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BRAIN BASES OF NON-WORD PROCESSING IN BILINGUALS

Мозгові основи немовленнєвих процесів у мові

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Abstract
Psycholinguistic literature abounds with bilingual word processing and how it is represented in the brain. There is converging evidence that the right hemisphere is involved to a larger extent in bilinguals. Also in a majority of these studies came out the result that there are differences between real word and non-word processing in terms of processing speed and accuracy. Despite the overwhelming number of studies with a variety of language pairs, research on Turkish-English bilinguals is scarce. In this study we investigated the lateralization of non-word processing Turkish-English bilinguals (N=48) who acquired both languages from birth. We found no across-language difference in the processing of non-words. Also, the results showed that bilinguals have bilateral organization, as reported in the literature.

Key Words: *Bilinguals, non-word processing, lateralization, psycholinguistics.*

Introduction

A bulk of research has been conducted in the field of psycholinguistics and neurolinguistics on lexical retrieval and the underlying mechanisms that distinguish real words from non-words. Non-words comply with the phonotactic and orthographic rules of a particular language, but are distinct from real words in that they lack meaningful associations in the semantic network. Their phonological and orthographic similarity render them potential candidates in the word retrieval process

while their lack of semantic associations make their recognition difficult. In fact, this aspect of non-words accounts for the delays and inaccuracies in their processing (Nemrodov et al., 2011). Kuchinke et al. (2005), attributes the relative difficulty in processing non-words to greater involvement of cognitive resources in their processing. There is a great deal of evidence that recognition of non-words requires more time and is more prone to errors (Hauk et al., 2006; Kuchinke et al., 2005; Mohr et al.,1994; Lavidor et al., 2004; Nemrodov et al., 2011). Similarly, non-word processing is effortful as compared to real words for bilinguals (Conrad, Recio & Jacobs, 2011; Proverbio & Adorni, 2011; Lehtonen et al., 2012). It is known that the words that belong to both languages of the bilinguals are stored in a shared mental lexicon (Brysbaert & Dijkstra, 2006). The speed and accuracy of word retrieval depends on some factors such as the age and the context of the acquisition of the two languages, proficiency and frequency of use play a significant role in the bilingual case (Paradis, 2004: 2).

Despite the well-established fact in the literature regarding the left hemispheric superiority in language tasks in monolinguals (Frost et al., 1999; Hellige, 2001; Lieberman, 2002; Sommer et al., 2004; Hugdahl, 2005; Deason & Marsolek, 2005; Jung-Beeman, 2005), no conclusive evidence has been obtained in the bilingual literature. However, the results of a majority of the studies seem to lean towards greater involvement of the right hemisphere particularly when both languages are acquired simultaneously (Hull & Vaid, 2006, 2007; Peng & Wang, 2011; Park, Badzakova-Trajkov & Waldie, 2012). To reveal how bilinguals process non-words in their two languages, we examined a sample of Turkish-English bilinguals (n=48) who acquired both languages from birth.

Method

Forty-eight participants (15 Males, 33 Females, Mean Age=29.75, Std= 9.64) took part in the experiment. They were simultaneous bilinguals who acquired Turkish and English from birth. They were all right-handed asassessed by the Edinburgh Handedness Inventory (Oldfield, 1971). Also, they were given a language history questionaire in which they rated their proficiency in four language skills (listening, speaking, reading and writing) in Turkish and English on a 5-point Likert Scale (1=the lowest grade, 5 the highest grade). A Friedman Test revealed that there was no

significant difference between their two languages in terms of the four language skills in both languages, $\chi 2 = 5.21$, sd = 3, p= 157> .05. They had normal or corrected-to-normal vision, and they gave a written consent for their participation in the study.

Stimuli

We used two word sets, one for each language. In the Turkish word set, there were 30 real words and 30 non-words with five or six syllables, chosen from a pool of 300 words in *Yazılı Türkçe'nin Kelime Sıklığı Sözlüğü* (Göz, 2003), and there was no significant difference in their frequency of use ($F_{2,27}$= 0.83, p> .05, ŋ2 =.058). The words in the English set were selected from *Affective Norms for English Words* (Bradley & Lang, 1999), and no significant difference was found in their freuency. (F2,27= 0.83, p> .05, ŋ2 =.058). Non-words (N=60) were created by changing one or two letters of real words, and they were phonologically and orthographically acceptable both in Turkish and in English.

Procedure

The participants performed a lexical decison task. Before the experiment a trial session was conducted, and the results were excluded from the statistical analysis. The participants were seated 40 cm away from the laptop computer and placed their chin on a chin rest. The stimuli was presented via a visual hemifield paradigm. Each word or non-word was presented either in the right or the left of the screen in a random order. The participants' task was to decide if the letter strings they saw on the screen were real words or non-words by pressing the designated keys on the keyboard (1 for real words, 2 for non-words) as quickly and accurately as possible. The data was collected via Superlab 4.0 software program and statistically analyzed.

Results

Response Times for the Lateralization of Turkish and English Non-words

No significant difference was found in the response times for Turkish (894.17 ms vs. 869.29 ms) and English (860.63 ms vs.859.93 ms) non-words presented in the

right and left visual fields respectively, suggesting that bilinguals process non-words in both languages with equal speed, (Turkish non-words: p=.182, English: p=.949).

Language-wise Comparison of Response Times for Non-words

A language-wise comparison of the response times revealed no significant difference between the participants' performance across languages, (RVF: p=.164, LVF: p=.709).

Accuracy Rates for the Lateralization of Turkish and English Non-words

Accuracy rates for each language shows that our participants performed similarly in both languages regardless of the visual field of presentation of the non-words, (Turkish non-words in the RVF: 57.69%, Turkish non-words in the LVF: 54.54%, p=.059 / English non-words in the RVF: 57.83%, English non-words in the LVF: 56.29%, p= .344)

Language-wise Comparison of Accuracy Rates for Non-words

Across-language comparison of the accuracy rates showed that the participants' performance do not differ between languages, (RVF: p=.735, LVF: p=.531).

Discussion

There is enormous literature investigating word processing both in monolinguals and bilinguals. Processing of non-words has been compared to real word processing, and the majority of studies favor the superiority of real words as compared to non-words in terms of speed and accuracy (Hauk et al., 2006; Kuchinke et al., 2005; Mohr et al.,1994; Lavidor et al., 2004; Nemrodov et al., 2011). In an attempt to uncover the brain bases of non-word processing in bilinguals, we employed a visual hemifield paradigm. Bilingual participants in our study performed a lexical decision task in which real words and non-words are presented either in the right or the left visual field.

The response time data confirmed that the bilingual participants processed non-words similarly when they are presented in both visual fields. This result shows that non-word processing in bilinguals is represented bilaterally. Similarly, no statistically significant difference was found in processing the non-words presented in either visual field, providing further support for bilateral representation. These results are in

line with the previously conducted research regarding both real words and non-words (Conrad, Recio & Jacobs, 2011; Proverbio & Adorni, 2011; Lehtonen et al., 2012).

We also compared if there were any differences in the way bilinguals process non-words in each language. Language-wise comparisons yielded no significant differences when response times and accuracy rates analysis, suggesting that bilinguals performed similarly in non-word processing regardless of the language.

Conclusion

This study investigated hemispheric representation of non-word processing in bilinguals. To this end we employed a visual hemifield paradigm in which bilingual participants (n=48) who acquired both Turkish and English from birth performed a lexical decision task. They were instructed to decide if the letter strings presented visually in the right or the left of the screen were words or non-words. Both the response time and accuracy data revealed that bilinguals displayed a similar performance in non-word processing regardless of the field of presentation and language. These results confirm bilateral hemispheric organization for language in bilinguals. Also, they show bilinguals process both Turkish and English non-words similarly.

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