Cross Language Priming in Normal Bilingual Adults

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Abstract

Bilingualism, more generally, multilingualism, is a major fact of life in the world today. Bilinguals have opened up newer portals for research as one cannot consider a bilingual as two monolinguals in one person and generalize results from monolingual studies. The nature of bilingual lexical organization is an enduring question in bilingual research. Two major theoretical view-points have been dominant. First, the language specific hypothesis and the language-independent hypothesis. Numerous models have been proposed to support or refute either of these two hypotheses. A variety of experimental tasks have been employed to study the bilingual mental lexicon. Among the online tasks the primed lexical decision task has been frequently used to study bilingual lexical organization. The present study employs the visual pair-wise LDT in a cross-language translation and semantic priming paradigm. A total of thirty normal bilingual adults in the age range of 18-40 years served as subjects. Amongst the thirty, they were further grouped as high proficient bilinguals (HP) and low proficient (LP) users of English on the basis of ratings obtained on the International Second Language Proficiency Rating Scale (ISLPR). They participated in the priming experiment, in both the language-order conditions i.e. Kannada-English and English-Kannada. Stimulus presentation was controlled by DMDX software. The reaction times of all the critical targets were subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS). The results of the reaction time analysis in general reveal asymmetry in cross-language priming. The findings are explained in the light of the revised hierarchical model (RHM).

Introduction

Bilingualism, more generally, multilingualism, is a major fact of life in the present world. Today, everyone is at least a bilingual; there is no one in the world who does not know at least a few words in languages other than their native language. Bilinguals have opened up newer portals for research as one cannot consider a bilingual as two monolinguals in one person and generalize results from monolingual studies (Grosjean, 1989). Several types of bilingualism have been put forth based on various parameters.

The nature of bilingual lexical organization is an enduring question in bilingual research (Snodgrass, 1984). Over the past couple of decades much of the research conducted in the bilingual domain has been concerned with the organization of a bilingual's two languages. Two major theoretical view-points have been dominant. First, the *language specific hypothesis,* which proposes that the lexical knowledge of the bilingual may be represented in two language-specific memory systems, one for each of the bilingual's languages. Second, the *language-independent hypothesis,* which proposes that bilinguals have a common, language-independent, conceptual representation for words in their two languages. Numerous models have been proposed to support or refute either of these two hypotheses. The Word Association Model, first put forth by Potter, So, von Eckhardt &

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Feldman (1984), assumes that second language (L2) words gain access to concepts only through first language (L1) mediation. [L1 refers to the language acquired first; most often the native language and the dominant language, L2 refers to the language acquired later, usually the relatively less dominant language]. The links between L1 and L2 are the lexical links and the links between L1 and the concepts are denoted as the conceptual links. This model predicts that translation from L1 to L2 will be faster than picture naming in L2 because translation relies on the lexical links and can thus by pass conceptual access. In contrast to the above, concept mediation model (Potter et al., 1984) proposes that second language words directly access concepts for words in both languages. This model predicts that the translation from L1 to L2 and picture naming in L2 should be similar because both require conceptual access prior to the retrieval of L2 lexical items. Potter et al (1984) investigated translation and picture naming in a group of fluent Chinese-English bilinguals and found that the time to translate from L1 to L2 and to name pictures in L2 were very similar, thus providing support for the model. However, the application of these models to bilingual adults depends on the respective proficiency in each language. Kroll and Curely (as cited in Kroll & de Groot, 2002) employing a similar task as Potter et al (1984) with bilinguals with low and high second language (L2) proficiency observed evidence for word association models in the low proficiency bilinguals and the concept mediation model in high proficiency bilinguals. In Revised Hierarchical Memory (RHM) Model by Kroll and Stewart (1990, 1994) bilingual memory is conceived as represented in separate but inter-connected lexicons. These two structures represent the bilingual's first (L1) and second language (L2) lexicons. This model's most critical assumption is that the lexical links differ in strength and words in each language are linked to a general concept and to each other. The L2 lexicon is connected to the L1 lexicon by strong links and the L1 is connected to the L2 lexicon by weak links that are sensitive to semantic processing. Because bilinguals seldom translate from their L1 to their L2, they develop a weak link from their L1 to their L2 and it does not develop as well as the active L2 to L1 lexical links. In addition to the connections between the two lexicons bilingual memory is thought to be composed of a conceptual store. The conceptual store is said to contain abstract representations about the world. The conceptual store is connected to both the L1 and L2 lexicons. However, the connections between the L1 lexicon and the conceptual store are strong and direct; whereas, the connections between the L2 lexicon and the conceptual store are weak. Thus, the subject's L1 is more likely to access the conceptual store directly (conceptually mediate) than the subject's L2. In other words, when exposed to an L1 concept, the bilingual is more likely to access the conceptual store because of his/her L1. Because the lexical link from the bilingual's L2 to L1 lexicon is stronger and faster, the bilingual would most likely utilize these links to access the conceptual store. In this way, the link from the conceptual system to the bilingual's L2 lexicon remains weaker. The RHM model assumes that both lexical and conceptual links are active in bilingual memory but the strength of those links differs as a function of fluency in L2 and the relative dominance of L1 to L2. Thus an asymmetry was hypothesized: L2 to L1 translation should be faster than L1 to L2 translation and also less sensitive to the efforts of semantic factors. Finally, de Groot (1992) proposed the Mixed Model which combines the word association and the concept mediation models. This model argues that the lexicons of a bilingual are directly connected to each other as well as indirectly connected by way of a shared semantic representation.

A variety of experimental tasks have been employed to study the bilingual mental lexicon. Online tasks are preferred as these can be used to measure effects occurring at various temporal points during ongoing processing and are often sensitive to fast acting, automatic processes that rely on integration and interaction of several types of information. Among the online tasks, the primed lexical decision task (LDT) (Meyer & Schvaneveldt, 1971) has been frequently used to study bilingual lexical organization.

Priming refers to an increase in the accuracy, probability or speed of response to stimulus (called the target) as a consequence of a prior exposure to another stimulus (called the prime). Priming patterns when seen across different languages is termed cross-language priming. The most common interpretation of priming is that the cortical representations of the prime and target are inter-connected or overlap in some way such that activating the representation of the prime automatically activates the representation of the target word. Priming patterns described above when seen across different languages is termed cross-language priming. E.g., among the pairs *perro* (Spanish for dog; prime) - CAT (target) and *casa* (Spanish for house; prime) – CAT (target), responses will be faster for the former than the latter as they are semantically related. Essentially, here the prime-target pairs are of different languages. Cross-language priming experiments' results enable us to get an insight into the bilingual memory architecture. If a bilingual's two languages are stored in separate language specific lexicons, then no cross language semantic priming would be expected. However, if semantic priming is found across languages, then one can conclude that both languages share a common representation system.

Priming can be of different types:

i) **Semantic Priming/Associative Priming:** It refers to easier or faster identification of a word when it is preceded by a word related in meaning. E.g., Identification of cat (prime)-DOG (target) is faster than book (prime)-DOG (target) as the first pair is semantically related. In the bilingual version of it, the prime is in one language and the target word in the other language. E.g. chien (prime) - CAT (target)

ii) **Repetition Priming or Translation Priming:** Repetition priming is the phenomenon whereby subjects are faster and more accurate at responding to a word if it is preceded by the same word (a repetition prime) than if it's preceded by a different, unrelated word. In translation priming a prime word is presented in one language of a bilingual followed by its translation in the other language of the bilingual. 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. In repetition or translation priming the presentation of a prime word automatically causes its lexical entry to be activated (Forster & Davis, 1984) so that if the subsequent target is the same as the prime word, less target processing has to be done before a response is made.

In the study of bilingual lexical organization, translation and semantic priming paradigms using lexical decision tasks (LDT) have been frequently used. The present study employed the visual pair wise LDT in a cross-language translation and semantic priming paradigm. The semantic priming effects obtained with the lexical decision task may be attributed to Posner and Snyder's (1975) dual process theory of priming. According to this, priming effects may be either due to:

i) Automatically, fast acting, inhibition-less automatic priming component,

OR

ii) Priming can be induced via attentional processes, reflecting subjects' awareness of contextual factors that extend beyond the prime-target relationship; strategic priming.

Automatic priming effects can be discussed in terms of automatic spreading activation (ASA). The concept of ASA is based on the assumption that semantically/associatively related word nodes are stored or linked closely together in lexical memory. In other words, the cortical representations of the prime and the targets are inter-connected or overlap in some way. Thus the spreading activation theory of semantic priming assumes that the prime preactivates the representations of every word that is semantically related to it. Also, as this spread of activation occurs only between word nodes that are semantically or associatively related, the presentation of a prime does not have an impact on the processing of words unrelated to the prime. Therefore, ASA can account for facilitatory effects but not inhibitory effects.

Automatic priming occurs under conditions which discourage conscious processing of the prime, for example, when the stimulus-onset-asynchrony (SOA) between the prime and the target is very short (250 ms or less). SOA refers to the amount of time between the onset of the prime presentation and the onset of the target presentation. According to Neely (as cited in Fox, 1996) a short SOA discourages the use of attentional processes, as these mechanisms require more time to be operative. The relatedness proportion (RP) which is defined as the proportion of related prime-target trials out of all prime-target trials also influences automatic and strategic processing. It has been shown that when the relatedness proportion is large (i.e., more related word pairs than unrelated in an experiment), the semantic priming effect is larger than usual (de Groot, 1984). Therefore, it is suggested that RP should be kept low when designing priming experiments if one is to obtain the most accurate estimate of priming effect (i.e., automatic processing). Nonword ratio also affects processing. The nonword ratio is best explained as the proportion of nonwords out of all nonword and unrelated word pairs. Therefore, when this ratio is below 0.50 (i.e., the experimental stimuli consists of more word pairs than nonword pairs), individuals may be biased to give a response when a nonword is presented, simply because more words than nonwords are in the experimental list. However, when the nonwords ratio is above 0.50, participants may choose nonwords because nonwords are presented more frequently than words (Mc Namara & Holbrook, 2003). The ideal nonword ratio is 0.50.

In studies investigating cross-language priming, it has generally been found that cross language priming occurs with SOAs of 300 ms or less (Chen & Ng, 1989; Keatley et al., 1994). With longer SOAs it is assumed that strategic factors play a role in producing priming effects.

During the past three decades there has been a plethora of studies conducted in cross-language priming, both translation priming and semantic priming (Altarriba, 1990; Basnight Brown & Altarriba, 2005; Chen & Ng, 1989; de Groot & Nas, 1991; Frenck & Pynte, 1987; Gollan, Forster & Frost, 1997; Grainger & Beauvillain, 1988; Grainger & Frenck-Mestre, 1998; Jiang, 1999; Jiang & Forster, 2001; Jin, 1990; Keatley & de Gelder, 1992; Keatley, Spinks & de Gelder, 1994; Kirsner et al., 1984; Larsen, Fritsch & Grava, 1994; Tzelgov & Eben-Ezra, 1992; Williams, 1994). Further, proficiency is an important variable that determines priming effects along with others like the presence or absence of phonemic/graphemic similarity of items across languages, word frequency, level of concreteness etc. Chen and Ng (1989) investigated semantic facilitation and translation priming effects in Chinese-English bilingual speakers with a lexical decision task (LDT). A 300 ms SOA was used between display of the prime and the target item. Results of the first experiment revealed that subjects' lexical decision responses were facilitated to a greater extent when primed by a translation equivalent than a semantically related between-language word. Results of their second experiment revealed that pictorial between language and within language primes produced comparable effects of semantic facilitation. The results are in line with the hypothesis that lexical items in different languages and pictures are processed by means of amodal conceptual system.

In a series of experiments Keatley, Spinks and de Gelder (1994) employing a LDT found that cross language priming does occur but only when primes are presented in the subjects' first language (L1-Chinese) and the target words are presented in the subjects' second language (L2-English). They attributed the asymmetry in cross language priming to stronger connections from L1 to L2 than from L2 to L1 and also suggest that this asymmetric cross-language priming can be accounted for by a language specific model of bilingual memory, where representations of words expressed in different languages are stored in separate memory systems which may be interconnected via one to one links between some translation equivalent representation as well as meaning integration processes. A few studies have specifically investigated only translation priming. These studies have revealed a wide range of results (Altarriba, 1990; Chen & Ng, 1989; de Groot & Nas, 1991; Gollan, Forster & Frost, 1997; Grainger & Frenck-Mestre, 1998; Jiang, 1999; Jiang & Forster, 2001; Jin, 1990; Keatley & de Gelder, 1992; Keatley et al., 1994; Williams, 1994). The studies have focused on determining if primes that are translation equivalents of their targets will facilitate target processing. Typically the results have shown that translation primes and targets that are form related (cognates) produce larger and more consistent priming effects than translation primes that have no form overlap (noncognates).

Thus a review of the existing literature reveals mixed results regarding the nature of cross-language priming, especially with regards to translation equivalents. But all these studies have been done in the western context and in structurally similar languages.

Considering bilingualism in India, it is different from that prevalent in the countries of Europe and America. In the light of this situation, generalization of the western research findings to the Indian context is not appropriate. Studies investigating priming patterns in Indian-English bilinguals are necessary. Further, the studies investigating priming patterns across different proficiency groups using online tasks such as the primed lexical decision task have been sparse. Hence, it would seem worthwhile to probe into the priming patterns of individuals who use languages with different scripts.

The present study was thus designed with the following objectives:

1. To investigate cross-language priming (translation and semantic) in Kannada-English bilingual adults using a stimulus set designed for automatic processing, when,

   i. The prime presented in Kannada (L1) and target in English (L2); L1-L2 condition.

   ii. The prime presented in English (L2) and target in Kannada (L1); L2-L1 condition.

2. To investigate the priming patterns across high proficient and low proficient bilinguals.

Method

Subjects

A total of thirty normal bilingual adults in the age range of 18-40 years served as subjects. The thirty subjects were further grouped as high proficient (HP) and low proficient (LP) bilinguals users of English on the basis of ratings obtained on the International Second Language Proficiency Rating Scale (ISLPR). All subjects had Kannada as their first language and learnt English as second language at ages ranging from 3.5 to 15 years (mean age of 6.1 years). All subjects demonstrated sufficient visual acuity (aided or unaided) to read stimulus words presented as white on black of a computer monitor. All subjects had no history of neurological, communicative or sensory impairment. Table 1 shows the particulars of subjects.

Table 1: Particulars of Subjects

Sl. no.	Age in years	Gender	Age of acquisition of L1	Age of acquisition of L2	Mode of acquisition of L2	ISLPR scores	Proficiency	Years of formal education	Years of formal education in L2	Educational qualification
1	18	F	0	3.5	Sc+ H	S5L5W5R5	HP	15	15	12+
2	20	F	0	3.5	S c+ H	S5L5W5R5	HP	17	17	G
3	20	F	0	3.5	S c+ H	S5L5W5R5	HP	17	17	G
4	23	F	0	3.5	S c+ H	S5L5W5R5	HP	19	19	PG
5	19	M	0	3.5	S c+ H	S5L5W5R5	HP	16	16	12+
6	20	F	0	3.5	Sc	S4L4W4R4	HP	16	16	12+
7	19	M	0	3.5	Sc	S5L5W5R5	HP	16	16	12+
8	19	M	0	3.5	Sc+ H	S5L5W5R5	HP	16	16	12+
9	19	M	0	3.5	Sc	S5L5W5R5	HP	16	16	12+
10	18	M	0	3.5	Sc	S4L4W4R4	HP	15	15	12+
11	19	M	0	3.5	Sc+ H	S4L4W4R4	HP	15	15	12+
12	18	F	0	3.5	Sc	S5L5W5R5	HP	15	15	Diploma
13	20	M	0	3.5	Sc	S5L5W5R5	HP	16	16	12+
14	19	F	0	3.5	Sc+ H	S5L5W5R5	HP	15	15	12+
15	18	M	0	3.5	Sc+ H	S5L5W5R5	HP	15	15	12+
16	20	F	0	3.5	Sc	S3L3W3R3	LP	17	17	G
17	18	M	0	9	Sc	S3L3W3R3	LP	15	10	12+
18	18	M	0	15	Sc	S2L2R2W2	LP	15	3	12+
19	30	M	0	15	Sc	S3L3W3R3	LP	18	6	B.S.Ed
20	19	M	0	15	Sc	S2L2R2W2	LP	15	3	Diploma
21	19	M	0	3.5	Sc	S3L3W3R3	LP	15	15	Diploma
22	20	M	0	13	Sc	S3L3W3R3	LP	17	6	G
23	21	M	0	13	Sc	S3L3W3R3	LP	18	7	G
24	20	M	0	3.5	Sc	S3L3W3R3	LP	16	16	12+
25	30	F	0	13	Sc	S3L3W3R3	LP	19	9	PG
26	24	F	0	13	Sc	S3L3W3R3	LP	19	9	PG
27	19	M	0	3.5	Sc	S3L3W3R3	LP	15	15	12+
28	18	F	0	3.5	Sc	S2L2W2R2	LP	15	15	12+
29	18	F	0	3.5	Sc	S2L2W2R2	LP	15	15	12+
30	23	M	0	3.5	Sc	S3L3W3R3	LP	18	18	G

S-Speaking; L-Listening; R-Reading; W-Writing; H-Home; Sc-School; HP-high proficient; LP-low proficient; G-graduate; PG - post graduate.

Stimulus Material

Translation equivalent word pairs, semantically related word pairs and semantically unrelated word pairs formed the stimulus material. Two base lists of one hundred and twenty five cross language prime-target containing seventy five nonrepeated word targets and fifty nonrepeated 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.

Words were selected from textbooks, dictionaries and Coltheart and Karanth (1982) word list. Attempt was made to include only frequently occurring words. Part of the nonwords 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 primes, twenty five were preceded by related primes and twenty five were preceded by unrelated primes. 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 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 2 shows the example of stimulus material used in the experiment

Table 2: Example of stimulus material used in the experiment

	Kannada-English		**English-Kannada**	
Prime-target pairs	Prime	Target	Prime	Target
Translation Eq.	Akki	Rice	rain	maLe
Related words	thaTTe	Rice	cloud	maLe
Unrelated words	enTu	Rice	bunch	maLe

To counterbalance target items across 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 version 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-targets 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 and one Linguist to judge the relatedness between prime-target word pairs and also to judge the frequently occurring words of the prime and targets.

In the two language-order condition 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 conditions. Primes and targets for the practice blocks were words not used in the experiment. Out of the 12 word targets, 4 were preceded by translations equivalents, 4 were 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 as white letters on black background on the computer monitor. Stimulus presentation was controlled by DMDX* software. Subjects responded by pressing the right arrow key and the left arrow key on the key board. Pressing the right arrow key (for a 'yes' response) and the left arrow key (for a 'no' response). 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.

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* 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.dmdx.

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 2000 ms (intertrial interval) after the previous target was 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 as 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

Before the mean values for reaction times were calculated all reaction times below 200 ms and above 2000 ms were considered as outliers and eliminated from the analysis (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. This accounted for 1.7% of the total data from both the groups.

Reaction Time Analysis

A 3 (prime type/relatedness) x 2 (language order) x 2 (proficiency) analysis of variance (ANOVA) was performed with item mean reaction times and the error rates. Table 3 shows the 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.

Table 3: Mean RT, SD and mean ER to word targets in each priming condition TE/R/UR.

Conditions	Prime types								
	TE			R			UR		
	RT	SD	ER	RT	SD	ER	RT	SD	ER
HPKE	638.61	137.10	1.54	678.03	214.63	1.47	754.88	53.64	1.66
HPEK	851.13	323.99	3.25	886.55	353.55	3.40	959.53	370.82	3.46
LPKE	953.26	149.25	3.25	1028.75	282.72	2.90	1036.93	193.10	3.01
LPEK	989.87	508.18	3.37	1022.60	260.07	3.19	1037.01	234.54	5.81

TE= Translation Equivalent, R= Related, UR= Unrelated priming conditions

A significant main effect was obtained for all the three variables considered, namely,

1. Proficiency (HP, LP)
2. Language order (K-E, E-K)
3. Relatedness (Translation Equivalents (TE), Related (R) and Unrelated (UR)

The main effect for proficiency groups was statistically significant [F (1, 4319)=657.438, P<0.05], indicating that the high proficient subjects were faster in the lexical decision task (LDT) (791ms) as compared to the low proficient subjects (1013.64 ms).

The main effect for language order was also significant [F (1, 4319) =157.37, P<0.05] suggesting that performance was faster in K to E condition (850.52 ms) than E to K (960.45 ms). The main effect for relatedness emerged significant [F (2, 4319) =36.08, P<0.05] revealing that translation equivalents (TE) were judged faster (858.86 ms) followed by related (R) targets (909.29 ms) and maximum reaction times to unrelated (UR) targets (945.80 ms).

The interaction effect of all the three variables suggested that out of the three interaction effects two were significant, namely,

i) Proficiency group and language order interaction.

ii) Proficiency group and relatedness interaction.

Language order and relatedness failed to reach statistical significance [(F (2, 4319) =1.102, P=0.332)]. The proficiency group by language order interaction was significant [F (1, 4319) =140.67, P<0.05] indicating that high proficient subjects judged the target words faster (690.53 ms) in the K-E order than the LP (1010.5 ms) in the same as well as reverse language order.

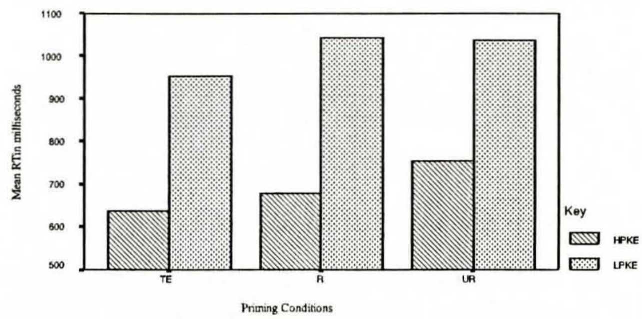

Figure: 1 Mean RT of HP and LP in K-E Condition

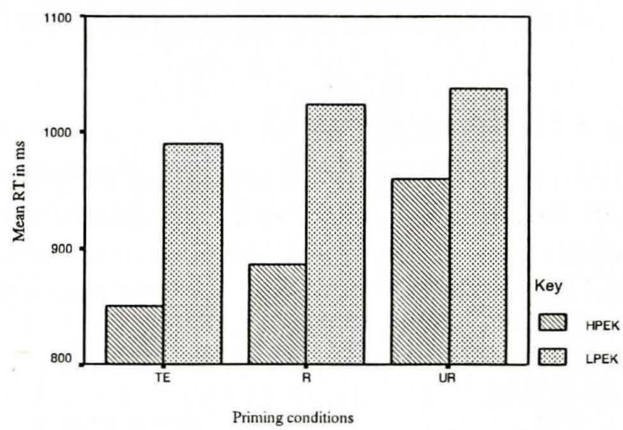

Figure 2: Mean RT of both the groups in E-K condition

The proficiency group by relatedness interaction was also significant [F (2, 4319) =5.95, P<0.05] indicating that performance of high proficient subjects on the translation equivalents were better followed by related targets and unrelated targets than by the low proficient group.

Four separate one way ANOVAs were performed for each of the relatedness condition (translation equivalents, related and unrelated items) in order to determine whether facilitation (i.e. the priming effect) was significant for the K-E and E-K condition individually, across both high proficient and low proficient bilinguals.

Performance of High Proficiency Group

This analysis revealed a significant main effect for priming in the K-E direction [(F (2, 1101) =57.088, P<0.05]. A Tukey Post Hoc analysis revealed that the +116.27 ms facilitation for translation equivalents word pairs was significant (p<0.05) and the +76.85 ms facilitation for the related word pairs was significant (P<0.05).

Significant priming was also observed in the E-K direction [F (2, 1020) =8.345, P<0.05]. A Tukey Post-Hoc analysis of the difference between the mean reaction times obtained in each priming condition indicated that the 108.4 ms facilitation obtained for translation equivalent word pairs and the +64.32 ms facilitation obtained for the related word pairs was significant (P<0.05).

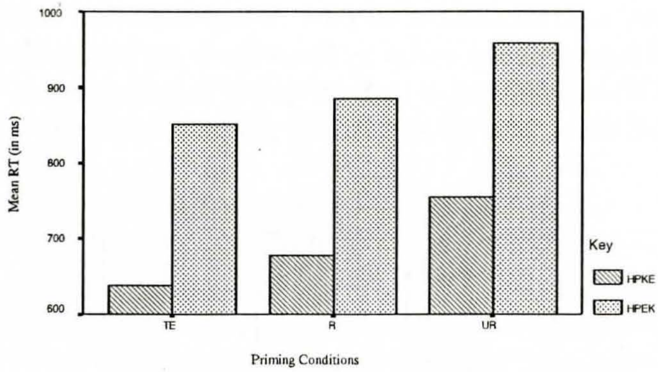

Figure 3: Mean RTs of HP in both language orders

To summarize the results of the high proficient group, significant priming (both translation and semantic priming) was observed across both the language directions (i.e. in K-E and E-K). But, the priming effects were more for translation equivalent word pairs, in both the language directions. Also L1-L2 overall priming effect was more (193.12 ms) than L2-L1 (172.72 ms).

Performance of the Low Proficiency Group

One way ANOVA revealed a significant main effect for priming in the K-E direction only [F (2, 1100) =20.02, P<0.05]. A Tukey Post-Hoc analysis of the difference between the mean reaction times obtained in each priming condition revealed a significant translation priming effect of +84.13ms (P<0.05). However, no significant facilitation was seen for semantically related word pairs.

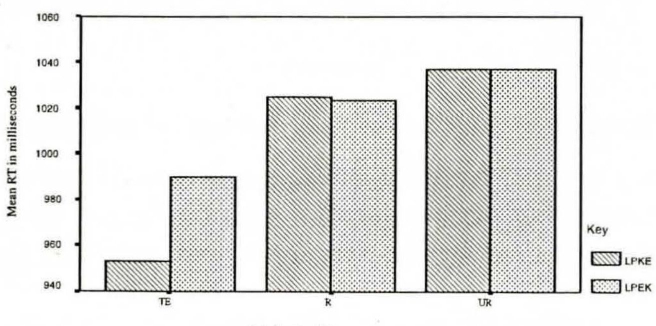

Figure 4: Mean RT of LP in both the language orders

Priming was not significant in E-K language direction [F (2, 1105) =1.708, P= .182]. Thus, the +47.14 ms facilitation effect for translation equivalent and the +13.40 ms facilitation for related word pairs were not statistically significant. Significant priming was observed only in the K-E (L1-L2) direction and not in the E-K (L2-L1) direction for this group. Further, only the facilitation effect for translation equivalent word pairs reached statistical significance. The related word pairs showed no significant facilitation effect.

The results of the reaction time analysis in general reveal asymmetry in cross-language priming. This asymmetry was especially evident in the language order and proficiency groups, with the priming effects larger in the Kannada to English direction than the reverse and larger priming effects in the high proficient groups than the low proficient bilinguals. Though priming was evident in low proficient bilinguals also, the magnitude of priming was small compared to that of high proficient bilinguals. Further, priming effects was significant across both the language directions (i.e. K to E and E to K) only for the high proficient group. In the low proficient bilinguals priming was significant only in the K-E direction. In terms of the prime types, translation equivalent word pairs were judged relatively faster than semantically related words and maximum reaction times were evidenced for unrelated word pairs. This general trend was noticed across both the proficiency groups and in both the language directions, though a statistical significance was not reached. Table 4 shows the summary of priming effects.

Table 4: Priming Effects Summary (in milliseconds)

Conditions	Facil TE	Facil R	Overall
KPKE	+116.27*	+76.85*	+193.12*
HPEK	+108.4*	+64.32*	+172.72*
LPKE	+84.13	-5.35	+78.78
LPEK	+47.14	+13.40	+60.54

*indicates statistical significance at 0.05 level

Facil TE= Facilitation for translation equivalent = (UR minus TE), Facil R= Facilitation for related = (UR minus R), Over all = Facil TE = Facil R

Error Analysis

The total percent errors produced by the high proficient bilingual group amounted to less than 1% of the entire data. Errors in the K-E language order condition was 2.31%. Error rate was high for unrelated word pairs (3.51%). A 2 (Proficiency group) x 2 (Language-order) x 3 (relatedness) ANOVA yielded a main effect for only the proficiency group and language direction and not for the relatedness factor. The main effect for proficiency yielded a significance [F (1, 4488) =7.02, P<0.05] suggesting that the HP group made the least errors compared to the LP group. Main effect for language direction emerged significant [F (1, 4488) =11.47, P<0.05] revealing that errors were less in the K-E direction than E-K.

The relatedness factor did not emerge statistically significant [F (2, 4488) =1.233, P=.291). Though a statistical significance was not attained, qualitatively it appears that subjects made more errors to unrelated targets than translation equivalents and related targets. None of the interaction effects were significant. A one way ANOVA of the mean error rates obtained in each (priming condition- translation equivalents, related and unrelated word pairs) was performed separately in each of the proficiency groups (HP and LP) and for both the language order conditions (K to E and E to K). The results yielded no statistical significance across any of the conditions compared.

Discussion

The results of the study reveal the presence of cross-language priming in both directions, Kannada-to-English (K-E, i.e. L1-L2) and English-to-Kannada (E-K, i.e. L2-L1) as evidenced by faster reaction times (RT) to the target words in either language when the prime preceding it was given in the opposite language (i.e. a Kannada prime facilitated an English target and vice-versa). Further, the performance of the high proficient group was faster as compared to the low proficient group. Thus there was an asymmetry in priming; larger priming from L1-L2 than L2-L1.

This finding is in consensus with previous literature reports (Altarriba, 1990; Chen & Ng, 1989; Frenck & Pynte, 1987; Keatley, Spinks & Gelder, 1990; Kirsner, Smith Lockhart, King & Jain, 1984) all reporting significant L1-L2 priming than in the reverse direction.

Asymmetrical cross language priming can be accounted for by a language independent/common storage model of bilingual memory (Kroll & Sholl (as cited in Kroll & de Groot, 2002); Kroll & Stewart 1990, 1994). According to the model the asymmetry is attributed to the different type of connections at work in a L1-L2 condition (conceptual links) as against the L2-L1 (lexical links) condition. 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 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.

Another finding that emerged from the study was significant translation priming (calculated as mean reaction time of unrelated minus mean reaction time of translation equivalent) was observed in both language-order conditions, L1-L2 and L2-L1. Semantic priming effects (calculated as the difference between the mean reaction time of unrelated and related targets) on the other hand, was smaller in magnitude compared to translation priming effects, in both the language directions L1-L2 and L2-L1. In other words, the translation priming effects for each language direction were larger than the semantic priming effects reported for the same language-order direction (i.e. L1-L2 translation priming was larger than L1-L2 semantic priming and L2-L1 translation priming was larger than L2-L1 semantic priming). A possible explanation for this could be that though semantic and translation word pairs are linked in a similar manner at the lexical level, translation equivalents may be different in that they have increased overlap at the conceptual level (de Groot & Nas, 1991; Basnight Brown & Altarriba, 2005). This enhanced semantic overlap that translation equivalents have over semantically related words may be able to explain the larger translation priming effects as compared to semantic priming effects.

The finding of larger translation priming effects in L1-L2 than L2-L1 can be best explained by the sense model (Finkbeiner et al., 2004). According to this model many words have language specific "senses". Each sense of a word is represented as a separate and specific representation in the semantic and lexical stores which can cause a representational asymmetry between related words. 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. The bilinguals are more proficient in their L1 than in their L2 and thus they would be more familiar with the range of senses that a word could have in the L1 as compared to the L2. The proportion of L2 senses primed by an L1 prime would 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 much lower because the L2 language skills may not be as strong as those in the L1 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, undoubtedly in translation equivalents.

Most of the studies on translation priming have delineated the word type effects on priming and increased priming effects for cognates (i.e. translations with similar spellings and meaning; for example, kalf-CALF; Dutch-English) than noncognates (i.e. translation with dissimilar spelling e.g. vrouw-WIFE). Typically, the results from a larger number of studies have shown that translation primes that are cognates (form related) produce larger and more consistent priming effects than translation primes and targets that are noncognate pairs (no form overlap) (de Groot & Nas, 1991; Grainger & Frenck-Mestre, 1998; Sanchez-Casas et al., 1992; Willaims, 1994).

In the present study, since the script structure of Kannada and English is different, there were no cognate pairs; all translation equivalent word pairs were noncognates and priming effects were observed for these noncognate pairs as well. Results from studies investigating cross-language translation priming in orthographically dissimilar languages have reported of robust priming effects, for both cognates and non cognates in L1-L2 direction (Gollan et al., (1997) in Hebrew-English bilinguals and Jiang, (1999) in Chinese-English bilinguals). In their study priming for non-cognates in L2-L1 direction, though significant, was reduced in magnitude. The robustness of L1-L2 priming is accounted for by the Revised Hierarchical Model (Kroll & Stewart 1990, 1994) in which L1-L2 translation may be conceptually mediated, unlike the L2-L1, which is mainly lexically mediated. Also it was further suggested that L1 words are typically associated with more information and are more rapidly recognized than L2 words. Therefore these serve as more efficient primes. The results of the present study where priming was observed for noncognate pairs as well offer a strong support for conceptual mediation in both high proficient and low proficient bilinguals. In general, the magnitude of priming was greater for the high proficient (HP) bilinguals than that low proficient (LP) group and this difference reached a statistical significance ($P< 0.05$). Again, priming was larger from L1-L2 than L2-L1.

A plausible explanation for our findings could be found in the RHM. In the RHM the development of links between the conceptual store and L2 lexicon depends to a great extent on the proficiency level. It has been suggested that this link may be very weak or non existent in a novice bilingual. A novice thus might have a weak connection between the concepts and L2 lexicon when compared to a more balanced bilingual. Several studies have shown that bilinguals who are at the very early stages of second language acquisition can access some forms of conceptual (i.e. semantic) information (Altarriba & Mathis, 1997; de Duyck & Brysbaert 2004; Frenck-Mestre & Prince, 1997; La Heij, Hooglander, Kerling & van der Veldon, 1996). Therefore, it appears that all bilinguals regardless of their level of proficiency can access some semantic information but the degree of that activation is influenced by proficiency and language dominance. Thus in our study both the groups, HP and LP were able to access the semantic concepts and thereby demonstrate priming effects. But the priming effects were larger for HP group as their connections with the L2 lexicon are stronger than the LP group.

Summarizing the results of the present study it can be said that the study offers interesting insights from cross-language translation and semantic priming paradigm. While both high proficient and low proficient bilingual adults revealed priming effects in both directions the magnitude was larger from L1- L2. Also, priming on translation equivalents was relatively higher than related pairs in both low proficient and high proficient bilinguals. Further, by virtue of the structural/orthographic distance between the two languages, which as a rule led to noncognate pairs did not influence priming negatively which offers a very clear evidence of semantic mediation and not lexical mediation nor orthographic inhibition as reported in cross-script studies with similar structural dimensions.

Conclusions

1. Significant priming was observed in both the language-orders, Kannada-English (L1-L2) and English-Kannada (L2-L1). That is, a prime presented in Kannada could activate the representation of the target word in English automatically and vice-versa. This provides evidence for a shared representation of concepts between the two languages.
2. Priming effects were found to be larger in Kannada (L1)-English (L2) direction than the reverse. This could be explained by the Revised Hierarchical Model, wherein the connections between L1 and the concepts are stronger than L2 and the concepts. Hence, larger priming effects are attributed to these strong conceptual connections from L1 to conceptual store as against the weaker connections from L2 to the concepts. Thus, a prime in Kannada activated its target representation in English faster owing to its stronger tie-up with the conceptual store than a prime in English which will take relatively longer to activate its target representations in Kannada.
3. Translation priming effects were more robust than semantic priming effects. A possible explanation for this could be that though semantic and translation word pairs are linked in a similar manner at the lexical level, translation equivalents may be different in that they have increased overlap at the conceptual level.
4. High proficient bilinguals were quicker and more accurate to judge the targets as words or nonwords in the lexical decision task than the low proficient subjects. Semantic priming studies have reported that fluent bilinguals are able to take advantage of the semantic context, even when it appears in the other language. Our finding of larger magnitude for overall priming in highly proficient bilinguals thus serves as an addendum to the previous research findings. Priming was observed even in the low proficient group but its magnitude was lesser than the high proficient group due to the weak connections between the concepts and L2 lexicon, when compared to more balanced bilinguals. Therefore, it appears that all bilinguals regardless of their level of proficiency can access some semantic information, but the degree of that activation is influenced by proficiency and language dominance.

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