Published in final edited form as:
J Cogn Psychol (Hove). 2012 August 1; 24(5): 591–601. doi:10.1080/20445911.2012.669367.

A Bilingual Advantage for Episodic Memory in Older Adults

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Abstract

The ability to remember events – referred to as episodic memory – is typically subject to decline in older adulthood. Episodic memory decline has been attributed in part to less successful executive functioning, which may hinder an older adult's ability to implement controlled encoding and retrieval processes. Since bilingual older adults often show more successful executive functioning than monolinguals, they may be better able to maintain episodic memory. To examine this hypothesis, we compared bilingual and monolingual older adults on a picture scene recall task (assessing episodic memory) and a Simon task (assessing executive functioning). Bilinguals exhibited better episodic memory than their monolingual peers, recalling significantly more items overall. Within the bilingual group, earlier second language acquisition and more years speaking two languages were associated with better recall. Bilinguals also demonstrated higher executive functioning, and there was evidence that level of executive functioning was related to memory performance. Results indicate that extensive practice controlling two languages may benefit episodic memory in older adults.

Keywords

language; memory; aging; bilingualism

Aging is often accompanied by decreased performance in several aspects of cognitive processing, including episodic memory (Craik & Salthouse, 2000; Park et al., 2002; Salthouse, 2004). Cognitive decline is likely to have a negative impact on an individual's life, his or her family's life, and society in general (Comijs, Dik, Aartsen, Deeg, & Jonker, 2005; Ernst & Hay, 1994; Mahoney, Regan, Katona, & Livingston, 2005). It is therefore valuable to identify environmental factors that can facilitate successful cognitive aging. In the present study, we consider whether bilingualism (i.e., knowing and using two languages as part of one's life) is a factor that helps maintain episodic memory in older adulthood.

Episodic memory refers to the ability to remember events that one has personally experienced (Tulving, 1983). This type of memory is necessary for remembering events ranging from one's first kiss a few decades ago, to what one ate for breakfast a few days ago, to a conversation held a few minutes ago. Memory for events is known to be vulnerable to decline with normal aging (Craik, 1994). For example, when adult participants are presented with a list of words and then asked to recall them without the help of any cues (i.e., a free recall task), older adults often exhibit a pronounced deficit, recalling considerably fewer words than younger adults.

The age-related decline in episodic memory is argued to be due in part to less successful executive functioning in older adults. The executive functions, a set of cognitive control

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abilities, work in collaboration with the medial temporal lobe memory system. Specifically, executive functions are necessary for "working-with-memory," or implementing controlled encoding and retrieval processes. These processes impact the input to and output from the medial temporal system, and ultimately determine episodic memory performance (Moscovitch & Winocur, 1992). Evidence for the involvement of executive functioning in episodic memory comes from neuroimaging studies reporting frontal lobe activation during encoding and retrieval (Nolde, Johnson, & Raye, 1998), and from neuropsychological studies indicating that damage to the frontal lobes impairs episodic memory (Wheeler, Stuss, & Tulving, 1995). As normal aging negatively affects the frontal lobes and therefore executive functioning, the ability to engage in strategic encoding and retrieval is likely to decrease in older age, resulting in poorer episodic memory. In support of this notion, previous studies find that performance on executive functioning tasks mediates the relationship between increased age and decreased performance on episodic memory tasks (Baudouin, Clarys, Vanneste, & Isingrini, 2009; Crawford, Bryan, Luszcz, Obonsawin, & Stewart, 2000; Troyer, Graves, & Cullum, 1994). These studies indicate that level of executive functioning partly determines the degree of age-related decline in episodic memory, and, by extension, suggest that older adults who can maintain an adequate level of executive functioning may be able to reduce decline in episodic memory.

A factor that has been suggested to help older adults maintain adequate executive functioning is extensive bilingual experience (Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok, Craik, & Luk, 2008; Salvatierra & Rosselli, 2011). Bilingual older adults have been found to outperform their monolingual peers in executive functions – namely, inhibitory control, task switching, and working memory. The better performance in bilinguals is thought to arise from the need to continuously recruit executive functioning to control two languages during language processing. For example, bilinguals use executive control processes to suppress interference from one language when using the other, and to switch between languages (Abutalebi & Green, 2007; Bartolotti & Marian, in press; Blumenfeld & Marian, 2010; Prior & Gollan, 2011).

Given that bilingualism helps maintain executive functioning in older adulthood, and that executive functioning mediates age-related decline in episodic memory, it follows that bilingualism may help maintain episodic memory. However, a previous study that assessed free recall of words found that bilingual older adults recalled fewer words than age-matched monolinguals (Fernandes, Craik, Bialystok, & Kreuger, 2007). The poorer recall in bilinguals was likely driven by the effects of lexical processing on performance. With words as stimuli, demands were likely placed on lexical processes, such as lexical access and retrieval. Bilinguals are known to exhibit a deficit in lexical processes. For example, compared to monolinguals, bilinguals have a smaller vocabulary in each language, more tip-of-the-tongue states, slower response times in picture naming, and lower accuracy in recognizing words in noisy conditions (Bialystok, Craik, Green, & Gollan, 2009; Gollan & Kroll, 2001). Thus, word recall may have largely assessed lexical processes, contributing to decreased performance in bilinguals. To avoid confounding lexical processing with episodic memory, the current study compared bilingual and monolingual older adults on free recall of pictures depicting scenes. The scenes in the task were presented rapidly and were sufficiently elaborate, so as to make it difficult for participants to form linguistic descriptions, and to encourage visual encoding instead. Moreover, encoding was incidental (participants did not know they would later have to recall the pictures), thereby lowering the likelihood that participants would label the pictures as a strategy for remembering. For these reasons, encoding in the current task likely relied less on lexical processing than encoding in Fernandes et al.'s task. The demands placed on lexical processing were also reduced at retrieval, as participants could use synonyms or circumlocution to describe pictures in the free recall task. With the lexical demands reduced, bilingual older adults were expected to reach or surpass the level of monolinguals. This prediction is consistent with preliminary evidence suggesting that when non-verbal stimuli are used, bilinguals may reach the level of monolinguals in source memory (memory for the context of an event; Wodniecka, Craik, Luo, & Bialystok, 2010). Here, we compared bilinguals and monolinguals in remembering the actual content of the event (item memory), as is measured by free recall.

In addition to assessing item memory, the current study also included a test of executive functioning, the Simon task. The Simon task yields a measure known as the Simon effect, which indexes the ability to resolve interference from irrelevant information via inhibitory and attentional processes (Bialystok, 2006; Liu, Banich, Jacobson, & Tanabe, 2004). The Simon task was administered to verify that bilingual older adults were more effective than monolinguals in executive functioning, and to measure the relationship between the Simon effect and episodic memory performance. In sum, we examined the effect of bilingualism on episodic memory in older adulthood. We hypothesized that if bilingual older adults exhibit better executive functioning than monolinguals, and if executive functioning is a determining factor in level of episodic memory, then bilingual older adults may exhibit better episodic memory.

Methods

Participants

Thirty-six older adults (*M*=80.8 yrs., *SD*=4.3 yrs., *Range*=73–88 yrs.) participated in the experiment, of which 18 (7 males, 11 females) were monolingual speakers of English and 18 (10 males, 8 females) were bilingual speakers of English and another language.[1] Bilingual participants were highly proficient in two languages (mean proficiency of 8.6 out of 10 in the less-proficient language), had been using both languages for an extended period of time (66.1 years on average), and were still using both languages at the time of testing (the less-used language was used 30.1% of the time on average) (see Table 1 for detailed information). Bilinguals spoke English and one of the following non-English languages: Bengali, French, German (3 participants), Gujarati, Haitian Creole, Hebrew, Mandarin (2), Polish, Romanian, Spanish, Tamil, Visayan, or Yiddish (3). English was the second acquired language for all bilinguals except one (who learned both languages from birth).[2] Participants varied in their age of acquisition of the second language (English): 3 participants learned by age 5, 5 participants learned after age 5 and by age 13, and the remaining 10 participants learned after 13 years of age. (The range of ages of acquisition in the bilinguals allowed for an analysis of how age of acquisition and length of second language use affect episodic memory performance.) Eleven of the monolingual English speakers reported having at least some experience with a non-English language. However, none of them reported extensive and ongoing use of a second language (see Table 1 for additional information regarding second language experience in monolinguals).

The monolinguals and bilinguals did not differ in age, education, English vocabulary knowledge (*Peabody Picture Vocabulary Task III; PPVT-III*), or nonverbal intelligence (the *Wechsler Abbreviated Scale of Intelligence; WASI*) (see Table 1). None of the participants scored below the normal range on the *WASI* and therefore none was suspected of having dementia.

[1]An additional participant was tested but not included because of low proficiency in English, as revealed by a score more than 2.5 SDs below the mean on the English vocabulary task (*PPVT-III*) and a rating of 5 out of 10 on the *LEAP-Q*.

[2]The more proficient language was English for 4 bilingual participants, the non-English language for 13 bilingual participants, and neither for 1 bilingual participant whose two languages were equally proficient. The more-frequently used language at the time of testing was English for 13 bilingual participants, the non-English language for 4 bilingual participants, and neither for 1 participant who used both languages equally often.

Procedure

Participants completed the experimental tasks in the following order: (1) The encoding phase of the episodic memory task; (2) the Simon task; (3) the *Language Experience and Proficiency Questionnaire* (*LEAP-Q*; Marian, Blumenfeld, & Kaushanskaya, 2007); (4) the free recall task in the retrieval phase of the episodic memory task; (5) the *PPVT-III*; (6) the *WASI*; and (7) the ratings task in which participants evaluated the valence and emotional arousal of the pictures used in the episodic memory task. [3]

Tasks

Picture Recall/Episodic Memory—In the encoding phase, participants viewed a still-picture slide show of scenes (Mather & Knight, 2005; see Figure 1 for examples of pictures). The slide show consisted of 80 pictures presented in a different randomized order for each participant and displayed at 2 seconds per picture for a cumulative duration of 2 minutes 40 seconds. In the instructions, participants were told that they would be seeing a series of pictures and that their task was to simply look at the pictures; they were not told to remember the pictures for a memory test. They were also not told prior to the experiment that they would be tested on their ability to remember pictures (instead they were told that they would perform tasks as part of a study investigating cognitive processing in older adults). In the retrieval phase, participants performed a delayed (20 minutes after encoding) free recall task. The retrieval phase occurred after a delay, as opposed to soon after encoding, to ensure that the task was an episodic long-term memory task, and not a working memory task. Participants were instructed to orally report in English all of the pictures they remembered seeing, and to describe them in as much detail as possible, so that coders could match descriptions to individual pictures. After describing all the pictures they remembered seeing, participants were encouraged to make a second and third attempt to remember additional pictures, and were given as much time as they needed at each attempt. The extra attempts and unlimited time were meant to ensure that episodic memory was being assessed, and not their ability to quickly generate adequate linguistic descriptions. At the end of the study, participants rated the pictures based on valence (scale of 1–9, 1=very negative, 5=neutral, 9=very positive) and emotional arousal (scale of 1–9, 1=calm, unaroused, 5=moderately aroused, 9=excited, stimulated). The set of pictures was chosen to represent varying levels of valence and emotional arousal, since previous studies indicate that these factors affect memory in bilinguals (Marian & Kaushanskaya, 2008) and in older adults (Charles, Mather, & Carstensen, 2003). The inclusion of a range of valence and emotional arousal levels also increased external validity and provided a fuller and more nuanced understanding of how bilingualism affects episodic memory. To analyze the effect of bilingualism on memory for pictures of varying levels of valence and emotional arousal, pictures were placed into valence categories (positive, neutral, and negative) and emotional arousal categories (low, moderate, and high) based on ratings of the pictures. Ratings were elicited so that pictures could be accurately placed into categories based on how the current group of participants subjectively interpreted the pictures. Ratings were also collected to ensure that bilinguals and monolinguals did not differ in their subjective interpretations of the pictures. If groups differed in their ratings, then a group difference in memory performance may not be to due to one group having better memory than the other; it may be that one group perceives the pictures in a way that makes them more salient and memorable.

Simon/Executive Functioning—The Simon task consisted of a control condition and an experimental condition. In the experimental condition, a sequence of blue rectangles and brown rectangles appeared on either the left or right side of the screen. Participants pressed a

[3]Due to time constraints, only a subset of participants completed valence ratings (14 monolinguals; 12 bilinguals) and arousal ratings (12 monolinguals; 9 bilinguals).

button on the left side of the keyboard (the 'A' key) when a blue rectangle appeared and a button on the right (the 'L' key) when a brown rectangle appeared, regardless of the rectangle's location on the screen. In half of the trials, the blue rectangle was on the left side of the screen or the brown rectangle was on the right. These were congruent trials, as the stimulus and the response were on the same side. In the other half of the trials, the blue rectangle was on the right or the brown rectangle was on the left. These were incongruent trials, as the stimulus and response were on different sides. The congruent trials did not require inhibitory control; the location of the stimulus was consistent with the correct response, and thus did not need to be suppressed. The incongruent trials, however, did require inhibitory control; the location of the stimulus conflicted with the correct response, and thus needed to be suppressed. Inhibitory ability was indexed by the Simon effect, i.e., the difference in performance between incongruent and congruent trials, with a smaller Simon effect reflecting better inhibitory control. The control condition differed from the experimental condition only in the locations of the colored rectangles; in control trials, the colored rectangles appeared in the center of the screen. The purpose of the control condition was to ensure that monolinguals and bilinguals did not differ in general response speed. If group differences in reaction time were observed in the control trials, then reaction time differences in the experimental trials could not be clearly attributed to inhibitory control ability, as they may be due to general response speed.

Participants completed the control condition first, and the experimental condition second. Both conditions began with 48 practice trials (Bialystok, 2006), followed by 48 test trials (Bialystok et al., 2004; Salvatierra & Rosselli, 2011). As per Bialystok et al., the sequence of a trial was as follows: First, cross-hairs appeared and remained on the screen for 300ms. Next, a blue or brown rectangle was displayed until participants made a response. Lastly, a trial ended with a blank screen that remained for 500ms. The trials were presented in a randomized order that was fixed across participants.

Data Coding

Picture Recall/Episodic Memory—Two coders who were blind to group membership independently coded the entire data set by matching descriptions to pictures. Coders attained 81.6% agreement independently, and then discussed the discrepancies until 100% agreement was reached.

Groups did not differ in valence ratings ($t(24)=0.18$, $p>.1$) or in arousal ratings ($t(19)=0.33$, $p>.1$) of the pictures, suggesting that bilinguals and monolinguals did not differ in their interpretations of the pictures. Based on combined bilingual and monolingual ratings, pictures were placed into positive (27 pictures), neutral (26), and negative (27) valence categories as well as into high (27), moderate (26), and low (27) arousal categories.

Simon/Executive Functioning—In reaction time analyses, incorrect trials and recovery trials immediately following an incorrect trial were not considered (Weiss, Gerfen, & Mitchel, 2010). In addition, trials faster than 200ms or slower than 1600ms (Costa, Hernández, Costa-Faidella, & Sebástian-Gallés, 2009) and outliers more than 2.5 standard deviations from a participant's mean (Beck, Freeman, Shipherd, Hamblin, & Lackner, 2001) were removed from analyses (2.9% of the data).

Results

Picture Recall/Episodic Memory

Bilinguals exhibited better episodic memory than monolinguals. A 2 (group: bilingual, monolingual) by 3 (valence: positive, neutral, negative) ANOVA yielded a significant main effect of group, $F(1,34)=9.44$, $p<.01$, $\eta_p^2=.22$ (Figure 2). The main effect reflected that bilinguals ($M=12.0$, $SD=4.97$, *Range*=2–20) recalled significantly more pictures overall than monolinguals ($M=7.33$, $SD=4.10$, *Range*=0–14).[4] The group by valence interaction was marginally significant, $F(2,68)=3.04$, $p=.054$. Follow-up *t*-tests indicated that bilinguals recalled more positive-valence pictures ($t(34)=2.12$, $p<.05$) and more negative-valence pictures ($t(34)=3.44$, $p<.01$) than monolinguals. The two groups did not differ and were both near floor-level on neutral-valence pictures ($M=1.5$ pictures, $t(34)=0.99$, $p>.1$). A second 2-way ANOVA with arousal replacing valence as the within-subjects variable yielded a significant main effect of group, again reflecting that bilinguals recalled more pictures overall than monolinguals, $F(1,34)=9.44$, $p<.01$. There was also a significant group by arousal interaction, $F(2,68)=3.56$, $p<.05$. Follow-up *t*-tests revealed that bilinguals recalled more high-arousal pictures ($t(34)=2.51$, $p<.05$) and more moderate-arousal pictures ($t(34)=3.37$, $p<.01$) than monolinguals. Groups were close to floor-level ($M=1.38$ pictures) and did not differ in low-arousal pictures ($t(34)=1.10$, $p>.1$).[5]

Within the bilingual group, earlier and more bilingual experience were associated with better recall. A Pearson's bivariate correlation indicated that age of acquisition of a second language (*Range*=0–35 years old) was negatively correlated with number of pictures recalled overall (*Range*=2–20 pictures), $r=-.63$, $p<.01$. A second correlation was conducted relating memory performance to number of years of bilingual experience, which correlated with age of second language acquisition ($r=-.89$). A participant's number of years of bilingual experience was calculated as age at the time of testing minus age of second language acquisition. A participant's age at the time of testing was entered as a covariate in a Pearson's partial correlation in order to factor it out as a confounding variable because more bilingual experience was associated with older age, and older age was associated with poorer recall. The correlation indicated that number of years speaking two languages (*Range*=41–82 years) was positively correlated with number of pictures recalled, $pr=.73$, $p<.01$.

Simon/Executive Functioning

Results from the control condition suggested that bilinguals and monolinguals did not differ in general response speed, with no difference between groups in RTs (bilingual $M=555$ms, $SD=49$ms; monolingual $M=562$ms, $SD=65$ms), and no difference in accuracy (bilingual $M=98\%$, $SD=3\%$; monolingual $M=97\%$, $SD=4\%$) (both *p*s>.1).

Results from the experimental condition suggested that bilinguals exhibited more efficient inhibitory control than monolinguals. A 2 (group: monolingual, bilingual) by 2 (trial type: congruent, incongruent) ANOVA conducted on RT data in the experimental condition yielded a significant main effect of trial type ($F(1,34)=31.38$, $p<.0001$), confirming that incongruent trials created interference and impeded response speed relative to congruent trials. There was no main effect of group, $F(1,34)=0.96$, $p>.1$, with no difference in overall RT between the bilinguals (congruent $M=609$ms, $SD=72$ms, *Range*=477–714ms; incongruent $M=632$ms, $SD=52$ms, *Range*=519–725ms) and monolinguals (congruent $M=573$ms, $SD=73$ms, *Range*=460–745ms; incongruent $M=624$ms, $SD=81$ms, *Range*=486–834). There was a significant interaction between group and trial type, $F(1,34)=4.23$, $p<.05$.[6] A follow-up t-test on the interaction revealed that the difference between incongruent trials and congruent trials (the Simon effect) was smaller in bilinguals ($M=23$ms, $SD=51$ms,

[4]The recall rates in the present study are similar to the recall rates reported in several previous studies on free recall of pictures in normal older adults (e.g., Berkman et al., 1993; Charles, Mather, & Carstensen, 2003; Cherry et al., 2008; Lupien et al., 1998; Luszcz, Bryan, & Kent, 1997).

[5]Groups did not differ in how detailed their descriptions were, as measured by number of words per description and number of adjectives per description (*p*s > .1).

Range=−56–136ms) than in monolinguals (*M*=51ms, *SD*=24ms, *Range*=11–93ms), $t(34)=2.06$, $p<.05$), indicating that bilinguals had more efficient inhibitory control. There was no main effect of group or interaction between group and trial type in accuracy (both *p*s>.1) (bilingual congruent *M*=99%, *SD*=2%; incongruent *M*=97%, *SD*=5%; Simon effect *M*=2%, *SD*=5%, *Range*=−4–17%; monolingual congruent *M*=99%, *SD*=3%; incongruent *M*=96%, *SD*=4%; Simon effect *M*=3%, *SD*=5%, *Range*=−9–13%).

Relationship between Simon/Executive Functioning and Picture Recall/Episodic Memory

Correlation analyses provided suggestive evidence that inhibitory control ability was related to episodic memory performance. The correlations assessed the relationship between reaction time and accuracy on the Simon task and total number of items recalled on the picture recall task.[7] The confounding effects of intelligence, education, vocabulary, and processing speed (RT on Simon control trials) were factored out by computing Pearson's partial correlations. Analyses yielded a moderate and significant correlation between a bilingual's Simon effect accuracy (*Range*=−4–17%) and number of items recalled (*Range*=2–20), $pr=-.49$, $p<.05$, 1-tailed (Figure 3a), and a moderate (yet non-significant) correlation between a bilingual's Simon effect reaction time (*Range*=−55ms–136ms) and recall, $pr=-.32$, $p>.05$ (Figure 3b). For monolinguals, there was a moderate (but non-significant) correlation between Simon effect accuracy (*Range*=−9–13%) and recall (*Range*=0–14), $pr=-.38$, $p>.05$ (Figure 3c) and a small non-significant correlation between Simon effect reaction time (*Range*=11–93ms) and recall, $pr=-.20$, $p>.05$ (Figure 3d).

Discussion

The current study examined the influence of bilingualism on episodic memory by comparing bilingual and monolingual older adults in picture recall. Bilingual older adults demonstrated better episodic memory than monolinguals, recalling more pictures overall. When valence and arousal were considered, bilinguals recalled more pictures than monolinguals in the higher-salience picture categories (i.e., positive- and negative-valence and moderate- and high-arousal), while bilinguals and monolinguals were near floor-level and did not differ in the lower-salience pictures categories (i.e., neutral-valence and low-arousal). Within the bilingual group, earlier bilingual experience and more bilingual experience were associated with better recall.

The increased recall observed in bilinguals (12 pictures recalled) relative to monolinguals (7.3 pictures) contrasts with Fernandes et al. (2007), in which bilinguals remembered fewer items than monolinguals (7.9 vs. 9.2 words). A notable difference between the two studies is that word recall was tested in Fernandes et al. and picture recall was tested in the current study. With pictures instead of words as stimuli, the lexical demands were reduced, which may have enabled bilinguals to perform better than monolinguals. In addition to differing in the type of stimuli used, the two studies differed in other ways as well. The current study used incidental encoding, delayed retrieval, and valenced stimuli, whereas Fernandes et al. used intentional encoding, immediate retrieval, and mainly neutral stimuli (see Methods for a rationale underlying task selection in the current study). These differences may be partly responsible for the contrasting results, and future research will aim to specify the extent to

[6]In several previous studies, bilinguals displayed a smaller Simon effect and responded faster overall than monolinguals on Simon-type tasks. In the present study, bilinguals were not faster overall; in fact, they responded slightly but not significantly slower. While at odds with some previous studies, the pattern of results reported here replicates that of two recent studies comparing bilingual and monolingual older adults on the Simon task (Bialystok, Craik, & Luk, 2008; Salvatierra & Rosselli, 2011).

[7]The outliers removed in the Simon analyses (described in the Data Coding Section) were also removed from the correlation analyses. No additional outliers were removed when computing the correlations.

which stimulus type, encoding instructions, retention interval, and other task parameters affect bilingual-monolingual differences in recall.

While in contrast with Fernandes et al. (2007), the current findings of better memory in normal bilingual older adults are in accord with research indicating that bilingualism delays the onset of memory problems in diseased aging (i.e., Alzheimer's dementia; Bialystok, Craik, & Freedman, 2007). Furthermore, the current finding that bilingualism may have a cumulative effect on memory, with more bilingual experience associated with increased recall, is consistent with a recent study correlating more years of bilingual experience in younger adults with increased executive functioning (Luk, de Sa, & Bialystok, 2011).

The better memory observed in bilingual older adults may be attributable to their superior executive functioning. Bilinguals demonstrated advanced executive functioning in the form of a smaller Simon effect, which is considered to reflect efficiency of inhibitory control. Moreover, there was a trend in the correlation analyses toward a relationship between a participant's level of inhibitory control and memory performance, suggesting that inhibitory control may have been recruited during episodic retrieval. It is noteworthy that the correlations were stronger in bilinguals than in monolinguals. This difference appears to be due in part to a restricted range in the monolingual Simon data, especially in the reaction time data. It may also be due in part to the possibility that bilinguals recruited inhibitory control more than monolinguals during episodic retrieval. Bilinguals have been found to recruit executive functions more than monolinguals in tasks involving retrieval of words from semantic memory, as evidenced by higher correlations between word retrieval tasks and executive functioning tasks in bilinguals compared to monolinguals (Blumenfeld & Marian, 2010; Kaushanskaya, Blumenfeld, & Marian, in press). As semantic memory and episodic memory are both part of the declarative long-term memory system and involve overlapping mechanisms (Rajah & McIntosh, 2005), it is possible that bilinguals use similar processes for both types of memory, and therefore rely on executive functioning more than monolinguals during semantic retrieval and episodic retrieval.

There are at least two ways in which executive functioning was likely involved at retrieval. The first way occurs at the level of strategies and internally specified cues that participants were likely to generate and employ in order to guide their search through memory and identify relevant items (Simons & Spiers, 2003). Bilinguals may have been better at holding cues in working memory, switching to new cues, monitoring the cue-directed search, and inhibiting previously used cues. A second way occurs at the level of items that become activated in a participant's memory (items that may have been activated by a cue). In cases where participants activated relevant items in memory (i.e., the stimulus pictures), participants had to monitor whether the items were relevant and should be described, hold the items in working memory as they were described, switch between items after describing each, and inhibit already described items. In addition to activating relevant items, irrelevant memories would also become activated, as episodic memory is known to be a competitive process in which irrelevant memories vie for selection (Anderson & Neely, 1996; Wimber, Rutschmann, Greenlee, & Bauml, 2009). In such cases, inhibitory control would be recruited to suppress interference from irrelevant memories and select relevant items. Given their better executive functioning, bilinguals were likely to carry out these retrieval processes more effectively, leading to better recall.

While the more successful memory found in bilinguals can be attributed to better executive functioning, increased recall may stem in part from better functioning of the hippocampus and medial temporal lobe memory system. The medial temporal lobe memory system is involved in bilingual learning and processing (e.g., in acquiring and using a second language's lexical items and grammatical rules; Ullman, 2001). A bilingual's extra reliance on the medial temporal lobe memory system may exercise and enhance its functioning, thereby contributing to increased recall. The goal of future studies will be to determine the extent to which the executive function system, the medial temporal lobe memory system, and other factors contribute to bilingual-monolingual differences.

In closing, the current study indicates that bilingual older adults exhibit better episodic memory than monolinguals. These results add to previous research on bilingualism and memory (Marian & Fausey, 2006; Marian & Kaushanksaya, 2007; van Hell & de Groot, 1998) and bilingual cognitive advantages (Bialystok, Craik, Green, & Gollan, 2009). These results also contribute to research on cognitive aging, and suggest that bilingualism may counteract some of the negative effects that normal aging has on episodic memory. With the growing size of the older adult population and a better understanding of how cognitive decline can negatively impact one's quality of life, it is becoming increasingly important to identify environmental factors that offer protection against memory loss and other cognitive declines. The current study points to long-term usage of two languages as a lifestyle factor that may foster successful cognitive aging.

Acknowledgments

The authors thank Anthony Shook, James Bartolotti, Sarah Chabal, Lucica Iordanescu, Jennifer Krizman, Natalia Daniel, Celia Berdes, Maria Hicks, Mara Mather, and Barbara Schroeder for their contributions to the current study. The project was funded by Grant NICHD 1R01HD059858 to VM and a Northwestern University School of Communication Graduate Research Ignition Grant to SRS.

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Figure 1.

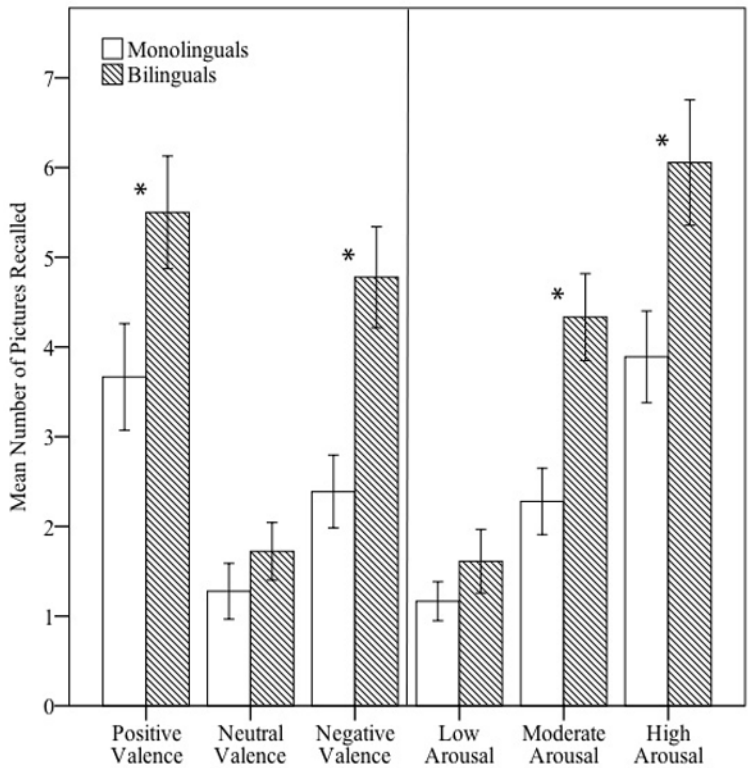
Monolinguals
Bilinguals
Mean Number of Pictures Recalled
0
1
2
3
4
5
6
7
*
*
*
*
Positive Valence
Neutral Valence
Negative Valence
Low Arousal
Moderate Arousal
High Arousal

Figure 2.

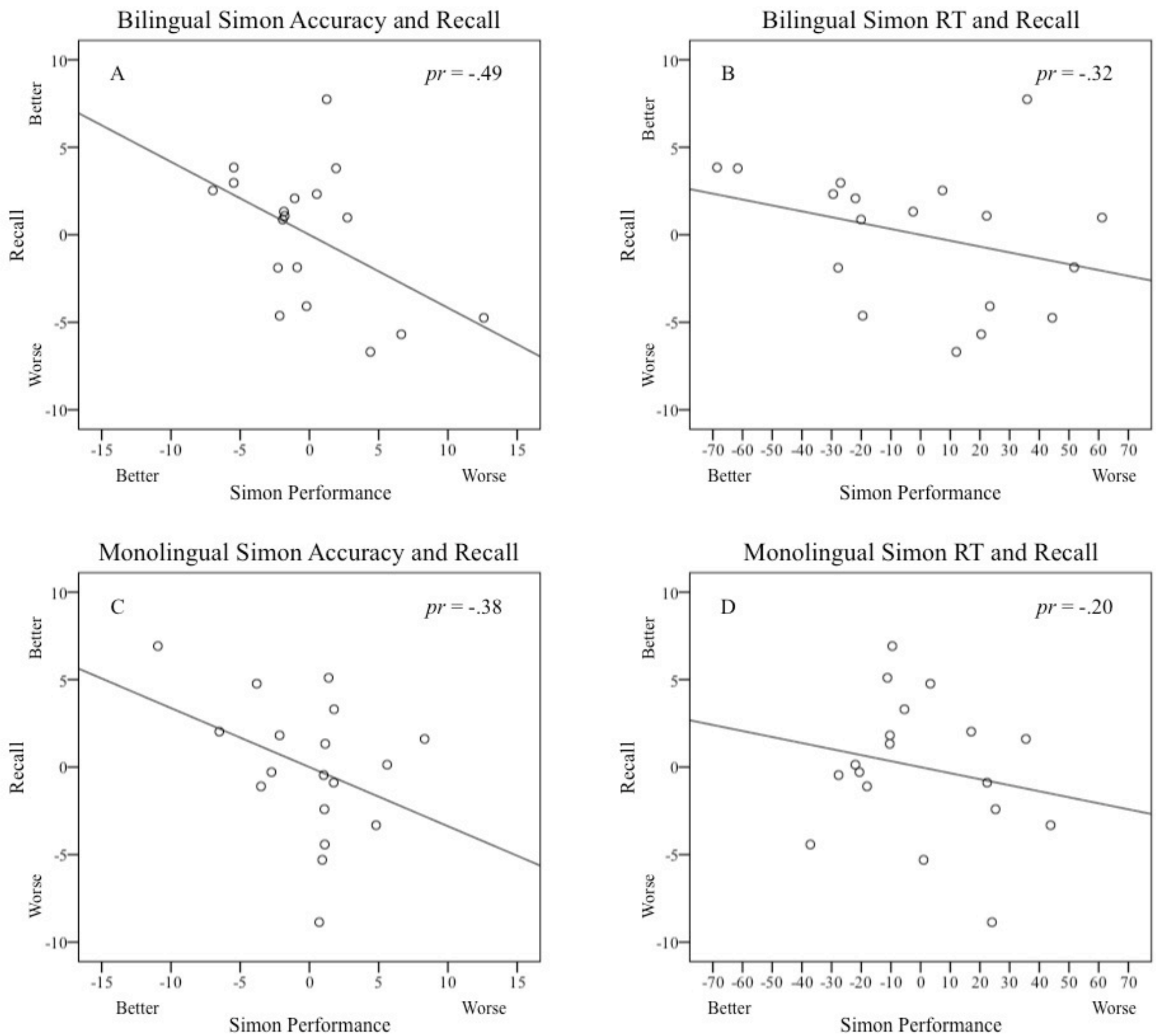
Bilingual Simon Accuracy and Recall
A
pr = -.49
Bilingual Simon RT and Recall
B
pr = -.32
Monolingual Simon Accuracy and Recall
C
pr = -.38
Monolingual Simon RT and Recall
D
pr = -.20
Recall
Better
Worse
Simon Performance
Better
Worse

Figure 3.

Table 1

Linguistic, Cognitive, and Demographic Measures

	Bilinguals			Monolinguals			Comparisons
	Mean	**SD**	**Range**	**Mean**	**SD**	**Range**	
Age	**80.6**	4.4	76–88	**80.9**	4.5	73–88	$t(34)=0.2$, $p>.1$
Years of Education	**17.0**	4.4	4–23	**15.3**	3.3	6–19	$t(34)=1.3$, $p>.1$
Nonverbal Intelligence (*WASI*)	**111.9**	17.7	90–138	**112.7**	13.0	90–141	$t(34)=0.1$, $p>.1$
English Vocabulary (*PPVT-III*)	**108.0**	18.6	87–154	**114.4**	16.3	95–146	$t(34)=1.1$, $p>.1$
Proficiency in Less Proficient Language (0–10 scale)[1]	**8.6**	1.0	7–10	**0.8**	1.2	0–5	$t(33)=20.5$, $p<.01$
Current Usage of Less Used Language (% of time)	**30.1**	14.4	10–50	**0**	0	0	$t(34)=8.9$, $p<.01$
Age of Acquisition of Second Acquired Language[1,2]	**14.5**	8.3	0–35	**17.8**	19.0	0–68	$t(26)=0.6$, $p>.1$
Years of Bilingualism[3]	**66.1**	9.7	41–82	-------	------	--------	----------------------

[1] A proficiency rating and age of acquisition is not available for one monolingual participant.

[2] Seven monolinguals reported no exposure to another language and thus no age of acquisition.

[3] A participant's number of years of bilingualism was calculated as age at the time of testing minus age of acquisition.