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BILINGUAL LEXICAL ACCESS AND LANGUAGE DECISION REVISITED: EVIDENCE FROM A GATING TASK WITH A TWIST

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In this paper we investigate bilingual auditory processing and the opportunities that language-specific cues based in the differences between the consonantal inventories of the Croatian and English languages offer in terms of non-parallel processing in early word recognition. A custom-made application presenting a gating task that incorporated language decision was designed. The test stimuli contained phoneme-based language-specific cues which were absent in the control stimuli. Croatian-English L1-dominant bilinguals participated in the experiment. The results showed that the language-specific cues in the auditory stimulus directed and sped up reaction latencies in participants' responses to L2 stimuli comprising language-specific cues, while this was not the case in the processing L2 stimuli that did not comprise such cues. Interestingly, L1 processing was unaffected by the language-specific cues. The results are interpreted by means of Léwy and Grosjean's 2008 Bilingual Model of Lexical Access (BIMOLA) and the markedness theory.

Keywords: language-specific cues, dominant bilinguals, Croatian, English, Bilingual Model of Lexical Access (BIMOLA)

INTRODUCTION

About two decades ago bilingual language processing enthusiasts witnessed a somewhat rare phenomenon in academia: a more or less unison agreement on a disputed issue. The scholars agreed that bilingual language processing is parallel, i.e. non-selective meaning that elements in the mental lexicon (or two separate mental lexica – a point still not entirely agreed upon) of the bilingual are accessed at the same time, automatically, at the very moment the bilingual encounters a word belonging to their linguistic experience of any of their two languages. This view was supported by behavioural research based in various paradigms within the experimental psycholinguistic studies in mental chronometry and eye-tracking, both in visual and auditory stimulus presentation (Bultena & Dijkstra, 2012; Dijkstra, 2005; Kroll & Ma, 2018; Palma & Titone, 2020; Yip et al., 2021). However, psycholinguists still labour with fervour to investigate whether there is anything in the linguistic input that can direct the processing to one or another language of the bilingual, making it language-selective in certain circumstances (e.g. Grainger & Beauvillain, 1987; Ju & Luce, 2004; Cergol Kovačević, 2012). If so, this should be reflected in the speed with which participants carry out experimental tasks, which in turn portrays the increased ease of bilingual lexical access. As a concept in language processing research this refers to the automatic access to the elements of a bilingual's mental lexicon that is followed by lexical retrieval, i.e. comprehension of the input. Units of language processing are many and experiments dealing with lexical access will focus on the processing of a single word, a sentence or a text. Sentence and text provide guiding co-text directing the processing to the appropriate language of the bilingual. Should one wish to focus on "bare" bilingual lexical access, stripped off most guiding contextual information, as is the case in the present paper, they will choose to investigate single-word processing. Another issue is that of the point at which a bilingual recognizes the language of the presentation of a string of letters (visual modality) or phonemes (auditory modality) they are being exposed to in an experimental condition, i.e. the point at which they can make a language decision. Some models of bilingual language processing commonly propose to attach the language tag only after the lexical and semantic levels of processing have been completed, e.g. Bilingual Interactive Activation Model+ (BIA+) (Dijkstra & van Heuven, 2002). However, a seasoned bilingual will know that they ofttimes do not need to understand the word they are processing in order to be able to classify it as belonging to one or the other of their languages. Arguably, this may be more apparent in auditory than in visual processing (provided the languages share the same script). In experimental conditions, phonetic characteristics of languages may be utilized to design stimuli that will carry language-specific cues, which may aid lexical, and more interestingly, language decision thus directing processing to one or the other language of the bilingual. Most available studies deal with either lexical access or language decision; in this paper, upon identifying this research gap, we incorporate both by blending them into a hybrid paradigm.

Croatian and English: differences in the consonantal inventories

For this purpose, we take advantage of the differences in the phonemic inventories between the Croatian and English languages (for reference see Josipović-Smojver, 1999). As far as the phonemic consonantal inventory is concerned, the English phonemes /θ/, /ð/, /w/, and /ŋ/ are not used distinctively in Croatian and, according to Josipović-Smojver, are commonly misplaced by their most similar Croatian correlates /t/, /d/, /v/ and the sequence /n+g/ in the non-native pronunciation of English the author coins Croglish. Josipović-Smojver continues to provide the more numerous phonetic differences. In English the phoneme /v/ is a labiodental fricative, while it is a labiodental approximant in Croatian. Moreover, the phoneme /r/, which is a frictionless continuant in English, is realized as a flap or a trill in Croatian. The voiceless stops /p/, /t/, and /k/ are aspirated (when they are followed by a vowel in a stressed syllable) in English, either at the beginning of the word or at the beginning of the stressed syllable in word-medial position. These phonemes are never aspirated in Croatian. English /t/ and /d/ are alveolar, while their Croatian correlates are dental. The English affricates /tʃ/ and /dʒ/ are postalveolar as opposed to their prepalatal or alveolar Croatian correlates. Finally, the phoneme /h/ is a glottal fricative in English as opposed to its velar Croatian correlate. One may consider these differences, alongside others, as language-specific cues a Croatian-English bilingual automatically utilizes to discern between their two languages. If stimuli are designed in such a way to position these cues strategically for a certain experimental paradigm, they may serve as reliable predictors of directed language-selective processing.

Auditory bilingual processing models

The desired outcome of research in language processing is the creation of a processing model. A model as a simplified version of a proposed reality is crucial for the understanding of the process it strives to represent. The model needs to be as detailed as possible, yet simple enough for it to represent commonalities and processing paths. Various versions of bilingual processing models have been created, both for the visual and auditory variants. Scholarly research in bilingual lexical access has long denounced the modular models and has worked upon the premises of the connectionist interactive activation models conceptualized upon the assumed existence of various levels of linguistic analysis within which elements that make part of the stimulus undergo activation, while the non-matching elements are inhibited. Another line of modelling, the computational models' arena, builds upon the premises of artificial intelligence (e.g. Li & Farkas, 2002). However, like any other AI undertaking, the computational models comprise the so-called black box stage that remains unclear as the processes that are hidden inside it cannot be deciphered and uncovered. Thus, should one wish to represent how one detail is embedded into the rest of the process, as is the case in this paper, they will most likely opt to show how their data may be incorporated into the interactive activation models. Thus, for the purposes of this paper an interactive activation model of auditory processing is consulted. The BIMOLA model (Bilingual Model of Lexical Access) (Léwy & Grosjean, 2008) rests upon the assumption of three levels of processing. The first one is the level of features that is activated upon the input presented in the form of the acoustic signal. The second level is the level of phonemes, while the third one is the level of words. Global (contextual) language information is accounted for as a top-down factor. The first level is shared between the languages, while the second and third levels are organized into language-related subsets belonging to the level-based sets that allow for activation and inhibition between the subsets, thus accounting for, e.g. negative language transfer effects, yet not predicting constant competition between L1 and L2 lexical items. This is important because it accounts for the non-parallel language processing of auditory stimulus once the level of phonemes is reached; however, it still accounts for any interaction between languages and the parallel processing at the very beginning of the auditory presentation, i.e. at feature level that is activated upon the presentation of the acoustic signal. In other words, the BIMOLA model does not predict language nodes in the way that its visual counterpart, the Bilingual Interactive Activation+ (BIA+) model does (Dijkstra & van Heuven, 2002) or the Semantic, Orthographic, Phonological Interactive Activation model (SOPHIA) (van Heuven & Dijkstra, 2001, in Thomas & van Heuven, 2005) that adds the phonological aspect to the processing accounting for the activation of the phonological information during visual (but not auditory) processing. However, BIMOLA allows for the allocation of the processing to the respective language subsets thus accounting for the prediction that the speaker should be able to identify the language of the input before recognizing the lexical item itself. This is what the present paper aims to investigate using the language-specific cues in the auditory stimulus that are based on the differences between the phonetic inventories of the Croatian and English languages.

AIM AND HYPOTHESES

The aim of this study was to investigate whether phonetic language-specific cues (LSCs), i.e. the elements characteristic of just one language and not the other, residing in the auditory input may help a bilingual listener opt for the appropriate language in the process of word recognition, before the target word is recognized. If LSCs can direct the auditory processing to the appropriate language of the speaker, they should speed up bilingual auditory processing in Croatian and English.

Three hypotheses were thus formulated.

First, that L1 dominant bilingual participants would be faster to decide on the language of the processing in stimuli with LSCs as opposed to the stimuli without such cues (measured in milliseconds).

Second, that the recognition latencies to the auditory stimulus bearing LSCs would be faster than the recognition latencies to the auditory stimulus not bearing LSCs.

And third, that the participants would be able to recognize the language of the stimulus prior to recognizing the target words.

Additionally, we were interested in learning whether there would be any differences in the processing of Croatian and English.

METHODOLOGY

A total of 32 participants consented as volunteers to take part in the research. They all attended their first year of university education and they all were students of English. The participants reported no hearing problems. They were tested with the Oxford Placement Test (Allan, 2004) to check their English language proficiency. Their L1 was Croatian and they used English on a daily basis thus fitting Grosjean's (Grosjean, 1994) definition of a bilingual. Following Mildner's (2002) deliberation on various types of bilinguals, they are best defined as L1 dominant bilinguals, i.e., such speakers of two languages who are more versed in one of their languages, this being their mother tongue (Mildner, 2002: 76).

Grosjean's gating paradigm was used in which the participants are presented with the auditory stimulus cut into short segments (gates) whereby the amount of signal increases with each new segment, thus emphasizing the temporal nature of the spoken language (Grosjean, 1980). In choosing the segment length of the stimuli we relied on the research carried out with phoneme identification. In 1987 Mackie, Dermody and Katsch showed that the initial phoneme in a word can be recognized 30 milliseconds after the beginning of the presentation of the auditory input, and sometimes even earlier. Therefore, for the purposes of this research words were cut into 30 millisecond long segments the length of which increased by 30 milliseconds with each further segment. Moreover, according to Bakran (1996) the voice onset time for the Croatian bilabial voiceless plosive /p/ is around 18 ms, while it can be as long as 80 ms for the aspirated English /p/. The 30 ms-long segmentation captures the 18 ms VOT as the shortest segment used initially in the experimental stimuli of the present paper. We used 40 target stimuli comprising a) stimuli in which Croatian and English phonological inventories overlapped and b) stimuli which comprised the phonological material specific for one or the other language of the participants – language specific cues (LSCs). The phonemes which had or did not have the distinguishing features studied were word-initial consonants so as to keep the linear presentation conditions uniform. Out of the 40 target words, 10 belonged to each category of the crossed languages and LSC inclusion. Stimulus selection was subjected to rigorous control. First of all, word frequency was controlled for so that only words with a frequency of 50 and more tokens per million (highly frequent words) were selected. Word class of the stimuli was also controlled for as it is known that nouns in nominative case (Erdeljac & Horga, 2003) are processed faster than other word classes. As the syllable is a highly salient processing unit, all words were one-syllable long nouns which consisted of three phonemes arranged in the consonant – vowel – consonant sequence (e.g. bird, car). The first consonant was language-specific (for the test stimuli) or not (for the control stimuli), while all vowels are considered language-specific in English and Croatian. The length of the vowel and the accent were controlled as well. English vowels were all long, while all Croatian vowels had a long falling accent (so that the difference in the length of the acoustic signal could be equalized between the stimuli). As one-syllable long nouns of the CVC form, the target words all had a rich phonological neighbourhood, so this condition was kept constant between the stimuli as well.

The gating paradigm was blended with the language decision task to fit the purpose of this study thus creating a novel hybrid testing paradigm. A tailor-programmed online application was designed for the purpose of the experiment (Kovačević, 2012) (see Figure 1). The participants sat at the computers on which the task was run. Each of them had headphones and worked at his/her own pace. They first did three practice stimuli, followed by 20 target stimuli, an obligatory break and another 20 stimuli. The participants were required to play segment by segment of each stimulus and provide their choice of language at the moment they were able to recognize (or thought that they had recognized) which language the word was being presented in. The question about language-identification was the modification of the gating paradigm, the blending of the gating paradigm and the language decision task. At the moment when they thought that they had recognized the word, the participants were asked to note down which word it was and to provide their confidence rating, i.e. say how certain they were of their answer. For this purpose, they used a drop-down menu providing 5, 25, 50, 75 and 100 percent certainty ratings. This part of the task was carried out in accordance with the original gating paradigm so as to mark the isolation point, i.e. the first moment the word was correctly recognized (Grosjean, 1980), as well as to allow for the intermediate levels of certainty and mark the total recognition point, i.e. the moment the participants confirmed the full certainty of their choice. The application was programmed in such a way not to allow for skipping of segments and to store the data in the data base which was later used in the analysis. The words in the experiment were presented in random order. For this purpose, they were randomized by means of a Research Randomizer Tool.

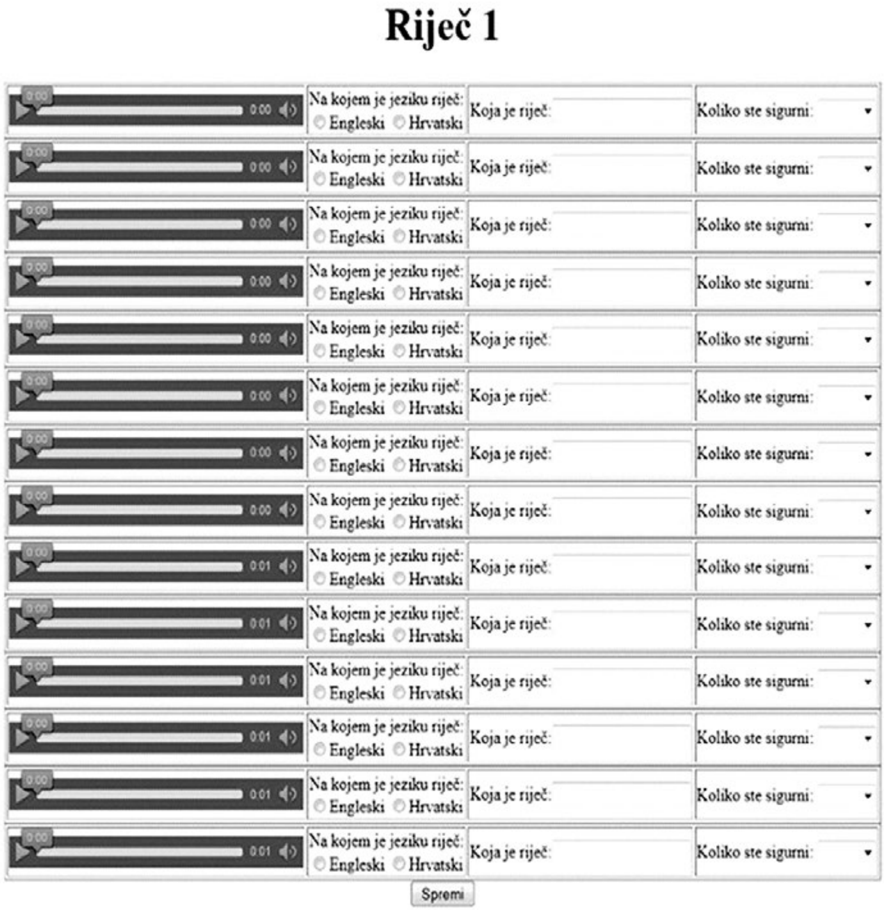

Figure 1. The hybrid paradigm used in the experiment (Kovačević, 2012). The participants play the auditory stimuli cut into 30 millisecond-long segments where every following gate is 30 ms longer than the previous one (first column). They are required to make a language decision (second column) and try to guess the word that is being presented (third column). Finally, they are asked to say how certain they are in their choice of the word by using a drop-down menu with 5, 25, 50, 75 and 100 percent certainty ratings (fourth column).

The speaker who recorded the stimuli was an early balanced Croatian-English ambilingual female residing in Croatia. The speaker had training in phonetics and was experienced in recording professional material for the English language. To make sure that the speaker was perceived equally proficient in the English language as she is in Croatian, a follow-up study was designed with 9 other native speakers of English who recorded the same target words. These recordings were organized into another tailor-made online application and assessed by another 10 native speakers of English who were asked to try to identify a non-native speaker in the set of 10 speakers. They were not able to do so proving the native-like realization of the English stimuli by the speaker who recorded experiment stimuli.

RESULTS

Data was inspected and outliers were removed. To obtain reaction times in milliseconds (response latencies) the number of the gate in which the response was noted was multiplied by 30 (milliseconds of the segment length increase) yielding the participants' reaction times in milliseconds. Kolmogorov-Smirnov test was used to confirm the normal distribution of the results. Analyses of all three focal conditions were carried out (RT of language decision, RT of isolation point, RT of 100% certainty point). In all three analyses the independent variables compared were: language specificity of the stimulus and language.

The first hypothesis predicted that language decision would be carried out faster when the stimulus began with a language specific cue. And indeed, main effect of language specificity was found ($p<0.001$; $F(1, 31)=319.034$). Language decision latencies (RTs in milliseconds) to language-specific stimulus were shorter ($M=231$) than language decision latencies to language non-specific stimulus ($M=303$). Moreover, interaction between the language of the stimulus and language-specificity was found ($p=0.007$; $F(1, 31)=47.221$). RTs to language-specific stimulus were faster in English ($M=212$) than in Croatian ($M=250$), while RTs to language non-specific stimulus were faster in Croatian ($M=286$) than in English ($M=320$). In other words, LSCs affected response latencies differently depending on the target language. The results are presented in Figure 2.

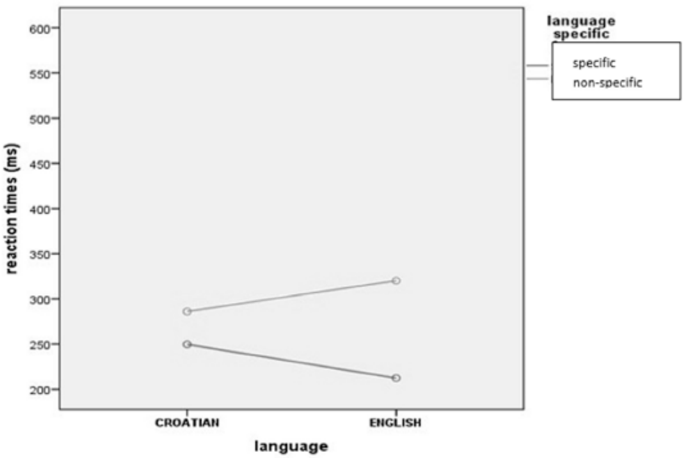

Figure 2. Language decision analysis: interaction between the language of the stimulus and language specificity

Moreover, the number of erroneous answers on the language decision task were counted for each of the stimulus categories. These were occasions when the participants originally thought the language of the stimulus was Croatian but later in the listening decided that it was actually English. Participants made most errors when processing English non-specific words (N=118), and least when processing English specific words (N=45). In the case of Croatian, language-specificity did not play a role (N of errors to language-specific stimulus=65; N of errors to language non-specific stimulus=69).

In summary, language-specific features in the stimulus seem to aid (concerning the number of errors) and speed up (concerning RT latencies) language decision. However, this is much more expressed in response latencies to the English than to the Croatian stimuli as the results of the erroneous answers and reaction time latencies show. It seems that language decision in L2 is significantly aided by means of language-specific cues in the stimulus. The non-native language seems to be marked allowing for the differentiation of stimuli that takes place when guided by LSCs (for markedness in phonology see e.g. Rice, 2007). On the contrary, the native language is processed as less marked, regardless of the language-specific cues. We may conclude that the first hypothesis was confirmed and particularly so in L2 processing as LSCs seem to have eased the processing of English. In other words, phonetic language specific cues in auditory processing speed up language decision, thus yielding early (but not initial!) language-selective access.

The second hypothesis predicted faster word recognition when the target stimuli began with a language specific cue. For this purpose, latencies of the isolation point responses, i.e. the first moment the word was correctly recognized and the total acceptance point, i.e. the 100% certainty that the answer was correct, were analysed.

As for the results of the isolation point analysis, main effects of both language ($p=0.008$; $F(1, 31)=8.182$) and language-specificity ($p<0.001$; $F(1, 31)=145.889$) were found. Isolation points occurred faster in the processing of English (M=417) than in the processing of Croatian words (M=434) and in words that began with language-specific cues (M=397) as opposed to the words which did not begin with language-specific cues (M=454). The patterns of results for the isolation point and the total acceptance point were found to be the same. So, in total acceptance point (100% recognition point) analysis, main effects of both language ($p=0.013$; $F(1, 31)=6.945$) and language-specificity ($p<0.001$; $F(1, 31)=53.130$) were also found. Again, reaction times were faster for English (M=534) than Croatian words (M=543) and for words with language-specific cues (M=524) as opposed to the words which did not have language-specific cues (M=553).

Further on, analysis of variance was used to analyze the interaction between the two independent variables: 1) whether stimulus contained language-specific features or not (specific/non-specific) and 2) language of presentation (Croatian/English), focusing on the total acceptance points, i.e. 100% recognition certainty. Interaction between the independent variables was found ($p<0.001$; $F(1, 31)=21.341$) showing that total acceptance points in the processing of language-specific target stimuli occurred earlier in Croatian (M=520) than in English (M=528), while total acceptance point latencies for language non-specific stimulus occurred earlier in English (M=540) than in

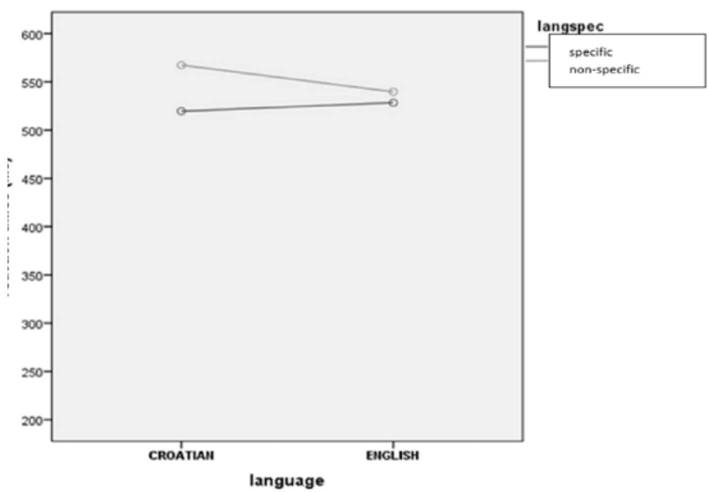

Figure 3. Total acceptance point analysis: interaction between the language of the stimulus and language specificity

Croatian (M=567). The results are presented in Figure 3. Interestingly, this is opposite to language decision results discussed in the presentation of the first hypothesis where language decision was made faster for language-specific English stimuli than the language-specific Croatian stimuli and faster to Croatian non-specific stimuli than to English non-specific stimuli. Such results provide support to the language-specific influence of the language-specificity in the auditory input that readily directs the language of the processing regardless of semantic retrieval that showed opposite result patterns. In other words, it seems that language decision can occur independently of word recognition.

The third hypothesis predicted that the participants would be able to recognize the language of the stimulus prior to recognizing the target words. This should be reflected in faster reaction, i.e. shorter response latencies for language recognition than for lexical decision reflected in isolation points latencies. To investigate this, a dependent sample t-test was used to establish if response times to the language decision task were significantly longer than the response times to the isolation points. The third hypothesis was confirmed for all four groups of stimuli where reaction times on the language decision were significantly shorter than the reaction times of the isolation points in the gating task: Croatian specific stimuli ($t(31)=19.128$, $p<0.001$), English specific stimuli (31.623, $p<0.001$), Croatian non-specific stimuli ($t(31)=17.598$, $p<0.001$) and English non-specific stimuli ($t(31)=13.371$, $p<0.001$). The results are shown in Table 1. In summary, the data show that the studied dominant bilinguals are able to recognize the language of the processing before completing lexical access where the semantic information becomes available. In other words, language recognition occurs sooner than lexical retrieval and is aided by language-specific cues positioned at the onset of the stimulus, but only for L2. L1 seems to be unmarked in terms of language specificity.

Table 1. T-test results of language decision (LD) latencies in milliseconds vs. isolation point (IP) latencies in milliseconds on the gating task

		N	M	sd	t	Sig.
Croatian specific	LD	32	250	52.596	19.128	0.001
	IP	32	388	54.821		
English specific	LD	32	212	45.959	31.623	0.001
	IP	32	407	33.853		
Croatian non-specific	LD	32	286	61.211	17.598	0.001
	IP	32	481	53.879		
English non-specific	LD	32	320	55.803	13.371	0.001
	IP	32	427	44.510		

DISCUSSION

Overall the present study results show that even though auditory bilingual processing starts out in parallel fashion, it can be made language-specific and thus sped up by means of phonologically-based language-specific cues. In this paper the studied phonological language-specific cues were based in the consonantal phoneme inventory and either focused on the English phonemes that do not exist in the Croatian language or the ones that portray phonetic differences between languages (i.e. aspiration of the voiceless stops at the beginning of the word or at the beginning of the stressed syllable when in word-medial position). When such cues were positioned word-initially, they were found to significantly speed up language decision in L2 but less so in L1. This pattern was the opposite in word recognition fortifying the effect of language specific cues in language decision even though lexical retrieval had not been completed. The unexpected stronger influence of the language-specific information in the L2 than in the L1 can be accounted for by finding grounding in the markedness theory proposing that the L1 phonological information is unmarked in comparison to the L2 phonological information. Markedness theory has been altered since its original version proposed by Trubetzkoy (1939) and as part of the Prague School of structuralist linguistics initially stating that not all elements in a phonological system share equal status and using this fact to account for relations between different phonological features belonging to the same class of related elements. This was followed by Jakobson (1968) who used the notion of markedness to account for historical sound change in language, etc. The currently accepted notion of markedness as it is used in phonology is a challenging concept to explain; yet, if generalized, it suffices to say that it refers to the difference between the "default" phonological element and its counterpart that somehow stands out (cf. Rice, 2007). In this paper the default is considered to be the phonology of the mother tongue and the L2 English phonology is considered to be marked in the perception of the Croatian-dominant L1 speaker. This is especially salient in the perception of the English phonemes bearing language specific cues, while the Croatian language-specific cues, i.e., the phonetic features non-existent in the English inventory, are not identified by the Croatian dominant bilingual as marked at all because the L1 is the unmarked "default". This is why the language-specific cues in the Croatian stimulus cannot make language processing selective and speed it up which would be reflected in shorter language decision latencies.

A rather large number of errors in language decision pertaining to language non-specific stimuli is due to the participants identifying a stimulus as part of the English lexical inventory only to discover later that it was a Croatian word. It is interesting that the participants portrayed what may be referred to as L2 bias. This can be accounted for by the point shown and supported by Meuter and Allport (1999) postulating that the less proficient language, i.e. L2, takes more cognitive effort to inhibit once it has been activated. So, when one needs to process in their L1 after their L2 has been activated, this will take more cognitive effort which will be reflected in longer reaction time latencies, especially in the language switch condition. A similar mechanism can be postulated to be at work in the processing of the Croatian words beginning in a language non-specific phoneme that can be interpreted as both an L1 and L2 inventory item. The L2 activation will prevail to bias the language decision toward the L2 while in fact the stimulus is presented in L1. Moreover, the fewest number of language decision errors were made in the processing of English language-specific stimuli which supports the markedness theory account as these were the marked non-default language elements.

The second hypothesis was confirmed both for the isolation points and the total acceptance points: shorter latencies for stimulus with language-specific cues than to stimulus without such cues. The fact that the pattern of results by language was different for the lexical retrieval only supports the influence of the language-specific phonological cues. If word recognition followed the same result pattern one could wonder if language decision was sped up by the fact that some stimulus items were easier to process. However, as the language decision and lexical retrieval patterns differ, this provides support for the idea that language specific cues directed processing independent of lexical retrieval.

Finally, the results collected and analysed in response to the third hypotheses show that isolation points occurred after the language decision points on each of the four conditions in which the Croatian and English languages and the presence or absence of language-specific cues were crossed. This fits into the Bilingual Model of Lexical Access (BIMOLA) which rests upon three processing levels. The first level comprising phonetic features, is a shared representation level, which supports initial parallel language processing in the auditory modality. This is the level that gets activated upon the presentation of phonological features that make up phonemes. The second is the level of phonemes and that level is already organized into language-specific subsets. Interestingly, in Shook and Marian's 2012 Bilingual Interactive Network for Comprehension of Speech (BLINCS) this level is considered to be shared between L1 and L2. Thus, the present research data find a better fit in the BIMOLA model. This organization is supported by the present study's results which shows that language decision occurs before lexical retrieval. Thus, phonological information is language-specific and directs processing before the third level which is the level of words. In sum, the results of the present study show that auditory processing of Croatian and English isolated words can be directed to a specific language by means of language-specific phonological elements in the stimuli making the processing language-selective in the early stages of lexical retrieval, even though it is initially language non-selective.

CONCLUSION

In this study we have set out to investigate if language-specific cues based on the differences between the phonological inventories of the Croatian and English languages can aid bilingual auditory processing by making it language-selective in the early stages of isolated word recognition. For this purpose, we designed a novel iteration of Grosjean's 1980 gating task, which incorporates a language decision task making it a hybrid methodological approach that allows comparison between language decision and word recognition within a single processing trial. Three hypotheses were formed that focused on the role of language-specific cues and language in auditory processing of isolated lexemes. The data support the initial parallel processing followed by early language-selective processing prompted by language-selective cues, but only for the L2, for which these cues present marked input. The data have been found to confirm the premises of the Bilingual Model of Lexical Access (BIMOLA) in auditory processing filling this gap with Croatian-based data.

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