A Brief Introduction into Bilingualism

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Introduction

Bilingualism has become an increasingly common phenomena and seems to be the norm (rather than the exception) for much of the world (Hope et al., 2015). Further, increased globalization has made the conversation about bilingualism and multilingualism extremely relevant in the world today. As a result, increasing research has focused on bilingualism, from the anatomical effects to various cognitive effects. This paper will discuss findings relating to structural brain changes in bilinguals, cognitive processes that occur in the brain as a result of bilingualism, cognitive processes relating to ADHD and bilingualism, factors that affect one's ability to learn a second language, such as socioeconomic status and home environment/parental involvement, and potential long-term cognitive benefits of bilingualism, such as a delay in the onset of age-related cognitive decline and stroke recovery. Thus, this paper seeks to provide a general overview of the many facets of bilingualism and its anatomical, cognitive, and social consequences.

Anatomical and Cognitive Effects of Bilingualism

Structural Brain Changes

Increasing amounts of research have explored the idea that learning a second language can have a physical effect on the brain. The use of new technology, specifically MRI machines, has allowed for increasing accuracy and precision in the discovery of anatomical brain changes as a result of second language acquisition. While many parts of the brain may endure anatomical changes as a result of the acquisition of a second language, the focus centers around gray matter. Gray matter seems to be an all-encompassing measure of the size of cells within the brain, specifically glial cells and neurons. This change in gray matter is measured using structural MRI (sMRI) findings. sMRI readings are conducted, then voxel-based morphometry (VBM) is able to

analyze and convert the sMRI findings into a readable and easily measurable amount of gray matter within the brain (Li, Legault, Litcofsky, 2014). In a 2021 study conducted by Liu, Jiao, Timmer, and Wang, researchers attempted to discover what parts of the brain physically changed over one year of intensive, immersive second language learning among Chinese college students. This study is important because it took a naturalistic approach to language learning, where the experience was similar to full language immersion, as one may experience when moving to a foreign country. Using voxel-based morphometry, results showed a decrease in gray matter volume in some key parts of the brain, specifically the left anterior cingulate cortex (ACC) and right interior frontal gyrus (IFG). These are both frontal regions heavily involved in changes language control. As explained in the study, the decrease in these areas indicates a switch from the cortico-frontal regions to the subcortical and posterior regions with significant second language (L2) learning. Another study conducted in 2012 (Mårtensson, Eriksson, Bodammer, Lindgren, Johansson, Nyberg, Lövdén) explored this same phenomenon of the anatomical changes as a result of the acquisition of a second language. This study was done over a much shorter period of time (3 months) than other studies in the same field, and thus may yield vastly different results. The major findings in this study focus on the size of the hippocampus, which is heavily involved in memory. This finding, which is generally not replicated in other similar studies, is likely due to the short timeframe of the study and implies a shift in the areas of the brain most involved in second language acquisition from the beginning of the process through the benchmarks of proficiency and eventually fluency. Arguably the most important findings from these two studies are that there are many complex factors that play into the specific anatomical changes that occur as a result of the acquisition of a second language. The above two studies explore factors such as the age at which one first begins to acquire the second language

(this is specifically important in the Liu study because all of the participants had varied prior levels of proficiency in the second language) and the proficiency one achieves over the course of their language-learning process. These factors point to the importance and individuality of neuroplasticity, which is the ability of the brain to alter its structure and function as a result of different stimuli, internal or external (Mateos-Aparicio & Rodriguez-Moreno, 2019). Language learning is not the only cognitive activity that has been studied under the lens of neuroplasticity, as the effects of mathematics, memorizing maps, and even juggling have been studied in the past (Li et al., 2014). Language learning is just one of many cognitive processes that influences the neuroplasticity of the brain, and has been studied extensively for the overall trends, as well as the individualized effects dependent on several physical and social factors.

Cognitive Processes of First and Second Language Learning

Cognitively, language acquisition takes place generally as a result of either implicit learning, explicit learning, or a combination of both. In his 2015 book 'Implicit and Explicit Learning of Languages', Ellis describes implicit language learning as something that happens rather informally, simply, and unconsciously. Ellis further argues that the way in which people are able to unconsciously process and understand sentence constructions and complex aspects of language epitomizes the idea of implicit language. Explicit language learning, on the other hand, is a much more formal and intentional mode of language acquisition. The debate of whether explicit or implicit instruction is more effective is long debated and has a complex answer. The reality is that this is not a black and white issue but tends to boil down to the specific learners and context of the learning. For example, in a chapter of 'The Handbook of Language Teaching' (2011), Dekeyser describes the idea that explicit and implicit knowledge almost always work together in language tasks, supporting the idea that both are necessary in learning and using a

language. Ellis expounds on this idea, explaining that the mere existence of a first language (L1) warrants the need for both implicit and explicit L2 instruction. While implicit instruction has been shown to be very useful in L2 acquisition (and obviously the basis of L1 acquisition as well), the existence of the L1 and its foundational basis in the brain warrants a need for explicit L2 instruction, essentially to deprogram the 'defaults' of L1. This idea leads to many further questions regarding L2 acquisition: How much of L2 acquisition should be done explicitly or implicitly? Lichtman (2016) sought to determine the effects of implicit and explicit L2 instruction, and specifically whether there were differences in how children and adults best acquired L2. In this study, a group of adults and a group of children aged 5-7 were split into groups, one group receiving implicit instruction and the other receiving explicit instruction. The results indicate that for both children and adults, those receiving explicit instruction were much more likely to pick up on the grammatical rules and structure of the language, and conversely those receiving implicit instruction were less likely to pick up on them. A major difference seen between children and adult learners, however, is that adults receiving implicit instruction were more capable of developing explicit knowledge from their instruction, whereas the children learning implicitly were unable to do this. This study is important in showing that there are many individual differences that factor into whether implicit or explicit instruction is more effective (namely the age of the learner in this study), but the reality is that a combination of explicit and implicit instruction has been shown to be the most effective for L2 learners (Ellis, 2015). This is, however, a complex issue that often depends largely on varying cognitive and social factors and is an individualized issue. Learners' individual differences are the most important element in determining how one best acquires a second language.

ADHD and Bilingualism

Interesting new discussion regarding the extent of cognitive discrepancies of bilingualism involves the impact of Attention-Deficit/Hyperactivity Disorder (ADHD) and bilingualism on cognitive development. It is known that both have a major impact on cognitive functioning, but the relationship between the two and how they potentially work together in the brain is a relatively new field of research.

Research in this field has uncovered interesting trends and results that may have implications for future research and practical applications in the field. A study by Mor, Yitzhaki-Amsalem, and Prior (2015) explored shifting, defined as "the ability to shift between mental sets or tasks", and inhibition, defined as "a general ability to suppress dominant or prepotent responses." These areas have been found important in studying cognitive impacts of both bilingualism and ADHD, so are relevant in finding any potential interaction between the two. This study featured 80 young adult college students and found interesting results. The main finding of this study was that bilinguals with ADHD had performance deficits compared to monolinguals with ADHD. While these two phenomena have often been treated as separate entities, this study suggests that viewing them as interactive and collaborative processes in the brain may be beneficial in providing future insight and may even be useful in treating ADHD in the future. Similar to the previous study, Bialystok, Hawrylewicz, Wiseheart, and Toplak (2016) sought to determine two things: whether vocabulary deficits would be larger with combined ADHD-bilingualism than either of the two on their own, and whether the cognitive advances of bilingualism compensates for deficits in ADHD or if ADHD prevents the cognitive advantages of bilingualism from occurring. Bilinguals tended to perform worse in the vocabulary section and the ADHD group performed better in the language ability section. In other areas, ADHD overall

tended to be more of a hindrance to bilinguals than monolinguals, suggesting some kind of interactive effect, similar to the findings of Mor et al.

A study conducted by Sharma, Katsos, and Gibson (2022) found some interesting results regarding the behavior associated with ADHD and how it is influenced by bilingualism. The main finding of this study is that bilingualism is associated with lower levels of ADHD-related behavior. Similar to previously mentioned studies, Sharma et al. describes a potential relationship between ADHD and bilingualism within the brain, specifically in the area of language skills.

While this field is fairly new and future research is still necessary, practical applications and interventions may result from this area of research and positively impact those with ADHD. Future research ought to focus on finding a more representative sample, including those of different ages, SES, and other potentially important factors. Further, future research could potentially explore anatomical differences between ADHD and non-ADHD monolinguals and bilinguals, utilizing new technology such as fMRI machines. Having precise knowledge about the specifics of the cognitive workings of the brain in this realm may enhance future research and applications of these findings.

Factors that Affect One's Ability to Learn a Second Language

Socioeconomic Status (SES)

Recent research has attempted to determine what factors in a person's life may influence their ability to acquire a second language. At the helm of this research has been one's socioeconomic status (SES), as SES can influence many other social factors in one's life. While further research is needed in this field, current research has already made some promising findings that may affect many people's ability to learn a second language. In a 2014 study, Butler

sought to determine whether SES, among other factors, impacted a group of Chinese students' ability to learn English. This study specifically focuses on how parental SES influences a child's ability to learn a second language and how this influence may change at different grade levels. Thus, students from three different grade levels (fourth, sixth, and eighth) and their parents were included in this study. The results found a substantial difference by SES at the eighth-grade level, but much of the results are more complex than this. In this study, as well as a longitudinal study conducted by Butler & Le (2018), found similar complexity to these results. Both results indicate that while SES may not directly influence results, the social factors that are intertwined with SES play a role in students' abilities to learn a second language. These factors include namely the style of parenting and parental expectations. Parental expectations appeared to remain high for children with high SES parents throughout the different ages studied, but for low SES children, parental expectations appeared to decrease as the child aged, which can have a major impact on a child's ability to learn a language. Further, high SES parents tended to have a more autonomous approach to parenting, which further influences the students' ability to acquire a second language. These studies both take place in fairly small areas of China, but similar results were found in a study of Spanish-speaking students in the United States and their journey of English acquisition (Howard, Páez, August, Barr, Kenyon, Malabonga, 2014). This study also found vast differences at different grade levels, influenced by SES and other social factors. Thus, it appears that parental SES may have an impact on their children's ability to learn a second language, but it isn't SES directly that influences this impact, but rather the stigmas and social differences that go along with SES differences.

Further research in this field is needed to determine any other impacts of SES on second language learning. Useful research would also include the second language acquisition of adults

based on their own SES, to determine whether the indirectness of parental SES on a child had an impact on the results of these studies. This is, however, a promising field of research and may open the door for future interventions in an attempt to counteract the potential negative effects of a low SES.

Home Environment and Parental Involvement

Another major social factor that has begun to become prevalent in psycholinguistic research is the home literacy environment (HLE). The HLE includes anything that exposes children to literacy and storytelling in the home, including verbal storytelling between parent and child and the number of children's books in the home (Bitetti & Hammer, 2016). While the idea of HLE has been intertwined with SES in many studies, there is potential for SES to not directly play into one's HLE, and thus this is another social factor that has the potential to affect a child's ability to acquire a second language.

A study conducted by Bitetti & Hammer (2016) suggests that only certain aspects of HLE has a significant effect on children's second language acquisition. In this study, children from Spanish-speaking homes enrolled in English-instruction schools were studied, and the results were interesting. The major finding of the study is that parental book reading has a significant impact on the ability of a child to acquire a second language, but other factors, such as storytelling and number of books in the home, did not have an effect.

In a meta-analysis of the impact of HLE on English as a second language (ESL) learning, Dong & Chow (2022) found a similar trend. While parental involvement in literacy activities (namely reading to children and interactive storytelling) affected their child's ability to learn English, parental beliefs and attitudes, as well as the number of books in the home did not have an effect on children's second language acquisition. This, along with the Bitetti et al. study,

suggests that it isn't the mere presence of literacy materials in the home or parental desire to have their children acquire a second language, but the act of actually being involved and encouraging their growth in the language, namely by reading to them and engaging them in the language. This may present a potential shortcoming for other studies in the field, as a common question given to parents asks how many books are present in the home, which may be a misleading factor in determining the strength of an HLE.

A similar finding by He, Gou, and Chang (2015) suggests that there is an added element to parental involvement that may impact their children's second language acquisition. This study focused on English learners in North Taiwan and again sought to determine what effect, if any, HLE had on English as a foreign language (EFL) acquisition. The findings remained similar to the others but additionally found that not only does parental involvement in literacy activities increase children's experience with the language and thus affect their acquisition but having parental involvement and engagement in helping their child learn a second language send the message of the importance of self-improvement to the child. Thus, this involvement by the parent can be perceived as providing a positive influence on the work ethic and self-efficacy of their children, which is a hugely important element to learning a second language.

A study conducted by Duursma, Romero-Contreras, Szuber, Proctor, Snow, August, and Calderon (2007) suggests another major factor that plays into the role of HLE in second language acquisition, which is the context of the language learning and the languages themselves. In this study, a group of Latino children learning English were studied to determine what factors determine proficiency and vocabulary growth in both languages. A main factor was the language used in school, as well as the language used at home (which in some cases even varied from mother to father). The study determined that English proficiency did not depend on

whether it was used in the home by parents and siblings but remaining proficient in Spanish required home exposure. These findings suggest a broad social pattern of Spanish use in the United States, but from a linguistic perspective, suggests that the home environment's effect on second language acquisition is largely dependent on the context of the acquisition as well as the languages themselves. In this study, the environment (Latinos in the United States) played a major role in the results of this study.

These findings, along with others in the field, provide useful insight into ideal environments for children's second language acquisition, and may influence future parental behaviors in this area. However, a major shortcoming of this research is that it almost exclusively focuses on elementary school children, which would likely yield different results than if another age group were studied. Future research in this field may consider determining whether there is a similar effect of home literacy environment on middle and high school children, and even adults, although the criteria for HLE would likely have to be updated to accommodate a different age group and different ways to approach second language acquisition within the home.

Potential Long-term Cognitive Benefits of Bilingualism

Age-Related Cognitive Decline, Dementia, and Alzheimer's Disease

There has been much research conducted into certain activities or factors that may influence one's ability to delay the onset of cognitive decline later in life (Antoniou, Gunasekera, and Wong 2013). This phenomenon is known as cognitive reserve, and includes factors such as occupation and education level, as well as activities that are physically and mentally challenging (Bialystok, Craik, & Luk 2012). The results of this research have been promising, suggesting a potential 3–4-year delay in the onset of cognitive decline. Further, the neurological impact of

bilingualism has been studied under the context of protecting against cognitive decline. (Antoniou et al., 2013) suggests that the areas of the brain stimulated by language learning has significant overlap with the areas involved in neural decline as a result of aging. Bialystok and colleagues (2012), examine what happens in the brain when one is bilingual or multilingual, as opposed to monolingual. Results imply that the mere fact of knowing a second (or more) language reorganizes the brain and changes the way it processes language, no matter which language is being used (Bialystok et al., 2012). Findings suggest that even if only one language is being used at a time, there is a constant activation of and interaction between both languages, which in turn creates a cognitively stimulating environment in the brain that has the potential to prolong the onset of cognitive decline later in life. The authors refer to this phenomenon as "cognitive control" and further than delaying the onset of cognitive decline, describe its potential to delay the onset of dementia symptoms. Calabria and colleagues (2020) explored this idea as well, further strengthening this argument with data that shows a lack of effect of other cognitive reserve factors, including occupation and mentally stimulating activities. Woumans, Santens, Sieben, Versijpt, Stevens, & Duyck (2015) actually tested this phenomenon with a non-immigrant sample of European patients diagnosed with clinical Alzheimer's Disease (AD). Extensive surveys were conducted to gauge the patients' experience with and understanding of more than one language, including how knowledgeable they are of each language and how often it is used in everyday life. These factors are important to account for, as the extent to which multiple languages are known and regularly used by the patients can be a factor in the strength of this association. This study found a stark difference in ages of AD onset of monolingual patients versus bilingual patients- 4.6 years for age of clinical manifestation and 4.8 years for age of diagnosis. These findings, along with other similar findings, open the door for a promising body

of research. It is suggested that now bilingualism may be included as an environmental factor that aids in delaying cognitive decline (Del Maschio, Sulpizio, Gallo, Fedeli, Weekes, & Abutalebi, 2018). While this research is still fairly young, these findings will open the door for much more research and advancement in the field. This research also has important societal implications. Bilingualism, as previously discussed, is prevalent in the world today, and this field of research, if it continues to grow, could increase that number substantially. These findings introduce language learning as a highly accessible leisure activity with the potential to provide major cognitive benefits and prolong the health of the brain into old age. Further research in this area ought to dive deeper into practical applications (such as age at which the language should be learned for optimal results, how often the language is used, which languages have the greatest effect, if any.

Stroke Recovery

With extensive research conducted about bilingualism's potential effect in delaying cognitive decline and dementia, similar research is focusing on other potential long-term cognitive benefits of bilingualism, one of which is stroke recovery. Much of this research, though not all, focuses on bilingualism's effect on the prevalence and severity of aphasia, language deficits that occur after a stroke (Hope et al., 2015). Hope et al. (2015) attempted to determine whether prognoses for monolingual stroke patients could be generalized to bilingual patients, having in mind the cognitive and anatomical differences of bilinguals previously discussed. Although there appeared to be no advantage for bilinguals, researchers found that the prognoses generally accepted for monolingual patients were generalizable to bilingual patients. However, a study conducted by Paplikar, Mekala, Bak, Dharamkar, Alladi, and Kaul (2019) found a different result. Researchers found that while bilingualism did not result in less aphasia,

it did result in less severe aphasia, even accounting for variables such as age, education (which is commonly associated with less severe aphasia), and immigration. These researchers gave a few potential reasons why their results may have differed from the results of Hope et al (2015). These reasons include the high prevalence of immigrants in the Hope et al. study, the lack of knowledge about use of the participants' native language, the use of an English test to differentiate monolingual vs. bilingual performance (without accounting for potential language discrepancies), and a largely heterogeneous group of bilinguals. Some or all of these factors may have played into the different results found from these two studies. While the above two studies focus specifically on aphasia post-stroke, several other studies focus more generally on cognitive outcomes following a stroke. Alladi et al. (2016) found a shocking result: bilinguals were over twice as likely as monolinguals to have intact cognitive functioning after a stroke. Further, bilingualism was an independent predictor, not confounding with other variables such as age or education level. Specifically, this study found similar results to Paplikar et al. (2019) that the frequency of aphasia is not affected by monolingualism vs. bilingualism, suggesting that the cognitive benefit of bilingualism in this situation is due to the cognitive processes that occur in the brain, such as language switching, and not due to linguistic factors themselves. In other words, the cognitive and anatomical effects of bilingualism provide a safeguard to the severity of and recovery from aphasia, but the second language itself (including its syntax and vocabulary) do not have an effect. Overall, this study implies a protective barrier effect of bilingualism in post stroke recovery, which is contradictory to the results of Penn, Barber, and Fridjhon (2017), which found that there is no 'bilingual advantage' in stroke recovery, specifically in the acute phase.

Overall, it can be seen that while there is potential for an advantage for bilinguals in certain areas of post stroke cognitive recovery, the research is mixed and often contradictory. Thus, more research in this field is necessary to determine whether there is a potential affect that can be seen consistently. Much of the current research in this field differs greatly in the geographic location, languages, and modes in which these advantages or disadvantages are tested. More uniformity in these domains may yield consistent results regarding these phenomena in the future and should be considered in future research.

Conclusion

In conclusion, this paper discussed several aspects of bilingualism, including anatomical effects, cognitive effects, factors in one's life that may affect their ability to learn a second language, and potential long-term effects of bilingualism on delaying cognitive decline and stroke recovery. As discussed throughout, there is much future research to be done in this field, but current literature provides promising benefits of bilingualism, as well as a better understanding of the minds of bilinguals. Due to increased rates of bilingualism and globalization, this is a necessary field of research as it provides insight into the cognitive structure and functioning of so many people in the world today.

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