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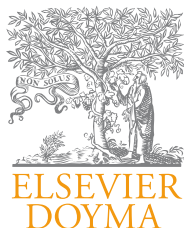
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Relationship between bilingualism and Alzheimer's

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Palabras clave

bilingualism,
Alzheimer's, symptoms,
hippocampus, cerebral
cortex, cognitive

Abstract

This paper compiles several studies that show the relationship between bilingualism and Alzheimer's disease. Studies here compiled were independently carried out between 1991 and 2012 in the United States, in Canada, in the United Kingdom, in India and in Sweden. The paper reviews the results of studies that show that the time elapsed between early Alzheimer's diagnosis and the actual appearance of telltale symptom is up to five years longer in elderly bilinguals than in elderly monolinguals. Cradle bilinguals benefit most from bilingualism but language learning in adulthood can also benefits speakers. These and related scientific facts are compiled. Reports of scientific research are presented, and its conclusions are summarized.

Palabras clave

bilingüismo,
Alzheimer's, síntomas,
hipocampo, corteza
cerebral, cognitivo

Resumen

Este paper recompila estudios que muestran la relación existente entre el bilingüismo y el mal de Alzheimer. Los estudios se realizaron independientemente entre 1991 y 2012 en Estados Unidos, en el Canadá, en el Reino Unido, en la India y en Suecia. El paper revisa los resultados de estos estudios que muestran que el tiempo que transcurre entre el diagnóstico precoz de Alzheimer's y la presentación de los primeros síntomas es hasta cinco años más demorado en ancianos bilingües que en ancianos monolingües. Quienes más se benefician del bilingüismo son los que han sido bilingües desde la cuna pero también se ha demostrado que se benefician los hablantes que aprenden idiomas en la adultez. Tanto estos como otros hechos científicos relacionados se presentan y se resumen sus conclusiones.

Introduction

The purpose of this paper is to present information about recent scientific discoveries concerning the relationship that has been found to exist between bilingualism and Alzheimer's disease. Research independently done in several countries, confirms the effect that bilingualism has on elderly brains. An experiment carried out at the Swedish Armed Forces Interpreter Academy found that changes of the cerebral structure were not limited to those who had acquired bilingualism in early childhood a.k.a. cradle bilinguals, but also appeared following intensive adulthood study. In the experiment, young Army recruits were made to learn a new language at a very fast pace. Learners worked for many hours a day, with no Sundays or holidays off. Their work was so intense that they mastered a new language and were practically native-like in only thirteen months. The young recruits' brains were measured before and after the intensive language training, and it was discovered that the benefits of bilingualism are not only evident in the elderly, but also in subjects in their early twenties.

Elderly people are now a higher percentage of the population of every country because average age has increased considerably in recent years; birth control has caused a dramatic birthrate drop, while people live longer thanks to the advances of modern medicine, the prevalence of healthy life styles and regular health screenings (Ruse, 2013). Couples have fewer children because marriage is postponed; when couples do marry, women usually work and postpone pregnancy (Cancian & Reed, 2008). These factors combine to cause population aging. As the average age of populations increases, so does the incidence of age-related diseases, such as dementias and certain cancers (Chappell & Cooke, n.d.). The *baby boomer generation*, born after World War II, between the years 1946 and 1964 makes up a substantial portion of the North American population. Baby boomers are now between fifty and seventy; this causes the average age of the population to increase substantially and brings a tidal wave of people who, by the nature of their age are at risk of Alzheimer's, certain cancers and other age-related diseases. Post-mortem brain dissections of elderly bilinguals often show that although they actually had underlying neuropathologies, they somehow showed no symptoms of the disease and they were able to lead perfectly normal lives. Even when such extreme benefits of bilingualism do not appear, bilingualism has been shown to delay symptom onset. This phenomenon has merited a great deal of scholarly attention (Hakuta, 1990) and extensive research. There is considerable literature on bilingualism and on delayed onset of memory and reasoning loss and other symptoms such as anger outbursts, aggression, restlessness and sleep disruption. Some patients have been described as having unfounded suspicions about their families and other worsening psychological changes (Janse, ADAMS, & Swain, 2002); abundant information is available not only in scientific and medical journals, but also in the daily press and in magazines (Reinberg, 2013).

Methodology and data gathering

This article rests on descriptive studies that document the effect of bilingualism on the onset of the telltale symptoms

of Alzheimer's. Since the main purpose of the study is to promote the understanding of the astounding relationship that exists between bilingualism and Alzheimer's, reports of investigations that concern research done in the United States, in Canada, in the United Kingdom, in India and in Sweden were studied and summarized. In six of these investigations, participants were elderly and, in one, they were young Army volunteers in their twenties.

Theoretical framework

Dementias and Alzheimer's disease

Although there is still a great deal that we do not know about Alzheimer's, we do know that it is an age-related, neuro-degenerative disorder characterized by the decline of cognitive functions, difficulty competing familiar tasks, or withdrawal from work and social life. Patients may pass a mirror and think there is someone else in the room.

Alzheimer's disease accounts for 60 to 80 percent of all dementias (Karch & Goate, 2014). German psychiatrist Alois Alzheimer and Emil Krapelin were the first to describe the disease in 1906 (Maya, n.d.), but their findings were largely ignored by physicians for years. So completely were Dr. Alzheimer's findings forgotten by physicians that, nearly 40 years later, famed movie actress Rita Hayworth's struggle with Alzheimer's, when she was in her forties, was persistently misdiagnosed as alcoholism. It was only when Ronald Reagan showed symptoms of the disease while still in the White House that Alzheimer's widespread frequency began to be recognized and millions were assigned for research.

It is a known fact that dementias are among the worst human illnesses but they are not actually a disease. The name is an umbrella word that describes loss of memory and reasoning as well as other mental conditions. Memory loss can often be a normal part of aging and not related to Alzheimer's but, in patients who have the disease, it is severe enough to affect daily life (Mayeux, 2007). Everyone dreads dementias because so little is still known about them, in spite of the considerable research that they are the subject of (Maya, n.d.). Science now knows that they are caused by structural and chemical changes in the brain that lead to cell necrosis and, ultimately, to the patient's death. Life expectancy in was a great deal shorter that it is now; elderly people were a small percentage of populations; advanced age was uncommon and, as a result, Alzheimer's was rare; as populations age, it has become prevalent in the late twentieth century and early twenty first (Alzheimer's Australia, n.d.). As we all know, modern medicine has increased life expectancy. In 1900, global average lifespan was just 31 years and below 50 years in even the richest countries. In 2010 it was 79 for whites and 75 for blacks. This has brought a tidal wave of elderly people who are subject to age-related ills (Gupta & Warner, 2008). Aging often entails Alzheimer's as well as other dementias and decrements in physical and cognitive functions. In 2010, the estimated number of world-wide patients was 35.6 million (ADMX, 2013) according to Alzheimer's Disease International (ADI), as many as three-fourths of the people worldwide who have Alzheimer's disease or other dementias have not

been diagnosed. Alzheimer's and dementia is most common in Western Europe (North America is close behind).

In the United States there are 5.5 million patients, of which 200,000 are younger than 65 and affected with early-onset dementias (Alzheimer's Society, n.d.). Recent estimates indicate that there is a new patient every 67 seconds. Alzheimer's kills more patients than prostate cancer and breast cancer combined; worldwide it is the sixth cause of death; in the U.S. alone, over 500,000 die yearly (Thies & Bleiler, 2011). Although there are cases of early-onset patients, those who live beyond sixty-five are at risk; as modern medicine advances, by 2050; 20% of the U.S. population will be 65 or over (National Center on Elder Abuse, n.d.); of those over 85, 47% have a dementia (Alzheimer's Association, n.d.).

There is a worldwide tendency for bilingualism to become more common and we have been led to believe that increased bilingualism may, perhaps, keep dementias at bay. Europe is at the forefront of the development of bilingualism-promoting policies. The European Union and the Council of Europe encourage the use of the *Europass Language Passport* (Ziegler, 2013). The bigger European nations are still largely monolingual but, in the smaller nations, monolinguals are few and usually older than 50. In Monaco, only one percent of the population can be described as monolingual.

Bilingualism

Bilingualism means using any of the numerous second languages that exist in the world. The word *bilingualism* appeared in 1875 (Ramsey, 2012). Webster's Collegiate (2014) defines it as the ability to use a second language, its frequent use, or its institutional recognition. We are all conscious of the fact that due to increasing globalization, Internet, education and international trade, bilingualism is now part of the life of millions (Edmonds, 2014). According to Francois Grossjean¹, more than half of the world's population uses two or more languages every day. Thirty five percent of the population of Canada is bilingual. Bilingualism is not the privilege of upper classes or limited to the educated. It occurs in all countries and in all classes. Millions of illiterate people in India speak two or more languages or dialects.

World population has grown exponentially (Knauth, 2007), and bilingualism is found all over the world (Grossjean, 2010); there are more bilinguals now than at any time in history (NABE, 2014). Bilingualism is not related to any one language in particular. English dominates, but millions speak other second languages. Fifteen million people speak Swahili as their mother tongue but at least 50 million speak it and use it as a second language.

Whatever the second language, bilingual speakers reap the benefits of bilingualism, particularly in old age.

The relationship between bilingualism and Alzheimer's

Six studies reached identical conclusions concerning this, although they were conducted by different scientists in different countries. These studies allow us to verify that bilingualism and Alzheimer's symptom delay are closely related.

ADCS (Alzheimer's disease Cooperative Study) (1991)

Scientific discoveries about bilingualism and the delayed appearance of Alzheimer's symptoms generate world-wide interest (Alzheimer's Disease Cooperative Study, 2014). Scientists are determined to find solutions to this devastating disease and to raise international awareness of it and of the hopeful research possibilities.

This led to the 1991 formation, by the National Institutes of Health (NIH), of the *Alzheimer's Disease Cooperative Study*, (ADCS). It is a consortium of medical centers and clinics formed between the National Institute on Aging (NIA) and the University of California, to collaborate on treatment, and development of diagnostic tools. It is at the forefront of aging research in the U.S. and pursues the understanding of its nature. Its fundamental purpose is the support of health and well-being of the elderly and the extension of years of healthy activity to their life. NIA is made up of more than 70 research sites in the United States and Canada; as the nation's premier Alzheimer's network, it received \$11 million 2013 (Shute, 2013). It will test drugs and intervene in patients in early disease stages, and examine disruptive agitation medication (Alzheimer's Disease Information Network, 2013). Disruptive agitation is a chronic patient problem, dramatically increasing caregiver burden and patient distress. The patient is distressed and so are caregivers and immediate family. In July, 4,300 investigators from 75 countries met in Copenhagen (Buckholtz, 2014) to explore ways to treat or prevent this disease. They worked hard to raise international awareness of it and of the hopeful research possibilities.

The Baycrest Research (2005)

A gift from a Canadian philanthropist enabled the establishment of the *Sam and Ida Ross Memory Clinic* (Williams, 2013). Its primary function is the care of Alzheimer's patients but its clinicians, headed by Dr. Ellen Bialystok, research memory disorders, focusing on elderly bilingual or multilingual patients. Bialystok recently replicated findings of an early experiment with 184 patients that had been diagnosed with Alzheimer's and other dementias (Connelly, 2013). She confirmed that bilingualism offers protection against symptom onset (Bialystok, Craik, & Freedman, 2007). As a result of her years of constant research, Bialystok states the following: "In the bilingual brain, both languages are constantly active, even in strongly monolingual contexts. This is surprising but well documented; it is the key to understanding how bilingualism affects the minds and the brain" (Marian & Shook, 2012).

Alzheimer's patients receive laboratory tests, a neuropsychological evaluation and a Magnetic Resonance Image (MRI) scan. Cognitive and executive function performance is measured; MRI's are used to diagnose and treat; using

¹ Professor emeritus of psycholinguistics at the University of Neuchâtel, Switzerland

structural and functional imaging, temporal lobe abnormalities are discovered (Baclet-Roussel, Ankri, & Ergis, 2010).

Ferguson et al found in 2010 that, as doctor Bialystok had discovered earlier, bilingual patients who have been diagnosed with probable Alzheimer's report symptom onset up to five years later than monolingual patients. Post-mortem examinations of 137 elderly bilinguals revealed that, in some, Alzheimer's neuropathology had been quite advanced although, in life, they had evinced no symptoms whatsoever (Moore, 2010) because lifelong bilingualism contributes to cognitive reserve and to the consequent delay of symptom onset (Roger, 2014); the effect of bilingualism was found to be muted in adulthood but it has a larger role in old age, protecting against cognitive decline, a concept known as 'cognitive reserve' (Bialystok, Craik, & Luk, 2012). Cognitive reserve appears to allow the brain to compensate for pathology by recruiting alternate brain networks, in the face of brain damage (Stern, 2002).

An important part of Bialystok's research consisted of her comparing the performance of monolinguals and bilinguals in specific tasks; she found that bilinguals not only experience much later onset of dementia symptoms but enjoy better mental health than monolinguals. She sought to explain how bilingualism does this, but, so far, the nature of the process remains disturbingly enigmatic (Bhattacharjee, 2012). One of her published papers reports executive function tests of 74 MCI (Mild Cognitive Impairment) patients and 75 AD (Alzheimer's Disease) patients, half of whom were bilingual. They were tested for about a year to detect symptom onset. Bilingual patients had been several years older than monolinguals at the age of their first clinic visit and were again older when symptom onset appeared (Bialystok, Craik, Binns, Osher, & Freedman, 2014). Bilingualism, therefore, did not prevent dementia, but it did delay symptom onset for several years (Science Daily, 2012 A).

Dr. Bak and the Hyderabad Research (2006-2012)

The *Center for Cognitive Aging and Cognitive Epidemiology of the University of Edinburgh* (Deary, 2014) studied the effects of bilingualism for several years. Elderly bilinguals were found to perform better than monolinguals in cognitive tests, even if intelligence tests had not shown that they had a high IQ. After several years, the Center decided to pursue research in Hyderabad, India, where bilinguals are always available for research because 850 languages are in daily use in India and plurilingualism is very common (Chakravartty, 2013). The Hyderabad study of delayed symptom onset in bilingual patients was the largest that had ever been performed and also the first to analyze different dementia sub-types separately. Doctor Bak was the first to document that neither literacy nor education level influence the relation between bilingualism and dementia onset (Alladi, y otros, 2013). Obviously, speaking another language trains the brain, and improves both mental health and general intelligence in old age. Edinburgh University studied a group of 853 participants who had been first tested in 1947 when they were 11 and were retested in 2008 when they were 72 (Khan, 2014). Bilinguals performed much better than they had been expected to, particularly

in general intelligence and reading. The effects of bilingualism on later-life cognition were positive even though some participants had acquired their second language in adulthood (El Universo, 2014).

Many illiterates are bilingual in India; this unusual opportunity of working with illiterate bilinguals showed that the benefits of bilingualism do not depend on education. Doctor Bak evaluated 648 people who had had symptoms for 6 months to 11 years; 391 bilinguals developed dementia at age 65.6, 4.5 years later than 257 monolinguals at age 61.1 (Mortimer, Alladi, Bak, Russ, Shailaja, & Duggirala, 2014). Doctor Bak's studies are the largest up to now to document the delay of dementia symptoms in bilinguals and confirm the results of research that had been done earlier by Bialystok. He discovered that elderly villagers in India have one of the world's lowest rates of Alzheimer's (Weil, n.d.).

Tom Schweizer & Michael Weiner (2007)

Dr. Tom Schweizer is the Director of the Neuroscience Research Program at St. Michael's Hospital in Toronto (Shepherd, 2011). His research seeks the understanding of the architecture and neural bases of cognitive functioning; he uses cognitive paradigms and neuro-imaging to identify how the cerebellum interacts with the frontal lobes to perform executive functions (Science Daily, 2011 A). This will ultimately help understand the effects of brain damage, which may be caused by Alzheimer's or by head injury (Shepherd, 2014).

Dr. Schweizer's has also researched novel approaches to traumatic head injuries and concussions suffered in the practice of sports (Schweizer, 2010). Head injury research throws promising results concerning posttraumatic cognitive problems and post-stroke dementia (Medana & Esiri, 2003).

This has also been studied in Army veterans by doctor Michael Weiner who researched disorders that followed Viet Nam combat experience (Stanford Geriatric Education Center, 2014). Cognitive impairment has long been identified as a component of depression and is very common in late life. It has long been identified as an adjunct to Alzheimer's and as a component of late-life depression, which causes a great risk of decline in the elderly; depression is often a predictor or an adjunct of dementia (van Reekum, Simard, Clarke, Binns, & Conn, 1999).

Dr. Schweizer's Alzheimer's study compared two groups who had earlier been diagnosed with probable Alzheimer's; they had similar education and skills. Half were bilingual. Both groups did equally well when tested, even though the MRI scans of the bilinguals showed twice as much brain damage; this proved that bilingual brains are better equipped to cope with Alzheimer's-caused damage. Dr. Schweizer concluded that, in speaking two languages, the brain is used more actively and is kept healthier. Schweizer said: "This is unheard of -- no medicine comes close to delaying the onset of symptoms and now we have evidence to prove this at the neuroanatomical level".

Schweizer said that because bilinguals constantly switch languages or suppress one to use the other, when Alzheimer's sets in, their brains are better prepared to use alternate pathways, but he cautioned that simply speaking

two languages cannot prevent Alzheimer's (Science Daily, 2011 B).

Learning in adulthood: The Swedish Experiment (2012)

Much of what has been said here centers on lifelong bilinguals. Does adulthood learning provide comparable benefits? The Swedish Armed Forces and Lund University conducted research that answers that question by showing that language learning in adulthood also expands the brain (Mårtensson & Lövdén, 2011).

At the Swedish Academy, volunteer Army recruits learn a new language (Russian, Arabic, Spanish, etc) at a very fast pace and are native-like in only thirteen months though they had no prior language knowledge. Classes and practice occupy the entire day, with little rest and no Sundays or holidays off (Mårtensson J. , 2012).

The Swedish experiment showed that structural brain changes are not limited to lifelong speakers. MRI's and computer programs analyzed brain structures before and after training. A civilian control group worked equally hard, but not in language learning. All had before-and-after MRI scans (de Bot & Kroll, 2010).

Scientists who had designed the program in collaboration with the Interpreters' Academy observed what happens to the brain when learning a language in a short period of intensive study. Scans taken after learning were compared with scans taken at the start and with those of the civilian control group; the civilian students had had to work just as hard, on Medicine or Social Sciences and the scans astonished the researchers because, as the head of the research team said, "Different parts of the recruits' brain developed differently, depending on how well the students performed and how hard they had had to work to keep up with the language course" (Science Daily, 2012 A). There appeared to be every indication that intensive language study keeps the brain fit (Mårtensson J. , 2013). Parts of the language students' brains showed changes, but the brain structure of the civilian control group remained unchanged. Some of the language learners acquired better skills easily and they showed greater hippocampus growth, but some language learners had to put more of an effort into their learning, and they showed greater growth in the middle frontal gyrus, a motor region of the cerebral cortex.

The hippocampus is a deep-lying paired brain structure that is involved in learning new material and in spatial navigation (Bailey, n.d.).

Thus, the areas of the brain in which the changes had taken place depended on how easy students found it to learn a language and development varied according to performance.

More surprising was the fact that the modifications depended on the degree and on how hard each had to work to achieve mastery (Science Daily, 2012 B). The Swedish experiment corroborates research separately done by Drs. Bialystok and Bak. The Swedish experiment did not concern the elderly but demonstrated that bilingualism confers benefits to adults in the very domain of cognitive control that is most likely to decline in later life. By showing that second

language mastery influences brain structure; it replicated previous conclusions.

Brian Gold's studies (2013)

Although not too long ago it was often thought that bilingualism was bad in general, and was said to be particularly bad for children, Dr. Brian Gold², who is himself bilingual and has been so since childhood, emphatically claims that bilingualism is good for you. In order to confirm or disprove his idea, he devised an attention-switching task for older people who had grown up bilingual. He focused on this because, as it is generally known, the ability to switch tasks normally tends to gradually disappear as one ages. Contrary to previously held belief that bilingualism was bad, he found that, on the contrary, people who had been bilingual since childhood continue to perform executive functions better than monolinguals as they age (Shute, 2013). Executive functions are actually a group of mental functions that help connect past experience with present action. They are used in planning, organizing, remembering details, and managing time (National Center for Learning Disabilities, 1964). Executive functions can become weak at any age, but their weakness is more noticeable in the elderly. By using MRI scanners Gold found that the brains of the monolingual seniors worked harder to complete tasks, while bilingual seniors were like young adults. He is now in the process of planning experiments to determine whether learning a language in adulthood can benefit speakers and, if so, to what extent.

The Benefits of Bilingualism

The ability to speak a second language, and the benefits it brings, have been the subject of extensive research during the last decades; the bilingual brain actually remains younger in spite of the negative effects of normal aging. This fact has not been found by one group of scientists working independently. Quite the opposite: scientists working independently in different and distant countries led us to reach similar conclusions that disprove the belief that bilingualism may be bad. There are still, however, organizations like the English Only Movement that are fiercely opposed to bilingualism and to bilingual education but their tenets are based on prejudice and ignorance and have no scientific foundation. A second language keeps the brain young, brings positive cognitive gains and attenuates the negative effects of normal aging. Bilinguals are usually smarter and job seekers are very much aware that bilinguals have access to better jobs and earn more than unilinguals.

A bilingual person is constantly aware of the fact that even when speaking one language, the two language systems are somehow active all the time, consciously or subconsciously; this gives the mind a non-stop workout that strengthens the brain, much as constant exercise strengthens muscle; this workout maintains youthful cognition; improvement occurs not only in skills that are related to lan-

² A neuroscientist at the University of Kentucky's College of Medicine,

guage, but also, surprisingly, in skills that are unrelated to bilingualism or plurilingualism. Balanced lifelong bilingualism not only shields against Alzheimer's but against other forms of old-age-dementia, protects against memory and reasoning losses.

Constant use of two languages increases grey matter density in the inferior parietal cortex (Mechelli, Crinion, Noppeney, O'Doherty, Ashburner, & et al., 2004). Although this might be genetically determined, research points to bilingualism as the sole reason (Marian & Shook, 2012). Elderly people who have spoken two languages for the majority of their lives are faster than monolingual seniors at switching from one mental task to another.

Conclusion

Our conclusion will need to be based on the facts that we have explored in the balance of this paper which have demonstrated the direct connection that exists between bilingualism and postponing the onset of Alzheimer's symptoms.

Alzheimer's is an age-related disease whose incidence increases as populations age. Every 67 seconds there is a new patient in the United States. We cannot, so far, speak of a cure for Alzheimer's but bilingualism can postpone symptom onset. According to research shown here, unless and until a cure is found, bilingualism seems to remain the only hope for those at risk. As populations age, therefore, a world-wide effort to extend bilingualism is needed. In this paper we have presented details concerning research carried out in Canada, the United States, the United Kingdom and India; these studies show the advantage of promoting bilingualism, not only as a practical working tool but also as a way of improving the quality of life in old age.

This does not seem an overly ambitious plan. More than half the world's population is already bilingual; over 50% of Europeans already speak at least two languages and in some areas there are no monolinguals younger than 50, although the larger countries are still monolingual.

The European Union is at the forefront of learning and of encouraging the use of the *Europass Language Passport*. It is hoped that educational programs will achieve bilingualism and trilingualism in the next generation. Movies, television and extended tourism will certainly aid in increasing bilingualism and hopefully decreasing the impact of Alzheimer's.

Thus, achieving world-wide bilingualism by the next generation does not seem impossible and, when compared to the benefit of postponing Alzheimer's symptoms in an aging population, it is well worth the effort. Every country should individually establish educational programs that will promote knowledge and use of a second language. This should be complemented at world level by international institutions, such as, perhaps, the United Nations, which must not delay starting educational programs to achieve universal bilingualism by the next generation.

Bilingualism helps to delay Alzheimer's symptom onset; it has been proved that this does not only benefit those who acquired their second language in early infancy. Those who learned a second language and became bilingual in adulthood also benefit. All educational institutions must

make a concerted effort to promote language learning. This will certainly cut down the incidence of Alzheimer's in old age.

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