LANGUAGE NON-SPECIFIC LEXICAL ACTIVATION IN BILINGUALS: EVIDENCE FROM THE PHONEME MONITORING TASK

[1]Prarthana Shivabasappa, [2]Rajashekar B, & [3]Gopee Krishnan

Abstract

The language-specific versus language non-specific views of bilingual lexical activation has been overwhelmingly debated in the contemporary bilingual research. In this context, the present study attempted to address this issue in a group of bilingual subjects. The study employing phoneme monitoring task in two orthographically dissimilar languages (Kannada & English) in a group of normal bilinguals. The subjects required more time to reject phonemes in the non-target language (translation) picture names. The findings of the study supported the language non-specific view of bilingual lexical activation. Further, the study also revealed the role of orthography in phoneme monitoring task especially when two orthographically dissimilar languages are considered.

Keywords : *Bilingualism, Orthography, Lexical activation, Phoneme monitoring task*

One of the most remarkable abilities of bilingual speakers is that of separating their two languages during the production of speech (Costa & Santesteban, 2004). Although the speech of highly proficient bilinguals in their second language (L2) often carries traces (e.g., accent, syntactic structures) of the first language (L1), it rarely exhibits lexical intrusions (Poulisse, 1999). That is, these bilinguals are competent enough at selecting and producing words from only one of their lexicons, both in L1 and L2 according to the communicative context. The contemporary investigations on the functioning of the bilingual mental lexicon focus to uncover this intricate mechanism. In the following section, we briefly review the architecture of the bilingual mental lexicon with emphasis on the points of disparities and proceed to the literature pertaining to the phoneme monitoring task in bilingual research.

Bilingualism has been gaining overwhelming interest in the contemporary literature owing to the rapid rise in the bilingual population across the world. This has further necessitated the research on the organizational principle of the bilingual mental lexicon. Literature on bilingualism reports various neurocognitive and neuroimaging studies relating to brain function investigating lexical representation and processes in bilinguals. Neuro imaging studies have been done using Positron emission tomography (PET) and Functional magnetic resonance imaging (FMRI), and also studies of Event related potentials (ERP) have helped us in understanding anatomical and physiological relationship during speech production in bilinguals.

Although significant advances have been made in the understanding of the organizational as well as the processing strategies of the bilingual mental lexicon, on certain fronts, such as the activation of the non-target language, a consensus is yet to emerge. One of the active areas of inquiries in bilingual research is the nature of lexical activation which focuses on the crucial issue of whether the activated semantic node spreads its activation only to the target lexical node (i.e. language-specific view) or both to the target and non-target lexical nodes (i.e. language non-specific view) in the bilingual mental lexicon. In the present study, we investigated this issue by employing a phoneme monitoring task in two orthographically different languages (Kannada – alphasyllabic and English – alphabetic, Vaid & Gupta, 2002). In the following section, we provide a brief overview of the nature of bilingual lexicon with special reference to the phoneme monitoring task employed in bilingual research.

The nature of lexical activation in the bilingual mental lexicon

Current lexical access models in bilingual speakers assume that the semantic system is shared by the two languages of a bilingual (De Bot, 1992; Costa, Miozzo & Caramazza, 1999; Green, 1986; 1998; Kroll and Stewart, 1994; Potter, So, von Eckhardt, & Feldman, 1984; Poulisse & Bongaerts, 1994) and It has now been agreed by a good majority of the researchers that there exists a conceptual/semantic store common to both languages in bilinguals. The contemporary research, therefore, focus on the crucial issue of whether the activated semantic node spreads its activation only to the target lexical node i.e. language-specific view or both to the target and non-target lexical nodes i.e. language non-specific view.

In the following section we briefly review the studies that have addressed the nature of lexical selection in bilinguals.

[1]Student, Dept. of Speech & Hearing, Manipal College of Allied Health Science (MCOAHS), Manipal University, Manipal, [2]Prof. and Dean, MCOAHS, Manipal University, & [3]Associate Prof. Dept. of Speech & Hearing, MCOAHS, Manipal University, Manipal, E-mail: brain.language.krishnan@gmail.com

The Language-specific view

Costa, Miozzo, and Caramazza (1999) investigated the nature of lexical selection (i.e. language specific or language non-specific) in Catalan-Spanish bilinguals using a picture-word interference paradigm. In their experiment, the distracter word was manipulated at two levels (with respect to the nature of relationship between the distracter and the target words (semantic, phonological, and identity conditions) and the language of the distracter (target and non-target language). Under the semantic conditions, an inhibition – that is, a slower naming when the subjects were presented with semantically related distracter words – was observed. Alternately, there was no difference between the magnitudes of inhibition when the distracter words were presented in either language. In addition, the authors also noticed a cross-language identity effect. That is, when the translation of the picture name was presented as the distracter, subjects named the pictures faster. This led Costa et al. (1999) to claim that the lexical selection took into account only the candidates within the target language, although both languages were activated. That is, according to these authors, the facilitation occurred as the target response was activated twice: once through the picture display and next through the translation equivalent of the distracter word in the non target language. To explain the cross-language semantic inhibition, these authors argued that in the semantic conditions, the distracter word activated its concept, which would spread its activation to the words in both lexicons, and competition would take place between the translation of the distracter and the name of the picture, both in the target language. Therefore, the target (picture name) and the semantically related distracter words (i.e. the translation equivalents in the target language) would compete for selection, thus delaying the lexical selection. Similar findings have been reported in other language pairs as well (e.g. Dutch-English; Hermans, Bongaerts, De Bot & Schreuder, 2000).

In yet another study, Costa and Caramazza (1999) tested whether there existed any competition between the two lexicons of bilinguals using two picture-word interference experiments. They performed the experiments on two groups of proficient bilinguals (English-Spanish and Spanish-English) while naming pictures either in their L2 (Spanish) for first group, or in their L1 (Spanish) for second group. Picture naming was facilitated when the name of the picture and the distracter word were the "same", regardless of the language in which the distracter was printed: same-language (e.g., mesa-*mesa* [*table* in Spanish]) or different-language pairs (e.g., *mesa-table*). The magnitude of this facilitatory effect was similar when naming in L1 and in L2. Costa and Caramazza (1999) also reported that naming latencies were slower when the distracter word was semantically related to the picture's name (e.g., *mesa-chair*), regardless of the language in which the distracter was presented. The results, therefore, suggested that there was no competition between the two lexicons of bilinguals during lexical selection for production, favoring the language-specific view of lexical selection in bilinguals.

Language non-specific view

There have been counter evidences to the language-specific nature of lexical selection in bilinguals. For example, Hermans et al. (1998) required a group of fluent Dutch-English bilinguals to name pictures in their L2 while ignoring the distracter words presented in L1 (experiment 1) and in L2 (Experiment 2). The authors varied the distracter word experimentally such that it was phonologically related to the target's translation (i.e. phono-translation condition). For example, while presenting a picture of a '*mountain*' to be named in English, the distracter word was '*berm*' ('verge') which was phonologically related to the target picture name's Dutch translation '*berg*'. The authors argued that the presentation of such a distracter would activate the targets' (mountain) Dutch translation ('berg'). In another way, target's Dutch translation would be highly activated when the target is presented with a phonologically related distracter compared to an unrelated one (e.g. '*kaars*' – candle) as in the former condition, there are two sources of activation. That is, the target lexicon receives activations from both the picture itself as well as from the translation of the distracter whereas in the latter – control – condition, the lexical node receives activation only from the picture's semantic representation. In this context, if lexical node of the non-target language (here, Dutch) is activated, it would compete for lexical selection which in turn, slower the naming latencies. This has been termed as phono-translation interference effect and Hermans et al.'s study supported such an interference effect. Therefore, these authors concluded that lexical nodes of both target and non-target languages compete for lexical selection, supporting the language non-specific selection models.

The support to this view can also be derived from few recent neuro imaging studies, Parker Jones et.al (2011) conducted a study using FMRI and found higher activation levels for bilinguals in five left hemispheric regions (dorsal precentral gyrus, pars triangularis, pars opercularis, superior temporal gyrus & planum temporale) relative to monolinguals in a task involving picture naming in their native or non native language. This higher activation may be attributed to language non specific activation patterns along with other factors.

Event related potentials have also been useful in understanding processes involved in bilingual lexical activation. The first ERP evidence was obtained in a picture-naming priming task using Chinese-English bilinguals of languages with distinct scripts (Guo, Taomei, Peng, Danling, 2006)**.** The results indicated that parallel activation of both languages supporting language non-specific hypothesis is a universal phenomenon in bilingual speech production. Furthermore, the study revealed that the temporal course and magnitude of activation of the non target language during target language production was modulated by the relative proficiency in the two languages.

Phonological activation in bilingual speech production

Yet another interesting question and perhaps a method to study the nature of language selection in bilinguals is the investigation into the phonological activations of the non-target lexical items. There are different views about spreading activation to corresponding lexical nodes from an activated conceptual representation. According to the cascaded view all the levels of representation (the semantic, lexical, and phonological levels) are activated. In the discrete stage models activation is restricted to the semantic and lexical levels, preventing phonological activation of non-selected lexical nodes. Considering the cascaded view of activation, which is widely accepted, studying the phonological activation of the target and non-target languages, might give us inferences on whether or not the non-target lexical nodes are considered for lexical selection. There have also been a few studies in the past addressing the activation of the phonological representation during bilingual speech production. In Hermans et al.'s (1998) study, the authors paired every picture stimulus with a semantically related word ('valley') and with phonologically similar term ('mouth') with the target 'mountain'. In addition, they presented the stimuli at different stimulus-onset-asynchronies (SOAs) of -300, -150, 0, and +150 ms. According to these authors, if the phonological (Phono-Dutch) interference occurred at the SOAs where semantic effects had previously been found, it could be said to occur at the lemma level. However, if the effects were observed when semantic interference was no longer obtained, but phonological effects had been observed, it could be concluded that the effects of the Phono-Dutch condition were operating at the lexeme level. The results of Hermans et al. (1998) showed interference only in the lemma level where semantic effects had previously been found. This led the authors to conclude that even if the translation had been activated, it had not been phonologically encoded.

Costa, Caramazza, and Sebastián-Gallés (2000) investigated the phonological activation of the non-target language by requiring a group of Catalan-Spanish bilingual subjects to name pictures with cognate and noncogante words in Spanish. According these authors, cognates – having similarity at the phonological level – may be named faster compared to non-cognates since the latter share only their meaning, but not the morphology and phonology. The reason for this cognate facilitation effect, according to the authors, was twofold. First, common phonemes for the target word and its cognate translation would receive extra activation and therefore would be more easily retrieved. Second, the noncognates would have phonemes of their translation activated, and since these differ from those that the speaker produces, they would cause interference. Costa et al.'s result supported the cognate facilitation effect as such words were named faster compared to the non-cognate words. Thus, these authors argued that the non-target language's phonology is activated during bilingual speech production.

In the following year, Colomé (2001) investigated the phonological activation in the non-target language using the phoneme monitoring task. When employed in bilingualism, the phonemes are experimentally altered to fall under one among the three conditions: a) part of the response language (answer 'yes' – filler trial); b) part of the non-response language (answer 'no' – critical trial); part of neither language (answer 'no' – control trial). Colomé (2001) required the Catalan-Spanish subjects to monitor whether a certain phoneme was in the Catalan name or not. This study revealed that the participants took more time to reject the phoneme appearing in Spanish (non-target language) compared to the control phonemes that neither occurred in Catalan nor in Spanish. In addition, this result was also obtained at different stimulus-onset-asynchronies (-2000, +200, & +400 ms). From these observations, Colomé argued that both the target and non-target languages were activated which in turn activated their sublexical units, leading to the delayed rejection of the phonemes in the non-target language.

Role of orthography in phoneme monitoring task

Spoken words are made of combining speech sounds or phonemes and orthography of a language represent and convey these phonemes in a graphic form. Orthography has been found to play vital role in visual word recognition wherein it is claimed that access to the lexical representation is mainly phonologic. According to this view, orthographic information is typically recoded into phonologic information at a very early stage of print processing (Frost1989). Thus orthography is proposed to have a role in phoneme monitoring tasks as well (Dijkstra & Roleofs, 1995). These authors studied whether orthography in addition to the phonology plays a role in phoneme monitoring task. They required a group of Dutch speaking subjects to monitor the experimental phonemes that varied as a function of their primary and secondary spelling. They used three experimental phonemes (/k/: primary grapheme - /k/, secondary grapheme - /c/; /s/: primary grapheme - /s/, secondary grapheme - /c/; and /t/: primary grapheme - /t/, secondary grapheme - /d/). The assumption behind this study was that if orthographic codes become available during speech processing and are consulted in phoneme monitoring, secondary spelling may lead to interference effects because they are not congruent with the canonical spelling of the phonemes. And, in Dutch stimuli, whether a phoneme has primary or secondary phoneme in a word could only be determined on the basis of the identity of the word, requiring the lexical access. Their result showed that the phoneme monitoring times were slower when the phonemes had secondary spelling than when they had only primary spellings. Thus, Dijkstra and Roelofs (1995) concluded that orthographic information of the word is engaged in phoneme monitoring. Although these authors claimed that orthography had an effect on phoneme monitoring task, their evidences was from a monolingual task, examining only the congruency of the graphemes with respect to their phonemes. However, in a recent study on bilinguals, Hoshino and Kroll (2008) asked their Spanish-English (orthographically similar languages) as well as Japanese-English (orthographically dissimilar languages) subjects to name the cognate pictures. Their results showed evidences for the phonological activation irrespective of the differences in orthography.

To summarize the previous research findings, the debate on language-specific versus language non-specific views of lexical selection in bilinguals still continues, with greater evidences prevailing for the language non specific hypotheses. However, before making specific conclusions about this issue, it is desirable to obtain evidences from bilingual subjects using structurally different languages. Additionally, in experimental paradigms employing the phoneme monitoring task, the orthography is expected to play a role, especially in the light of research findings from monolinguals. The present study aimed primarily at investigating the first issue – the nature of lexical selection in bilinguals – by employing the phoneme monitoring task in two orthographically different languages (Kannada – alphasyllabic; English – alphabetic, Vaid & Gupta, 2002). This provided us an opportunity to look into the role of orthography in phoneme monitoring task.

Method

Participants

Fifty right-handed adult bilingual (L1 – Kannada and L2 – English) subjects (males – 27 and females – 23) in the age range of 18 – 30 years (mean – 24 years; SD – 3) participated in the study. All had normal or corrected-to-normal vision and started learning their L2 at the age of 4-5 years with the commencement of schooling and had comparable proficiency in L2 (i.e., ratings of S4 in speaking and R4 in reading in English as per the Australian Second Language Proficiency Rating Scale (Ingram, 1985).

Stimuli

A set of 128 Black & White line drawings were selected from the Kannada adaptation (Ahmed, Krishnan, & Rajashekar, 2008) of Snordgrass and Vanderwart (1980) standardized set of pictures. The frequency, complexity, and imageability of these stimuli were matched. One hundred and twenty pictures were grouped into two blocks (60 items each) to be used for naming in Kannada (L1) and in English (L2). Remaining eight pictures were used as trial items, four in each language.

Design

The experiment was conducted in two different blocks, one for each language. In each block, the pictures were presented in three experimental conditions: *Related* (Condition 1 – Appendix A), *Unrelated* (Condition 2 – Appendix B), and *Control* (Condition 3 – Appendix C). In the *Related* condition, each picture was followed by the grapheme corresponding to the initial phoneme of the picture’s translation in the non-response language. For example, while naming the picture of a *DOG* in English (L2) the grapheme corresponding to the phoneme /n/ - the initial phoneme of picture name in Kannada (*na:ji*) – was presented. This was designated as '*English related*' condition. Similarly naming in

Kannada (*na:ji*) followed by the presentation of the grapheme (e.g. /d/) of its English translation formed the '*Kannada related*' condition. In the *Unrelated* condition, each picture stimulus in both language blocks was followed by a grapheme which was neither a part of the picture's name in Kannada nor in English. For example, while naming the picture of *CAT* in English (L2), the grapheme corresponding to the phoneme /p/ - which was not the part of the picture name neither in Kannada (*bekku*) nor in English (*kæt*) – was presented. This formed '*English unrelated*' experimental condition and naming the picture in Kannada followed by the monitoring of an unrelated phoneme neither in L1 or L2 formed '*Kannada unrelated*' condition. In the *Control* condition, a grapheme that was the part of the target picture name in the response language was presented. For example, while naming the picture of a *BAG* in English (L2) the grapheme corresponding to the phoneme /b/ was presented. This formed '*English control*' experimental condition and naming in Kannada in this condition formed '*Kannada control*' condition.

In each language block, 15 pictures were presented under the '*Related*' and '*Unrelated*' conditions whereas 30 pictures were presented under the '*Control*' condition. This was necessary to balance the number of '*Yes'* and '*No'* responses in each language trail. In the *Related* and *Unrelated* conditions, the expected accurate responses were '*No*' whereas in the *Control* condition, the accurate response was '*Yes'*. Half of the subjects named the pictures in Kannada first followed by English and the remaining half named the pictures in English first followed by Kannada. Thus, each subject performed both Kannada as well as English tasks. The three conditions were randomized within each language block.

Procedure

The participants were tested individually in a quiet environment. The stimulus presentation and the response measurements were controlled using DMDX software program for Windows (Forster & Forster, 2003). The eyes-to-monitor distance was maintained at about 50 cm. The subjects were familiarized with the pictures and their names in both languages to eliminate the ambiguity of line drawings, if any. In addition, this familiarization task deemed important as the word length of the picture names were different in English and Kannada. That is, most of the picture names were monosyllabic in English whereas they were bi- or tri-syllabic in Kannada (majorly due to the alphasyllabic nature of Kannada language). They were also provided with grapheme – phoneme conversion training before the commencement of the experimental trial. The grapheme- phoneme conversion training was given in order to rule out misjudging of phonemes with irregular orthographic representation (for eg. c for /s/ phoneme as in the word cigarette). Subsequent to this, they were instructed to press the 'm' key of the keyboard if the sound of the letter displayed immediately after the presentation of the picture was a part of the picture name they just saw. If it were not the part of the picture name, they were instructed to press the 'n' key of the keyboard. The subjects were required to make the responses using right hand. They were additionally asked to keep their palm on the palm rest of the keyboard and not to remove it after each response is made. This was to avoid the time lag in reaching the target keys on the subsequent trials. The entire testing session was completed in 30 minutes for each subject.

The experimental sequence

Following the above instructions, the subjects were familiarized with the procedure by presenting the trial items. This was followed by presentation of test items. Initially, a '+' sign was displayed at the centre of computer screen for 500ms. This was followed by the presentation of the picture to-be-named for 2000 ms. At the end of the picture presentation, the critical stimulus – a letter – was displayed for 2000 ms. The reaction time was calculated from the time of onset of the critical stimulus on the monitor until the subject pressed the button or the end of the 2000 ms period, whichever occurred earlier. A short break was provided at the end of the first block.

Results

The incorrect and out of time responses (i.e. before 400 ms or after 2000 ms) were removed from the statistical analysis of reaction time (RT). This constituted about 10% (601) of all the responses (6000; [15 related + 15 unrelated + 30 control] X 2 languages X 50 subjects). Table 1 provides the mean (SD) of the reaction times as well as the errors in each language across the experimental conditions.

Table 1: *Mean (SD) reaction time (ms) and error rates in Kannada and English across the experimental conditions*

	Experimental conditions					
	Related		Unrelated		Control	
	Mean RT (SD)	Mean Error (SD)	Mean RT (SD)	Mean Error (SD)	Mean RT (SD)	Mean Error (SD)
Kannada	1149 (*260*)	2.4 (2.17)	1048 (227)	0.96 (1.28)	1003 (247)	1.06 (1.42)
English	1010 (230)	2.92 (2.06)	958 (190)	1.72 (1.97)	837 (200)	2.64 (2.12)

After naming the pictures in the target language, to examine if the time required to reject a phoneme in the non-target language differed significantly from that of the phoneme which occurred neither in the target nor in the non-target language (i.e. under the related and unrelated conditions), we performed paired comparisons of the reaction times and errors for each language. In the Kannada Related condition, the subjects required 121 ms more than the Kannada unrelated condition and this difference was significant ($t_{K\text{-}RT}$ (49) = 4.74, $p <$ 0.001). The error pattern in these conditions also revealed similar finding (mean difference = 1.44) ($t_{K\text{-}error}$ (49) = 5.31, $p < 0.001$). As evident from Table 1, subjects exhibited more errors in the Related compared to the Unrelated condition. In English, the mean difference in RT between the related and unrelated conditions was 52 ms and this difference was significant too ($t_{E\text{-}RT}$ (49) = 2.75, $p < 0.05$). The error mean in English related and unrelated conditions also showed a statistically significant difference (mean difference = 1.2) ($t_{E\text{-}error}$ (49) = 3.87, $p < 0.001$). Like in Kannada, the English related condition showed more errors compared to English Unrelated condition (see Table 1).

To examine the performance across the experimental conditions and languages, we performed repeated measures one-way ANOVAs (3 experimental conditions x 2 languages) separately for RT and error data. The analysis of the RT showed a significant difference between the experimental conditions ($F1(2, 49) = 39.85$, $p < 0.001$, $\eta^2 = 0.449$, $MSe = 753623$). Post hoc LSD comparisons revealed that all three means were significantly different from each other. The mean RT in the related condition (M = 1080 ms) was significantly higher than the RTs in the unrelated (M = 1003 ms) and control conditions (M = 920 ms). Similarly, the two language also revealed a significant difference across the experimental conditions ($F2(1, 49) = 37.83$, $p <$ 0.001, $\eta^2 = 0.436$, $MSe = 1301063$). However, the interaction between language and experimental conditions was not significant (see Figure 1).

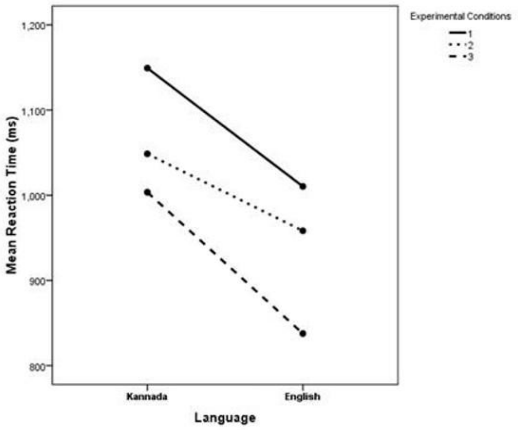

Figure:1 *Mean Reaction Times (ms) as a function of languages and experimental conditions (1 – Related; 2 – Unrelated; and 3 – Control)*

The repeated measures one-way ANOVA of the error data showed a significant differences in the experimental conditions ($F1(2, 49) = 26.31$, $p <$ 0.001, $\eta^2 = 0.35$, $MSe = 88.62$) as well as in languages ($F2(1, 49) = 16.48$, $p > 0.001$, $\eta^2 =$ 0.252, $MSe = 68.16$). Post hoc LSD comparisons revealed that all three mean error rates were significantly different from each other in the three experimental conditions. The participants exhibited maximum errors in the related conditions (M = 2.66) compared to the control condition (M = 1.85), which in turn was significantly higher than the mean error in the unrelated condition (M = 1.34). However, the interaction between the language and experimental conditions was not significant (see Figure 2). Between the languages, subjects committed fewer errors in Kannada compared to English (Figure 2). Combining this observation with the RT data, that is, faster judgments in English compared to Kannada, it becomes apparent that there existed a speed-accuracy trade-off between the two languages.

The difference in RT between Kannada and English deemed worth exploring. For this, we performed paired comparisons of the RTs obtained from the two control conditions as they were devoid of any experimental variables.

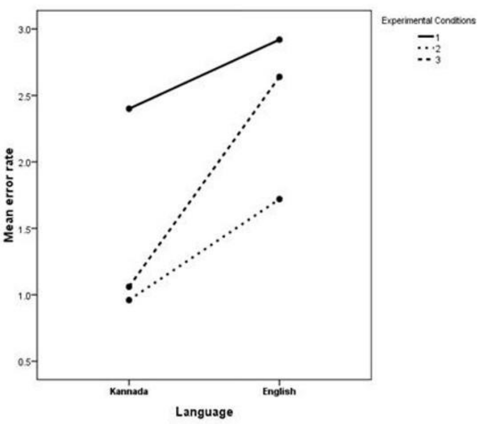

Figure 2: *Mean Error rates as a function of languages and experimental conditions (1 – Related; 2 – Unrelated; and 3 – Control)*

In addition, the *Control* condition required 'Yes' responses unlike the *Related* and *Unrelated* conditions. Therefore, the RT differences between *English* and *Kannada Control* conditions obtained may be attributed to the stimuli used in the current study. The results showed a significant difference in RT (Mean difference = 166 ms; $t_{KE\text{-}RT}(49) = 7.36$, $p < 0.001$; $SE = 22.54$) between the two languages.

Discussion

The primary aim of the current study was to investigate the phonological activation in a group of normal bilingual subjects who spoke two structurally different languages (Kannada and English) using a phoneme monitoring task. Secondarily, it aimed at exploring the influence of orthography in such a language pair employing phoneme monitoring task.

With respect to the primary objective, the results of the present study showed that in the *Related* condition, subjects required significantly more time to reject a phoneme which was present in the non-target language. This was the case both in Kannada as well as in English. The results, therefore, closely followed the findings of Colomé (2001) who employed a similar paradigm. In her study too, when two negative conditions (i.e. *Related* and *Unrelated* conditions as in the present study) were presented the subjects required more time to reject the phoneme that was present in the translation of the picture names they just monitored. As confirmatory evidence, Colomé did not find a significant difference in reaction time when the same task was performed by the monolingual subjects. However, in the present study, no monolinguals were employed. Yet, in the light of previous research findings, we confirm that bilingual subjects take more time to reject the phonemes in the non-target language. Therefore, it is apparent that the semantic nodes spread their activations to the both lexicons in bilinguals, which in turn activate their sublexical nodes (phonemes). These activated phonemes are suppressed at the cost of extra effort (i.e. increased reaction time) in phoneme monitoring task. The results of error analysis too showed that the subjects committed more errors in the *Related* condition in both languages compared to the *Unrelated* conditions. The significantly more number of errors in the *Related* conditions may be indicative of the momentary failures to suppress the activated phonemes in the non-target language, leading to the subject responding '*Yes*'. It is also noteworthy that the subjects committed minimum number of errors in the *Unrelated* condition and this may be attributed to the lack of possibility for any momentary inhibitory failure while making the judgments. In essence, both the reaction time as well as the error data supported the activation of both lexicons (i.e. language non-specific view) in bilingual subjects, despite the orthographically different nature of the languages used in the current study.

The additional objective of the study was to explore the influence of the orthography in phoneme monitoring task, especially in two structurally different languages. The comparison of the reaction times in the control condition revealed a significant difference between Kannada and English. That is, the RT was shorter in the English language compared to Kannada. We attribute this difference to the possible role of orthography in phoneme monitoring task. The presence of this effect in the Control condition, where the task is evidently straightforward and eliciting a 'Yes' response, strengthens the role of orthography in phoneme monitoring task. Kannada and English are two orthographically dissimilar languages where the former is alphasyllabic and the latter is alphabetic (Vaid & Gupta, 2002). In the present study, the task employed was essentially a phoneme rather than grapheme monitoring task. All the subjects were trained on grapheme-phoneme conversion before the commencement of the experimental trials. Yet the advantage for English trials may be attributed to the experimental presentation of the English grapheme. That is, irrespective of the prior training and practice, when the subjects were presented with an English grapheme and required to monitor its sound in the picture's English name, their responses were faster, as this task was quite straightforward. In contrast to this, in the Kannada condition, the subjects were required to name the pictures in Kannada and then monitor the sound of an English grapheme as whether or not it is a part of the Kannada name may have produced some interference, leading to the prolonged RT in this condition. In simple terms, the incongruence between the phoneme-to-be monitored and its physical (graphical) appearance may have resulted in the prolonged RT in Kannada trials. It may have been interesting to observe the RT when Kannada graphemes were presented. However, our paradigm was not equipped with the presentation of the Kannada graphemes, as the role of orthography was not the primary objective of the present study. In future, studies designed to investigate the phoneme monitoring task in orthographically distinct language shall take this variable into consideration.

Summary

The present study provided further evidences for the language non-specific view of bilingual lexical activation by extending the phoneme monitoring task into two orthographically different languages. In addition to this, the study also shed light into the possible role of orthography in phoneme monitoring task especially in orthographically distinct languages. The present study thus adds on to the understanding basic aspects of bilingual language processing and activation providing indirect implications in clinical practice. However further studies of similar nature in bilingual adult language disorders such as Aphasia, may provide greater insight about activation in impaired lexical systems. This might further help explaining clinical phenomenon of recovery in untrained language and may help in choosing the appropriate language for intervention.

Acknowledgment

The authors thank the participants of their study.

Author roles:

Author GK conceptualized the idea, reviewed the relevant literature, designed the method, analyzed and interpreted the data, and prepared the manuscript. Author PS reviewed the literature, collected data, analyzed and interpreted the data and prepared the manuscript. BR coordinated the study.

References

Ahmed, W., Krishnan, G., & Rajashekar, B. (2008). *A set of 260 pictures standardized for name agreement, complexity, image agreement in Kannada*. Unpublished Masters Dissertation. Manipal University.

Altarriba, J., & Mathis, K. (1997). Conceptual and lexical development in second language acquisition. *Journal of Memory and Language, 36,* 550-568.

Chen, H., -C., & Ho, C. (1986). Development of Stroop interference in Chinese-English bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 397-401.

Colomé, À. (2001). Lexical activation in bilinguals' speech production: Language-specific or language-independent? *Journal of Memory and Language, 45,* 721-736.

Costa, A., Caramazza, A., & Sebastián-Gallés, N. (2000). The cognate facilitation effect: Implications for the models of lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 1283-1296.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection *Journal of Memory and Language, 41*, 365-397.

De Bot, K. (1992) A Bilingual Processing Model: Levelt's 'Speaking Model Adapted. *Applied Linguistics, 13:* 1-24.

Dijkstra, T., Roelofs, A., & Fieuws, S. (1995). Orthographic effects on phoneme monitoring. *Canadian Journal of Experimental Psychology, 49*, 264-271.

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers, 35*, 116-124.

Green, D. W. (1986). Control, activation and resource: A framework and a model for the control of speech in bilinguals. *Brain and Language, 27,* 210-223

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition, 1*, 67-81

Hermans, D., Bongaerts, T., de Bot, K., & Schreduer, R. (1998). Producing words in a foreign language: Can speakers prevent inferences from their first language. *Bilingualism: Language and Cognition, 1*, 213-229.

Hoshino, N., & Kroll, J. F. (2008). Cognate effects in picture naming: Does cross-language activation survive a change of script? *Cognition, 106,* 501-511.

Ingram, D. E. (1985*). Assessing proficiency: An overview on some aspects of testing.* In K. Hyltenstam & M. Pienemann (Eds.*), Modelling and assessing second language acquisition (pp. 215-276).* Clevedon, NJ: Multilingual Matters.

Kroll, J. F. & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language, 33*, 149-174.

Parker-Jones, O., Green, D.W., Grogan, A., Pliatsikas,C., Filippopolitis, K., Ali, N., Lee, H. L., Ramsden, S., Gazarian, K., Prejawa, S., Seghier, M.L., Price, C.J.(2011). Where, When and Why Brain Activation Differs for Bilinguals and Monolinguals during Picture Naming and Reading Aloud. *Cerebral Cortex*, 2011.

Potter, M. C., So, K. -F., von Eckhardt, B., & Feldman, L. B. (1984). Lexical and conceptual representation in beginning and more proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior, 23,* 23-38

Poulisse, N., & Bongaerts, T. (1994). First language use in second language production. *Applied Linguistics, 15*, 36-57.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 646-662.

Vaid, J., & Gupta, A. (2002). Exploring word recognition in a semi-alphabetic script: The case of Devanagari. Brain and Language, 81, 679-690.

Appendix A

Related stimuli

Kannada		English	
Picture	Grapheme	Picture	Grapheme
/iruve/	/a/	Door	/b/
/kɑrɑdi/	/b/	Donkey	/k/
/omte/	/k/	Fox	/n/
/ɑlugɛdde/	/p/	Pig	/h/
/nɑ:ji/	/d/	Wheel	/ʧ/
/bɑ:vuʈɑ/	/f/	Goat	/ɑ/
/mɑne/	/h/	Swing	/u/
/nɑvilu/	/p/	Violin	/p/
/kɑθɑri/	/s/	Table	/m/
/mɑrɑ/	/ʈ/	Corn	/ʝ/
/sɑrɑ/	/n/	Button	/g/
/i:ruɭɭi/	/o/	Dress	/ɑ/
/kɑ:lu/	/l/	Hat	/t/
/sɑrɑpaɭi/	/c/	Frog	/k/
/hebberɑɭu/	/θ/	Lion	/s/

Appendix B

Unrelated stimuli

Kannada		English	
Picture	Grapheme	Picture	Grapheme
/ʧitte/	/m/	Cat	/p/
/mo:ɖɑ/	/ r/	Finger	/k/
/mi:nu/	/b/	Window	/m/
/huli/	/n/	Pumpkin	/s/
/molɑ/	/k/	Orange	/u/
/uɳgurɑ/	/t/	Owl	/r/
/bi:gɑ/	/d/	Needle	/t/
/θuʈi/	/ɑ/	Knife	/b/
/kuðurɛ/	/ʧ/	Lemem	/g/
/kivi/	/p/	Deer	/ɭ /
/pusʈɑkɑ/	/ v/	Candle	/v/
/hu:vu/	/g/	Apple	/g/
/noɳɑ/	/t/	Glass	/n/
/kai/	/l/	Spider	/m/
/buguri/	/m/	Spoon	/k/

Appendix C

Kannada		English	
Stimuli	Grapheme	Picture	Grapheme
/koɖli/	/k/	Arrow	/a/
/ʝɛ:nuhuɭɑ/	/ʝ/	Bag	/b/
/hʌkki/	/h/	Pineapple	/p/
/pɑ:ðɑ/	/p/	Monkey	/m/
/ʧʌnðrɑ/	/ʧ/	Toothbrush	/t/
/ili/	/i/	Sheep	/ʃ/
/gɑɖijɑ:rɑ/	/g/	Grapes	/g/
/ðo:ɳi/	/ð/	Hare	/h/
/bɑsɑvɑnɑhuɭa/	/b/	Key	/k/
/nu:lu/	/n/	Pen	/p/
/su:rjɑ/	/s/	Zeebra	/z/
/gombe/	/g/	Vase	/v/
/rʌilu/	/r/	Heart	/h/
/θuθuri/	/θ/	Ladder	/l/
/nʌkʃʌʈrɑ/	/n/	Fork	/f/
/bɑ:vi/	/b/	Gun	/g/
/ɑ:me/	/ɑ/	Helicopter	/h/
/hʌððu/	/h/	Pencil	/p/
/kiri:ʈɑ/	/k/	Guitar	/g/
/ɑɳʌbe/	/ɑ/	Church	/ʧ/
/lɑʈʈɑɳigɛ/	/l/	Cigarette	/s/
/mu:lɑɳgi/	/m/	Cake	/k/
/kɑmbɭihuɭɑ/	/k/	Drum	/d/
/kɑɳɳu/	/k/	Hanger	/h/
/bɛ:li/	/b/	Lamp	/l/
/kɑnnɑdɑkɑ/	/k/	Kettle	/k/
/pʌrvɑθɑ/	/p/	Gorilla	/g/
/mosɑɭe/	/m/	Ostrich	/ɔ/
/bɑ:θuko:ɭi/	/b/	Paint brush	/p/
/ koɭɑlu/	/k/	Shoe	/s/

Control condition