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Age-of-Acquisition Effects in the Development of a Bilingual Advantage for Word Learning

Margarita Kaushanskaya and Viorica Marian
University of Wisconsin-Madison and Northwestern University

1. Bilingual advantage in cognitive processing

Recent work examining interactions between linguistic experience and cognition suggests that bilingualism can positively influence some aspects of cognitive processing (e.g., Bialystok, 1999; Bialystok, 2006; Bialystok, Craik, & Ryan, 2006; Bialystok, Klein, Craik, & Viswanathan, 2004; Bialystok & Martin, 2004; Bialystok & Shapero, 2005; Kormi-Nouri, Moniri, & Nilsson, 2003). Bialystok et al. localize the positive impact of bilingualism on cognitive processing to bilinguals' superior executive function, or more specifically, to superior inhibitory mechanisms. The inhibitory-control advantage is proposed to underlie bilingual performance patterns on a number of cognitive tasks, including the card-sorting task (e.g., Bialystok & Martin, 2004) the antisaccade task (e.g., Bialystok, Craik, & Ryan, 2006), the ambiguous-figure reversing task (e.g., Bialystok & Shapero, 2005), and the Simon task (e.g., Bialystok, 2006; Bialystok, Craik, Klein, & Viswanathan, 2004). In addition, bilingualism appears to be advantageous for phonological development, and bilingual children outperform monolingual children on a number of phonological measures, including an onset-rime awareness task (Buck & Genesee, 1995), a phoneme segmentation task (Bialystok, Majumder, & Martin, 2003), and phoneme counting and non-word decoding tasks (Bialystok, Luk, & Kwan, 2005).

Some of the most striking evidence for a bilingual advantage in cognitive functioning in general, and phonological development, in particular, comes from a small number of studies examining word learning in bilingual and multilingual adults. These studies consistently demonstrate a robust difference between monolingual and bilingual foreign-word-learning performance, with bilinguals consistently outperforming monolinguals (e.g., Papagno & Vallar, 1995; Van

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Hell & Mahn, 1997). For instance, Van Hell and Mahn (1997) showed that experienced language learners outperformed novice language learners in both the number of retained foreign words, and in the speed of their retrieval. This bilingual advantage was present independent of the learning method, although bilingual speakers appeared to benefit from the rote rehearsal method (repeating the foreign word out-loud) more than from the key-word method (associating the foreign word with a similar-sounding key-word in the native language). Similar to the Van Hell and Mahn (1997) findings, Papagno and Vallar (1995) found that bilinguals performed better on tests of phonological short-term memory (both the digit span and the non-word repetition) and on a foreign-word learning task than monolinguals. A comparable bilingual advantage was reported by Kroll, Michael, Tokowicz, and Dufour (2002), who found that English-Spanish and English-French bilinguals outperformed monolinguals on a reading span task – a task that involves verbal working memory.

While bilingual advantage on a number of non-linguistic and linguistic tasks has been amply demonstrated, the mechanisms that underlie this advantage remain elusive. Similarly, it remains unknown to what degree the development of the bilingual advantage is sensitive to the age-of-acquisition effects. The impact of acquisition age on the development of the bilingual advantage has not been explicitly studied, in either the linguistic domain or the general cognitive domain. However, in Bialystok's studies of bilingual advantage for executive-control tasks, adult bilingual participants were all early bilinguals, who acquired their second language no later than 6 to 12 years of age (e.g., Bialistok, Craik, & Ryan, 2006; Bialystok, Klein, Craik, & Viswanathan, 2004). It is possible, therefore, that bilingual advantage for executive function develops only as a result of early exposure to two languages, with early exposure to the two languages in turn resulting in an extensive period of time when both languages are used and activated in parallel. However, it is possible that later acquisition of a second language is sufficient to modify the executive control mechanisms. For instance, it may be that successful acquisition of a second language even later in life brings about a cognitive benefit, especially when the second language is acquired to the level of high proficiency.

The objective of the present work was to examine the AoA effects in the development of bilingual advantage for word-learning and to identify potential cognitive mechanisms of such advantage. The mechanism chosen for study was phonological working memory because ability to acquire novel vocabulary is intimately linked to phonological ability. Within Baddeley's working memory model (Baddeley, 1986), acquisition of a novel phonological wordform relies on the function of phonological loop. Phonological memory capacity is key to learning new verbal information. Phonological memory capacity is frequently measured using non-word repetition and digit-span measures (e.g., Gathercole & Baddeley, 1990; Service, 1992). For instance, Gathercole and Baddeley (1990) found that children with poor non-word repetition skills were slower at learning phonologically unfamiliar names for toys. Along the same lines, Service (1992) found that repetition accuracy for English pseudowords was a good predictor of learning English vocabulary for Finnish primary school students. In adults, similar relationships between phonological working memory and word learning were demonstrated. For instance, Gupta (2003) found a correlation between non-word repetition performance and word-learning in adults, which was mediated by participants' performance on the digit span task. These studies strongly indicate the role of phonological working memory in word learning. Therefore, it seems that if bilingual advantage were to be observed on a word-learning task, phonological working memory would be the likely cognitive locus of this advantage.

To examine the AoA effects in the development of the bilingual advantage for word-learning, highly-proficient English-Spanish bilinguals were compared to monolingual speakers of English on a novel word-learning task. Half of the English-Spanish bilinguals acquired Spanish at birth or very early in life, while half acquired Spanish later in life. Because the two groups were both highly proficient in Spanish, the division of English-Spanish bilinguals into early and late bilinguals resulted in two groups of bilinguals with comparable L2 proficiency levels, but different L2 acquisition ages. Comparison of the two groups to that of monolingual participants was therefore likely to reveal the impact of L2 acquisition age on the development of a bilingual advantage in foreign vocabulary learning. In order to uncover the cognitive mechanisms driving the bilingual advantage of word-learning tasks, the relationship between phonological working memory and participants' performance on the word-learning task was examined using correlation analyses. It was hypothesized that if bilingual experience modifies the cognitive mechanisms that drive word-learning, then the relationship between phonological working memory and word-learning performance would differ for monolingual and bilingual participants.

2. Method

2.1. Participants

Thirty monolingual speakers of English and 30 highly-proficient English-Spanish bilinguals participated in the study. Bilingual participants were further divided into early (n = 15) and late (n = 15) bilinguals. The three groups of participants did not differ in age, education level, or performance on measures of phonological working memory (see Table 1).

Early bilinguals (M = 3.07, SE = 0.69) acquired Spanish significantly earlier than late bilinguals (M = 12.54, SE = 0.71), F (1, 25) = 92.01, $p < 0.01$. Self-reported measures of Spanish proficiency (on the scale from zero = no knowledge of the language to ten = native-like knowledge of the language) revealed high levels of speaking proficiency in both groups (M *early* = 7.79, SE = 0.34; M *late* = 6.69, SE = 0.36), with slightly higher proficiency in the early bilingual group, F (1, 25) = 4.90, $p < 0.05$. In addition, the two groups of bilinguals differed significantly in the extent of exposure to Spanish, especially in the family context, F (1, 25) = 18.35, $p < 0.05$.

Table 1. Monolingual and Bilingual Participant Data

	Mono linguals	Early Bilinguals	Late Bilinguals	*F* and *p* values
N	30	15	15	
Age (years-months)	22-06 (0-11)	21-08 (0-11)	24-00 (0-2)	F (2, 63) = 1.27, p = 0.29
Years of Education	16.14 (0.49)	15.36 (0.50)	16.67 (0.55)	F (2, 59) = 1.95, p = 0.15
CTOPP digit span	75.82 (3.77)	72.80 (5.14)	79.62 (5.52)	F (2, 59) = 0.41, p = 0.67
CTOPP non-word repetition	24.82 (3.31)	28.53 (4.52)	29.72 (4.67)	F (2, 59) = 0.69, p = 0.51

2.2. Materials

A version of an artificial foreign vocabulary was constructed to simulate learning of foreign language that mismatches English in phonology. Acquisition of such a language frequently occurs in natural language learning situations, such as when speakers of English learn Spanish, French, or German as a second language. In the current study, this version of a foreign language was chosen because it allowed for examining the impact of knowing Spanish (a -P language in relation to English) on the ability to acquire a different -P foreign language (Spanish and the artificially-constructed foreign language did not share phonology). The phonological inventory of the artificial language consisted of four English phonemes, two vowels (/℘/ and /E/) and two consonants (/f/ and /n/). The four non-English phonemes were taken from languages other than English (French, Russian, Urdu, and Hebrew), and consisted of two non-English vowels /⟩/ and /y/ and two non-English consonants /□/ and /ξ/.

Forty-eight monosyllabic and disyllabic non-words mismatching English phonology were constructed. All non-words were recorded by a native-English-speaking male audiologist, who was extensively trained on the non-words' pronunciation prior to the recording session. Each non-word was paired with its

English "translation." All 48 English translations referred to concrete, highly imageable objects with frequent English names. None of the non-words were phonologically similar to their English translations.

2.3. Procedure

Vocabulary learning. Participants heard the novel word pronounced twice over the headphones, and saw its written English translation on the right side of the computer screen. Participants were instructed to repeat the novel word and its English translation out loud three times. Each pair was presented twice during the learning phase. Learning was self-paced.

Immediate vocabulary testing. After the learning phase, the participant's memory for presented items was tested using both production and recognition tasks. Production testing always preceded recognition testing in order to eliminate priming effects (since the correct English translation was one of the alternatives in recognition testing). During production, participants heard the foreign word and pronounced its English translation into a microphone. During recognition, participants heard foreign words over headphones and chose the correct English translations from five alternatives listed on the computer screen as fast as possible.

Delayed vocabulary testing. One week after the initial learning session, participants returned to the laboratory, and were tested on long-term retention of the learned vocabulary. After delayed testing, participants were administered standardized assessment measures of phonological short-term memory in order to ensure comparable performance across the three groups, and to examine the relationship between these measures and word-learning performance. In addition, bilingual participants filled out the *Language Experience and Proficiency Questionnaire* or LEAP-Q, (Marian, Blumenfeld, & Kaushanskaya, 2007). Bilinguals rated their proficiency in speaking, understanding, and reading Spanish, as well as specified patterns of use for each of their languages, modes and ages of acquisition, and lengths of immersion for each language.

2.4. Analyses

Accuracy data were analyzed using a 2 x 2 x 3 Analysis of Variance, with testing method (production vs. recognition), and testing session (immediate vs. delayed) as within-subjects variables, and group (monolingual, early bilingual, late bilingual) as a between-subjects variable. A-priori analyses comparing each of the two bilingual groups to the monolingual group on all the performance measures were also performed. In addition, correlation analyses among phonological working-memory measures and word-learning performance were conducted for each group.

3. Results

3.1. Between-Group Results

The 2 x 2 x 3 Anova revealed a main effect of testing method, F (1, 53) = 134.27, $p < 0.01$, $\eta_p^2 = 0.72$, with recognition testing ($M = 0.55$, $SE = 0.02$) yielding better performance than production testing ($M = 0.39$, $SE = 0.02$), and a main effect of testing session, F (1, 53) = 1321.85, $p < 0.01$, $\eta_p^2 = 0.96$, with immediate testing ($M = 0.66$, $SE = 0.02$) yielding better performance than delayed testing ($M = 0.27$, $SE = 0.02$).

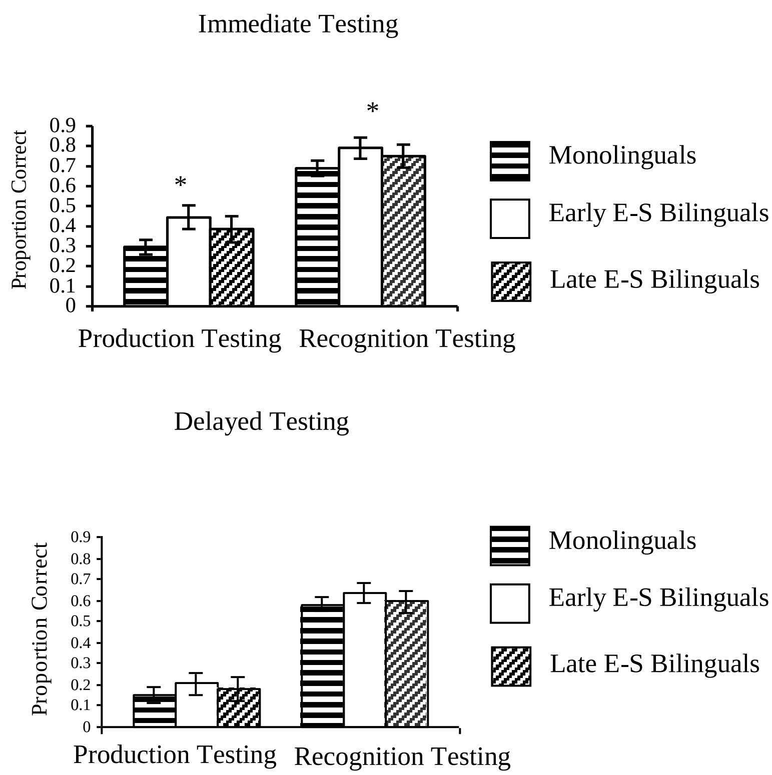

Figure 1. Comparing early and late English-Spanish bilinguals to monolinguals on accuracy of retrieving English translations.

A-priori analyses of group differences during immediate testing revealed that early bilinguals outperformed monolingual speakers of English on the word-learning task, both during recognition testing (F (1, 44) = 4.92, $p < 0.05$, η_p^2 = 0.10), and production testing (F (1, 43) = 6.66, $p < 0.05$, $\eta_p^2 = 0.23$), see Figure 1. However, late bilinguals did not differ significantly from monolinguals on either the recognition ($p > 0.1$), or the production measure. Moreover, late bilinguals did not differ from early English-Spanish bilinguals on either performance measure ($p > 0.1$). Instead, the performance of late English-Spanish bilinguals fell in-between that of early English-Spanish bilinguals and monolinguals.

A-priori analyses of group differences during delayed testing revealed a similar trend, with early bilinguals demonstrating higher accuracy rates than monolinguals during recognition testing and production testing, but these differences failed to reach significance ($p > 0.05$).

3.2. Correlation analyses

For each group of participants, correlation analyses were conducted among the phonological working-memory measures and word-learning performance. For the non-word repetition measure, different correlation patterns for the three groups were revealed (see Table 2). Strong positive correlations were found among all word-learning performance measures and non-word repetition scores for the early bilinguals. However, these correlations were not significant in either the monolingual or the late bilingual group.

Table 2. Correlations between non-word repetition and word-learning performance in monolingual and bilingual participants.

	Mono linguals	Early Bilinguals	Late Bilinguals
Non-word repetition against:			
Immediate Recognition Testing	$R = 0.01$	$R = 0.57$*	$R = 0.35$
Immediate Production Testing	$R = 0.09$	$R = 0.66$*	$R = 0.29$
Delayed Recognition Testing	$R = 0.14$	$R = 0.55$*	$R = 0.56$*
Delayed Production Testing	$R = 0.15$	$R = 0.74$*	$R = 0.47$

Note: Significance at the level of $p < 0.05$ is marked by an asterisk*.

The digit-span measure of phonological working-memory did not correlate significantly with word-learning performance in either the early or the late bilingual group. However, it correlated significantly with monolinguals' performance on the delayed-recognition testing ($R = 0.43$, $p < 0.05$).

4. Discussion

There is overwhelming evidence for age-of-acquisition effects in second language learning, with earlier language acquisition leading to superior language performance (e.g., Johnson & Newport, 1989; Weber-Fox & Neville, 1999; Bialystok & Miller, 1999; Flege, Yeni-Komshian, & Liu, 1999; Mayo & Florentine, 1997). Early learning of a language makes native-like language attainment more likely, although the effects of acquisition age and length of exposure on the attained proficiency are confounded (e.g., Bialystok & Miller, 1999). In the current study, the effect of L2 acquisition age on the development of bilingual advantage for novel word learning was examined by comparing monolingual English-speaking adults to early English-Spanish bilinguals and to late English-Spanish bilinguals.

The findings revealed an Age-of-Acquisition effect in word-learning performance. Early bilinguals, but not late bilinguals, outperformed monolinguals on the word-learning task. In general, the finding of stronger bilingual advantage in the early-bilingual group is consistent with general age-of-acquisition effects in L2-acquisition, where earlier acquisition of a second language leads to superior language performance (e.g., Johnson & Newport, 1991; Flege, Yeni-Komshian, & Liu, 1999). Here, examination of AoA effects in the development of the bilingual advantage for foreign word learning suggests that earlier acquisition age amplifies bilingual advantage. These findings suggest a continuum of word-learning skills, with early bilinguals and monolinguals occupying the two ends of the continuum, and the late bilinguals occupying the middle-point of the continuum. It is possible however, that lack of differences between early and late bilinguals is driven by a relatively small sample size, with only 15 participants per group. As more data are acquired, it is possible that differences between early and late bilinguals will be revealed.

Theoretically, there are two mechanisms through which earlier acquisition age can amplify bilingual advantage on cognitive tasks. The first is based on a critical-period-based phenomenon, where early acquisition of two languages modulates the development of the cognitive system in a particularly advantageous way. The second is based on the proficiency and exposure-based outcomes of early L2 acquisition, where longer usage of two languages, and not the age of acquisition itself, drives the development of bilingual advantage. In the current study, it proved impossible to dissociate the two potential mechanisms, as early bilinguals were exposed to Spanish for a longer duration of time than late bilinguals. However, three participants in the late-bilingual group identified prolonged durations of exposure to Spanish, comparable to the length-of-exposure measures in the early bilingual group. When word-learning performance of these bilinguals was compared to that of late bilinguals with shorter exposure to Spanish, findings suggested a facilitating effect of longer exposure, separable from that of age-of-acquisition. Specifically, late bilinguals with longer exposure to Spanish (M = 0.74, SE = 0.07) outperformed late bilinguals with shorter exposure to Spanish (M = 0.34, SE = 0.07). While it is premature to draw any conclusions from a sample size of three, these findings are promising in suggesting that it may be possible to dissociate the AoA effects from length-of-exposure effects in the development of bilingual advantage.

Work examining effects of bilingualism on cognitive and linguistic performance strives to identify and localize cognitive mechanisms that can be influenced by bilingual experience. Prior studies of bilingual advantage in word learning provide similar explanations for the bilingual advantage in foreign word learning. Van Hell and Mahn (1997) suggest that experienced language learners possess superior rehearsal abilities, attained through extensive experience with vocabulary learning procedures. Papagno and Vallar (1995) propose that experienced learners' better performance stems from their superior phonological skills. In the current study, the effect of bilingualism on word-learning capacity was examined within the context of the working memory model (Baddeley, 1986), which proposes that acquisition of novel verbal information draws on the function of phonological loop. Non-word repetition tests measure the capacity of the phonological loop to maintain novel phonological information in the working-memory buffer. While monolinguals, early bilinguals, and late bilinguals received comparable scores on the non-word repetition measure, different relationships between the non-word repetition and word-learning performance were observed across the three groups. Specifically, correlations between non-word repetition and word-learning performance measures were strong and positive for early bilinguals, but were not significant in monolinguals and in late bilinguals. These findings suggest that while early bilinguals relied on their phonological working-memory when learning novel words, neither the monolingual nor the late bilingual participants did.

Lack of correlations between non-word repetition scores and word-learning performance in monolingual and late bilingual participants is surprising, since prior work on the role of phonological memory in word learning has established firm correlations between the two measures (De Jong, Seveke, & Van Veen, 2000; Gathercole & Baddeley, 1990; Masoura and Gathercole, 1999; Papagno, Valentine, & Baddeley, 1991). Here, the lack of correlations is likely driven by non-overlapping phonological characteristics of the non-word stimuli on the non-word repetition task and the non-word stimuli on the word-learning task. While the non-words used by the CTOPP are English pseudowords that follow English-appropriate phonological and phonotactic properties, the non-words used in the experimental word-learning task were explicitly manipulated to mismatch English phonology and contained non-English phonemes. Therefore, the non-word repetition measure used in the current study may measure the phonological memory-capacity for phonologically-familiar material – a cognitive skill that may have little to do with one's ability to acquire phonologically-novel information. Lack of correlations between the non-word repetition measure and the word-learning measures in monolingual and late bilingual participants indicates that in these groups of participants, the phonological working memory is tuned to the native language and is not recruited when novel verbal information incorporates non-native phonological contrasts. Conversely, robust positive correlations between word-learning performance and non-word repetition in early bilinguals indicate that in this group of participants, the phonological working memory may not be specific to the native language. Instead, it may be that phonological working memory in early bilinguals is capable of storing and rehearsing non-native phonemic entities, thereby allowing it to be recruited for word-learning tasks that involve non-native phonemic contrasts. It appears, then, that early (but not late) bilingualism can influence the degree to which phonological working memory can support acquisition of phonologically-novel material, as well as the degree to which it is recruited during word-learning tasks.

While the current study did not explicitly test the relationship between non-linguistic cognitive control measures and word learning performance, prior research in the area of cognitive control suggests that such a relationship is likely. Specifically, a number of studies by Bialystok et al. find a bilingual advantage on non-linguistic inhibitory control tasks that require participants to selectively attend to one aspect of the task, while ignoring other aspects. In the working-memory model, word-learning is accomplished not only through the function of phonological loop, but also through the function of the central executive, which acts to distribute appropriate attentional resources to the phonological loop. It is easy to draw a parallel between Bialystok's work and the current study by hypothesizing that bilingual experience may facilitate the function of the central executive, thereby yielding an advantage on the word-learning task. This hypothesis would be in conjunction with the Bialystok work since it would localize the bilingual advantage to a non-linguistic cognitive mechanism. Future work will explicitly test this hypothesis by administering non-linguistic cognitive-control measures to participants and correlating them with the word-learning performance measures.

In conclusion, the current study revealed a bilingual advantage on a word-learning task, demonstrated age-of-acquisition effects in the development of bilingual advantage, and showed that bilingualism can shape the relationship between working-memory mechanisms and word-learning capacity. If bilingual advantage for word-learning is rooted in the same mechanisms as the bilingual advantage for cognitive control (e.g., Bialystok, 2006), and for phonological awareness (e.g., Buck & Genesee, 1995), the current study indicates that *early* bilingualism is crucial for modification of the underlying cognitive system by the linguistic experience.

References

Baddeley, A.D. (1986). *Working Memory*. Oxford, UK: Clarendom.

Bialystok, E. (1999). Cognitive complexity and attentional control in the bilingual mind. *Child Development, 70*, 636-644.

Bialystok, E. (2006). Effects of bilingualism and computer video game experience on the Simon Task. *Canadian Journal of Experimental Psychology, 60*, 68-79.

Bialystok, E., Craik, F.I.M., Klein, R., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: Evidence from the Simon Task. *Psychology and Aging, 19*, 290-303.

Bialystok, E., Craik, F.I.M., & Ryan, J. (2006). Executive control in a modified antisaccade task: Effects of aging and bilingualism. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32*, 1341-1354.

Bialystok, E., Luk, G., & Kwan, E. (2005). Bilingualism, biliteracy, and learning to read: interactions among languages and writing systems. *Scientific Studies of Reading, 9*, 43-61.

Bialystok, E., Majumder, S., & Martin, M.M. (2003). Developing phonological awareness: Is there a bilingual advantage? *Applied Psycholinguistics, 24*, 27-44.

Bialystok, E., & Martin, M.M. (2004). Attention and inhibition in bilingual children: evidence from the dimensional change card sort task. *Developmental Science, 7*, 325-339.

Bialystok, E., & Miller, B. (1999). The problem of age in second-language acquisition: Influences from language, structure, and task. *Bilingualism: Language and Cognition, 2*, 127-145.

Bialystok, E., & Shapero, D. (2005). Ambiguous benefits: the effect of bilingualism on reversing ambiguous figures. *Developmental Science, 8*, 595-604.

Buck, M., & Genesee, F. (1995). Phonological awareness in young second language learners. *Journal of Child Language, 22*, 307-324.

De Jong, P.F., Seveke, M-J., & van Veen, M. (2000). Phonological sensitivity and the acquisition of new words in children. *Journal of Experimental Child Psychology, 76*, 275-301.

Flege, J. E., Yeni-Komshian, G. H., & Liu, S. (1999). Age constraints on second-language acquisition. *Journal of Memory and Language, 41*, 78-104.

Gathercole, S.E., & Baddeley, A.D. (1990). The role of phonological memory in vocabulary acquisition: A study of young children learning new names. *British Journal of Psychology, 81*, 439-454.

Johnson, J.S., & Newport, E.L. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology, 21*, 60-99.

Kroll, J. F., Michael, E., Tokowicz, N., & Dufour, R. (2002). The development of lexical fluency in a second language. *Second Language Research, 18*, 137-171.

Marian, V., Blumenfeld, K.H., & Kaushanskaya, M. (in press). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals, *Journal of Speech, Language, and Hearing Research.*

Masoura, E.V, & Gathercole, S.E. (1999). Phonological short-term memory and foreign language learning. *International Journal of Psychology, 34(5/6)*, 383-388.

Mayo, L.H., & Florentine, M. (1997). Age of second-language acquisition and perception of speech in noise. *Journal of Speech, Language, and Hearing Research, 40*, 689-693.

Papagno, C., Valentine, T., & Baddeley, A. (1991). Phonological short-term memory and foreign-language vocabulary learning. *Journal of Memory and Language, 30*, 331-347.

Papagno, C., & Vallar, G. (1995). Verbal short-term memory and vocabulary learning in polyglots. *Quarterly Journal of Experimental Psychology, 48A*, 98-107.

Van Hell, J.G., & Mahn, A.C. (1997). Keyword mnemonics versus rote rehearsal: Learning concrete and abstract foreign words by experienced and inexperienced learners. *Language Learning, 47*, 507-546.

Weber-Fox, C. and Neville, H.J. (1999). Functional neural subsystems are differentially affected by delays in second-language immersion: ERP and behavioral evidence in bilingual speakers. In D. Birdsong (Ed), *New perspectives on the critical period for second language acquisition,* Hillsdale NJ: Lawrence Erlbaum, pp. 23-38.