

## **HOW ARE THE WORDS OF TWO LANGUAGES STORED IN THE BILINGUAL BRAIN?**

The question of how bilingual people store linguistic information in their brain has been in the focus of bilingualism research for about 30 years now. Studies have been mushrooming to find out whether languages are stored in a unitary or a separated way. Research first concentrated on bilingual child language development, and first the unitary, later the separated hypothesis was proved. Psycholinguistic data gained from adult bilinguals have shown the complexity of the question, and still we have no definite answer. However, it has been discovered that there are influencing factors: age, proficiency level and manner of acquisition. The latest, neuroimaging methods in studying the multilingual brain enable us to see what is going on in the brain during multiple speech processing. There is no final answer yet concerning multilingual storage, but the influencing factors really have a major role, only we do not know which of them is primary. The latest research (brain mapping) proves that concepts are spread all across the brain in both hemispheres. Words are activated in different parts of the brain depending on their meanings (e.g. the 'top' in areas related to numbers, clothing, buildings). Although each individual's brain map is different, different people have the same concepts in the same areas, irrespective of the languages. If this is true, the question whether the storage of the two languages is unitary or separated has no relevance any longer.

*Keywords:* multilingual storage, processing, lexical access, word recognition

### **1. BILINGUAL DEVELOPMENT IN EARLY CHILDHOOD**

Testing the bi- or multilingual mental lexicon has been in the focus of research among psycho- and neurolinguists in the past two decades or so. The central question of the investigation is to find out about the structure of the mental lexicon and to see how languages are stored in one brain: in a unitary or a separated way. First, researchers concentrated on bilingual child language acquisition, and

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from the results of numerous case-studies they first came to the conclusion that there is a unitary system developing, which serves both languages.

Volterra and Taeschner (1978) propose a three-stage model for early phases of language development in bilingual children, according to which (i) the child has only one lexical system comprising words from both languages; (ii) the child develops two distinct lexical systems while applying the same syntactic rules to both languages; and finally (iii) the child is able to differentiate between the two linguistic systems, at the lexical as well as syntactic levels.

Contrary to Volterra and Taeschner's one-system (unique-system, single-system) hypothesis, Meisel (1989) claims that it is very difficult to find positive evidence in support of the one-system stage. Bilinguals do differentiate between the two grammatical systems from early on. The question is: at what point of language development may one reasonably assume that the child is able to use syntactic (or, more generally grammatical) modes of language processing? In Meisel's opinion monolinguals and bilinguals alike start out with a mode of processing which follows general semantic-pragmatic strategies rather than more language specific grammatical principles.

In fact, if one can show that a bilingual child uses different grammatical means for expressing the same or similar semantic-pragmatic functions in both languages, this not only indicates that s/he is indeed differentiating the two grammatical systems, but also constitutes what I believe the clearest evidence that one can and, indeed must attribute to the child – the ability to use the grammatical mode.” (Meisel 1989:20)

De Houwer (1990) sharply criticizes Volterra and Taeschner's views. In her opinion, they use psycholinguistic terms to prove that during the mixing stage the child has one lexical system. However, it is due to pure sociolinguistic categories that the child uses mixed utterances.

Lanza (1997) deeply explores the unitary vs. separated systems hypotheses and the questions surrounding whether simultaneously input languages are learnt in isolation and it is the maturity and development of the child which determines the choice of language use and the use of mixing, or whether bilinguals are the sum of two monolinguals in one person. In order for real language differentiation to take place, Lanza suggests that a true bilingual must be conceived of two monolinguals as one person, since not only is the appropriate choice of language necessary, but an awareness of the context, too. Based on her studies on the bilingual development of two Norwegian-English children, she claims that the children, despite their differing systems, still managed to use mixing appropriately, as and when the situation arose,

demonstrating an awareness of the pragmatic parameters and that the differentiation process clearly does exist and that it exists despite having no preference of support for either system hypothesis and that it is the social situation which determines the language choice, even in infants so young.

Recently, Vihman (2016) studying both first produced words and later words of bilingual children and comparing each of the observed children's two languages comes to the following conclusion: the first 10 words are relatively accurate and selected from phonologically accessible targets. In the first 100 words, there are different proportions of each prosodic structure, in any variant. She also finds evidence of later generalization or overuse of the preferred structures, what she calls 'templates'. She claims child templates draw on both languages that the bilingual child knows, and they do not restrict themselves to 'separate systems'. Instead, they give evidence of emergent systematicity – which seems to disregard or minimize language boundaries (cf. Kehoe 2015).

Language mixing and code-switching are phenomena often used as evidence by both camps: supporters of the unitary system hypothesis argue for the lack of ability to differentiate between the two language systems, while proponents of the separated systems hypothesis claim that switching between the languages has a pragmatic force, and behind mixing there may be many other reasons (e.g. developmental, cognitive).

Grosjean (1985) posits that the two systems must remain autonomous if language mixing is to be considered a pragmatic strategy. Others argue that language mixing in infants can be considered as a period of confusion during the developmental stages, before reaching language competence.

Those who deny the existence of code-switching in early childhood explain the phenomenon of mixing with the simple fact that the lack of the equivalent lexical item in one vocabulary makes the child switch to the other language. Children use the words they know independently of their being aware of which language they are using. Others claim that there is code-switching at as early an age as infancy elicited by some psychological factors, and it is always triggered by something. However, there is some obscurity in the definition of the term 'code-mixing': some use it as the equivalent of code-switching, others simply call it mixing and the existence of mixing is explained by the undifferentiated language systems.

Vihman (1985), a proponent of the one-system hypothesis, claims that there is a qualitative difference between the code-switches of infant bilinguals and those of the more mature ones. As Lanza (1997a) describes it:

she (i.e. Vihman) makes an important observation that in the speech of young bilinguals, the category of function words is the most often mixed while this category is rarely switched (as single items) by older bilinguals. More mature bilingual speakers tend to switch nouns most often as a single category. This purported qualitative difference in mixing patterns is interpreted as support for the view of the young bilingual child's lack of language differentiation or bilingual awareness. (Lanza, 1997a:136)

Studying German-French infant bilingualism Meisel (1994) argues for the qualitative difference, too, but he claims that the bilingual infant at first does not have access to functional categories. Code-switching, similar to that of more mature bilingual speakers will be observable only after the acquisition of grammatical constraints on code-switching, after gaining grammatical skills and grammatical competence.

Lanza (1997b) claims that there is no qualitative difference between infant language mixing and adult code-switching. She argues for the mixing of function words being not indicative of the bilingual child's lack of access to grammatical categories or a lack of a bilingual awareness, but rather it can be an indicator of language dominance. Considering that the child's language system is under development, Lanza also argues that there is no qualitative difference between the code-switches of children and those of adults. In the former case it is a competence to be achieved, in the latter, a competence already acquired. Language context determines both children's and adults' code-switching.

In my own longitudinal research, in the course of which I observed the acquisition of Hungarian as a third language by an English-Persian bilingual pair of siblings (Navracsecs 1999a, 1999b), I found many reasons beyond the linguistic ones for the children to switch or to not switch between the languages. I found that even at a very early age (2 and 3 years), children are capable of language control. In a Hungarian monolingual environment (e.g. in the kindergarten), they never used English or Persian between themselves. If they could not express something in Hungarian, they chose non-verbal communication to make themselves understood. The Hungarian monolingual environment made them adapt to the Hungarian language, and Hungarian became very soon the language of playing sessions for them. When the two children played at home together, they always used the Hungarian language. At the same time, person-related language use could also be observed, and whenever either of the parents entered the room and asked the children something or said something to them, they switched to English, but only until the parent left the room. When they were alone again, they switched back to Hungarian. When I asked them in Hungarian to tell their father that we should be

leaving, they turned to the father and said *Daddy, let's go!*, and when right after this I asked them what we were going to do, they answered in Hungarian: *Megyünk*. ('We are leaving').

The language of the environment was so decisive in the language choice of these children that even in conversations referring to events that happened in monolingual Hungarian contexts, they switched again to Hungarian. What is more, naming also happened according to the contexts. For instance, tea was named in English at home, but if they spoke about the tea they had in the kindergarten, they referred to it in Hungarian as if the two teas were something totally different.

When naming pictures, they would use the language in which they had learnt the word, without hesitation (e.g. 'dates' in Persian, 'mushroom' in English). However, I could find examples of a special function of code-switching as well: if they wanted to make sure that the other understood what they had said, they repeated the sentence in the other language as well, e.g. *Az a te sálád. That's your scarf*.

All these observations proved to me that there is a highly developed multilingual awareness of the children, and this is what controls the language choice. It is not the lack of vocabulary or the incapability of language differentiation that enhances code-switches. With the cognitive development, multilingual awareness reaches higher and higher levels. The question is not whether the children keep their languages in a common system or separately, but rather, how they can inhibit one while enforce the other from their language repertoire or constellation. This may depend on many more extra-linguistic factors, like psychology, attention, memory, the amount and quality of input, emotions, attitude, sociolinguistic factors, just to name a few. Early words belonging to different languages are different in their phonological structures, in their forms, but their meanings are shared, and these extra-linguistic factors help the child to choose which form is appropriate in different contexts.

## 2. TESTING THE ADULT BILINGUAL MENTAL LEXICON

In adulthood, bilinguals are capable of speaking in just one language if they are in a monolingual language mode. Language mode is one of the determining factors of how bilinguals behave in a conversation. They move along an imaginary continuum all through their lives as they discover in every situation what the language configuration of their partners in communication is. If they speak to a monolingual person, they use just one of their languages, which requires a very strong control over their languages. If, on the contrary, they have a bilingual

partner, they may be free from this control and can switch between the languages. But to what extent they can afford switches from one language to the other is also to be discovered during the interaction. Bilinguals also need to have a very well developed metalinguistic awareness in order to make a decision about the other person's language competence or proficiency level in order for them not to fail in a communicative situation.

The fact that there is an inhibitory control (Green, 1998), which makes it possible for bilinguals to be fluent in single-language production and comprehension, proves that there is a functional independence of the systems so they must be separated. It has also been proved that there is an independent representation of word forms in L1 and L2 at the orthographic and phonological levels, but this is within a single neural network (Abutalebi and Green 2007). Research on adult bilingualism of the past 10-15 years (cf. Kroll and Tokowicz, 2005) denies the existence of a previously believed 'language switch' that turns one language off and the other on (Penfield and Roberts, 1959). Instead, both languages are thought to be activated in bilingual processing.

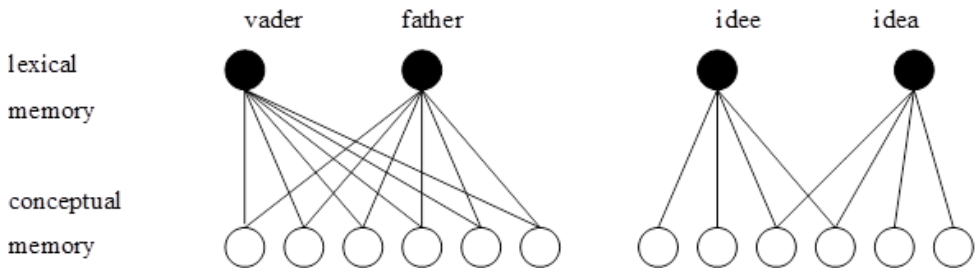
Most researchers agree that there is a parallel activation of the two languages in lexical access in both comprehension and production, and this is a general feature (Kroll et al., 2010). Under current processing models (e.g. BIA+, BIMOLA, etc.), the languages of a bilingual constantly compete. What is more, there is also abundant evidence of co-activation beyond the lexicon, in processing at every linguistic level: phonology (Kroll et al., 2000), syntax (Kootstra et al., 2010), semantics (Pavlenko, 1999). At the phonological level, for instance, homophonic word onsets activate the non-target language as well (Marian and Spivey, 2003). Normally, there is a stronger effect of L1 than L2 competition, but higher proficiency in L2 leads to more symmetrical effects, due to a common neural network for both languages (Abutalebi et al., 2001). Lexical items generally belong to L1 or L2, given the differences in form, i.e. phonology. However, the meanings of most of the words are shared if experience is shared and the usage is comparable.

In the psycholinguistic approach to the study of bilingual speech processing, language fluency has been taken into account when considering the question of storage. According to Kroll and Stewart's hierarchical model of bilingual memory representation (Kroll and Stewart, 1994), less fluent bilinguals appear to have a dual-store, and more fluent ones a single-store conceptual representation. This model proposes that the conceptual store is connected to both L1 and L2 lexicons. However, the connections between the L1 lexicon and the conceptual store are strong and direct, whereas the connections between the L2

lexicon and the conceptual store are weak. Thus, the subject's L1 is more likely to access the conceptual store directly than the subject's L2. In his Second Revision (R-2) Hierarchical Model ('date') Heredia (1996) suggests using the terms MDL (more dominant language) and LDL (less dominant language) instead of L1 and L2, based on the simple fact that in many cases L2 becomes more dominant than the earlier acquired L1. In this way, MDL has a stronger and more direct connection to the conceptual store regardless of whether it is L1 or L2.

As language proficiency increases the connection between the word and its meaning becomes more direct, relying less on a mediating connection through the L1 lexicon. The degree of meaning similarity between the words within a translation pair may ultimately determine the bilingual representational form (Fig. 1.). The more similar the meanings of the translations, the more likely they are to be stored in a compound way in the mental lexicon. Words that share the same conceptual features (e.g. 'father' in any languages) are stored in a compound way while words sharing only a limited number of features (e.g. 'idea') are stored in a coordinated way. For many words in one language a truly equivalent term does not exist in the other language (De Groot, 1993).

Fig. 1. The bilingual semantic decomposition of conceptual representation (De Groot 1992)



Singleton (1999) claims that the relationship between a given L2 word and a given L1 word in the mental lexicon will vary from individual to individual, depending on how the words have been acquired and how well they are known, and also on the degree to which formal and/or semantic similarity is perceived between the L2 word and the L1 word in question.

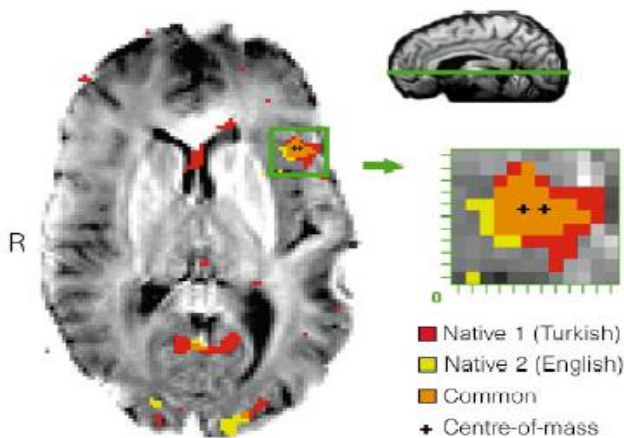
Models of speech production distinguishing thought from verbal formulation carry two immediate implications for models of bilingual performance: (i) there must be a mapping between the conceptual representation and the specification of word meanings; (ii) such a mapping might differ between languages because languages differ in terms of how concepts are lexicalized. Macro-planning is language-independent, while micro-planning is language-specific (Green, 1993).

### 3. NEUROIMAGING EVIDENCE OF BILINGUAL ACTIVATION

The existing neuroimaging literature on bilingual lexico-semantic representation is contradictory with respect to how the brain represents the two languages. Neurophysiological and neuroimaging studies support a similar cerebral representation of L1 and L2 lexicons both in early and late bilinguals (Fabbro, 2001; Chee et al., 1999 and Illes et al., 1999) and claim that cortical activation for L1 and L2 is located in identical regions of the left hemisphere. At the same time, other fMRI and PET studies have found distinct neural representations for L1 and L2 within the classical left hemisphere language regions (Kim et al., 1997, Perani et al., 1998).

There is also evidence that though the languages may be represented in different portions of the cortex in the multilingual brain (Hervais-Adelman et al., 2011), this may be a function of proficiency or age of acquisition of L2. Studies that examine lexico-semantic processes in bilinguals in the less proficient language observe that greater activity is modulated by L2 proficiency. They also demonstrate that L1 and L2 are not completely isolated from one another, and they interfere and mutually reinforce one another (Leonard et al., 2010) (Fig. 3.).

Fig. 3. Cerebral activation of an early bilingual (Broca-area) (Kim et al., 1997)



Kovelman et al. (2008) suppose that the bilingual person's neural processing differs across the two languages, and they found differential behavioural and neural patterns in studying English monolingual and English-Spanish bilingual participants' data in a sentence comprehension task. The basic difference is that



bilinguals have a significantly greater increase in the blood oxygenation level when they process English as compared to the English monolinguals. What they suppose happens is due to is that there might be a “neural signature” of bilingualism as differential activation sheds light on a different kind of language processing for bilinguals than for monolinguals.

Pillai et al. (2004) checked the activation topography with semantic and phonological tasks and found that it was different when the tasks were performed in the second language (English) from that of the first language (Spanish). In our own study (Navracics and Sary, 2017) on phonological and semantic awareness of bilinguals, we came to the conclusion that for bilinguals, phonological processing is a greater cognitive task than processing semantics. The difference may be explained by the fact that languages of different phonological typology are represented separately in the bilingual brain, whereas lexical semantics and sense relations do not differentiate languages in the cerebral representation, and the semantic representation is common for all the languages a person speaks. Buchweitz et al. (2013) in their review also propose a similar semantic representation at the neural level in proficient bilinguals.

In ERP (Event-Related Potentials) tests, certain interference effects can be observed in bilingual tasks. More recent evidence (Huster et al., 2010) suggests that an early ERP component may reflect response selection, and that a later component may reflect inhibitory cognitive components. Studies claim that the later ERP component is systematically greater in amplitude in bilingual than in monolingual participants (Moreno et al., 2008). They suggest that this component reflects enhanced cognitive control mechanisms related to the everyday demands of being bilingual.

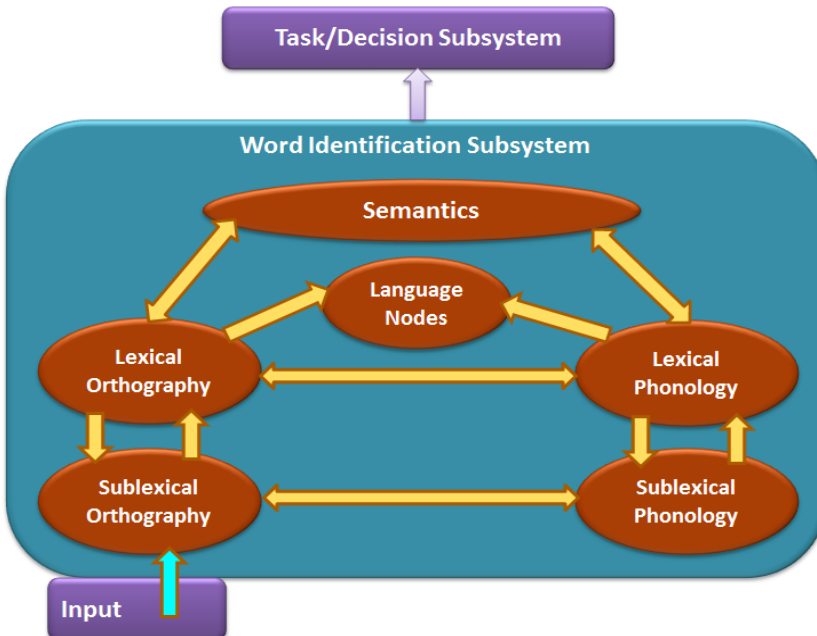
In lexical access, the frequency of use of a bilingual’s languages may be an influential factor. The more frequently a language is used, the faster the words are identified as members of the language and the greater interference is caused if it is not the target language (Ng and Wicha, 2013). Paulesu et al. (2000) in their fMRI study show that in addition to the frequency, regularity and familiarity of the word, the orthographic pattern of the language that the word belongs to has an influential factor in brain activation. They found selective activation for reading English words, which has a deep orthography, and for Italian, which has a shallow one, i.e. the predominant process while reading is the letter-to-sound conversion or the grapheme-phoneme correspondence.

Reading involves the joint activation of orthography, phonology and semantics. The question is whether these processes are independent from each other, whether they are performed one after the other or in parallel and whether they

are automatic or strategic (Rastle, 2007). There are two presumed pathways to lexical access: (i) a direct one from orthography to semantics and (ii) an indirect one, the ‘phonological mediation hypothesis’ (Tan and Perfetti, 1999). Price et al. (1996) and Price (2000) claim that reading frequent, regular words does not require precise phonological recoding. On the contrary, phonological forms are accessed directly and automatically. At the same time, Braun et al. (2009) carried out an ERP study to find out about the time course of visual word recognition and to check the role of phonological processing. Their subjects’ reaction time, event-related potentials and LORETA results showed phonological activation in silent reading as well, which serves as evidence for phonological processes being involved in visual word recognition.

Van Heuven and Dijkstra (2010) reviewed the EEG and fMRI evidence for various psycholinguistic models of bilingual word recognition, and found that their BIA+ (Bilingual Interactive Model, Fig. 2.) was supported, i.e. the bilingual lexicon is integrated and words are accessed in a language non-selective manner.

Fig. 2. BIA+ model of bilingual word recognition



## 4. OUR OWN STUDY

### *4.1. Introduction*

How the two languages of bilinguals are activated during visual word recognition has been a focal research question for many years. Researchers with different methods have tried to provide evidence for selected or non-selected storage or processing (Albert and Obler, 1978; Kroll and Stewart, 1994; Grosjean, 1997; Paradis, 1997; Brysbaert and Dijkstra, 2006; De Groot, 2010; Laszlo and Plaut, 2012; Heredia and Altarriba, 2014; Tokowitz 2014; Brysbaert et al., 2017). So far there has been no consensus in support of the two languages being active all through processing. However, it seems to be proved that different parts of the brain get into interaction within milliseconds during the word recognition phase (Carreiras et al., 2014). The ‘where and when the brain gets activated’ question can be checked by studying EEG correlates of the brain as EEG is the most accurate means of temporal resolution of brain activity. A number of fMRI studies (Haist and Song, 2001; Price, 2012; Protopapas et al., 2016) have been carried out in hope of finding the location of the activated brain areas, but for the testing of visual word recognition, the temporal resolution of the blood-oxygen level dependent level response is too slow. Since the time course of visual word processing and recognition is essential to see the temporal flow of information in the lexical system, i.e. how we process visual information, we use EEG to get the current time and space of brain activation in a Hungarian-English bilingual language and lexical decision test. We carried out an EEG study to see the ERPs of 20 Hungarian-English bilingual participants when they recognize 60 Hungarian and 60 English words appearing on the screen randomly.

### *4.2. Methods*

Before the test, the participants filled out a standardized language proficiency test (Marian et al., 2007), based on which we could see how frequently they use their languages. They were also orally interviewed about their language history, family background and socio-economic status. The participants were considered to be early bilinguals if they were exposed to their L2 before age 9. They were also categorized according to the manner of L2 acquisition: some of them acquired both languages naturally, others in the educational context.

For checking the frequency of English words we used COCA (2012), which is a 400 million-word database, from which the 5,000-60,000 word lists are based

on the only large, genre-balanced, up-to-date corpus of American English (<http://corpus.byu.edu/coca/>). The 100,000-word list supplements COCA with detailed frequency data from Corpus of Historical American English, the British National Corpus and the Corpus of American Soap Operas (for very informal language). In this database dispersion is given, i.e. how evenly the word is distributed in the corpus. All the words selected for the test are in MRC Psycholinguistic Database, which contains 150837 words (<http://www.psych.rl.ac.uk>). Psychological measures are recorded for only about 2500 words. The English words used in the test were included in the 5-60,000-frequency list with dispersion between 0.92-0.98. Their average familiarity was 567 (minimum 393, maximum 643) on the 100-700 scale. The average frequency of words was 0.0000732.

For the frequency of Hungarian words we used the Hungarian National Corpus, which currently contains 187.6 million words ([http://corpus.nytud.hu/mnsz/index\\_eng.html](http://corpus.nytud.hu/mnsz/index_eng.html)). In this database, rank, lemma, word category, absolute and relative occurrence and genre are given, but there is no dispersion available. Nor is familiarity list available. The 60 Hungarian words ranked on average 3110, and the frequency occurrence was 0.00002. All the words both in English and Hungarian contained two syllables.

A custom made program (MATLAB, MatLab Inc.) running on a PC was used for the experiments. Words were presented on a white background, using black characters (Arial, font size 14) in the middle of the screen. The viewing distance was set to be the appropriate normal viewing distance of a computer screen (~ 50 cm). Participants received written instructions at the beginning of the experimental session.

EEG data were recorded using a 128-channel Biosemi ActiveTwo measurement device with Ag/AgCl active electrodes placed and arranged in the Biosemi equiradial ABC layout cap. Measurement was performed at  $f_s = 2048$  Hz sampling frequency. Word stimulus and response key press events were transformed into Biosemi EEG trigger signals using a special-purpose trigger unit (Issa et al., 2017). The digitised EEG data was stored in raw reference-free Biosemi format in BDF data files.

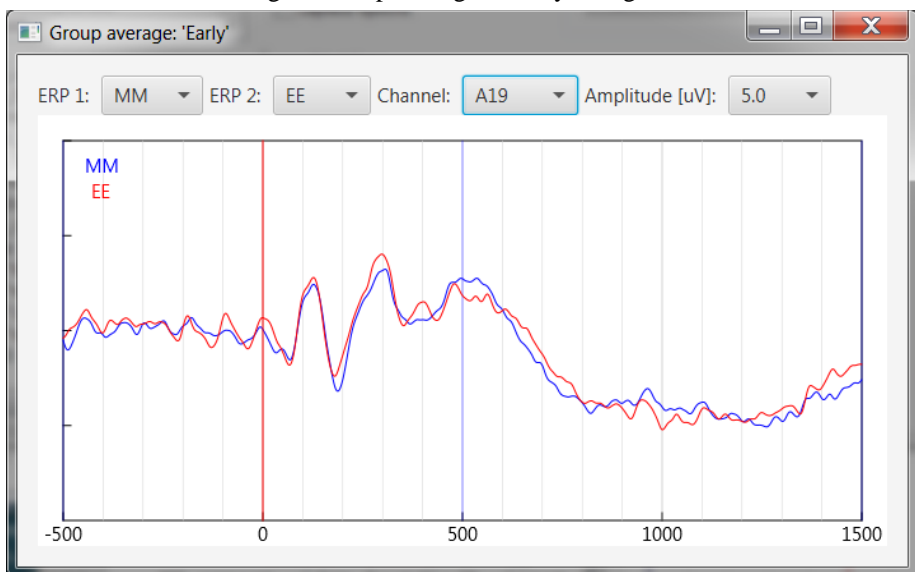
Trials started with the onset of a fixation spot in the middle of the screen, which was followed by a word chosen from the pool. The inter-trial interval was set for 2 s, each word stayed on the screen for 5 s (exposure time). During this time participants were required to hit the right arrow key if they considered the word on the screen English, and the left arrow key if they thought the word was Hungarian.

If no response key was selected during the exposure time, the program did not record anything and the next trial started (fixation onset for 2 s, etc.). The task was machine paced to ensure a constant level of attention of the participants. Participants were shown 8 words initially to become familiar with the procedure; this was the training phase. After a short break the 60 Hungarian and 60 English words were presented in a semi-random fashion (test phase). The program recorded correct/incorrect hits and response latency times. In the data analyses we included only the correct decisions. Data were analysed with the Statistica software (StatSoft, Inc.) using nonparametric statistical methods (Wilcoxon Test and Mann-Whitney U Test). Tests were classified as significant if the corresponding type I. error was smaller than 0.05.

### 4.3. Results

We registered the reaction times and the accuracy of decisions in both languages, and we did not find any significant difference between the recognition of the words of the two languages. Hungarian words were recognized on average in 0.79 seconds, English – in 0.78 seconds. However, we found the influencing factors of brain activation: age and manner of L2 acquisition. Fig. 4. shows the average results of early and Fig. 5. those of late bilinguals.

Fig. 4. Group average of early bilinguals



While the activation of the two languages goes together without any difference in early bilinguals, a considerable difference can be detected in the activation patterns in the two languages of the late bilingual group between 0 and 600 milliseconds. Between 300 and 600 milliseconds, we can see the cognitive effort in processing. Word recognition takes place during this period of time.

We must understand that there are individual differences in the cognitive efforts carried out in word recognition. Here, we can illustrate how the brain activation is going on in one of the participants, who acquired both languages simultaneously (Fig. 6.) There is no difference between the recognitions of the two languages.

Fig. 5. Group average of late bilinguals

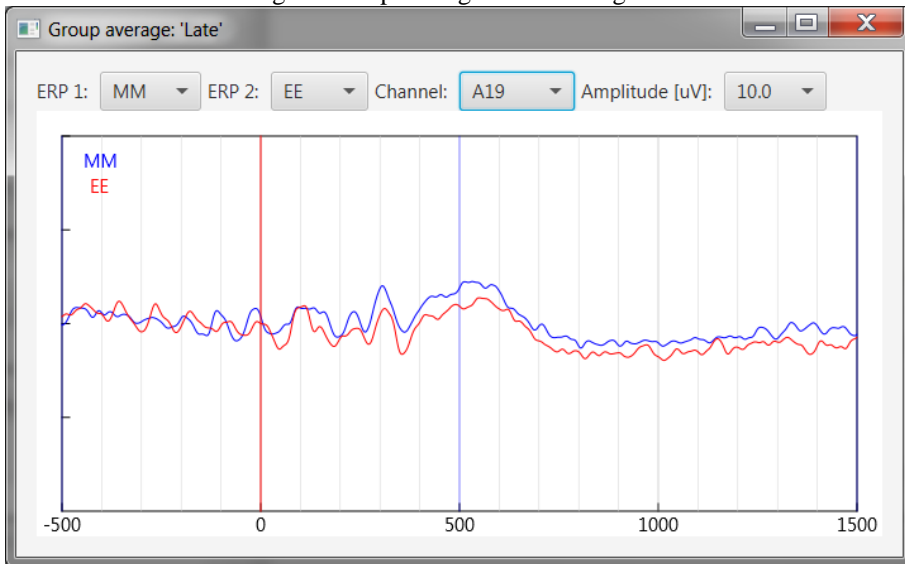
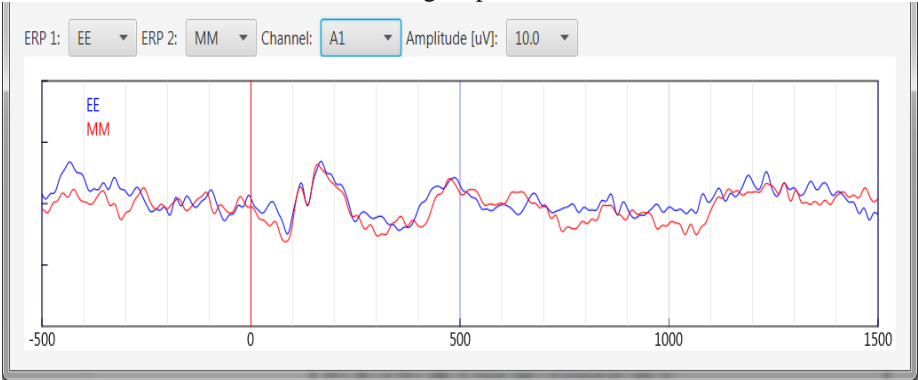
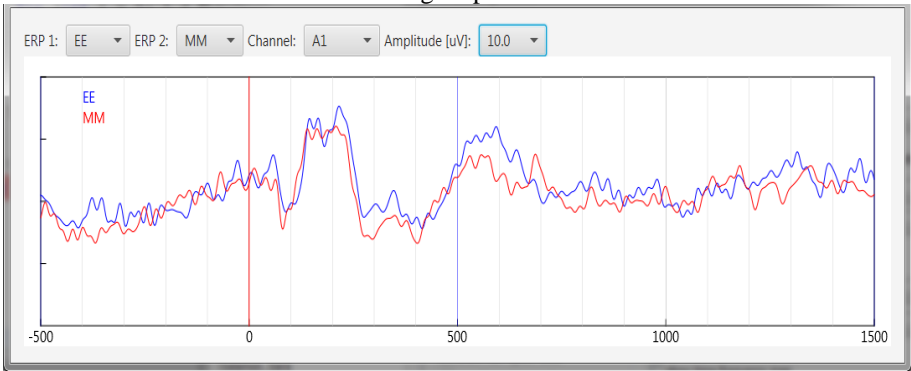


Fig. 6. The histogram of the word recognition of an early natural Hungarian-English bilingual person



However, in the histogram of the performance of a late bilingual, who acquired L2 in an instructed way at school, we can see that there is a significant difference between the ERP curves during the recognition of the words of the two languages (Fig. 7.). There is a delay between the recognition times and patterns between the words of L1 and L2 as compared to those of the early, natural bilingual's. The performance of the cognitive task makes a real difference between 500 and 700 milliseconds. This is the time period when word recognition is happening, and is going on in different ways in the two languages.

Fig. 7. The histogram of the word recognition of a late instructed Hungarian-English bilingual person



What we can conclude from the above results is that how bilinguals process and activate their languages depends very much on the age and manner of L2 acquisition.

## 5. CONCLUDING REMARKS

The mental lexicon is spread all over the cortex of the brain, and it is structured according to topics. Bilinguals have a shared conceptual representation, which is based on their everyday experiences, their mental representation. Concepts and thoughts are conveyed through linguistic tools: lexical items, multiple word expressions, phrases, etc. They may be expressed in different ways offered by the languages, by linguistic properties. Bilinguals – depending on the situation they are in – can control their language use, even in early childhood. They can speak just one of their languages and avoid code-switches. However, in the bilingual language mode, this control is not very strong so they can switch between their languages without causing any problems in the actual interaction.

The bilingual mental lexicon is the storehouse of the linguistic tools, but when, how and why these tools are activated depends very much on the circumstances of the interaction. Bilingual people can differentiate between their languages, and can use them properly and appropriately. However, the languages are in constant interaction with each other, which can be proved by the cross-linguistic influences.

How language activation takes place is the question of linguistic and metalinguistic awareness, and of the frequency of language use. Age and manner of language acquisition as well as the proficiency levels of the languages the bilingual person possesses make an influence on the quality of language production and perception. The brain activation patterns of early bilinguals are more similar in the two languages than those of bilinguals who were exposed to their L2 after age 9 and learnt their L2 in an instructed way.

Judit Navracsics

### KAKO SE SKLADIŠTE REČI DVAJU JEZIKA U DVOJEZIČNOM UMU?

#### *Rezime*

Kako dvojezične osobe skladište jezičke informacije u umu pitanje je koje je u fokusu istraživanja dvojezičnosti proteklih trideset godina. Brojna istraživanja imala su za cilj da daju odgovor na pitanje da li se jezici skladište zajedno ili odvojeno. Na osnovu podataka iz jezičkog razvoja bilingvalne dece, prvo je vladao stav da se oni skladište zajedno, da bi se u kasnijim istraživanjima dokazala hipoteza o odvojenom skladištenju. Psiholingvistički podaci dobijeni od odraslih dvojezičnih ispitanika ukazali su na složenost ovog istraživačkog pitanja, na koji ni danas nemamo konačan odgovor. Međutim, otkriveno je da



postoje faktori koji utiču na način skladištenja informacija u višjezičnom umu, kao što su starost, nivo jezičkog znanja i način usvajanja jezika. Najnovije metode neurooslikavanja u proučavanju višjezičnog mozga omogućavaju nam da vidimo šta se dešava u mozgu tokom obrade višjezičnog govora. I dalje nema konačnog odgovora u vezi sa višjezičnim skladištenjem, jer iako je dokazano da navedeni faktori zaista igraju važnu ulogu u skladištenju jezika, i dalje ne znamo koji je od njih primaran. Najnovija istraživanja (mapiranje moždanih funkcija) dokazuju da su pojmovi rašireni po celom mozgu, u obe hemisfere. Reči se aktiviraju u različitim delovima mozga, u zavisnosti od značenja, npr. kada govornik engleskog jezika čuje reč *top* aktiviraće se regije mozga u kojima se skladište reči vezane za brojeve, odeću ili zgrade jer van konteksta ova reč može imati značenje koje je vezano za bilo koju od ove tri grupe reči. I mada je mapa mozga svakog pojedinca drugačija, različiti ljudi imaju iste pojmove u istim područjima, bez obzira na to koje jezike govore. Ukoliko je ovo tačno, pitanje da li dvojezične osobe skladište jezike u umu zajedno ili odvojeno više nije relevantno.

*Ključne reči:* višjezično skladištenje, obrada, pristup leksičkim informacijama, prepoznavanje reči

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