

LITERATURE REVIEW

Does Bilingualism Delay the Development of Dementia?

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It has been suggested that bilingualism (where individuals speak two languages) may delay the development of dementia. However, much of the research is inconclusive. Some researchers have reported that bilingualism delays the onset and diagnosis of dementia, whilst other studies have found weak or even detrimental effects. This paper reviews a series of nine empirical studies, published up until March 2016, which investigated whether bilingualism significantly delays the onset of dementia. The article also explores whether the inconsistent findings can be attributed to differences in study designs or the definitions of bilingualism used between studies. Based on current evidence, it appears that lifelong bilingualism, where individuals frequently use both languages, may be protective against dementia. However, becoming bilingual in adulthood or using the second language infrequently is unlikely to substantially delay onset of the disease.

Keywords: bilingualism; dementia; degree of bilingualism; language proficiency; age of acquisition

Introduction

Dementia is a neurodegenerative disorder that results in cognitive decline and a marked deterioration in the capacity to function independently (American Psychiatric Association [APA], 2013). Patients experience memory problems, such as difficulty recognising familiar faces or places (APA, 2013). In addition, individuals also frequently present with impairments in other cognitive domains, such as language or attention (APA, 2013). The most common type of dementia is Alzheimer's disease (AD; Ott et al., 1995; World Health Organization, 2015), where proteins gradually build in the brain to form plaques and tangles (Alzheimer's Society, 2014a; Price & Morris, 1999). This eventually leads to the death of cells and loss of brain tissue, which causes cognitive decline (Alzheimer's Society, 2014a). Other types of dementia include vascular dementia, which is caused by cell death resulting from reduced blood flow to the brain (Alzheimer's Society, 2014b), and frontotemporal dementia, which occurs due to cell death in the frontal and temporal regions of the brain and the pathways connecting them (Alzheimer's Society, 2013).

Dementia is the largest cause of dependency and disability in older adults, affecting approximately 47.5 million people worldwide (WHO, 2015). It also produces large economic burdens, almost matching those caused by cancer, heart disease and stroke combined (Wimo, Jönsson, Bond, Prince, & Winblad, 2013). These individual and societal costs are set to rise rapidly in coming years with cases of dementia predicted to triple by 2050 due to population ageing (Roberts & Petersen, 2014; WHO, 2015). As current

treatments for dementia are poor, research has recently shifted, with an aim of discovering methods to delay or prevent the onset of the illness (Gold, 2015).

Although controversial, some research has demonstrated that higher workplace complexity and educational attainment is associated with a delayed onset of dementia (Andel et al., 2005; Bennett et al., 2003; Sattler, Toro, Schönknecht, & Schröder, 2012; Valenzuela, & Sachdev, 2006). This is thought to occur due to an increase in cognitive reserve, which refers to an enhanced ability to adaptively use resources to mitigate damage to the brain (Guzmán-Vélez & Tranel, 2015; Meng & D'Arcy, 2012; Nithianantharajah & Hannan, 2009; Stern, 2002; Stern, 2009). This enhanced cognitive reserve is proposed to delay the clinical manifestations of dementia, thus allowing individuals to function independently for longer (Gold, 2015). Recently, it has been suggested that bilingualism, which refers to the ability to speak two languages, may also delay the development of dementia. Substantial evidence has been found to suggest that speaking two languages alters the brain, resulting in enhanced executive control and cognitive functioning (Abutalebi, Canini, Della Rosa, Green, & Weekes, 2015; Bialystok, 2011; but see Paap & Greenberg, 2013). Based on this, it has been suggested that bilingualism may also enhance cognitive reserve, providing protection against neurological damage and thus delaying the onset of dementia (Abutalebi, Guidi, et al., 2015; Bialystok, 2011).

However, inconsistent findings have been reported. This paper will therefore review studies which have investigated whether bilingualism delays the onset of dementia. It will also consider whether differences in study designs and the definitions of bilingualism used between studies can explain the inconsistent findings reported. This review

will not provide an in-depth discussion of the mechanisms thought to link bilingualism with a delayed onset of dementia, but interested readers should refer to Gold (2015) or Perani and Abutalebi (2015). Several reviews have previously been conducted in this area (Bialystok, Craik, & Luk, 2012; Gold, 2015; Perani & Abutalebi, 2015), but these are either out of date given the high number of recent publications, or do not specifically investigate whether bilingualism delays the development of dementia and the factors which may affect the relationship.

Search Strategy

PsycINFO and Google Scholar were searched for relevant articles in English published up until March 2016. The following search strings were used: 'bilingualism AND cognitive reserve' and 'bilingualism AND dementia'. Only original studies were included. Studies which investigated associations between bilingualism and the development or progression of other health conditions, such as strokes, were excluded. Studies that investigated whether bilingualism is associated with slowed progression of dementia were also excluded, as this review was primarily interested in exploring whether bilingualism delays onset of the disease. Nine studies were found which met the criteria. These are outlined in **Table 1** below.

Data synthesis

The first of these studies was conducted by Bialystok et al. in 2007. They used medical notes and interviews to investigate whether the onset age of dementia and the first appointment to a memory clinic in Canada significantly differed between monolinguals and bilinguals. Individuals were defined as bilingual if they had "spent the majority of their lives, at least since early adulthood, regularly using at least two languages" (Bialystok et al., 2007, p. 460). Bilinguals were diagnosed with the disorder and experienced symptom onset significantly later than monolinguals. These associations were present despite heterogeneous factors between groups which should have benefitted the monolinguals. The monolingual group had on average received a higher level of formal education (12.4 years, compared to 10.8 years in the bilingual group), a factor which has been suggested to increase cognitive reserve and potentially delay the onset of dementia (Bennett et al., 2003; Meng & D'Arcy, 2012; Sattler et al., 2012). In addition, a much higher number of the bilingual group were immigrants (87%, compared to 14% of the monolinguals). As many of these immigrants arrived from Europe after World War II, it is likely they were exposed to more stressful life events than the non-immigrants, which is a known risk factor for dementia (Chertkow et al., 2010; Gollan, Salmon, Montoya, & Galasko, 2011; Guzmán-Vélez & Tranel, 2015; Machado et al., 2014). Nevertheless, despite these factors, a significant difference was present between groups, leading the authors to conclude that bilingualism markedly delays the development of dementia (Bialystok et al., 2007).

Critics, however, argue that the higher levels of immigrants within the bilingual group may have actually favoured the bilinguals (Craik, Bialystok, & Freedman,

2010; Guzmán-Vélez & Tranel, 2015). Although stressful, migration requires learning and adaptation to a new environment, an experience which is cognitively stimulating (Guzmán-Vélez & Tranel, 2015). Migration may therefore positively impact upon cognitive functioning, potentially increasing cognitive reserve and delaying the development of dementia (Guzmán-Vélez & Tranel, 2015). Given the significantly higher percentage of immigrants in the bilingual group, it has been suggested that the beneficial effect of migration on cognitive reserve may at least partially account for the differences observed between the monolinguals and bilinguals by Bialystok and colleagues (Guzmán-Vélez & Tranel, 2015).

Nevertheless, bilingualism has been reported to delay dementia even after potentially confounding variables such as immigration and education status have been controlled for (Alladi et al., 2013; Craik et al., 2010). Craik and colleagues (2010) compared the age of symptom onset and diagnosis in monolinguals and bilinguals diagnosed with Probable AD in Canada. Individuals in the bilingual group were, on average, diagnosed with dementia 4.3 years later than individuals in the monolingual group, whilst also reporting onset of symptoms 5.1 years later. Groups did not differ in occupation and cognitive level, and the monolingual group had received more formal education, leading the authors to conclude that the differences observed between groups could be attributed to bilingualism.

The results were corroborated by Alladi et al. (2013), who compared retrospective reports of symptom onset for all types of dementia in monolinguals and bilinguals who were all born and raised in India. Significant differences between groups were observed for several types of dementia, including AD, frontotemporal dementia and vascular dementia. Across all dementia types, bilinguals were, on average, 4.5 years older at the age of onset of dementia compared to monolinguals. These associations were found independent of potentially confounding variables such as education status, occupation, and gender.

However, inconsistencies are present within the literature, with some studies reporting no significant difference in the age of symptom onset and the age of diagnosis between monolinguals and bilinguals (Chertkow et al., 2010; Lawton, Gasquoine, & Weimer, 2015; Yeung, St. John, Menec, & Tyas, 2014; Zahodne, Schofield, Farrell, Stern, & Manly, 2014). Zahodne and colleagues (2014) conducted a 23-year prospective study, following Hispanics living in the USA. Participants were all fluent in Spanish, and were defined as bilingual if they reported speaking English "very well", "well" or "not well." They were defined as monolingual if they reported not speaking English at all. Although bilingualism was associated with initial higher scores on measures of memory and executive function, no significant differences were observed in the rate of cognitive decline or the proportion of participants diagnosed with dementia (after controlling for potentially confounding variables such as education level, gender, and age of enrollment). Similar results were also found by Yeung et al. (2014) and Lawton et al. (2015) who reported no significant association between bilingualism and the risk of dementia development.

| Paper | Method | Relevant findings |
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| Bialystok, Craik, & Freedman (2007) | <p>Participants: 132 with probable AD; 52 with other dementias. Recruited in Canada.</p> <p>Definition of bilingualism: Bilinguals had "spent the majority of their lives, at least since early adulthood, regularly using at least two languages". Monolinguals spoke only English, whilst bilinguals spoke English and at least one other language (e.g., Polish).</p> <p>Participants: 211 participants with probable AD. Recruited in Canada.</p> <p>Definition of bilingualism: Same definition as Bialystok et al. (2007). Monolinguals spoke English. Bilinguals spoke English and at least one other language (e.g., Yiddish).</p> <p>Participants: 632 participants with probable AD. Recruited in Canada.</p> <p>Definition of bilingualism: Participants were monolingual (spoke one language), bilingual (spoke two languages), or multilingual (spoke three or more languages). Definition for bilingualism taken from Bialystok et al. (2007).</p> | <p>Symptom onset significantly later in bilinguals, even after controlling for demographics. First appointment at memory clinic was also significantly later in bilinguals.</p> <p>Age of symptom onset and diagnosis significantly later in bilinguals.</p> <p>No significant effect of immigration status. No interaction between immigration status and language group on age of onset of symptoms or age of diagnosis. This suggests bilingualism delays onset and diagnosis regardless of immigration status.</p> <p>Multilinguals had later age of diagnosis and symptom onset than monolinguals. No significant differences between bilinguals and monolinguals.</p> <p>In non-immigrants, English-French bilinguals diagnosed significantly earlier than monolinguals. However, non-immigrant multilinguals diagnosed significantly later than non-immigrant monolinguals.</p> <p>In immigrants, bilinguals diagnosed significantly later than monolinguals.</p> <p>Overall, higher degree of bilingualism (assessed by BNT) was associated with a later diagnosis of AD.</p> <p>Participants separated into low and high education group. Higher degree of bilingualism only protected against dementia in low education group.</p> <p>Bilinguals developed dementia significantly later than monolinguals, even after controlling for demographic factors. No additional benefit of speaking more than two languages.</p> <p>Illiterate bilinguals developed dementia significantly later than illiterate monolinguals, suggesting effects are not due to education.</p> |
| Chertkow et al. (2010). | <p>Participants: 44 bilinguals with probable AD. Recruited in the USA.</p> <p>Definition of bilingualism: Participants spoke both Spanish and English. Degree of bilingualism assessed using the Boston Naming Test (BNT) and self-report.</p> <p>Participants: 648 records of patients with dementia recruited in India. All participants were born and raised in India. Included individuals who were illiterate.</p> <p>Definition of bilingualism: Participants were classified as monolingual (spoke one language) or bilingual (spoke two or more languages). Bilinguals were defined as individuals "with an ability to meet the communicative demands of the self, and the society in their normal functioning in two or more languages in their interaction with the other speakers of any or all of these languages" (Mohanty, 1994). Participants spoke a variety of languages, including Telugu, Hindi, and English.</p> | <p>Overall, higher degree of bilingualism (assessed by BNT) was associated with a later diagnosis of AD.</p> <p>Participants separated into low and high education group. Higher degree of bilingualism only protected against dementia in low education group.</p> <p>Bilinguals developed dementia significantly later than monolinguals, even after controlling for demographic factors. No additional benefit of speaking more than two languages.</p> <p>Illiterate bilinguals developed dementia significantly later than illiterate monolinguals, suggesting effects are not due to education.</p> |
| Gollan, Salmon, Montoya, & Galasko (2011). | <p>Participants: 44 bilinguals with probable AD. Recruited in the USA.</p> <p>Definition of bilingualism: Participants spoke both Spanish and English. Degree of bilingualism assessed using the Boston Naming Test (BNT) and self-report.</p> <p>Participants: 648 records of patients with dementia recruited in India. All participants were born and raised in India. Included individuals who were illiterate.</p> <p>Definition of bilingualism: Participants were classified as monolingual (spoke one language) or bilingual (spoke two or more languages). Bilinguals were defined as individuals "with an ability to meet the communicative demands of the self, and the society in their normal functioning in two or more languages in their interaction with the other speakers of any or all of these languages" (Mohanty, 1994). Participants spoke a variety of languages, including Telugu, Hindi, and English.</p> | <p>Overall, higher degree of bilingualism (assessed by BNT) was associated with a later diagnosis of AD.</p> <p>Participants separated into low and high education group. Higher degree of bilingualism only protected against dementia in low education group.</p> <p>Bilinguals developed dementia significantly later than monolinguals, even after controlling for demographic factors. No additional benefit of speaking more than two languages.</p> <p>Illiterate bilinguals developed dementia significantly later than illiterate monolinguals, suggesting effects are not due to education.</p> |
| Alladi et al. (2013). | <p>Participants: 44 bilinguals with probable AD. Recruited in the USA.</p> <p>Definition of bilingualism: Participants spoke both Spanish and English. Degree of bilingualism assessed using the Boston Naming Test (BNT) and self-report.</p> <p>Participants: 648 records of patients with dementia recruited in India. All participants were born and raised in India. Included individuals who were illiterate.</p> <p>Definition of bilingualism: Participants were classified as monolingual (spoke one language) or bilingual (spoke two or more languages). Bilinguals were defined as individuals "with an ability to meet the communicative demands of the self, and the society in their normal functioning in two or more languages in their interaction with the other speakers of any or all of these languages" (Mohanty, 1994). Participants spoke a variety of languages, including Telugu, Hindi, and English.</p> | <p>Overall, higher degree of bilingualism (assessed by BNT) was associated with a later diagnosis of AD.</p> <p>Participants separated into low and high education group. Higher degree of bilingualism only protected against dementia in low education group.</p> <p>Bilinguals developed dementia significantly later than monolinguals, even after controlling for demographic factors. No additional benefit of speaking more than two languages.</p> <p>Illiterate bilinguals developed dementia significantly later than illiterate monolinguals, suggesting effects are not due to education.</p> |

Contd.

| Paper | Method | Relevant findings |
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| Zahodne, Schofield, Farrell, Stern & Manly (2014). | <p>Participants: 1,067 Hispanic immigrants recruited in the USA. Records of 228 participants who developed dementia analysed.</p> <p>Definition of bilingualism: Monolinguals spoke Spanish and bilinguals spoke Spanish and English. Participants were asked how well they speak English. If they answered "not at all", they were classed as monolingual. If they answered "not well", "well" or "very well", they were classed as bilingual. A subset of participants completed the English-language Wide Range Achievement Test Version 3 (WRAT-3) to ensure self-report was valid.</p> | <p>Higher self-reported bilingualism associated with lower chance of dementia diagnosis, but no significant associations after controlling for demographic factors.</p> <p>Similarly, performance on the WRAT-3 did not independently predict rates of dementia diagnosis after demographic variables controlled for.</p> |
| Lawton, Gasquaine, & Weimer (2015). | <p>Participants: 1,789 Hispanic-Americans recruited in the USA. Case records of 55 diagnosed with probable AD and 26 with vascular dementia examined.</p> <p>Definition of bilingualism: Participants spoke Spanish and/or English. To assess language status, participants were asked "Do you speak Spanish?" and "Do you speak English". If participants answered "not at all" or "not very often" about one of the languages, they were classified as being monolingual. If they answered "very often" or "almost always" to both, they were classified as being bilingual.</p> | <p>Proportion of monolinguals and bilinguals diagnosed with AD and vascular dementia did not significantly differ.</p> <p>Bilinguals diagnosed later than monolinguals, though difference non-significant. Difference remained non-significant when immigrants and non-immigrants examined separately.</p> |
| Woumans et al. (2015). | <p>Participants: 134 participants with probable AD recruited in Belgium. All native Belgians.</p> <p>Definition of bilingualism: Participants were asked how many languages they had experience using. They were then asked how proficient they were in each language and how often they used it. Participants were categorised as being bilingual if they estimated that they had good proficiency in speaking, reading, writing and listening in two or more languages, and used them both at least weekly. Monolinguals spoke Dutch or French. Bilinguals spoke a variety of languages, including Dutch, French, Spanish, German, and English.</p> | <p>Bilinguals experienced first symptoms significantly later and diagnosed significantly later, after controlling for demographics.</p> |
| Yeung, St John, Menec & Jyas (2014) | <p>Participants: 1,616 older adults recruited in Canada.</p> <p>Definition of bilingualism: Self-report. Individuals were classified as a monolingual English speaker, a bilingual with English as a first language, or a bilingual with English as a second language. All participants spoke English. Bilinguals spoke English and another language (e.g., Ukrainian, German, or French).</p> | <p>No significant association between speaking more than one language and risk of dementia diagnosis.</p> |

Table 1: A Summary of Studies which Met the Inclusion Criteria.

Further refuting the relationship, Chertkow et al. (2010) found no significant differences in the age of symptom onset or dementia diagnosis in monolinguals and bilinguals. However, protective effects of multilingualism were reported, with individuals speaking three or more languages diagnosed with dementia significantly later than monolinguals. A significant interaction between bilingualism and immigration status was also reported. In immigrants, bilingualism was protective, delaying dementia diagnosis by almost five years. However, in non-immigrants, speaking two languages was actually burdensome, with bilinguals diagnosed with dementia, on average, 2.6 years earlier than monolinguals.

Thus, based on the aforementioned studies, the relationship between bilingualism and the development of dementia is inconclusive. Although some studies have reported that bilingualism is protective, others have found no significant differences between groups or even a detrimental effect. Caution should therefore be taken when making recommendations on whether bilingualism delays the onset of dementia.

However, there have been large differences in the definitions of bilingualism used between studies (e.g., language proficiency required and the age of acquisition of the second language), which may potentially explain some of the inconsistent findings yielded. Furthermore, studies have employed different study designs, which may have also impacted the results found. The next section will therefore evaluate whether these factors are likely to be important, and whether they could potentially explain some of the inconsistent findings reported in this research area thus far.

Definition of bilingualism used in studies

Language proficiency

An important factor which may influence the relationship between bilingualism and the development of dementia is the level of proficiency in the second language (Antoniou, Gunasekera, & Wong, 2013; Gollan et al., 2011; Kavé, Eyal, Shorek, & Cohen-Mansfield, 2008; Kaushanskaya & Prior, 2015; Zied et al., 2004). For instance, Zied and colleagues (2004) reported that balanced bilinguals (who use both languages proficiently) performed significantly better on a Stroop task, measuring executive function, than unbalanced bilinguals (who were less proficient in one language). As increased levels of executive control may mediate the relationship between bilingualism and delayed dementia development, it would follow that the levels of language proficiency are likely to impact on whether bilingualism delays the onset of dementia (Abutalebi, Guidi, et al., 2015; Bialystok, 2011).

The level of proficiency required for participants to be classified as bilingual has varied substantially between studies, which may explain some of the inconsistent findings reported within the research area. Indeed, in studies which have required participants to be highly proficient in their second language, bilingualism has been associated with delayed onset of symptoms and diagnosis (Bialystok et al., 2007; Craik et al., 2010; Woumans et al., 2015). However, in studies which have used more

liberal definitions, non-significant differences have been reported (Zahodne et al., 2014). Taken together, these studies suggest that bilingualism may only be protective if individuals are highly proficient in both languages. However, this suggestion is speculative and based on a limited number of studies. Furthermore, some studies which have used strict proficiency criteria (e.g., Chertkow et al., 2010) have not found significant difference between monolingual and bilingual groups, suggesting that language proficiency cannot be the only factor responsible for the inconsistent findings reported.

Age of acquisition of the second language

Another factor proposed to impact upon whether bilingualism delays onset of dementia is the age of acquisition of the second language (Zahodne et al., 2014). Given that studies have used differing age of acquisition criteria, this may potentially explain some of the inconsistent findings reported. In many studies reporting that bilingualism delays the onset and diagnosis of dementia, participants have been lifelong bilinguals (Bialystok et al., 2007; Craik et al., 2010). Conversely, in studies where more liberal definitions of bilingualism have been used, no significant differences have been reported (Lawton et al., 2015; Zahodne et al., 2014). In the study conducted by Zahodne et al. (2014), most participants acquired their second language during adulthood, whilst in the study conducted by Lawton et al. (2015), no data on age of acquisition was collected. Nevertheless, some studies which have recruited lifelong bilinguals have found no significant differences between groups (Chertkow et al., 2010), suggesting that age of acquisition alone cannot fully account for differences in findings reported between studies.

Study design

Prospective studies which have followed healthy, community-dwelling adults for a number of years have typically found that bilingualism is not associated with delayed onset or diagnosis of dementia (Lawton et al., 2015; Yeung et al., 2014; Zahodne et al., 2014). Conversely, retrospective studies which have investigated age of onset or diagnosis in individuals already diagnosed with the disease have typically reported that bilingualism delays the development of dementia (Alladi et al., 2013; Bialystok et al., 2007; Craik et al., 2010; Gollan et al., 2011; Woumans et al., 2015). Generally, prospective studies are preferred to retrospective studies as they are less affected by potential confounds such as recall bias, where individuals recall details incorrectly (Guzmán-Vélez & Tranel, 2015). However, as Bialystok et al. suggested (2007), there is no reason why bilinguals would be more likely to recall information differently to monolinguals. Furthermore, age of diagnosis was determined by medical records in these studies (Alladi et al., 2013; Bialystok et al., 2007; Craik et al., 2010; Gollan et al., 2011; Woumans et al., 2015), which are unlikely to contain false information. Nevertheless, further research is needed to explore why strikingly different findings have been reported using prospective and retrospective studies.

Conclusions and Recommendations for Further Research

In conclusion, research investigating the relationship between bilingualism and the onset of dementia has yielded inconsistent findings. Some studies have suggested that bilingualism protects against dementia, whilst others have suggested that there is likely to be no benefit or even a detrimental effect of speaking two or more languages. To some extent, these inconsistent findings can be resolved by taking into account the sample of participants recruited and the study design used. Retrospective studies which have used a strict definition of bilingualism have generally found significant results, whilst prospective studies using more liberal definitions have not. Based on the available evidence, it can therefore be concluded that lifelong bilingualism, where both languages are used frequently, may be protective against dementia. Delays in the development of dementia are unlikely to occur if participants become bilingual during adulthood or infrequently use their second language. As such, it should not be recommended that individuals learn a second language as a method for delaying or preventing the development of dementia.

The inconsistent findings between studies could not, however, be fully attributed to differences in the definitions of bilingualism used, as some studies which have employed strict criteria have found no protective effect of bilingualism (Chertkow et al., 2010). Additional research is therefore required to investigate whether bilingualism significantly delays the development of dementia. This research should control for potentially confounding factors such as demographic variables, whilst also carefully controlling for language factors that may affect the relationship (such as age of acquisition of the second language and language proficiency). Where possible, this research should use prospective study designs, which are generally preferred to retrospective designs (Guzmán-Vélez & Tranel, 2015).

To conclude, lifelong bilingualism where individuals frequently use both languages appears to significantly delay dementia, though benefits are unlikely to emerge if individuals become bilingual later in life or use their second language infrequently.

Acknowledgements

The author would like to thank Dr Jelena Havelka for useful discussion.

Competing Interests

The author declares that they have no competing interests.

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How to cite this article: Atkinson, A. L. (2016). Does Bilingualism Delay the Development of Dementia? *Journal of European Psychology Students*, 7(1), 43–50, DOI: <http://dx.doi.org/10.5334/jeps.375>

Published: 31 August 2016

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