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ABSTRACT

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LEXICAL ACCESS IN L1 AND L2

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INTRODUCTION

Studying the bilingual mental lexicon is a relatively new domain in the cognitive research of the mental lexicon. It was in the late 1980's when a new approach developed, focusing on the lexical processes rather than on the organization of the lexicon. Thus, the emphasis is not on the question to know how words of different languages are stored in the lexicon. The most important aim of psycholinguistic research is to find out the point in the recognition process where the language of a word comes to play a role. Mainly three theoretical approaches can be formulated. Language selection might be made before the recognition of a word, based on the hearer's expectation determined by the context. In this case lexical process is language selective. Another possibility might be that the research process is language non-selective and the recognition of a word is accessed in parallel with its language. It is also conceivable that language selection is postlexical, thus it can be made only after the word has been selected (Grainger 1987; Kroll & Tokowicz 2005).

More and more cognitive models of lexical activation processes aim to represent the bilingual mental lexicon as well. Among these theoretical approaches accounting for empirical findings on bilingual lexical access, Interactive Activation models are viewed as the more developed ones. According to the BIA (Bilingual Interactive Activation) model, developed by Dijkstra and Van Heuven, L2 lexical access is strongly determined by proficiency. In the case of unbalanced, L1 dominant bilingualism, L2 words can be activated more slowly during both perception and production. Although L1 language node inhibits more the activation of L2 words, according to experimental results, the L2 lexicon cannot be switched off even if experimental instructions require the use of L1. Cross-language interference might be explained by the language non-selective nature of bilingual lexical processing. The Léwy and Grosjean BIMOLA (Bilingual Model of Lexical Access) model, contrary to the BIA model, has separate lexicons for each language, which means that during speech perception L1 words only compete with L1 words and L2 words with other L2 words. Thus bilingual word recognition is language specific (van Heuven et al. 1998; Lemhöfer & Dijkstra 2004; Dijkstra 2005; Thomas & Van Heuven 2005; Grosjean 2008).

The structure of the lexicon as well as lexical processes during perception or production can be investigated via the analysis of production and comprehension errors, with word association tests aiming to map the links between lexical items, or using methods of mental chronometry (Gósy 2003, 2005: 193–240; Navracsics 2007: 93–129; Ferrand 2002: 30–31, 2007: 29–43). One of the most popular experimental methods based on reaction-time measurement is the lexical decision. In lexical decision tasks participants are told to decide whether the string of letters appearing on the screen (or the sequence of speech sounds heard) is an existing word or not. Decisions are communicated by a keyboard or mouse button press or via a special device called button box connected to the computer. In such experiments participants are always instructed to react as quickly as possible but without making errors. The complexity of mental processes can be investigated via the analysis of reaction times and error rates. Reaction times and the number of correct answers are strongly determined by the characteristics of the stimuli. The most common factors are word frequency, the number and frequency of orthographic neighbors, the age of acquisition, orthographic deepness of the given language and other word characteristics such us letter or bigram frequency, concreteness or imageability (Ferrand 2007; Seidenberg 1995).

In the dissertation the visual recognition of L1 and L2 words is investigated in language-specific and generalized lexical decision tasks. Reaction times and error rates are measured and compared between L1 and L2 in different experimental situations. The most important research aim is to find out how the recognition process of L1 and L2 words is influenced by the coactivation of both languages.

1. STRUCTURE OF THE DISSERTATION

In **chapter 1** the theoretical background of the dissertation is presented: the most important models of lexical representation and process, the main research findings on the bilingual mental lexicon and on the interactive activation models of bilingual comprehension, research methods developed for the investigation of the mental lexicon and the fundamental aspects of visual word recognition; I also present the aims of the present study and the research hypotheses.

In the dissertation L1 (Hungarian) and L2 (English) lexical processes are investigated with reaction time measurement in visual lexical decision tasks. The following hypotheses were formulated: 1. There are typical differences between L1 and L2 lexical decision in the recognition of words as well as in the rejection of non-words. 2. In a generalized lexical decision task when L1 and L2 words are also presented, response latencies will be longer (according to the BIA model) compared to language-selective experimental situations when only L1 or L2 words are presented. This increase in reaction time is larger in the case of L2 words. 3. Proficiency, the age of acquisition and the frequency of language use might influence L2 lexical access. More proficient L2 learners who started learning their L2 earlier or use their second language more often in their everyday life might respond faster and with higher accuracy to stimuli presented in a L2 lexical decision task.

In **chapter 2** I present the computer program developed for the present study, the stimulus materials used in the experiments, the participants and the procedure of the research.

Experimental results are presented in detail in **chapter 3**. Differences between responses to words and non-words are analyzed, as well as reaction time and error rate differences between L1 and L2 in different experimental conditions. The effects of proficiency, age of acquisition and language use are also discussed. Finally reaction times measured in the English lexical decision task are compared to the results of the English Lexicon Project (Balota et al. 2007).

The Hungarian-French control study is presented in **chapter 4** corroborating the major findings of the main study.

In **chapter 5** an additional experiment is presented, investigating the recognition of cognates in L1 and L2 language-selective lexical decision tasks.

Responses to the hypotheses are presented in **chapter 6**. The theoretical implications of bilingual interactive models are reexamined in the light of experimental results. Some further research aims and other possible applications of the method are discussed as well.

2. METHOD

To measure the response latencies and decision accuracy in the visual word recognition tasks I developed a dedicated software tool. Participants were told to decide whether the letter string appearing on the screen is an existing word or not. Positive responses were communicated by pressing the mouse button while for a negative response participants had to press the spacebar. Reaction times and accuracy were measured and saved after each experiment and further analyzed.

40 native speakers of Hungarian with English as their second language participated to the experiment. They all had learned english at school or university and they all had Hungarian as their dominant language.

For the three different experimental conditions 6 lists composed of words and word-like non-words were elaborated. For the L1 and L1 language-specific tasks I also developed 2 shorter lists for the trial sessions. In the L1 lexical decision task only L1 words, in the L2 lexical decision only L2 words were presented. Lists of items used in the generalized lexical decision task were

composed of words and non-words appearing also in the language-specific experiments. As the repetition of stimuli had to be avoided I divided the participants into two groups. Items presented in the mixed list of the generalized lexical decision task in one group appeared in the L1 or L2 lexical decision of the other group. English words and half of the non-words used in the present study were selected from the database of the English Lexicon Project investigating the recognition of English words in word naming and lexical decision tasks (Balota et al. 2007).

3. RESULTS

3.1. Reaction times and error rates for words and non-words in L1 and L2 lexical decision tasks

Mean reaction times of participants and stimulus categories were analyzed. There are significant differences between response latencies to words and non-words in the case of both L1 and L2. The rejection of non-words requires more time than the recognition of words (mean reaction times are presented in Table 1).

Error rate differences between words and non-words were also analyzed. Since the stimulus material was different for the two groups of participants, statistical analyses were run separately. There were significant differences only in one of the two groups but just in the L2 (English) task (error rates are given in Table 2).

Table 1: Mean reaction times in language selective lexical decision tasks

	mean RT's of stimuli		**mean RT's of participants**	
	words	**non-words**	**words**	**non-words**
Hungarian	530 ms	593 ms	530 ms	591 ms
English	575 ms	651 ms	572 ms	648 ms

Table 2: Number of erroneous responses in language selective lexical decision tasks

	words		**non-words**	
	all	**proportion**	**all**	**proportion**
Hungarian	24	3%	35	4.75%
English	66	8.25%	112	14%

Differences between words and non-words show the same pattern in L1 and L2 lexical decision. Reaction time latencies are longer in the case of non-words than in the case of words. The differences between the two categories are mainly observed in reaction times rather than in error rates.

3.2. Differences between L1 and L2 in language-selective lexical decision tasks

Mean response latencies were significantly shorter in L1 lexical decision in the case of words and non-words as well (frequency histograms are shown in Figures 1 and 2). These results coincide with the findings of a Dutch-English visual lexical decision task when Dutch participants responded faster in the L1 experiment (de Groot et al. 2002).

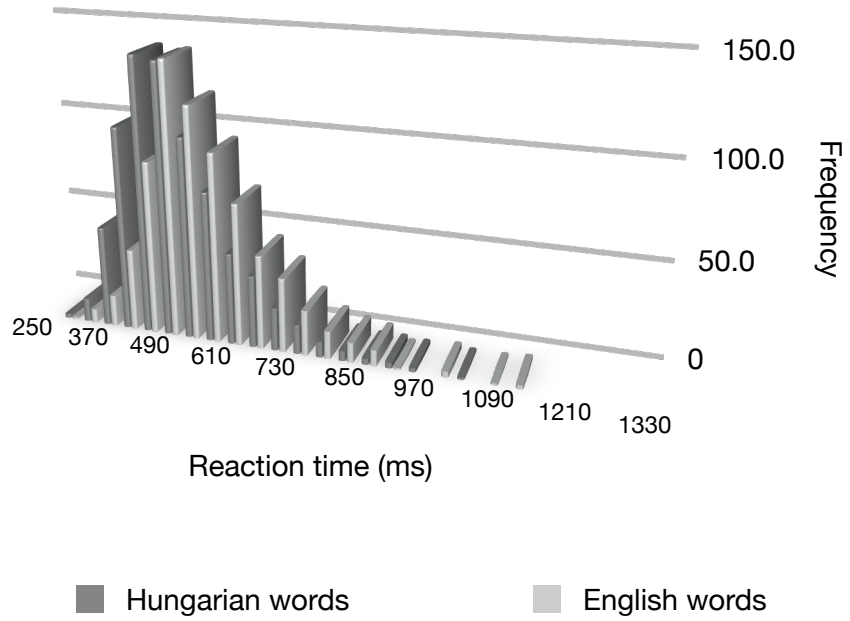

Figure 1: Frequency histogram of Hungarian and English words in language selective tasks

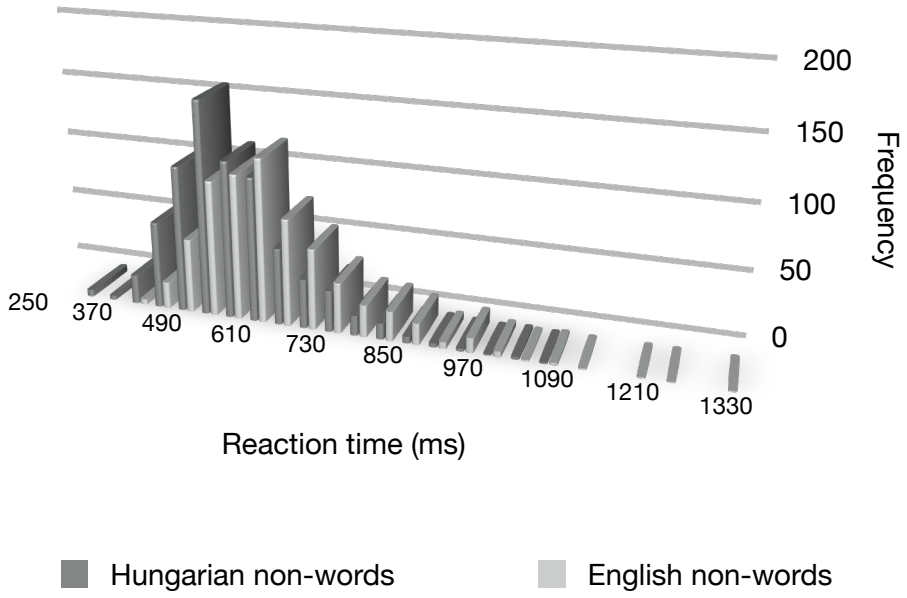

Figure 2: Frequency histogram of non-words in Hungarian and English lexical decision tasks

As shown in Table 1, there were more errors in the L2 lexical decision. Longer reaction times and more errors in the case of L2 might be explained by the uncertainty. However in the case of word stimuli the difference between L1 and L2 is significant only in one of the groups.

3.3. The effect of experimental conditions on reaction time

Language behavior, word activation, occurrence of code-switching are strongly determined by the bilingual's language mode. Language mode can affect also the recognition of L1 and L2 words (Grosjean 2001). In the present study the language selective tasks were followed by a generalized lexical decision task when L1 and L2 lexicon had to be activated at the same time.

3.3.1. Reaction time differences between words and non-words in generalized lexical decision

Relative frequency of reaction times is presented in Figure 3. Comparing the three different kind of stimuli it appears that responses latencies were shorter in the case of Hungarian words and standard deviation was smaller than in the case of English words and non-words.

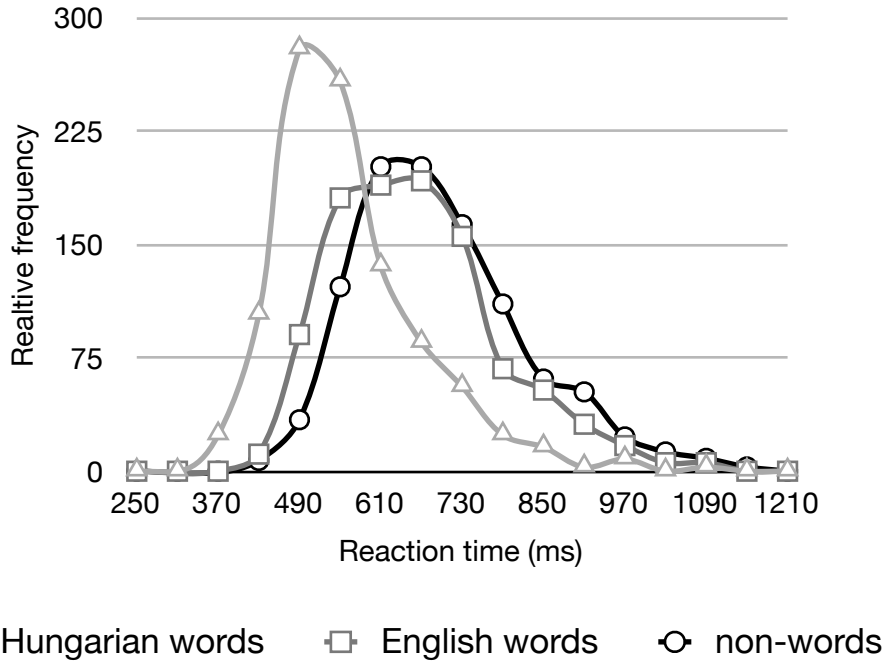

Figure 3: Relative frequency of reaction times for different stimuli in generalized lexical decision

Comparing the mean reaction times, participants responded significantly faster to Hungarian words than to English words or non-words. Difference between the mean reaction times of English words and non-words reached significance as well (mean response latencies are shown in Figure 4).

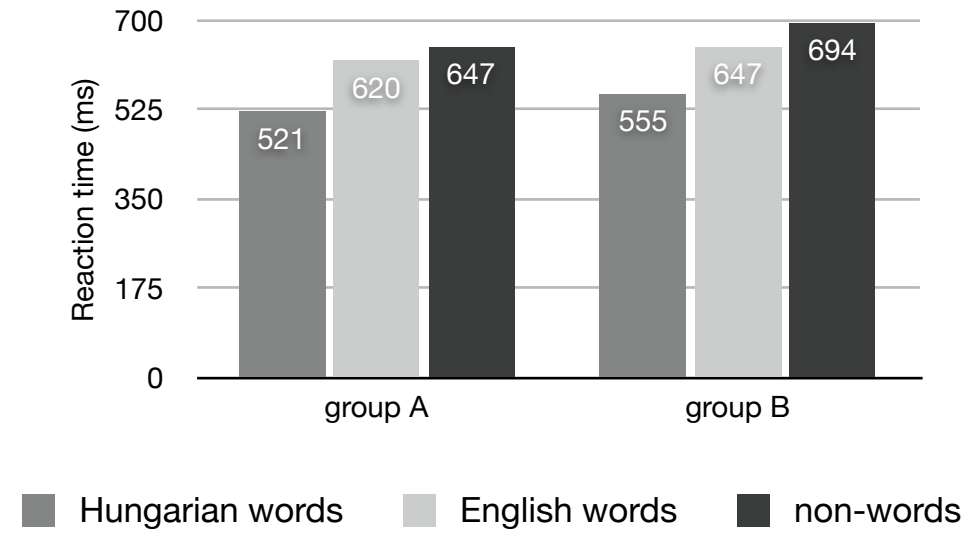

Figure 4: Mean reaction times in the two groups of participants

Reaction time differences between English and Hungarian words in generalized lexical decision are similar to the differences observed between mean reaction latencies in language-specific tasks. L1 words are activated faster than L2 words. As non-words are responded to significantly slower than English words, the difference between the mean reaction times of non-words and Hungarian words appears to be greater than the difference between the mean reaction times of non-words and English words.

3.3.2. Activation of L1 and L2 words under different experimental conditions

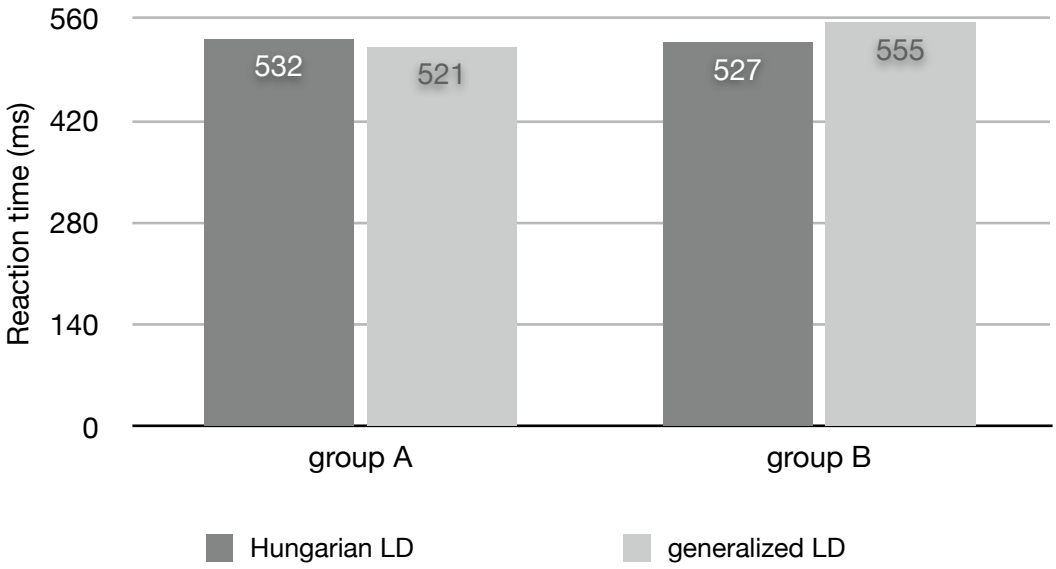

Figure 5: Mean response latencies of Hungarian words in Hungarian and generalized lexical decision tasks

Mean response latencies of Hungarian and English words in different experimental situations are shown on Figure 5 and 6. English words were responded to faster in the language specific, English lexical decision task than in the generalized task when the Hungarian lexicon was more activated. The difference between the mean reaction times is statistically significant. In the case of Hungarian words the difference between the mean reaction times of participants was only significant in one of the two groups.

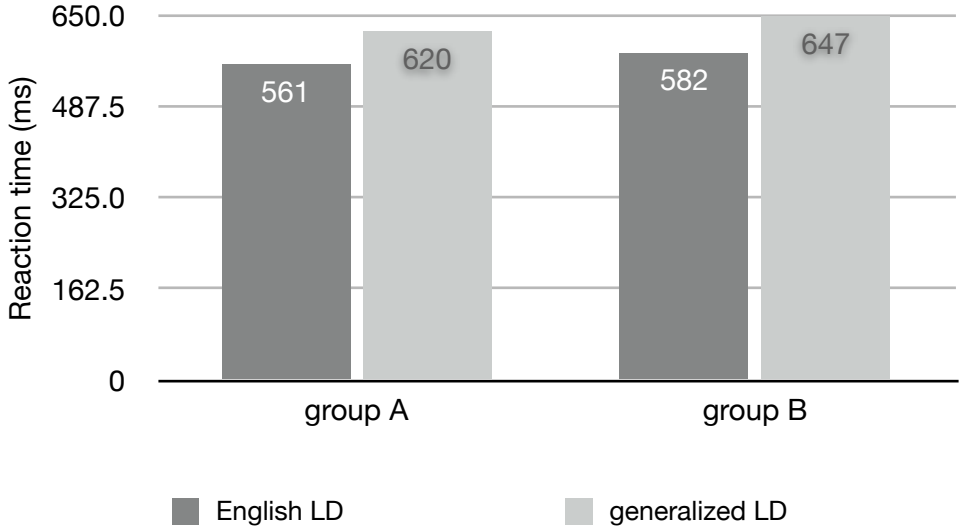

Figure 6: Mean response latencies of English words in English and generalized lexical decision tasks

The effect of different experimental situations on the recognition of L1 and L2 words can be examined by comparing reaction times of the same words tested in language selective and generalized lexical decision. There were 20 English and 20 Hungarian words appearing in both experimental conditions. The mean reaction times for these Hungarian words were 529 ms in the Hungarian and 545 ms in the generalized lexical decision task. The small, 16 ms difference did not reach significance. The experimental situation did not affect the activation of Hungarian words: the activation of the L2 lexicon did not have a significant slow down effect on the recognition of L1 words.

According to mean response latencies there is a more important difference in the case of L2 words. In the language specific, English lexical decision task the mean reaction time was 567 ms, in the generalized lexical decision it was 637 ms. In the case of L2 the difference between mean response latencies under different experimental conditions is significant: one-sample t-test: t(19) = 5,997 (p = 0,0000)***; Johnson test: J(19) = 5,286 (p = 0,0000)***. According to reaction time differences the experimental situation affected the recognition of L2 words. The presence of Hungarian words in the generalized lexical decision task, implying the activation of the L1 lexicon, had a significant slow down effect on L2 word responses.

3.3.3. Non-word responses in generalized and language specific lexical decision tasks

Mean reaction times of participants in different experimental situations are given in Figure 7. There is a significant difference between the mean reaction times for non-words in Hungarian versus generalized lexical decision. At the same time, the difference between the mean reaction times of participants in the English versus the generalized lexical decision task reached significance only in one of the two groups (“B”).

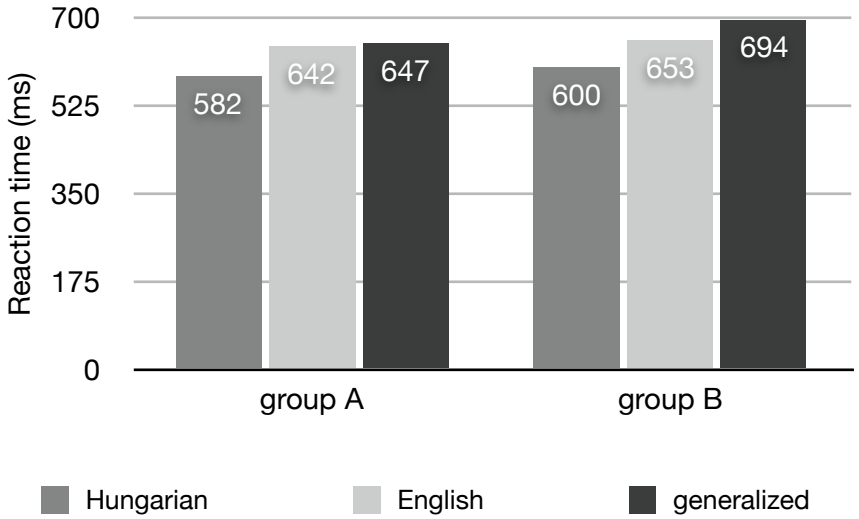

Figure 7: The mean reaction times of participants for non-words in different lexical decision tasks

The composition of the word lists used in the experiment makes it possible to compare the response latencies measured for the same non-word stimuli in different tasks.

The same non-words were rejected more slowly when presented in generalized than in Hungarian lexical decision. The difference between the mean reaction times is 62 ms. The same non-words were rejected faster when presented in a language-specific Hungarian task. The direction of the difference is the same when comparing the same non-words in English and generalized lexical decision, but the 24 ms difference did not reach significance. Comparing the normalized reaction times the difference was significant at the 10% (tendency) level.

Reaction times for non-word responses in the generalized lexical decision task are similar to those measured in the English lexical decision. The increase in reaction times compared to the Hungarian lexical decision affects also orthographically Hungarian-like non-words (e.g. *vögyülcs, abráty, pány*).

3.3.4. The recognition of the words "hely" and "kerek" in different experimental situations

Although—according to the analysis of word response latencies—the experimental situation does not have a significant effect on the recognition of L1 words, two words were recognized significantly more slowly when presented in a bilingual list in generalized lexical decision. The activation of the L2 lexicon might have an effect on the recognition of orthographically neutral L1 words that have various L2 neighbors as in the case of the Hungarian word *hely* ('place, location'). The similarities of the word stimuli presented in the same list might produce a slow down effect as well. The word *kerek* ('round') presented a few items after the word *kerék* ('wheel') is recognized more slowly in the generalized lexical decision task.

3.4. Effects of independent variables concerning language acquisition

The mean reaction times and error rates of the participants were analyzed in relation to three independent variables: the age at the beginning of L2 acquisition, the results of an English language test and the frequency of language use.

In accordance with earlier results (Vargha 2006) language proficiency (as measured by the English test) did not significantly affect reaction times, it did have, however, a significant effect on error rates. Those who obtained better results in the English test committed less errors in the English lexical decision task, especially in the case of non-words. It can happen that there is a

connection between mean reaction time and error rates: if the error rate of those who give many erroneous responses (typically to more difficult thus normally more time consuming stimuli) is higher, their mean reaction time (where only the correct responses are considered) might be relatively lower as a side-effect.

The age at the beginning of language acquisition did not have a significant effect of L2 word activation, although the results point to the expected direction.

Language use did not prove to have any effect on the differences between L1 and L2 lexical access.

3.5. Comparisons with the results of the English Lexicon Project

English words and half of the non-words used in the present study were taken from the English Lexicon Project (ELP) database. The mean response time for every word is given in the database. The results of the ELP and the present research were compared from two points of view. On the one hand the correlation between the responses of English and Hungarian subjects was tested, on the other hand mean response latencies were compared.

There is a stronger positive correlation between non-word responses than between word responses. According to the comparison of mean response latencies the subjects of the present study responded faster to the same English words and non-words than the English subjects of the ELP. The difference should be explained by the experimental conditions rather than by different ways of lexical processing. The fast and immediate feedback provided by the computer program used in the present research probably induced subjects to respond faster.

4. FRENCH-HUNGARIAN CONTROL STUDY

The aim of the control study is to confirm the most important findings of the main research. The method and the stimulus material are highly comparable to those of the English-Hungarian study presented earlier. 16 subjects participated to the experiment, all native speakers of Hungarian who had learned French as a second language.

The results of the French-Hungarian study confirm those of the main research. In language specific lexical decision tasks both words and non-words were responded to faster when the language of the experiment was Hungarian. Mean reaction times are similar to those obtained in the English-French study.

In accordance with the results of the English-Hungarian experiments, the experimental situation did not have a significant effect on the activation of L1 words based on reaction time latencies, whereas L2 (French) words were responded to more slowly when presented in a generalized lexical decision task.

Non-word responses show the same pattern as in the English-Hungarian study. While non-words presented in the Hungarian lexical decision task were responded to more slowly in generalized lexical decision, the experimental situation did not have a significant effect on non-word stimuli presented also in the French task. As in the main research, in the case of non-words the reaction time results of the generalized lexical decision task are quite similar to those of the L2 lexical decision task.

5. RECOGNIZING COGNATES IN FUNCTION OF THE LANGUAGE

Cognates are words in two languages that share a similar meaning, spelling, and pronunciation. Considering connections between L1 and L2, it is obvious that these words are the most likely to share their representations at the lexical level. To complete and to confirm from an

other aspect the findings of the main study, an additional experiment was conducted investigating the recognition of cognates in function of the test language.

Contrary to the research hypothesis—using the same list of English words, Hungarian words and non-words—cognates were not recognized faster when presented in a Hungarian (L1) lexical decision task than in an English (L2) lexical decision. From this it follows that the participants could not disregard that cognates were existing words also in L2. Cognates seem to activate automatically the L2 lexicon. Although in the lexical activation process the L1 is dominant, it cannot suppress the activation of the L2 lexicon.

7. CONCLUSION

In the dissertation L1 and L2 lexical processes were investigated in visual lexical decision tasks under different experimental conditions. The following theses can be formulated as a general conclusion:

1. Differences between word and non-word responses show the same pattern in L1 and L2 lexical decision. For both languages reaction times are longer in the case of non-words than in the case of words. Differences between word and non-word responses manifest themselves in reaction times rather than in error rates.

2. There are significant differences between L1 and L2 word recognition even in language specific lexical decision. Reaction times are longer for L2 than for L1 words. However, the results coming from the analysis of error rates are ambiguous.

3. The rejection of non-words takes more time in L2 lexical decision and error rates are higher than in the L1 lexical decision task. The higher error rates in non-word responses could be explained by the decision mechanism. In L2 lexical decision participants are more likely to base their responses on the global lexical activation. They try to guess how word-like the presented stimulus is and might judge it as an existing word without complete identification.

4. L2 word responses require more time in generalized lexical decision than in L2 language specific lexical decision tasks. Consequently, the identification of L2 words is more difficult when the L1 lexicon is also kept activated. The same experimental condition does not have a significant slow down effect on the recognition of L1 words.

5. There is a significant difference between the mean reaction time for non-words in Hungarian versus generalized lexical decision. In the case of L2 no such relationship between non-word responses and experimental conditions could be proven. Non-word responses in the generalized lexical decision task are based on the searching of the L2 lexicon: a correct non-word response is possible only if the presented stimulus could not be found in either L1 or L2 lexicons. The increase in reaction times, compared to the Hungarian lexical decision, affects also orthographically Hungarian-like non-words. The response latencies for non-words do not seem to depend on the orthographic characteristics of the stimuli.

6. Based on the results, lexical process is language specific also in the case of visual word recognition, in accordance with the BIMOLA model. Reaction time differences between L1 and L2 in generalized lexical decision suggest that in the verification mechanism during lexical decision the two lexicons are searched separately and the L1 lexicon is dominant. At the same time lexical items might activate the language nodes. When the task demands are different between languages (L1 word = positive decision; L2 word = negative decision) the higher activation of the L2 language node might have a slow down effect on the responses to cognates.

7. Language proficiency (as measured by a language test) did not have a significant effect on reaction time differences between L1 and L2 lexical decision, but it affected error rates. In the English lexical decision task those who had better results in the English test committed less errors,

especially in the case of non-words. It can happen that there is a connection between the mean reaction time and error rates, that is to say those who give correct responses to more difficult stimuli might think longer in the case of these items, thus more complex mental processes result in longer mean reaction time. Those who tend to give erroneous responses might have shorter mean reaction times, since only the reaction times of correct responses (presumably to the less complicated stimuli) are taken into consideration. Thus stimuli requiring more complex processing make the mean reaction time longer in the case of participants who respond correctly (more proficient L2 learners) while those who press the wrong key do not worsen their mean response latency. That is why proficiency has a significant effect on error rates but not on reaction times.

As a general conclusion, dedicated computer programs developed in function of the research aims have clear advantages in psycholinguistic research. Dedicated software tools make it possible to shape the methods without trying to fit them into the schema and the limits of an existing application. At the same time, the software developed for the lexical decision tasks (if duly modified) might be useful in other researches investigating lexical processes.

The phenomenon of dual-lingualism as described in dialect research (Kiss 2006) is in many aspects comparable to bilingualism. Since language use is changing in relation to the spread of the standard, new methods and viewpoints should be involved into the research of dialects. Lexical decision might be a relevant experimental technic to retrieve the vernacular form of a linguistic variable. The use of portable computers is a way to surmount the practical difficulties in making the tests executable in the field. Reaction time measurement techniques (as they developed in the field of psycholinguistics) might, due to the time constraint, reduce linguistic control and thus a more accurate picture might be drawn of the subject's vernacular.

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