

The cognitive benefits of bilingualism across the lifespan

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Moving forward in the lifespan, it has been found that bilingual toddlers may develop theory of mind earlier than their monolingual peers (Goetz, 2013). This study gave monolingual and bilingual toddlers in two age groups false belief and level two perspective taking tasks in order to examine if bilingual children develop theory of mind at a younger age than monolingual children. The researchers hypothesized that linguistic knowledge might foster a greater understanding of the mind in young children. Bilingual children performed significantly better than their monolingual peers in the tasks. Goetz (2013) suggests that inhibitory function and greater sociolinguistic awareness may explain their better performance, meaning the knowledge that an object can be represented in multiple ways (i. e. languages) may contribute to an overall understanding of the mind and different viewpoints.

Childhood

Researchers have shown that cognitive functioning benefits extend to early childhood (Bialystok, 2011; Carlsen & Meltzoff, 2008). In a study conducted on bilingual and monolingual eight year olds, bilingual children maintained higher accuracy and better response times on a dual-task paradigm designed to assess responses to the combination of auditory and visual stimuli (Bialystok, 2011). Dual-task paradigms are common in assessing bilingual advantages because they assess an individual's ability to inhibit irrelevant stimuli. In the present study, participants had to inhibit a response to one of the two stimuli and favor the other. In congruence with Inhibitory Control Theory, Bialystok (2011) argues that being bilingual in itself is a constant dual-task paradigm because the person must inhibit the irrelevant language, shift to and from it, and selectively attend to either language at

the appropriate time. Thus, bilingual children are always in a heightened state of cognitive functioning in order for them to tend to their multiple languages, which have semantic systems that are always activated (Green, 1998).

In tandem, Carlsen and Meltzoff (2008) found significant differences in executive functioning between monolingual and bilingual eight year olds. This study examined if children need mastery of their language to experience cognitive benefits. To answer this, they included three groups representative of different levels of bilingualism. The children included in the immersion group were enrolled in a language immersion program that exposed them to English for half of their school day, and either Spanish or Japanese for the other half. The average time that the students had been enrolled was six months. The participants in the monolingual group were exclusively English speakers, while the bilingual group had been exposed to both Spanish and English since birth. The results of this study suggest a significant executive functioning advantage for bilingual children, but not for immersed children. The results also support higher verbal functioning in monolingual children, as evidenced in performance on a picture naming task. Not only does this study show cognitive benefits in bilingual children, but it also suggests that children need mastery of more than one language to experience cognitive benefits in EF. Nonetheless, the findings pose an interesting question for developmental psychologists: at what age does language need to be acquired for cognitive benefits to be present? And to what degree of fluency?

Early vs. Late Bilinguals

An under-researched issue on the topic of bilingualism and cognition is age of acquisition. There has been limited research on the cognitive benefits of late versus early bilinguals. Although some definitions may vary, VanPatten and Benati (2010) define the line between early and late bilingualism as age four, meaning that an early bilingual must be exposed to multiple languages very early in the lifespan. Although it is possible that one could become fluent in an L2 after age four, one needs to learn L2 before age four to be deemed an 'early bilingual'. It would be reasonable to expect that early bilinguals have more cognitive functioning benefits than late bilinguals due to exposure to L2 during critical periods of development, but the existing literature has not made concrete distinctions between the two populations. In a study of bilingual adults, Pelham and Abrams (2013) found no significant differences in early and late bilinguals in performance on a picture naming task (lexical access) and attentional network task (executive functioning), suggesting that age of acquisition has little to do with cognitive benefits. Rather, persistent and habitual use of an L2 seems to lead to cognitive change.

Some researchers have found the differences between early and late bilinguals to be more nuanced. In another study of early and late bilinguals, researchers found that late bilinguals showed the most advantage in a conflict monitoring task (e. g. differences between responses in congruent and incongruent conditions on the flanker task), while early bilinguals showed enhanced monitoring processes (e. g. knowing when to switch mental functioning and attention between congruent and incongruent tasks)

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(Tao, Marzecová, Taft, Asanowicz, & Wodniecka, 2011). More research needs to be done investigating questions pertaining to the effects of age of acquisition on cognitive functioning. More concrete findings could have implications regarding the limitations of neuroplasticity and the attitude towards L2 acquisition in American schooling.

Adulthood

Thus far, the evidence for EF benefits in bilingualism is substantial. Much research has been done on toddlers, children, and the elderly to show cognitive differences. The literature on bilingual cognitive differences in adults is the most controversial; it shows an unclear trend in EF benefits. Many researchers attribute this to the fact that adulthood is the time of highest cognitive functioning, therefore the differences between monolingualism and bilingualism will be smallest in these periods (Bialystok, 2011). Several studies show null, if not reverse results in executive functioning in monolingual and bilingual adults (Paap & Sawi, 2014; Wang, 2015). The following section will synthesize these null findings in the context of bilingualism research and also will talk about the concerns and limitations of this field.

Although some researchers have found significant results pertaining to differences in EF in adulthood (Costa, Hernández, & Sebastian-Galles, 2008), much controversy has arisen from null findings in adults. In an attempt to explain the lack of significant evidence, de Bruin, Treccani, and Sala (2015) compiled data examining studies published on bilingualism. They ultimately found a concerning trend in the data: studies supporting bilingual advantage

were more likely to be published than null findings, suggesting an overarching example of publication bias in the literature of bilingualism cognition. According to their review, 68% of studies affirming a bilingual advantage were published, whereas only 29% of studies showing opposite results were published. Months later, prominent researchers Bialystok, Kroll, Green, Macwhinney, and Craik (2015) refuted these claims, saying that de Bruin et al. made some critical mistakes in their analyses. Bialystok and her colleagues argued that their conclusion was flawed in three ways: through faulty methodology, by grouping negative and null findings, and by grouping the effects of bilingualism on verbal and nonverbal task performance. It is not within the scope of this review to provide a full analysis of either argument, but rather to explain that concerns have been voiced in regards to publication bias on the subject of bilingual research.

Other issues have been attributed to failures in finding significant effects in adults. In an effort to define executive functioning while establishing convergent and discriminant validity in its factors, Paap and Sawi (2014) explored 13 different 'executive functioning' measures and analyzed them through regression. Overall, the researchers found limited convergent validity between common measures of EF, namely antisaccade tasks, Simon tasks, flanker tasks, and the stroop task. The researchers also claimed that there is little discriminant validity between executive functioning and fluid intelligence. Essentially, the researchers argue that years of bilingual research has been misinformed by invalid methods of assessing EF. Also in their review, Paap and Sawi invoked evidence from Antón et al, (2014) describing null findings in the largest-n study of bilingual research to date.

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Furthermore, the article by Paap and Sawi (2014) shows that most of the significant findings in the field have been done with small-n studies. These findings would encourage readers to be skeptical of all findings in the discipline, but as we move forward, the evidence for a bilingual advantage becomes more convincing.

Neurological Differences

Skeptic researchers may question cognitive benefits in bilinguals, but it is hard to dispute findings showing differences in brain structures between monolingual and bilingual subjects. Researchers have identified two important brain structures in facilitating language production, switching, and inhibition in bilinguals: the dorsolateral prefrontal cortex and the left anterior cingulate cortex (ACC) (Abutalebi and Green, 2008). Both of these areas are important in the functioning of executive control. Functional MRI studies have identified increased grey matter density in these areas, which would suggest higher level of functioning (Abutalebi et al, 2012). Furthermore, some researchers have conducted fMRI studies on participants undergoing EF tasks. During high-conflict and incongruent trials in tasks such as the Simon task, both monolinguals and bilinguals recruit the ACC to a higher extent than low-conflict trials; however, bilinguals show less ACC activation on the more mentally taxing incongruent trials. These neurological findings suggest greater efficiency in this structure from constant inhibition of language.

Other research has shown alternative neurological response to the Simon task. Monolinguals recruit the Broca's area, the speech production center of

the brain, to a higher extent than bilinguals on the task, whereas bilinguals recruit the dorsolateral prefrontal cortex more so than monolinguals (Bialystok, Craik, Klein, & Viswanathan, 2004). These findings support the theory that language acquisition can shape and develop the frontal cortex in bilinguals. Since the frontal cortex is a region that deals with both attention and inhibition, the discussed findings by Bialystok and colleagues are congruent with Green's (1998) Inhibitory Control Theory, and the overall theory that bilinguals experience advantages in executive functioning.

The Elderly

The “use it or lose it” principle argues that mental stimulation in old age is necessary for the maintenance of cognitive functioning, including fluid intelligence, which concerns information processing and working memory (Feldman, 2011). One hypothesis says that, due to Inhibitory Control Theory, increased mental activation in elderly bilinguals may contribute to cognitive preservation. Therefore, the significance of the previously discussed neurological findings are not to be undermined when considering bilingual advantages over monolinguals.

Convincing evidence of this is the remarkable finding that elderly bilinguals experience dementia symptoms on average 4.1 years later than their monolingual peers (Bialystok, Craik, & Freedman, 2007). This striking result was found after careful examination of medical records of both monolinguals and bilinguals. The study was repeated three years later, and an even more exaggerated effect was found (Craik, Bialystok, & Freedman, 2010). These results are fascinating evidence of neural plasticity. They suggest that,

because bilinguals' brains are constantly more active than monolinguals' brains, they develop a greater fortitude for protection against degenerate diseases caused by the cognitive costs of aging.

Furthermore, higher discrepancies in performance on EF tasks are seen in elderly participants, further suggesting the cognitive-preserving function of bilingualism. Differences in performance are exaggerated on the Simon task for elderly participants. In an age and gender matched test of bilinguals and monolinguals on the Simon task, researchers found that the discrepancy in score between the language groups grew more pronounced as participants aged. On average, response time for middle aged (age 30-55) participants on the Simon task was 535ms for monolinguals and 40ms for bilinguals. Response time for elderly (age 60-80) participants was 1713ms for monolinguals and 748ms for bilinguals (Hilchey & Klein, 2011). The drastic gap between elderly participants show that monolinguals decline in their ability to respond accurately and quickly to stimuli whereas elderly bilinguals do not experience as much of a decline in those respects.

Concluding Remarks

Many of the findings in the field of bilingualism research have provided evidence that Inhibitory Control Theory supports higher EF functioning in bilingual individuals, but some researchers have voiced many concerns regarding this research discipline including lack of validity in EF measures, prevalence of publication bias, and lack of large-n research. However, narrowly attending to these allegations and the studies that they stem from do not give a full picture of bilingualism research. The only way to get a full

picture is to look at bilingualism through the scope of a lifetime. Using developmental psychology and significant neurological findings shows the high likelihood that knowing more than one language does have a lasting positive cognitive impact on the bilingual individual.

Although bilingualism is a highly researched topic, there are some holes in the literature. More research needs to be done on early versus late bilingualism. If researchers can show that somebody learning L2 at 40 can be equal to a crib bilingual in all aspects of mental functioning, it would have massive implications to the fields of psychology and neuroscience, specifically to the concept of neuroplasticity. A questionable aspect of bilingualism research is the dichotomy approach (i. e. using two groups: monolinguals and bilinguals) because everybody differs substantially in their knowledge of L2. Some researchers have adopted a more spectral approach, routinely measuring each participant for their L2 level, and this approach can provide more insights about the semantic requirements for experiencing cognitive benefits. Furthermore, this approach could help explain previous null findings. Lastly, more research needs to be done on multilingual participants, meaning people who know more than two languages. Research in this area could be particularly fruitful in proving bilingual advantages if multilingual participants could outperform bilinguals on cognitive tasks. Alternatively, it could be found that multilingualism would have no particular advantage over bilingualism, and that the verbal detriments of managing multiple languages would outweigh the positive cognitive benefits seen in bilinguals.