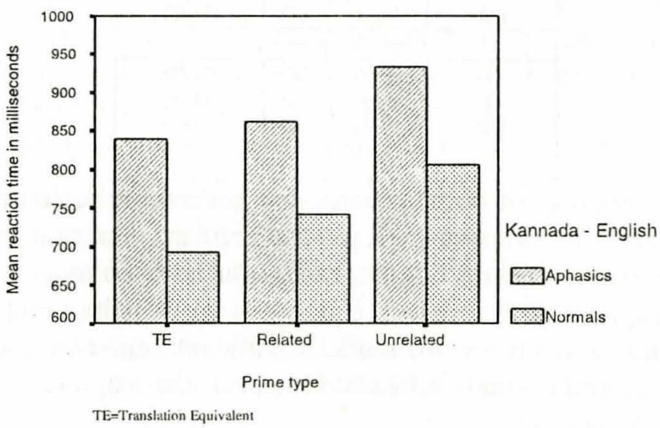

Figure 1: Mean RTs across different prime types in Kannada-English condition between aphasics and normals

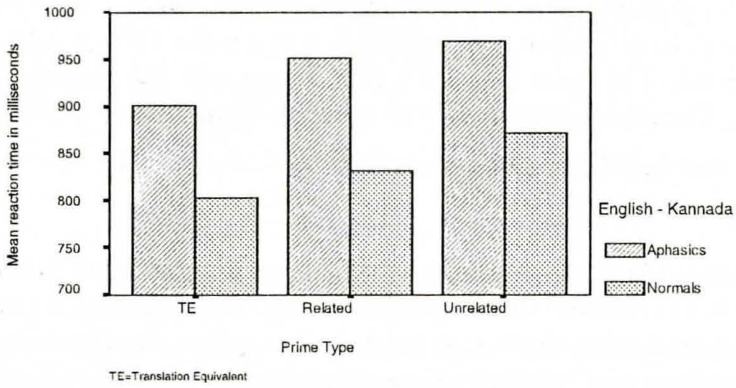

Figure 2: Mean RTs across different prime type in English-Kannada condition between aphasics and normals

ii) Error rates:

An independent t-test was performed in order to check whether differences present in the error rates between normals and aphasics in the two language order condition (Kannada-English and English-Kannada) across translation equivalents, semantically related and semantically unrelated word pairs were significant. This indicated that there was a significant difference which suggests that the normals were able to recognize the target words more easily and accurately than aphasics. The t values df's and significance level for error rates is given in Table 8.

Table 8: The t values, df's and significance level of error rates between normals and aphasics

Condition	t value	df	significance
Kannada – English			
TE	8.45	248	0.000
R	11.64	248	0.000
UR	9.27	248	0.000
English – Kannada			
TE	10.69	248	0.000
R	10.41	248	0.000
UR	13.74	248	0.000

Reaction time measures of both aphasics and normals indicate that both the groups of subjects were faster in their response in Kannada-English condition compared to English-Kannada condition. In the Kannada-English condition both aphasics and normals subjects were faster in their response to translation equivalent word pairs compared to semantically related and semantically unrelated word pairs. Significant semantic and translation priming was present for aphasics and normals subjects. However, the magnitude of priming was more in normals compared to aphasics.

In English-Kannada significant semantic and translation priming was present only in normals and not in aphasics. Normals responded to translation equivalent word pairs faster compared to semantically related word pairs. Aphasic subjects made more errors in English-Kannada condition compared to Kannada-English condition. The errors made by normal subjects were not significant. In addition aphasic subjects made more errors compared to normal subjects.

Discussion

The aim of the present study was to determine whether cross language semantic and translation priming is present in bilingual aphasics and normals in a pair-wise lexical decision task presented with a 250 ms SOA and a stimulus set designed to induce automatic processing (relatedness proportion of 0.3 and nonword ratio of 0.5) when the prime is presented in Kannada (L1) and target is presented in English (L2) (Kannada-English) and the prime is presented in English (L2) and target in Kannada (L1) (English-Kannada).

Results indicate that significant semantic priming and translation priming was present in aphasics and normals when the prime is presented in Kannada and target is presented in English (Kannada-English). Aphasics responded to semantically related words 54.6 ms faster compared to unrelated word pairs and 77.5 ms faster to translation equivalent word pairs compared to unrelated word pairs. Normal subjects responded to semantically related words 64 ms faster compared to unrelated word pairs and 113.85 ms faster to translation equivalent word pairs compared to unrelated word pairs. Though priming was present in aphasics the magnitude of semantic and translation priming was less. This suggests that lexical processing of primes was slower in aphasics compared to normals.

Significant semantic and translation priming was present in normals when the prime was presented in English and target was presented in Kannada (English-Kannada). Normal subjects responded to semantically related word pairs 40 ms faster compared to unrelated word pairs and 60 ms faster to translation equivalent word pairs compared to semantically unrelated word pairs. However, semantic and translation priming was not present for aphasics.

In the aphasic group, priming was present only in Kannada-English condition and not in English-Kannada condition. The absence of priming in English-Kannada condition shows that prime words in English are apparently not activated to a sufficient threshold to spread to Kannada target words. Stadie et. al., (1995) reported significant lexical activation in German words (L1) compared to French (L2) and English (L3). The results of the present study are in agreement with Stadie et. al., (1995). Further it was observed that for translation equivalent and semantically related word primes in Kannada facilitated activation of English targets than primes in English and target in Kannada. Therefore recognition of translation equivalent and semantically related word targets in English was easier than Kannada.

The results of the error data analysis did not reveal any significant difference between the two language-order conditions in normals. However, the aphasic subjects made more errors in English- Kannada condition than Kannada-English condition. This suggests that for the aphasic subjects priming in English (L2) did not facilitate recognition of target in Kannada (L1) whereas priming in Kannada (L1) facilitated speed and accuracy of recognition of target in English (L2). Aphasics also made more errors compared to normals in both the conditions.

The magnitude of translation priming obtained in this study was larger than semantic priming in aphasics (L1-L2 condition) and in normals (L1-L2 and L2-L1 condition). This may occur because translation equivalents word pairs have more semantic overlap, since translation activates the same or almost similar conceptual representation (De Groot & Nas, 1991; Altarriba & Basnight Brown, 2005). The presence of translation priming in orthographically dissimilar languages as in the present study (non cognates) can be attributed to automatic spreading activation to semantic nodes. When the translations are cognates and both are clearly visible it is conceivable that the priming effect might be due to orthographic similarity between the prime and the target, facilitating peripheral processing of the target and by the retrieval of episodic traces. But the presence of priming in non cognates can be attributed to spreading activation between the lexicons of the bilingual, thus suggesting a cross language connection between the representations of translation equivalent at the semantic level. The presence of translation priming in aphasics for non cognates further supports the notion that cross language connection does exist between translation equivalents. The above findings corroborate those of Jin and Fischler (1987) obtained with Korean-English bilinguals, Chen and Ng, (1989) who tested Chinese-English bilinguals, De Groot and Nas (1991) who tested Dutch-English bilinguals and Altarriba & Basnight Brown (2005) who tested Spanish-English bilinguals.

The results of the semantic priming obtained in this study for aphasics and normals are in agreement with a number of other studies done on normals that show that semantic priming can occur between languages (Chen & Ng, 1989; Keatley, Spinks & De Gelder, 1990, De Groot & Nas, 1991, Keatley, Spinks & De Gelder, 1994, Altarriba & Basnight Brown, 2005). The magnitude of semantic priming was less in aphasics and normals compared to translation priming which may be due to fewer overlaps between semantically related word pairs compared to translation equivalent word pairs.

Asymmetry in priming for aphasics and normals

The translation and semantic priming obtained in this study for aphasics and normals were both larger in Kannada-English condition than English-Kannada condition revealing that priming asymmetry was present. The pattern of priming asymmetry is reported by several authors who have conducted studies on normal bilingual adults (Altarriba, 1992; Keatley, Spinks & De Gelder, 1994; Fox, 1996; Altarriba & Bansnight Brown, 2005). One explanation for this asymmetry is that subject's fist language Kannada was processed faster than their second language English. Stronger cross language effects from L1-L2 may be attributed to richer and stronger representation in the L1 language system.

Presumably even in proficient bilinguals, L1 representation may be richer and strongest than those of L2 because they are based on multiple encoding of the word in various verbal contexts and on many encoding of the various cross modal contexts such as naming of an object. L2 acquisition may produce representations that are less highly connected within and across memory system, but which till refer to the same external objects (Keatley, Spinks & De Gelder, 1994).

The results obtained in this study on aphasics are also consistent with this view point that even in proficient bilinguals L1 might be richer than L2. The asymmetry that is reported in normal bilingual individuals perhaps gets exaggerated in its manifestation after brain insult leading to marked difference between L2-L1 condition and L2-L1 condition and thus insignificant priming in L2-L1 condition. Apart from pre-morbid proficiency and exaggerated difference in priming consequent to brain insult, the factors of pattern of recovery and the intensity of language therapy appear to have contributed to the results. But, all subjects had parallel recovery in both languages and type of aphasia was also the same as evident from WAB and BAT results. Therefore, it is very unlikely that the difference could be due to recovery and language therapy.

Explanation for the asymmetry obtained for aphasics and normals

The revised hierarchical model is successful in predicting the priming asymmetries that is observed in this study. According to this model L1 is seen as being larger than the L2 since it is assumed that the bilingual would have a larger vocabulary in his native language than in his second language. The link between the L1 and concepts appears to be bidirectional and very strong since a child acquiring his first language would form the strongest link between the language's lexicon and the corresponding concepts. However, as a person acquires a second language especially if it is later in life, L2 words would be integrated into memory by developing a pathway that is attached to the lexicon of the first language. Since the link between the conceptual store and the L2 lexicon is described as being weaker than the link between the conceptual store and the L1 lexicon, it has been suggested that priming in L2-L1 direction would be weaker and less in magnitude than L1-L2. Similar findings are observed in the present study which supports this premise.

Explanation for the asymmetry obtained for translation priming

A more recent proposal that may provide some explanation for the translation priming effects observed in this study, as well as in previous studies, was proposed by Finkbeiner et al. (2004). They proposed the "sense model" to account for the pattern of data observed in cross-language priming studies. They point out that many words have language specific "senses" and that this aspect of language is often not taken into account in the bilingual literature. For example, they suggest that the word *black* in English and the word *kuroi* (black in Japanese) are translation equivalents, but in reality they really do not have much in common besides sharing the same sense for color. Black in English can refer to the color, a person of African American decent, an illegal sales market (i.e., black market), or even a cup of coffee that lacks cream and sugar. Meanwhile, the Japanese language also contains its own specific senses for the word *black* (or *kuroi*).

This characteristic of language, particularly the differences in senses across languages, can shed some light on the reported translation priming effects in that "the amount of priming may depend not only on the overlap in the semantic senses activated by the prime and target, but crucially, on the ratio of primed to unprimed senses associated with the target" (Finkbeiner et al., 2004,). This idea suggests that each sense of a word is represented as a separate and specific representation in the semantic and lexical stores, which can cause there to be a representational asymmetry between related words. Since translations are classified as "translations" they obviously have one meaning in common, but it is often the case that bilinguals are more proficient in their L1 than in their L2, which would suggest that they would be more familiar with the range of senses that a word could have in the L1 as compared to the L2. Finkbeiner et al. (2004) point out that if priming increases as the proportion of primed to unprimed senses of the target word increases, one can expect the proportion of L2 senses primed by an L1 prime to be very high in bilinguals who are more proficient in their L1 (i.e., reliable and significant L1-L2 priming). However, in the opposite direction (L2-L1), the proportion of L1 senses primed by the L2 prime will be lower because the L2 language skills may not be as strong as those in the L1 even in proficient bilinguals and as a result, many of the L1 senses will not be associated with L2 senses. This type of processing suggests that L2-L1 priming should occur to a lesser degree, a phenomenon that has been repeatedly reported. This study also supports this view point that processing in L2-L1 occurs to a lesser degree than L1-L2.

To summarize the results of the present study on bilingual aphasics is very important in that cross language translation and semantic priming was obtained in bilingual aphasics despite the structural/ orthographic distance between the two languages indicating the presence of a common conceptual system and a stronger link from L1 to conceptual link than from L2 to conceptual link. Despite the absence of cognate words between English and

Kannada, cross-language priming was evident in the result which is in contrast to most of the studies carried out in bilingual aphasia which report of improved performance or facilitation for cognate words compared to noncognates (Roberts & Desslauriers, 1999).

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