The Bilingual Advantage Debate

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Dvopredmetni prijediplomski studij Informatologija i Engleski jezik i književnost

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Prijepori oko prednosti dvojezičnosti

Završni rad

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Znanstveno područje: humanističke znanosti

Znanstveno polje: filologija

Znanstvena grana: anglistika

Mentori: prof. dr. sc. Gabrijela Buljan, doc. dr. sc. Ana Werkmann Horvat

Osijek, 2024.

J. J. Strossmayer University of Osijek

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Bachelor's Thesis

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Scientific Area: Humanities

Scientific Field: Philology

Scientific Branch: English Studies

Supervisors: Dr Gabrijela Buljan, Full Professor; Dr Ana Werkmann Horvat, Assistant Professor

Osijek, 2024

Prilog: Izjava o akademskoj čestitosti i o suglasnosti za javno objavljivanje

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Sažetak

Pozitivan utjecaj dvojezičnosti na kognitivne sposobnosti čovjeka tema je žustrih debata u akademskim krugovima psiholingvista. Nakon početnog, negativnog stava akademske zajednice o dvojezičnosti, istraživanja u kojima je primijenjena poboljšana metodologija ukazala su na to da uporaba dva (ili više) jezika ima blagotvoran učinak na mnoge vidove ljudskog života, uključujući i kognitivne sposobnosti. Rezultati tih istraživanja sugeriraju da dvojezičnost pozitivno utječe na izvršne funckije, kognitivni razvoj te da odgađa nastup neurodegenerativnih poremećaja poput demencije. S druge strane, mnogi znanstvenici pronalaze metodološke nedostatke prijašnjih istraživanja. Upravo zbog toga oni i dalje osporavaju ideju prednosti dvojezičnosti. U svijetu u kojemu je dvojezičnost sve češća pojava važno je stremiti nedvosmislenim zaključcima koji će pojasniti složenu vezu između dvojezičnosti i kognitivnih sposobnosti. Cilj ovog preglednog rada jest istražiti utjecaj dvojezičnosti na ljudske kognitivne sposobnosti kroz pregled brojnih istraživanja.

Ključne riječi: dvojezičnost, prednosti dvojezičnosti, izvršne funkcije, kognitivni razvoj, kognitivno starenje

Summary

The bilingual advantage in human cognition is a topic of much debate in psycholinguistic academic circles. After the initial negative opinion of academia on bilingualism, studies which implemented improved methodologies demonstrated that the use of two (or more) languages has favourable effects across many domains of human life, including cognition. It has been suggested that bilingualism positively affects executive functions, cognitive development, and that it delays the onset of neurodegenerative disorders such as dementia. On the other hand, many scientists regularly find methodological flaws in previous studies. Because of this, they continue to challenge the concept of the bilingual advantage. In an increasingly bilingual world, it is important to strive to definite conclusions which would shed light on the intricate connection between bilingualism and human cognition. By examining an extensive body of research, this review aims to explore the influence of bilingualism on human cognition.

Keywords: Bilingualism, Bilingual Advantage, Executive Functions, Cognitive Development, Cognitive Aging

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Introduction

While rare in the United States, bilingualism is fairly common in the rest of the world (Diamond 2010). According to a European Commission report (2006), more than a half of European citizens are bilingual. Due to an ever-changing socioeconomic dynamic of the world, growing numbers of immigrants, and social mobility being on unprecedented levels, this number will undoubtedly rise in the following years. This is why it is important to understand the effects bilingualism has on human cognition throughout the lifespan, from the very beginnings, when the brain and personality are formed, until the very end of life, when a person's cognitive abilities naturally start to diminish and deteriorate.

Bilingualism was initially thought of as a negative trait. Without a properly developed methodology, scientists reached verdicts mostly based on assumptions (Antoniou 2019). Peal and Lambert's study in 1962 was the first to challenge those assumptions and to conclude bilingualism has many benefits on human cognition. Subsequent studies further explored the favourable impact of bilingualism on cognitive functions. Lee and Kim (2011) positively correlated bilingualism with creative thinking, as well as cognitive benefits, regardless of age and gender. Studies done by Bialystok et al. (2004, 2012) indicate faster processing and improved mental flexibility in bilingual adults compared to monolinguals in the same age group. They argued that bilingualism is a powerful tool in offsetting cognitive, age-related losses.

One of the most intuitive ideas as to why bilingualism is an overall positive trait is that a bilingual person always has both languages activated to a degree in their mind. These languages are in a constant, lifelong interaction, which inevitably leads to cognitive benefits for a person managing and resolving this interaction (Antoniou 2019). Many activities lead to a similar, cognitively positive effect, such as playing musical instruments, playing computer games or solving crosswords. But the ability to speak a language, being one of the most cognitively complex activities a human being can do, results in biggest cognitive improvements.

However, many researchers have put forward the proposition that bilingualism might not be the factor that spurs positive cognitive change. They raise several questions regarding the theories that bilingualism is an overwhelmingly positive trait, arguing that most claims are merely suggestive due to the methodological issues (Duñabeitia & Carreiras 2015). Potential advantages of bilinguals in many tasks have little to do with the ability to speak more than one language, and much to do with other factors, such as age or social class (Gathercole et al. 2014). These variations in outcomes predominately stem from differences in characteristics of the participants in the

experiments. Cultural backgrounds, languages spoken, and literacy levels are some of the variables which have made it difficult to reach a verdict everyone will accept. Due to the lack of proper methodology for researching impacts of bilingualism on cognitive abilities, researchers who believe in such impacts regularly find evidence that supports their claim, while researchers who do not believe consistently find no evidence (Antoniou 2019).

The aim of this paper is to elucidate the idea of the bilingual advantage on human cognition. This topic will be covered in several sections. The first section will give a brief overview of the concept of speaking multiple languages and explore early studies on the topics. The following three sections introduce the concepts of executive functions, cognitive development, and cognitive aging. Additionally, a review of studies supporting, as well as those challenging the bilingual advantage in those areas of cognition will be given. Because of the complex and multifactorial nature of studying bilingual advantages, some overlap in presentation of those concepts may be impossible to avoid. Finally, the idea of publication bias and its importance in understanding the full picture of the bilingual advantage will be explained.

1 Bilingualism

Defining bilingualism is a complex task, so naturally, many researchers give their own definitions of bilingualism which are influenced by many factors. Diamond (2010: 332) defines multilingualism as "the ability to understand and speak several languages". Therefore, the meaning of bilingualism should be self-explanatory. 'Bi' meaning two, the word suggests bilingualism is the ability to speak and understand two languages.

Grosjean (2012) argues that the most important factors in defining bilingualism are language fluency and language use. Regarding fluency, the common impression that bilinguals speak two languages perfectly fluently is far from the truth. As the languages spoken by a person are almost inevitably used for different purposes, to different extents, and with different intentions, the level of fluency depends on the person's need to use a given language. Grosjean also lists four domains of language usage: speaking, listening, reading and writing. A person may be more proficient in one of those skills, but less in others. He raises the question of how fluent a person must be in their second language to be considered bilingual. Unlike the criterion of language proficiency, Grosjean considers the criterion of language use more straightforward as it is less open

to interpretation. If a person uses two or more languages or even dialects in their everyday life, they can be considered bilingual.

One of the most common ways to classify bilingualism is by the nature of acquisition. Flynn et al. (2004) state that a person who has acquired two or more languages at the same time can be considered a simultaneous bilingual, whereas a person who has acquired their second language after the acquisition of the first is considered a sequential bilingual. While Flynn et al. (2004) focus on the timing of acquisition, Mahmud and Salehuddin (2023) propose a broader classification of bilinguals. Simultaneous early bilinguals are those who learn two languages concurrently from an early age. Sequential early bilinguals acquire the second language during their childhood. Late bilinguals acquire it after a critical period, usually after adolescence. Passive bilinguals are individuals who comprehend both the spoken and written aspects of the second language but do not write or speak it themselves. Finally, dominant or unbalanced bilinguals are more skilled in one of the languages they acquire, while balanced bilinguals have the same degree of proficiency in both.

There are numerous advantages to knowing and effectively using more than one language. Those with the ability to effectively communicate with more people can inevitably expand their social circles and communicate with a broader range of people. They might also be more appreciative of different cultures and visit foreign countries. Finally, they might be granted more employment opportunities since bilingualism enhances job prospects, most frequently in international business and tourism (Antoniou 2019).

While these conclusions seem very logical, bilingualism was not always thought of positively. Throughout much of the 20th century, it was believed that bilingualism causes cognitive disadvantages. For example, Goodenough (1926: 393) argued that “the use of a foreign language in the house is one of the chief factors in producing mental retardation”. Another researcher, Saer (1923), took a less extreme stance, arguing that bilingualism results in confusion in children. However, many of these studies did not consider factors such as age, socioeconomic status or refugee status of the children tested (Antoniou 2019). A seminal study done by Peal and Lambert (1962) addresses the methodological flaws of the previous studies and marks a turning point in researching bilingualism. The most prominent change from previous studies was that they administered the test in the participants’ dominant language. By doing so, they found “that bilingual children have a more diversified set of mental abilities than the monolinguals” (Peal & Lambert 1962: 22). Traditional, negative outlook on bilingualism had finally been challenged,

which opened the door to many other studies exploring the positive aspects of bilingualism. This point in time marked a shift towards the idea that bilingualism might be beneficial in many aspects of human cognition – the bilingual advantage.

The following paragraphs will explore the idea of the bilingual advantage across three domains of human cognition: executive functioning, cognitive development, and cognitive aging.

2 Bilingualism and Executive Functioning

2.1 Executive Functioning

Executive functions (henceforth: EFs), also referred to as executive control or cognitive control, include some higher cognitive processes which are essential for uninterrupted, focused attention and concentration, especially in situations where automatic responses are impossible or inadvisable (Diamond 2013). These require a lot of effort. It is well known that continuing doing any task the same way as always is much easier than changing one's ways. Miyake et al. (2000) proposed a three-pronged division of core EFs. First, shifting between tasks or mental sets, also known as "shifting", involves alternating between multiple tasks or operations. This function is critical for understanding failures of cognitive control in patients with brain damage, in tasks which involve cognitive transition. The ability to shift between tasks is considered a very important aspect of executive control. Second, updating and monitoring of working memory representations, or "updating", is strongly tied to the concept of working memory – information retention and manipulation. It involves continuous monitoring and assessing incoming information for its importance to the current task. Therefore, the outdated or irrelevant contents of working memory need to constantly be updated with new information. The core of the updating function is the active manipulation of pertinent information in working memory, rather than merely saving information passively. Third is the inhibition of prepotent responses, or "inhibition", which makes intentional suppression of inappropriate responses possible. Simply put, this is the ability to resist interference, and it includes self-control – behavioural inhibition and interference control – cognitive inhibition (Miyake et al. 2000). However, this division of EFs is not universally accepted. Some scientists choose to include or exclude various other functions or use different names for similar concepts. For example, Diamond's (2013) definition of cognitive flexibility is very similar to "shifting", but she places more stress on the developmental aspect of it (discussed later in the paper).

Miyake et al. (2000) claim that EFs are critical in academic success, but are also the first to suffer from stress, sadness, or loneliness which academic success may cause. Additionally, they argue that well-developed EFs in early childhood are a precursor to a healthy life, and that they can be improved in any age through repeated practice. On the other hand, while initial reliance on EFs is key for learning a new task, its overactivation can hinder the performance after the task is mastered. The goal of mastery is to automate the task and have it become so well learned that EFs are no longer needed for accomplishing it (Diamond 2013).

These claims are crucial for relating EFs with bilingualism. It is a trait usually developed in childhood; it certainly is practiced repeatedly, but can also be overdone. Everyday use of two or more languages involves constant monitoring, inhibition, selection, and planning. A logical conclusion might be drawn: bilinguals, who regularly practice these cognitive tasks, will score better in neuropsychological tests compared to monolinguals (Antoniou 2019). There are several psychological tests used to assess a person's EFs, two of which are commonly used in the field of cognitive neuroscience. The Stroop task is a basic test used to study the delay in reaction time when individuals are presented with a discrepancy between the name of a colour and the colour it is printed on. When the ink does not match the word's colour name, people are more likely to make errors in naming the ink colour. Similar to this task is the Simon task, which consists of two stimuli (e.g., a triangle and a square), which are individually shown either on the left or the right side of a screen. The participants need to identify the displayed stimulus by pressing a corresponding button on the left or the right side of the keyboard. In spatially congruent trials, the answer key and the corresponding answer are placed on the same side of the keyboard and the screen. In spatially incongruent trials, the answer key and the corresponding answer are placed on opposite sides. The latter usually leads to more mistakes and slower reaction time. The test shows that people respond quicker and more accurately when the stimulus and response features match (Champoux-Larsson & Dylman 2020).

2.2 Studies Supporting the Bilingual Advantage in Executive Functioning

The greatest contribution to the field of neuroscience, particularly studying the cognitive effects of bilingualism, was made by Ellen Bialystok and her colleagues (Bialystok 2001, 2005). Her research primarily focused on the cognitive benefits of bilingualism. She has studied the navigation between languages of bilinguals and the effects of this on executive control and decision-making. Her work advocates the recognition of bilingualism as a cognitive asset, rather than a deficit, and has advanced the understanding of how language shapes cognitive processes

and brain development. Alongside Bialystok, there are several researchers who have made significant contributions to the field, most notably Morales et al. (2013), De Cat et al. (2018), and Goral et al. (2013).

Research in general has shown enhanced executive functioning in bilingual children in comparison to their monolingual peers. Tasks used to test these claims were the Simon task (in which, as shown above, participants respond to stimuli shown on either the left or right side of a screen by pressing a button on the corresponding side), the Attention Network Test (used to measure differences in alerting and executive control of conflict), and the Dimensional Change Card Sort Task (sorting of cards according to several dimensions – e.g. colour and shape) (Antoniou 2019). Bialystok (2001) examines the differences in the performance of bilingual and monolingual children in both linguistic and non-linguistic cognitive skills. Her research indicates that bilingualism notably influences children's capacity to selectively focus on relevant information. In a follow-up study, Martin-Rhee and Bialystok (2008) demonstrated through three experiments that bilingual children outperform monolinguals on the Simon task. Bilinguals showed faster responses in conflict-based tasks, indicating more advanced early-stage interference suppression and attention control. In two studies, Morales et al. (2013) conclude that bilingual children aged 5 performed more accurately in a Simon-type task, and that the advantage in performance was even greater in more difficult conditions, in which children needed to recall several pieces of information while ignoring interference. This indicated that "bilingual children outperform their monolingual peers on the working memory tasks" (Morales et al. 2013: 199).

To deepen the understanding of the bilingual advantage, De Cat et al. (2018) defined bilingualism along a continuum, using advanced statistical methods to analyse the data collected from a sizeable sample of children who spoke only one or multiple languages. The researchers noticed a significant correlation between bilingualism and inhibition in children aged 5 to 7 years. They proposed the existence of a critical threshold of bilingual experience, defined by the level of exposure to and everyday usage of a second language, where EF advantages emerge. The superiority in EFs of bilingual children is associated with demands that bilingualism places on brain networks. However, De Cat et al. (2018) also stress that there are many other factors that contribute to the enhanced performance of bilingual children, such as age, gender, and socioeconomic status.

Further exploring the effects of bilingualism on executive functions of children, Janus et al. (2016) studied the effects of short second language or music training. After a short, 20-day

period of learning either the French language or music, children in both groups, matched on age and socioeconomic factors, improved in receptive vocabulary, cognitive level, and spatial span tests. Therefore, researchers concluded that improvement in EFs is evident even in the earliest stages of training, and that early training in the two skills leads to an improvement in similar aspects of EFs.

The least amount of evidence for a bilingual advantage in EFs was found in young adults, as they are at the peak of their EFs. For that reason, the possibility of emergence of additional benefits of bilingualism is minimal, especially in simpler tasks (Antoniou 2019). Little evidence suggesting a bilingual advantage in young adults does exist. Bialystok et al. (2014) noticed the advantage in two tasks, however, the advantage was more prominent in older adults, as well as in nonverbal versions of the tasks. Since the highest levels of EFs are exhibited by young adults, the bilingual advantage comes into play only when the participants are presented with the most complex of conflict-based tasks. Bilingual young adults perform more slowly in these types of tasks, but they can handle the conflict better and yield better overall results (Bialystok et al. 2016).

When young adults engage in complex tasks, they accomplish better overall results due to their amplified EFs. On the other hand, advantages attributed to bilingualism are much more prominent during the development and decline stages of EFs, in children and older adults (Bialystok et al. 2014). The strongest evidence supporting the bilingual advantage in relation to EFs is observed in older adults (Antoniou 2019). This claim is supported by several studies, most notable of which is Bialystok et al. (2016). These authors claim that older bilingual adults manage two or more languages for years, so they are expected to have accumulated greater benefits across different aspects of EFs. It is also stated that positive structural changes in the brain are associated executive control among bilinguals, which makes the bilingual brain better equipped for fighting against diseases related to old age. Higher levels of conflict detection and appropriate cognitive control were also observed among bilingual adults (Teubner-Rhodes et al. 2016). Results in a series of tests indicated a bilingual advantage in recognition memory and sentence comprehension tasks, suggesting enhanced cognitive control abilities, even after controlling for socioeconomic status and posing several tasks with varying degrees of complexity.

Most of the previous research has focused largely on comparisons between bilingual and monolingual individuals. One study by Hofweber et al. (2016) examined the variability among bilinguals. After comparing the differences in frequency of code-switching in bilinguals, the researchers indicated that individuals who engage in more complex and frequent code-switching

exhibit better performance in inhibitory control tasks under high-monitoring conditions. This is attributed to the enhanced specific aspects of EFs ("inhibition" and "shifting") among bilinguals who engage in intensive code-shifting. In another study, Goral et al. (2013: 85) claim that "bilingual experience affects age-related cognitive changes in inhibition, attention and working memory". Their research focused on how different types of bilingualism (balanced or dominant) influence age-related cognitive decline. The key finding was that dominant bilinguals benefit from continuous inhibition and perform better in Simon tasks than balanced bilinguals.

However, due to restrictions in the studies such as the greater number of balanced bilingual participants (Goral et al. 2013), confounding factors such as socioeconomic status (Hofweber et al. 2016), and the presence of bilingual advantages hinging on the presence of conflict itself (Teubner-Rhodes et al. 2016), the results of studies presented above might be inconclusive.

2.3 Studies Challenging the Bilingual Advantage in Executive Functioning

Researchers have been faced with many difficulties in constructing a perfect methodology for examining the bilingual advantage in executive functioning. Paap and Liu (2014) state that one of the most common methodological issues is the publication bias – the tendency to disregard experiments with null results – due to them having less of a chance of being published. Furthermore, the authors claim that the bilingual advantage inevitably correlates with other factors which affect EFs, such as socioeconomic status, immigrant status, and cultural differences. These methodological issues, along with inconsistent findings in many studies explained in this passage, have led scientists to question the positive link between bilingualism and improved executive functioning.

Similar in terms of influence to Ellen Bialystok, Kenneth Paap is another prominent figure in the field of bilingualism research. He emphasizes the importance of rigorous methodology and argues that earlier, positive effects of bilingualism on EFs might not be replicable when more strict experimental designs are employed. Paap's research spurred debate in the field of neuroscience by encouraging researchers to consider alternative explanations for the observed bilingual cognitive advantages. Paap and Sawi (2014) conducted a study in which bilingual and monolingual university students completed tasks assessing switching ability (cognitive flexibility required to switch between languages), monitoring (active management of speech to reduce mistakes), and inhibitory control (the ability to suppress non-relevant or conflicting responses). Very few significant results were found, with most supporting a monolingual advantage. Through cross-task correlations, they also suggested that bilingual advantages in EF might be task-specific, therefore

not broadly acceptable. Paap and Sawi concluded that assumptions about EF measures might overlap with general intelligence or processing speed. Similar conclusions were reached in a study by Paap and Greenberg (2013). By examining correlations between performances on "shifting", "updating", and "inhibition" tasks, researchers concluded that the potential bilingual advantage among young adults is either non-existing or inconsistent. Paap and Greenberg (2013) also criticise earlier studies for using only one task for each EF aspect and for having no tests of convergent validity, stating that the results of those studies are usually impossible to replicate.

In another study, Paap and Liu (2014) tested bilingual advantages in resolving conflicts during the processing of sentences. Conflict resolution means the ability to change a response in order to handle situations with conflicting pieces of information, one familiar and the other not. By overriding automatic responses, one recognizes new instructions, allowing for consideration of less typical actions (Hussey & Novick 2012). Paap and Liu (2014) suggested that bilinguals and monolinguals are equally skilled at suppressing inappropriate meanings and assessing sentence acceptability or grammaticality. This study showed that there is no evidence which supports superior conflict resolution abilities in bilinguals.

When comparing the results of bilingual and monolingual children on a Simon task, but after controlling for the socioeconomic status and ethnicity of the participants, Morton and Harper (2007) concluded that the groups do not differ significantly. Similarly, Gathercole et al. (2014) examined the performance on EF tasks across several age groups, from children around 3 years of age, to older children, teenagers and adults. The researchers concluded that performance generally improves with age. However, not one age group demonstrated a bilingual advantage.

After examining both supporting and challenging evidence for the bilingual advantage in executive functioning, it is apparent that the debate is yet to be resolved. As Antoniou (2019) observes, some studies provide plenty of evidence for cognitive benefits of bilingualism, but others fail to replicate them. These conflicting results highlight the importance of refined methodology and addressing untested variables. As mentioned earlier, one of the major challenges is accounting for all the variables which may influence the relationship between executive functions and bilingualism, such as socioeconomic status, immigrant background, and cultural differences. Constructing a perfect methodology which considers every variable is difficult, as even minor contrasts between participants might impact the results.

3 Bilingualism, Cognitive Development and Flexibility

3.1 Cognitive Development and Flexibility

Cognitive development refers to the development of thinking and reasoning. It encompasses several gradual stages which exhibit "the growth of such diverse capabilities as perception, attention, language, problem solving, reasoning, memory, conceptual understanding, and intelligence" (Siegler et al. 2010: 129). According to Jean Piaget's theory, children move through four stages of cognitive growth: sensorimotor stage – in which infants develop and express their intelligence through sensory and motor abilities; preoperational stage – in which children acquire the ability to express their experiences through language and mental imagery; concrete operational stage – in which children start to logically reason various events; and the formal operational stage, the ultimate stage in cognitive development – in which children gain the capacity to deeply consider abstractions and hypothetical situations (Siegler et al. 2010). Additionally, language development is one of the crucial aspects of cognitive development. Through interaction with their caregivers and environment, children gradually progress from babbling to simple words, to complex structures and abstract use of language by going through several stages: phonological, semantic, syntactic, and pragmatic stage of development (Siegler et al. 2010).

Another important concept closely related to cognitive development is cognitive flexibility – the ability to change the approach to a problem, more efficiently switch between tasks, and to flexibly adjust to new demands (Diamond 2013). The author states that cognitive flexibility starts to develop early, but fully develops late in a child's life (at 7 to 9 years of age). This owes to the fact that it requires simultaneous usage of both previously explained EFs: "inhibition" and "updating". Learning and using two or more languages requires pronounced inhibitory control. When speaking one language, bilinguals need to inhibit words from their other language. When listening to one language, bilinguals need to update or replace information from their other language in their working memory. These processes lead to greater cognitive flexibility in bilingual individuals (Teubner-Rhodes et al. 2016). Therefore, Diamond (2013) argues that cognitive flexibility is one of the most demanding EFs to master, as well as to maintain.

The complex relationship between bilingualism and cognitive development has been a topic of much debate. Some researchers suggest advantages for bilingual children, while others find potential drawbacks or no significant differences.

3.2 Studies Supporting the Bilingual Advantage in Cognitive Development

As mentioned earlier in the paper, the prevailing belief in the first half of the 20th century was that speaking two languages results in suboptimal cognitive development. One of the first

researchers to challenge that idea was Rafael M. Diaz (1983). He criticizes earlier negative views and advocates positive impact of bilingualism on cognitive abilities, highlighting areas such as cognitive flexibility, problem-solving ability, and metalinguistic awareness. By surveying earlier research, Diaz (1983) claims that bilingual children develop a higher level of awareness and understanding about the structure of a language. Furthermore, he states that bilingual children demonstrate greater cognitive flexibility, and suggests that cognitive benefits from bilingualism may have a positive effect on academic success, especially in the subjects which require verbal skills. However, Diaz also addresses gaps in the methodology of research of the time. Even though methodologies have improved from the beginning of the 20th century, he claims that research of the time does not address the effects of bilingualism on children with unequal proficiency in both languages (dominant bilinguals) and that it excludes children who are in the initial stages of learning a second language.

Bialystok (2005) provides an overview of the effects that bilingualism has on cognitive development, but much like her colleagues, she acknowledges the challenges in the methodologies, such as varied language proficiency among bilinguals. She argues that bilingual educational programs may support cognitive development and calls for educational policies which would promote these benefits. Bialystok concludes the study by acknowledging that bilingualism alters cognitive processes in children. However, the extent of the change is still being studied.

Building on Bialystok's notion that bilingualism can positively influence cognitive development, Kovacs and Mehler (2009) found evidence that infants raised surrounded with two languages from birth exhibit enhanced cognitive control abilities, indicating early development of cognitive control systems influenced by exposure to multiple languages. Further supporting this positive link, Yoshida (2008) shows that positive effects of bilingualism on cognitive development are noticable in tasks which require self-control, inhibition, and cognitive flexibility. She explores knowledge transfer between languages, i.e. the benefits of learning one language for understanding another, which is particularly relevant for immigrant children. Like earlier scholars, Yoshida emphasizes the need for a strict methodology which takes into consideration factors such as socioeconomic status, cultural background, balance of linguistic knowledge, and age of second language acquisition.

The studies surveyed above show that bilingualism offers noteworthy cognitive benefits, especially when it comes to knowledge transfer and cognitive flexibility. Challenging previous

misconceptions, bilingualism was argued to have the potential to positively influence cognitive development and academic achievement.

3.3 Studies Challenging the Bilingual Advantage in Cognitive Development

After exploring studies that support the notion that bilingualism has a positive effect on cognitive development, it is of great importance to consider contrary research. Achieving a balanced understanding of the potential impacts of bilingualism can greatly help in constructing quality methodologies and developing comprehensive educational policies. As Antoniou (2019) states, early methodologies were inconsistent; therefore, a lot of results were open to interpretation. Peal and Lambert's seminal study in 1962 shifted the perspective of bilingualism from being disadvantageous to having potential cognitive benefits. The authors were among the first to highlight the need for more solid methodology. Some of the drawbacks of earlier studies are not paying attention to the nature of the bilingual populations tested, to their competence in the language they were tested in, socioeconomic status, and the interpretation of tests and results (Bialystok 2005). As methodologies continue to improve, many studies which support, as well as those which challenge the bilingual advantage, continue to arise.

Several recent studies present several viewpoints that question the positive effect of bilingualism, pointing out a lack of consistent cognitive advantages for bilinguals. Despite being a fervent supporter of the bilingual advantage, Bialystok does not shy away from studies that challenge her views. One of the most common arguments against bilingual advantages is the typically smaller vocabulary of bilingual children in each language when compared to that of their monolingual peers, which is especially important in the context of the cognitive development of children. A varied vocabulary, such as that of the vocabulary of bilingual children, reflects a deeper understanding of language; however, developmental research proves that bilingual children possess a more limited vocabulary in each language, which could potentially impact their overall language development (Bialystok 2008).

In a study conducted by Hoff et al. (2011), 47 US children who were raised with both English and Spanish from birth were compared with 56 children exposed to English only. The objective was to examine the effects of being exposed to two languages. Aside from vocabulary size being smaller and less varied in bilingual children, the researchers observed a higher grammatical complexity among monolingually developing children across all ages. Additionally, while both groups ultimately achieved language development milestones within the expected range, monolingual children exhibited larger gains in grammatical complexity of English language

production. In a similar study, Páez et al. (2007) examined oral language and early literacy skills in monolingual Spanish-speaking children and bilingual children speaking Spanish and English. In contrast to monolingual children, bilingual children performed slightly worse in both English and Spanish tests. However, the biggest difference was observed in oral language skills, across all ages. Bilingual children consistently performed worse, both in English and in Spanish, when compared to their monolingual peers.

When considering vocabulary size and grammatical proficiency, cognitive capabilities must be paired with other factors, such as socioeconomic background, fluency in home language and the effectiveness of education methods. A child that has no access to books at home or that is physically less healthy, raised in a family which does not value their cultural background is expected to perform worse on cognitive tests. This line of thought suggests that circumstances which surround language learning play a pivotal role in the outcome (Oller & Pearson 2002).

Again, more comprehensive research methods are needed to fully comprehend the effect of bilingualism on cognitive development. The lack of those is the driving force behind those who challenge the bilingual advantage with regards to cognitive development, but also those who support it.

4 Bilingualism and Cognitive Aging

4.1 Cognitive Aging

After exploring the intersection of bilingualism and executive functions, and how this all relates to cognitive development, this section examines how bilingualism may affect the later stages of human cognition: cognitive aging and the possible occurrence of dementia. Executive functions built in the process of cognitive development represent the peak of cognitive ability (Diamond 2013). These complex abilities, essential for proper development, as well as mental and physical health, require a lot of concentration and attention. Therefore, it is only natural that aging is linked with a decline in their effective usage, especially the usage of inhibitory control (Goral et al. 2013). This shift from exploring cognitive development to cognitive decline stresses the shifting nature of human cognition.

The gradual decline in cognitive abilities which occurs naturally with age is referred to as cognitive aging. This process typically affects memory, attention, problem-solving and decision making. While cognitive aging is a normal part of aging, it is important to distinguish it from more

severe, pathological cases of cognitive decline such as neurodegenerative dementia, most well-known example of which is Alzheimer's disease (Institute of Medicine 2015).

In extreme cases of cognitive aging, the decline in executive functioning manifests as neurodegenerative dementia (henceforth: dementia). The Diagnostic and Statistical Manual of Mental Disorders, Third Edition (1980: 107) defines dementia as a syndrome characterized by a "loss of intellectual abilities of sufficient severity to interfere with social or occupational functioning." Dementia is described as a disorder which impairs memory, judgement, personality, and behaviour, leading to partial or full dysfunctionality.

Critical in this discussion is the role of bilingualism as a likely intermediary of age-related cognitive changes. The concept of successful aging is characterized by three components: "low probability of disease and disease-related disability, high cognitive and physical functional capacity, and active engagement with life" (Rowe & Kahn 1997: 433). Papageorgiou et al. (2018) list several factors which contribute to this concept: the continuation of physical activity in old age, increased cognitive effort, and bilingualism. The authors link the ability to speak two languages with increased inhibitory, attentional, and working memory demands, which, subsequently, increase cognitive capacity or cognitive reserve. Influenced by a lifetime of intellectual, social, and other environmental factors, cognitive reserve refers to the brain's ability to adapt to and withstand damage while maintaining normal function (Barulli & Stern 2013).

Apart from cognitive benefits tied to bilingualism, Luk et al. (2011) claim there might be beneficial neurological effects as well, such as improved white matter integrity and functional connectivity, and increased tissue density in areas associated with cognitive control. Most fervent supporters of the bilingual advantage in cognitive aging claim that people speaking two languages exhibit symptoms of dementia significantly later than those speaking one, and show better post-stroke cognitive recovery (Bialystok et al. 2016).

However, as was the case in previous sections, many additional factors need to be considered when determining the effects of bilingualism on cognitive aging. Although Bialystok et al. (2016) claim that bilingualism improves cognitive performance in old age, they present other factors which do the same, such as social class, occupational status, educational attainment, and participation in physical, intellectual and social activities. All of these must be taken into consideration when constructing methodologies for researching bilingual advantages in cognitive aging.

4.2 Studies Supporting the Bilingual Advantage in Cognitive Aging

Cognitive functions undergo a gradual decline as individuals age (Goral et al. 2013). While this is a natural process, aging of the world population must be considered. The local healthcare systems might face more and more difficulties in treating the increasing number of people experiencing neurocognitive disorders such as dementia (Mertz 2017). Recently, the idea of cognitive reserve has been recognized as a potential mitigator of age-related cognitive impairments. By processing tasks in a more efficient manner during their lifetime, individuals with more cognitive reserve can sustain greater damage before succumbing to neurocognitive disorders (Stern 2002). Factors which contribute to greater levels of cognitive reserve are education, occupational status, socioeconomic class, physical, and intellectual engagements, bilingualism being one of the most important such engagements. Many researchers have found that bilingualism promotes healthy aging, improves the level of cognitive reserve, and even delays the onset of neuropathological disorders (Antoniou 2019).

Keeping in mind the methodological difficulties mentioned several times in this paper (the potential simultaneous impact of factors like education level, socioeconomic status, immigrant status), researchers are trying to construct studies which would minimize such environmental factors and paint a true picture of the impact of bilingualism on human cognition (Bak et al. 2014). In one study on Israeli adults, Kavé et al. (2008) examined whether the number of languages a person acquires during their lives improves cognitive reserve. After controlling for variables such as age, gender, education, and immigration age, researchers found that a person's cognitive state in old age correlates with the number of languages they speak, meaning that multilingualism is a strong indicator of improved cognitive ability in old age. Even though it might be argued that mastery of more languages is associated with the formal education level, when examining participants without formal education, Kavé et al. (2008) found that among such individuals, those speaking multiple languages exhibited greater protection against cognitive deterioration. In a similar study on Scottish older adults, Bak et al. (2014) revealed that bilinguals demonstrated better cognitive performance compared to their monolingual peers, after controlling factors such as ethnicity, immigration, and socioeconomic status. Better cognitive performance also extended to reduced risk of neurodegenerative disorders. Both Kavé et al. (2008) and Bak et al. (2014) observed that the protective effect on cognitive abilities grows with the number of languages a person has mastered.

To dive deeper into the potential protective effects of bilingualism, Bialystok et al. (2007) extend the focus of research from cognitive performance to neuropathological disorders. They controlled for factors such as cultural differences, education and employment status, immigration,

and, most importantly, level of cognitive impairment. The results have shown that bilingualism postpones the onset of dementia by 4 years. However, Bialystok et al. (2007) call for caution in interpreting the results, since the connection between bilingualism and delayed dementia onset cannot be definitively proven due to the observational design of the study, and due to subjective reports on the age of onset of dementia in patients. Gollan et al. (2011) replicated the study and reached a similar conclusion – fluency in multiple languages might delay the onset of dementia. Additionally, researchers discovered that a later age of the onset of dementia is most prominent in bilinguals with a low educational attainment. Another study confirming the link between bilingualism and the delay of neuropathological disorders was conducted by Chertkow et al. (2010). In this study, researchers concluded that a small but significant protective effect of bilingualism does exist across all groups tested. This effect is most prominent in bilingual immigrant participants with low education levels (delay of Alzheimer's disease by up to 5 years). Similar conclusions were reached by Alladi et al. (2013). By examining case records of patients with dementia, researchers confirmed the later onset of dementia suggested in earlier studies. The difference in onset between bilinguals and monolinguals was noticed in several types of dementia. Another important finding was that dementia had a later onset even among illiterate bilinguals compared to their monolingual peers. This suggests that bilingualism is a variable separate from education level when it comes to studying bilingual advantages in cognitive aging (Alladi et al. 2013).

4.2 Studies Challenging the Bilingual Advantage in Cognitive Aging

Despite the robust evidence for bilingual advantages in cognitive aging, many studies have been criticized for their retrospective design and methodological issues (Antoniou 2019). All researchers involved in studies mentioned in the previous section have acknowledged methodological limitations that could potentially lead to a misinterpretation of the results. Bak et al. (2014) warn that language knowledge in their study was defined by a simple questionnaire, not proficiency, and that most participants acquired the second language late in childhood. These limitations do not eliminate the possibility of a bilingual advantage, but certainly act as confounding variables which may influence the results. Similarly, Kavé et al. (2008) reported that their study did not implement rigorous criteria for determining language experience and usage frequency. Participants reported details regarding their language proficiency by themselves, which

means the strength of the results might be reduced. Even though Chertkow et al. (2010) noticed a small protective effect of bilingualism across all groups, the only groups prominently displaying the effect were the immigrant and low education groups (these features often coincided).

One of the primary criticisms against studies supporting bilingual advantages in cognitive aging is their retrospective design (Antoniou 2019). In retrospective studies, researchers gather information about the past of an individual or a group. Opposite to those are prospective studies, in which the outcomes are observed during a period of time. Many such studies observed no bilingual advantages in cognitive aging. In a two-fold study (both retrospective and prospective research) conducted on 1616 older adults, Yeung et al. (2014) observed no bilingual advantages in delaying cognitive impairment, neither in retrospective, nor in prospective analyses. Furthermore, researchers found no connection between bilingualism and higher cognitive test scores. Similarly, Zahodne et al. (2014) studied 1067 native Spanish-speaking immigrants to the US over the course of 23 years. Proficiency in English was self-reported by the participants. 40% stated they were proficient in English, the other 60% stated the opposite. Throughout the study, 282 participants were diagnosed with dementia. Even though bilingualism was linked with better initial performance when testing for executive function and memory, researchers found no connection between the delay of onset of dementia and bilingualism. Additionally, no evidence was found indicating different decline rates in episodic memory or executive function between bilingual and monolingual participants of the study. Lawton et al. (2015) conducted a similar study on monolingual and bilingual Hispanic Americans. However, participants in the study were not immigrants but bilinguals who had learned English early in life. During the course of 10 years, the groups did not differ significantly in the age of dementia onset.

There is also growing evidence that challenges the bilingual advantage in executive functions among older individuals. In a series of cognitive tests (working memory, inhibition, planning, non-verbal reasoning), Papageorgiou et al. (2018) even proposed a bilingual disadvantage among older individuals in tests which require accurate and fast responses. With their findings in hand, they challenged studies which argue that bilingualism offers cognitive advantage throughout the lifespan, proposing that the advantage might arise from other background factors, among others, from socioeconomic status. In a similar experiment, Lee Salvatierra & Rosselli (2010) tested the inhibition of older adults. Not surprisingly, older bilinguals were more efficient in simpler tasks; however, no difference was observed in the performance of bilinguals and monolinguals in complex inhibition tasks.

Most of the studies challenging the bilingual advantage in cognitive aging (along with other aspects of human cognition) trigger a response from disagreeing scientists, and vice versa. Both sides most frequently criticize methodological issues or limitations by the other side (Antoniou 2019). This ongoing debate highlights the need for meticulous research designs if scientists are to reach a more thorough understanding of the connection between bilingualism and cognitive aging.

5 Publication Bias

The preceding sections have explored the complex relationship between bilingualism and cognitive functions across the lifespan. The evidence suggesting a bilingual advantage is abundant and compelling. However, one factor challenging the advantage needs to be further explained to better grasp the true effect of bilingualism.

Publication bias represents the higher likelihood of submission and publication of research with statistically significant results. Studies with inconclusive or unfavourable results tend to go unpublished in journals with a high citation impact factor (Easterbrook et al. 1991). The authors, who examined publication bias in medical, educational, and psychological studies, claim it can have serious consequences for the validity of studies. Similarly, publication bias can compromise the validity of review studies, as well as that of research which draws conclusions from the available literature. This phenomenon was first described by Sterling (1959), who analysed psychological journals of his time and found only 8 results disproving the initial hypothesis in 298 published articles. The author further explained that comparable practices can be observed across nearly all areas of science. A bias towards publishing statistically significant research may emerge in several steps of the publication process (De Bruin et al. 2014). Firstly, an author may choose to submit their study partially, excluding null or negative results, out of fear of rejection or time-wasting. Secondly, editors and reviewers might reject studies with null or negative results due to them being difficult to interpret or being a result of statistical errors.

De Bruin et al. (2014) were among the first researchers to examine publication bias on the topic of bilingualism and its cognitive advantage. Through a meta-analysis of conference abstracts, the authors revealed that the publication rate was much higher for studies demonstrating bilingual benefits compared to studies with null findings. Only 4 of the 104 examined abstracts identified a clear bilingual disadvantage. Studies in question did not show notable differences in terms of methodology or number of participants. This has left De Bruin and colleagues to believe that a strong publication bias arose from the first step (the author's submission of their work) and

continued throughout the rest of the steps (reviewers' and editors' evaluations). Lehtonen et al. (2018) supported de Bruin's claim by conducting a meta-analysis of the results of earlier studies, which revealed that the small bilingual advantage in executive functioning was no longer evident after adjusting for publication bias. These authors underline the need of pre-registration practices – registering the hypotheses and methods before conducting the study – in the field of psycholinguistics.

Studies which aim to answer novel research questions and pose new methodologies should be publishable even though they might yield null results, as that is the only way for a particular field to advance and successfully tackle methodological issues (Duñabeitia & Carreiras 2015).

However, Bak (2016: 217) challenges De Bruin and colleagues' work stating that there is no "baseline information given about the frequency of publication bias in other areas of science". More than half a century ago, Sterling (1959) noted that the existence of publication bias is a problem present across all scientific fields. Since this is the case, one should not consider this bias as an issue particular to bilingualism research, and it should not be approached differently than in other fields of science.

These findings indicate that verdicts based only on a review of published data must be approached cautiously. The existence of studies with null or negative results, unpublished due to publication bias, must be taken into consideration before reaching any kind of conclusion.

6 Conclusion

Being bilingual is undoubtedly a positive trait. There are many benefits of speaking more than one language, such as enhanced social interaction, cultural appreciation, and improved social prospects. However, one of the most important benefits is cognitive stimulation. Much like participating in a pub quiz or completing crosswords, speaking two languages acts as a stimulant for many activities in the brain throughout a person's life.

Even though these conclusions might seem perfectly logical, many who tried to empirically prove it faced numerous obstacles. After the negative outlook on bilingualism in the beginning of the 20th century, research methods were changed, and a new outlook on bilingualism took over the world. Refining research methodologies has shifted public perception from predominately negative to mostly positive. Numerous benefits of being bilingual were found in human executive functioning, cognitive development, and healthy cognitive aging. However, after this shift,

researchers continued to question and improve the methodologies used in the studies of bilingual advantage. Due to this constant scrutiny, findings which contradict the idea of the bilingual advantage still exist and constantly emerge. In addition to that, publication bias might be an impassable barricade for many studies, most likely those that challenge the idea of the bilingual advantage on human cognition with null or negative results.

What is needed to find conclusive evidence is a radical change in research paradigms. More sophisticated research methods need to be devised to better understand bilingualism and its relation to human cognition and cognitive change. By acknowledging that the methodology is not yet perfected and addressing the need to change it, researchers may be able to gain deeper insight into how bilingualism affects brain function. Thus, researchers may finally resolve this stalemate of opinions and advance the understanding of the correlation between bilingualism and cognitive function.

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