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# A COMPARISON OF BILINGUALS' LEXICAL PROCESSING IN THEIR TWO LANGUAGES

**Filiz MERGEN*, Gülmira KURUOĞLU****

**Abstract**

Bilinguality literature abounds with evidence that both languages are activated in parallel in lexical processing and the words belonging to two languages are stored in a shared lexicon. This accounts for interferences across languages, and slower processing speed and lower accuracy rates when compared to monolingual lexical processing. This study investigates how bilinguals process words in both languages. In a lexical decision task, simultaneous bilinguals (N= 48) who acquired English and Turkish from birth were asked to decide if the visually presented letter strings were either real or non-words in Turkish and in English. Response times and accuracy were recorded via a software program and were statistically analyzed. The results showed that bilinguals processed real words faster and more accurately than non-words in both languages, and that there was no difference between languages in terms of speed and accuracy rates.

**Keywords:** *Simultaneous bilingualism, Lexical processing, Psycholinguistics.*

# İKİDİLLİ BİREYLERİN BİLDİKLERİ DİLLERDEKİ SÖZCÜKSEL İŞLEMLERİNİN KARŞILAŞTIRILMASI

**Özet**

Alanyazında her iki dile ait sözcüklerin sözcüksel işlemlemede eş zamanlı olarak aktive olduğu ve aynı kavram deposunda saklandığı bilinmektedir. Bu durumun ikidilli sözcüksel erişimde diller arası girişimlere sebep olduğu ve tekdilli bireylere göre işlemleme hızının daha yavaş, doğruluk oranlarının daha düşük olduğu görülmüştür. Bu çalışmada ikidilli bireylerin bildikleri dillerdeki sözcükleri işlemlemeleri araştırılmıştır. Sözcüksel Karar Verme Görevinin kullanıldığı çalışmaya Türkçe ve İngilizce'yi çocukluk döneminde eş zamanlı olarak edinen ikidilli bireyler katılmıştır (N=48). Görsel olarak sunulan harf dizilerinin Türkçe ve İngilizce'de anlamlı birer sözcük olup olmadığına karar vermeleri istenmiştir. Tepki süreleri ve cevaplarının doğruluğu bir yazılım programı aracılığıyla kaydedilmiş ve istatistiksel olarak çözümlenmiştir. Elde edilen bulgular, ikidilli katılımcıların her iki dildeki gerçek anlamı olan sözcükleri uydurma sözcüklerden daha hızlı ve daha doğru işlemlediklerini göstermiştir. Ayrıca, katılımcıların bildikleri diller arasında hız ve doğruluk açısından bir fark bulunmamıştır.

**Anahtar Kelimeler:** *Eş zamanlı ikidillilik, Sözcüksel işlemleme, Psikodilbilim.*

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## 1. INTRODUCTION

There seems to be no consensus on the definition of bilingualism in the literature. Age and manner of acquisition of the languages, frequency of use and proficiency level are considered to affect the nature and extent of bilingualism in different ways (Paradis, 2004: 2), which may be responsible for the multiple definitions of bilingualism to appear. For example, *early* and *late* bilinguals are categorized according to age of acquisition. *Simultaneous* bilinguals, who acquire both languages from birth, are also considered in this category. When proficiency level is taken into account, there emerge *balanced* and *dominant* bilinguals. According to the manner of acquisition, on the other hand, *foreign language learners* refer to those who learn a language after their native language, and generally in formal settings, while *second language learners* are those who are exposed to a second language in immersion. Bilinguals are labelled either *Compound* or *Coordinate*, according to the cognitive structuring of the languages in the brain.

Lexical processing in bilinguals has recently attracted much attention in the literature. Initially, lexical processing models *the Selective Access Model* argued for separate lexical stores for the two languages, and they maintained that one language was 'switched off' when the other was in use. However, more recent research has supported the view of *Non-selective Access*, which predicts that words in both languages are kept in a single store, and are activated in parallel during lexical processing (Brysbaert and Dijkstra, 2006). One of the prominent models is Dijkstra and van Heuven's *Bilingual Interactive Activation Model* (2002). According to this model, word recognition is a series of steps which starts with recognizing the physical properties of letters (i.e. parallel or vertical lines) and associating them with the word representations in the mental lexicon, and it culminates with choosing the suitable language node or tag. This node has the function of determining the language to which the most likely candidate for a particular word representation belongs. This final component facilitates or inhibits the selection of a particular word in the mental lexicon, depending on the level of activation each candidate has received (i.e. the most activated candidate is facilitated and selected, while others are inhibited).

Frequency of use is thought to be an important factor that affects word retrieval in bilinguals. According to this view, frequently used words have lower activation thresholds than the less frequently used ones, enabling faster and easier recognition. To put it more simply, it is faster and easier to recognize frequently used words (Thomas and van Heuven, 2005:208). Considering that it is not possible for bilinguals to use each language with exactly the same frequency, it is conceivable that this factor exerts more influence on bilinguals' processing of words in each language compared to monolingual speakers of those languages. Experimental support for this view is provided by Gollan et al.'s (2008) *Weaker Links Hypothesis*, according to which lexical ties in either language of bilinguals cannot be as strong as those in monolinguals' in the respective language. Similarly, Paradis (2004: 29) suggested *Activation Threshold Hypothesis*, while Dijsktra and van Heuven (2002) used *Temporal Delay Hypothesis* to explain the same phenomena. A good deal of experimental research in the bilingual literature supports these hypotheses (Lehtonen et al., 2012; Duyck et al., 2008). The current study aims to provide more evidence from Turkish-English bilinguals. To this end, we employed a lexical decision task in which bilingual participants were asked to decide whether the visually presented Turkish and English words were real words or non-words. Our aim was to explore if bilinguals would differ in the way they processed Turkish and English words. We hypothesized that as our participants acquired both languages simultaneously from birth, they would perform equally well in both languages.

## 2. METHOD

### 2.1. Participants

48 Turkish-English bilinguals (15 Male, 33 Female) who acquired both languages from birth took part in the study. To determine their eligibility, the participants were given a questionnaire to self-assess their proficiency in both languages This questionnaire was adapted from the assessment criteria of the Common European Framework For Languages in which listening, reading, speaking and writing skills in both languages were assessed on a 5-point Likert Scale (5 is the highest, 1 is the lowest) and a Friedman Test revealed no significant difference between four language skills, $\chi^2 = 5.21$, $df = 3$, $p = .157 > .05$. The Mean age of the participants is 29.75(*Std*= 9.64, Min. 18- Max. 49).

**2.2. Stimuli**

The stimuli comprised of 30 words (*Barış, İflas, Etken*) and 30 non-words (*Moyur, Banay, Navşat*) in Turkish and 30 words (*Angel, Cruel, Bottle*) and 30 non-words (*Repson, Vursey, Trang*) in English. The real words in Turkish were chosen from a pool of 300 words from *Yazılı Türkçe'nin Kelime Sıklığı Sözlüğü* (Göz, 2003), and rated by a hundred Turkish native speakers on a 5-point Likert Scale according to their frequency of use, for which no significant differences were found, $F_{2,27}$ = 0.83, $p$> .05, $\eta^2$ =.058. Similarly, the real words in the English set were chosen from a pool of 300 words taken from *Affective Norms for English Words* (Bradley and Lang, 1999). Ratings collected from 30 English native speakers revealed no statistically significant difference in terms of frequency of use, $F_{2,27}$= 0.46, $p$= .638, $\eta^2$ =.033. Non-words in each language were formed by exchanging the initial letters and final letters of real words, and they all complied with the phonotactic rules of both languages. In addition, a Paired Samples *t*-Test revealed no significant difference between the frequency of Turkish and English words, $t$ (2)= 1.31, $p$> .05, $r$= .55.

**2.3. Design**

To explore whether there are any differences in bilinguals' processing of words in their two languages, a lexical decision task was used in the study; In this task, the participants were instructed to decide whether the visually presented letter strings were real or non-words, and were told to be as fast and accurate as possible. A trial session was conducted to familiarize them with the task and the results were excluded from the statistical analysis.

The participants were instructed to press on the designated keys on a lap top computer (key 1, for yes and key 2, for no) to indicate their perception of lexicality of the stimuli. Their response times and the accuracy of their answers were recorded via SuperLab 4.0 Software Program and SPSS was used to analyze the data. Response times below 250 ms and those above 1800 ms. were discarded from the statistical analysis. As the data were normally distributed, a Paired Samples *t*-Test was conducted. The accuracy of the responses was analyzed based on the number of correct responses within the time permitted. Due to the variation in the proportion of the words and non-words for each participant, individual accuracy rates were calculated, and a non-parametric test (Wilcoxon test) was used to analyze the data.

**3. FINDINGS**

Latencies for real words and non-words in Turkish and English were analyzed and the results can be seen in Table 1.

**Table 1. Latencies for real words vs. nonwords**

| Words | Language | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Turkish | | | | English | | | |
| | Mean (ms) | Std. | *t* | *p** | Mean (ms) | Std | *t* | *p** |
| Real Words | 726.22 | 170.59 | -8.94 | .000 | 710.59 | 147.71 | -8.12 | .000 |
| Non-words | 881.73 | 193.67 | | | 860.27 | 182.5 | | |

*p< .001

As shown in Table 1, bilinguals were faster in processing real words both in Turkish and English than non-words. The differences between the response times were found statistically significant in both languages (real words vs. non-words in Turkish: $t$(47)= -8.94, $p$< .001, $r$= .79, real words vs. non-words in English: $t$(47)= -8.12 $p$< .001, $r$= .72). An analysis of the response times showed that the participants were faster in recognizing real words than non-words both in Turkish and in English.

Latencies were also analyzed to see if there were any differences between languages for each participant, and the results can be seen in Table 2.

**Table 2. Language-wise comparison of latencies for real words and non-words**

| Words | Mean Difference | Std. | *t* | *p** |
|---|---|---|---|---|
| Real Words in Turkish and English | 15.64 | 138.52 | .78 | .438 |
| Non-words in Turkish and English | 21.45 | 146.79 | 1.01 | .316 |

**p*> .025 (*p* value has been adjusted by dividing .05 by the number of pair-wise comparisons, 2 in this case)

A language-wise comparison of latencies for real words revealed no significant difference, *t*(47)= .78, *p*> .05, *r*= .63 The same result was obtained for non-words, *t*(47)= 1.01, *p*> .05, *r*= .70. This indicates that the bilingual participants in our study performed similarly in responding to real words and non-words in both languages. In other words, there was no difference in the time needed to differentiate real words from non-words across languages.

A Wilcoxon test was used on the accuracy rates of the participants, and the rates for real words vs. non-words in both languages were presented in Table 3.

**Table 3. Accuracy rates for real words and non-words**

| Words | N | Language | | | |
|---|---|---|---|---|---|
| | | Turkish | | English | |
| | | Mean (%) | Std. | Mean (%) | Std |
| Real Words | 48 | 80 | .13 | 76 | .12 |
| Non-words | 48 | 56 | .09 | 58 | .06 |
| *Z* | | -5.96 | | -5.78 | |
| *p** | | .000 | | .000 | |

**p*< .001

An analysis of accuracy of the participants' responses to real words vs. non-words in Turkish and in English revealed significant differences, as shown in Table 3 (real words vs. non-words in Turkish: *N*= 48, *Z*= -5.96, *p*< .001, *r*= .86; real words vs. non-words in English: *N*= 48, *Z*= -5.78, *p*< .001, *r*= .83). These results are in line with those obtained from response time data, suggesting that the participants were faster in recognizing real words than non-words.

Table 4 shows language-wise comparison of accuracy rates for real words and non-words.

**Table 4. Language-wise comparison of accuracy rates for real words and non-words**

| Words | Language | | | | | |
|---|---|---|---|---|---|---|
| | Turkish | | English | | | |
| | Mean (%) | Std. | Mean (%) | Std. | *Z* | *p** |
| Real Words | 80 | .13 | 76 | .12 | -2.18 | .029 |
| Non-words | 56 | .09 | 58 | .06 | -.68 | .495 |

**p*> .025 (*p* value has been adjusted by dividing .05 by the number of pair-wise comparisons, 2 in this case)

No significant difference was found in language-wise comparisons of the accuracy rates for real words and non-words, real words: *N*= 48, *Z*= -2.18, *p*> .025, *r*= .31; non-words: *N*= 48, *Z*= -.68, *p*> .025, *r*= .09. In other words, the participants performed better in recognizing real words in both languages.

**4. DISCUSSION**

This study investigated Turkish-English bilinguals' processing of words in both languages. In a lexical decision task, they were asked to decide if the letter strings were either real words or non-words. The response time data showed that the participants responded faster to real words both in Turkish and in English. The analysis of the accuracy of responses replicated these results. Another finding was that the participants' performance did not differ across languages, suggesting similarity in the processing of words in Turkish and in English by bilinguals. These results are in accord with the majority of views in the literature.

To begin with, it is well-established both in the monolingual (Hauk et al., 2006; Kuchinke et al., 2005; Mohr et al.,1994; Lavidor et al., 2004; Nemrodov et al., 2011) and bilingual literature (Conrad, Recio and Jacobs, 2011; Proverbio and Adorni, 2011; Lehtonen et al., 2012) that real words are processed faster and more accurately than non-words. As suggested by the *Word Superiority Effect*, non-word stimuli, despite complying with the orthographic and phonotactic rules of a particular language and thus resembling real words in that language, differ from real words in that they have no meaningful associations or representations in the semantic network. This leads to delay and inaccuracies in their processing (Nemrodov et al., 2011). In Kuchinke et al. (2005), it was reported that the relative difficulty in processing non-words is due to the greater involvement of cognitive resources in their processing. Functional Magnetic Resonance (fMRI) images obtained in the same study gave support to this result, and there is plenty of further evidence in the bilingual literature (Conrad, Recio and Jacobs, 2011; Proverbio and Adorni, 2011; Lehtonen et al., 2012). The results obtained in our study are in line with the *Word Superiority Effect* view, which is generally accepted in the literature.

Another topic of interest in the literature is whether bilinguals differ in the way they process each language. To contribute further to the literature, we conducted pair-wise analyses for each language of the bilingual participants in our study. The results showed that the participants were equally competent in processing real words and non-words in Turkish and in English in terms of their speed and accuracy of processing.

These results can be attributed to the simultaneous acquisition of the two languages in the natural environment in which both languages are spoken as part of daily communication. In the initial eligibility questionnaire, the participants reported using both Turkish and English for communication on a daily basis, i.e. at home, or work. Furthermore, the analysis of self-assessment of their proficiency level in both languages on a 5-point Likert Scale revealed no significant difference between languages, which can be taken as evidence for their equal performance in processing words in both languages. Although it could be argued that grounding our results on the self-assessment questionnaire is departure from objectivity, there is, in fact, plenty of evidence in the literature supporting the reliability and validity of self-assessment questionnaires, as these are closely related to the frequency with which bilinguals use their languages on a daily basis. For example, Luk and Bialystok (20013) found a significant correlation between bilingual participants' assessment of their proficiency levels in the languages they spoke and performance in standard language proficiency exam. Another source of support for the balance in proficiency in both languages of the participants in our study is the self-reports revealed during informal interaction before the study.

Our results are also in line with the word recognition models in the bilingual literature. According to the *Interactive Bilingual Activation Model* (Dijkstra and van Heuven, 2002; Thomas and van Heuven, 2005: 206, 208), bilinguals retain the words in both languages in a shared lexicon, and that, in lexical processing, all words become activated and compete for selection. When our results are interpreted from this perspective, it can be said that the shared Turkish and English lexicon of the bilingual participants provided them with equal speed and accuracy in processing words. Illes et al. (1999) reported similar results in a semantic processing task, and Altarriba and Canary (2004) in bilinguals' processing of emotion words in a lexical decision task. Marian, Spivey and Hirsch (2003) replicated these results with late bilinguals.

## 5. CONCLUSION

This study investigated lexical processing in Turkish-English bilinguals who acquired both languages from birth. In a lexical decision task, the participants were asked to decide if the visually presented letter strings were either real or non-words. Their response times and accuracy of the responses were recorded and statistically analyzed. The results showed that the participants processed real words significantly faster and more accurately than non-words, both in Turkish and in English, replicating the view of *Word Superiority Effect*, a widely-known phenomenon in the literature. It was also found that bilinguals did not differ in speed and accuracy in processing Turkish and English words, suggesting a fine balance in lexical processing in both languages. Our study focused specifically on visual word processing in simultaneous bilinguals; therefore it is recommended that future studies investigate whether factors such as modality or late acquisition of languages have any effects on bilinguals' lexical processing.

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