The Effect of Bilingualism on Amnestic Mild Cognitive Impairment

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Objectives. Previous reports have found that lifelong bilingualism is associated with a delay in the onset of dementia, including Dementia of the Alzheimer’s Type (DAT). Because amnestic mild cognitive impairment (aMCI) is often a transition stage between normal aging and DAT, our aim in this paper was to establish whether this delay in symptom onset for bilinguals would also be seen in the onset of symptoms of aMCI and whether this delay would be consistent in different subtypes of aMCI.

Method. We examined the effect of bilingualism on the age of diagnosis in individuals with single- or multiple-domain aMCI who were administered a battery of neuropsychological tests and questionnaires about their language and social background.

Results. Our results showed an interaction between aMCI type and language history. Only individuals diagnosed with single-domain aMCI demonstrated a later age of diagnosis for bilinguals (M = 79.4 years) than monolinguals (M = 74.9 years).

Discussion. This preliminary evidence suggests that the early protective advantage of bilingualism may be specific to single-domain aMCI, which is the type of aMCI most specifically associated with progression to DAT.

Key Words: Mild cognitive impairment—Memory—Cognitive reserve—Aging—bilingualism—Alzheimer’s disease.
We examined the possible protective effects of bilingualism in the onset of aMCI. We were also interested in the protective effects among aMCI subtypes in that they may have different underlying causes. Given that previous studies have found bilingual protection to be more reliably associated with diagnoses of DAT than other dementias (Bialystok et al., 2007) and that single-domain MCI patients have been found to progress to DAT more specifically than multi-domain MCI patients, we hypothesized that any effect of delay in onset of MCI symptoms associated with bilingualism would be greater in single-domain than in multi-domain patients.

**Method**

**Participants**

One hundred and eleven older adults were recruited from physician referrals and newspaper advertisements on the basis of concerns about their memory. Participants provided informed consent and received financial compensation for their time. Clinical evaluation and consensus by two neuropsychologists (A.T. & K.M.) were used to diagnose and classify participants into single-domain or multiple-domain aMCI groups (Petersen, 2004). All participants met the following criteria: (a) Presence of a new memory complaint and normal daily activities determined by clinical interview; (b) Normal general cognitive functioning defined as scores on the Mini-Mental State Examination (MMSE) falling within one standard deviation (SD) of age- and education-corrected normative data (Folstein, Folstein, & McHugh, 1975); (c) Presence of an objective memory impairment, indicated by memory scores that were lower than expected for age, education, and intellectual function on two or more memory tests, including Hopkins Verbal Learning Test (Benedict, 1997), Logical Memory (Wechsler, 1987), and Rey-Osterreith Complex Figure Recall (Spreen & Strauss, 1998)—on average, memory scores in this group fell within one standard deviation below age norms and more than 2 SDs lower than verbal intelligence as estimated with a vocabulary test (Table 1); (d) Absence of dementia, determined by considering all previous criteria and depending crucially on the degree of functional independence; (e) Absence of any medical or psychiatric condition (other than possible incipient DAT) that could account for memory impairment, determined by a careful review of background information, such as medical and psychiatric history and informant report.
BILINGUALISM AND MILD COGNITIVE IMPAIRMENT

self-reported medical conditions and mood, and the cognitive assessment. Participants not meeting these criteria were not included in the sample.

Further classification as single- or multiple-domain aMCI was based on performance on Digit Span (Wechsler, 1997), Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983), Rey–Osterreith Complex Figure Copy (Spreen & Strauss, 1998), and Trail Making Test (Delis, Kaplan, & Kramer, 2001). Participants obtaining normal scores for their age, education, and verbal intelligence (estimated from Vocabulary test scores) on all these tasks were classified as single-domain aMCI, and participants obtaining lower than expected scores (1 to 2 SDs below normal for age and estimated intelligence) were classified as multiple-domain aMCI.

Information about language experience included age at which fluency was acquired in each language and frequency with which each language was spoken. Our questionnaire asks about the first language acquired, other languages spoken fluently, and when they were acquired, as well as details about frequency of use and linguistic competence in each language spoken fluently. The criterion for bilingualism was that individuals had spent the majority of their lives, beginning at least in early adulthood, speaking two or more languages fluently approximately 50% of the time—ideally daily, but at least on a weekly basis. We required that this approximately equal use of both languages had continued until the time of testing, except in circumstances where cognitive impairment may have prevented continued fluent use of both languages. All patients were proficient in English, but bilinguals spoke a variety of other languages (e.g., Italian, Yiddish, French) and were not drawn from any single specific sociocultural group (e.g., French–English bilinguals in Canada). Patients who could not be classified either as fully bilingual or monolingual were not included in the sample.

The final sample consisted of 68 individuals with single-domain aMCI (49 monolingual, 19 bilingual) and 43 with multiple-domain aMCI (22 monolingual, 21 bilingual). Demographic information is presented in Table 1. There were no significant differences in education, \( p > .7 \) or sex, \( \chi^2(1, N = 68) = 3.03, p > .05 \) between bilinguals and monolinguals with single-domain aMCI. There were also no differences in education or sex between bilinguals and monolinguals with multiple-domain aMCI (all \( p > .60 \)).

**Procedures**

Participants completed the MMSE and cognitive tests in a single testing session that also included an interview about language and social background, education, and onset of symptoms. Because bilingualism is known to confer an advantage on tasks of executive function (see Bialystok et al., 2008) we administered two subtests from the D-KEFS battery of executive function tests (Color-Word Naming and Verbal Fluency; Delis et al., 2001) to explore how aMCI subtype and bilingualism might interact with respect to this advantage in measures not used to diagnose participants. All data were obtained in compliance with the ethical regulations of the Baycrest Research Ethics Board.

**Results**

A 2-way analysis of variance for language group (monolingual vs. bilingual) by aMCI subtype (single vs. multiple domain) revealed no main effect of diagnosis, \( F(1, 107) = 2.47, p > .10 \), or language, \( F < 1 \), but a significant interaction between them, \( F(1, 107) = 5.94, p < .02 \). Planned comparisons showed that the bilinguals in the single-domain aMCI diagnostic category were significantly older than the monolinguals at the time of diagnosis \( t(66) = 2.46, p < .02 \). In the multiple-domain aMCI category, however, age of patients at diagnosis was not significantly different for the two language groups, \( t(41) = 1.11, p = .27 \) (Figure 1).

To address the possibility that cultural differences resulted in bilinguals simply waiting longer from the time of the onset of their symptoms before seeking evaluation and diagnosis, information about age of onset (obtained via self-report and corroborated by relatives or close friends at the time of diagnosis, where possible) was used to calculate the approximate duration of symptoms in advance of diagnosis. There was no difference between the duration of cognitive symptoms between the language groups in either the single-domain \( t(61) = 0.75, p = .46 \) or multiple-domain \( t(36) = 1.47, p = .23 \), aMCI groups (see Table 1), indicating that participants sought evaluation following approximately similar delays.

The only significant difference between language groups in each aMCI subgroup on the D-KEFS neuropsychological tests was in the multiple-domain aMCI group for completion time in the color-naming condition of the color-word interference test; on this measure, bilinguals performed

![Figure 1. Age of diagnosis for monolingual and bilingual aMCI patients by subtype. Bilinguals diagnosed with single-domain aMCI were significantly older than their monolingual peers at age of diagnosis; however, bilinguals diagnosed with multiple-domain aMCI were slightly younger than their monolingual peers at age of diagnosis (ns). Error bars refer to standard errors. Note. aMCI = amnestic mild cognitive impairment.](http://psychsocgerontology.oxfordjournals.org/)

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more slowly than monolinguals, $F(1, 27) = 7.03, p < .02$. This subtest requires simply that participants name the color of squares of printed ink, and the result is consistent with documented bilingual disadvantages in lexical access (Bialystok et al., 2008). For all other comparisons, performance was equivalent for the two language groups, $p > .10$.

**DISCUSSION**

The present results are consistent with the hypothesis that the delay of onset of DAT observed in bilinguals (Bialystok et al., 2007; Craik et al., 2010) extends to a presumed preclinical characterization of DAT, namely, single-domain aMCI. Bilinguals in the single-domain aMCI sample were an average of 4.5 years older than their monolingual counterparts at time of diagnosis. This protective advantage was not observed in the multiple-domain aMCI group, however. Given that single-domain aMCI is specifically associated with conversion to DAT whereas multiple-domain aMCI has a higher prevalence of conversion to other forms of dementia, this finding is consistent with the observation that the bilingual delay in the onset of dementia is stronger in a DAT sample than in a general dementia sample (Bialystok et al., 2007).

If multiple-domain aMCI represents more advanced pathology than single-domain aMCI as some have argued, then the prediction would be that individuals in the multiple-domain group would be older than their single-domain counterparts. Instead, we found that the monolinguals in each diagnostic category were the same age, while the bilinguals in the multiple-domain aMCI group were somewhat younger than any of the other groups. However, the multiple-domain aMCI group is more likely to include individuals who have cerebrovascular damage or who are at increased risk for progression to other nonDAT dementias (e.g., van de Pol et al., 2009; Villeneuve et al., 2009). We therefore favor the interpretation that bilingualism selectively protects cognitive functioning in single-domain aMCI, consistent with the protection in DAT reported in previous research.

The protection associated with bilingualism in single-domain aMCI and DAT may reflect contributions from other brain systems that compensate for the cognitive losses associated with these conditions. One speculative possibility for this compensation is an enhancement of the frontal systems responsible for executive functions and attentional control. Previous work has shown that bilinguals perform better than monolinguals on executive function tasks (Bialystok et al., 2008) and those older bilinguals have better preserved white matter integrity in frontal regions (Luk et al., 2011). However, multiple-domain aMCI is characterized by greater amounts of frontal lobe pathology than is found in single-domain aMCI (Bell-McGinty et al., 2005). It may therefore be the case that bilinguals with multiple-domain aMCI have lost a frontally based compensatory mechanism because their impairment is precisely in that enhanced network. The present results thus both confirm the protective effects of bilingualism on precursors of DAT and limit them to specific subtypes of aMCI while also supporting the diagnostic distinction between single- and multiple-domain forms of the disease.

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