The Academic Advantages of a Bilingual Brain

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Bilingualism in young children has several cognitive benefits that lead to increased academic performance. Between monolingual and bilingual children, behavioral differences can be observed as early as infancy. Studies show that bilingualism influences the development of executive control, which includes cognitive abilities such as problem-solving, memory, and inhibition control. This early cognitive advantage carries into the classroom where skills such as problem solving and adapting to new information are critical for educational success. Learning a second language trains the mind to better recognize linguistic patterns that can be applied to increased reading skill.

Infancy is a stage for critical lingual development in children. Although their behavior may seem relatively simple, infants are constantly making observations that will guide their cognitive development. For example, newborn babies can sense a difference between their mother's voice and a stranger's voice (Winkler et al., 2003). Babies must learn to recognize the unique phonemes in the languages surrounding them before they can learn how to speak. In her book Train Your Mind, Change Your Brain, author Sharon Begley discusses how the neuroplasticity of infant brains is the basis for forming lifelong neural circuits in parts of the brain that are responsible for language (2008). In babies, hearing a language exercises the neural circuits in the brain that will encode the unique phonemes required for fluency. Thus, sounds heard in the earliest years of life structure language-related brain tissue.

Neuroplasticity involves the relationship between an individual's brain and external environment. For bilinguals, the additional language-learning practice changes the physical composition of white and grey matter in their brains. White matter refers to the myelinated nerve axons in the brain while grey matter represents the unmyelinated nerve cell bodies (Mercadante & Tadi, 2020). Through VBM brain imaging, Mechelli et al. found that bilinguals have a higher amount of grey matter in the left inferior parietal cortex, a region responsible for language processing, than monolinguals (2004). Furthermore, they compared grey matter composition between "early bilinguals" who learned their second language before age five and "late bilinguals" who learned their second language during adolescence. The researchers showed that early bilinguals have a stronger increase in grey matter than late bilinguals. Additionally, bilinguals completed tests to measure skill level in their second language, and imaging analysis concluded that subjects with higher test scores had increased grey matter than those with lower scores. Overall, the evidence of increased grey matter in bilinguals could explain the observed differences in executive function between bilinguals and monolinguals.

Researchers, Agnes Melinda Kovács and Jacques Mehler (2009), designed an experiment to assess the effect of bilingualism on the executive function in babies. The researchers placed 7-month-old monolingual and bilingual babies in front of a screen divided into right and left sections. To begin each trial, a predetermined word was said to the baby. Right after the baby heard the word, a picture of a puppet appeared on the left or right side of the screen. The puppet appeared on the same side of the screen for the first part of the experiment, and trials were repeated so that the baby learned to expect the puppet after hearing the word. For the 2nd phase of the experiment, the researchers changed the location of the puppet to the opposite side of the screen and measured how many rounds were necessary for the baby to adapt to the change. The experimental data showed that bilingual babies relearned the puppet location faster than monolingual babies (Kovács & Mehler, 2009). This ability to adjust to a new stimulus is a measurable indication of executive control, proving that bilingual babies have better executive control than monolingual babies. Cognitive gains from bilingualism represented by similar studies signal language development in infancy as the foundation for enhanced academic performance observed in older age.

As children learn how to speak, executive control is measured using a wide variety of tests because they can respond to verbal or written instructions. One commonly explored cognitive advantage in bilinguals is the idea of "conceptual inhibition," which measures the ability of the participant to redirect their focus to a new stimulus after having learned to associate a predetermined sensory cue with an old stimulus (Carlson & Meltzoff, 2008). This method of measuring inhibition was also the premise for the infant study that assessed the babies' ability to relearn which side to expect the puppet picture. Researchers, Stephanie M. Carlson and Andrew N. Meltzoff, measured executive control in groups of bilingual and monolingual children to better understand the relationship between bilingualism and conceptual inhibition. One experiment--the Advanced Dimensional Change Card Sort (DCCS) test--required the children to separate a stack of cards. Various shapes and colors were pictured on all the cards, but a portion of the cards also had a star next to the shape. Then, the children were told to organize the cards by shape unless the card had a star. Instead, cards with stars were categorized based off the card's color. The children had to inhibit the instruction to separate by shape each time they pulled out a card with a star. Inhibition tests like the Advanced DCCS from the Carlson and Meltzoff study found that bilingual children were better than monolingual children in evaluating conflicting information through suppression of a previously learned

concept to adapt to the new requirements of a task. Thus, organizing one's own brain around two languages induces early problem-solving practice that can be applied in academic environments.

Bilinguals also have an advantage in developing metalinguistic awareness, which is a skill involved in learning how to read. Metalinguistic awareness is "the metacognitive ability that consciously reflects on the structure of linguistic knowledge and the cognitive processes engaged in literacy learning" (Sun 1, 2016). Therefore, an individual with high metalinguistic awareness can effectively analyze their language's rules for grammar, syntax, etc. In a study conducted by Lichao Sun, monolingual and bilingual children were given the same exercises that measured metalinguistic awareness. One exercise, called the "Zoo Game," involves a similar premise of conceptual inhibition used in the other studies. Children had to choose whether to press a button depending on what animal appeared on screen i.e., clicking the button when an orangutan appeared was considered an incorrect response. In the collected data, bilingual children made fewer mistakes than monolingual children in choosing the right response, meaning that they were better able to inhibit a conflicting response by remembering the game rules and applying them to the provided stimulus. Additionally, the bilingual children gave their responses quicker than the monolingual children.

Although bilingualism lends its cognitive advantages to the classroom environment, secondary factors like socioeconomic status influence greatly to the extent of an individual's academic performance. For example, the Carlson and Meltzoff study included participants from various socioeconomic backgrounds, which is an extra variable during data analysis. Bilinguals of different socioeconomic backgrounds might display different characteristics of executive control due to individual access to books, libraries, teachers, and other resources involved in language development. Ultimately, Carlson and Meltzoff were able to adjust for variability in socioeconomic status in order to isolate differences in executive function that were directly related to monolingualism and bilingualism. In addition, the Sun study was able to compare monolingual and bilingual children of similar socioeconomic backgrounds and conclude that bilinguals had a metalinguistic advantage over monolinguals.

In the United States, a 2010 survey found that 22% of school-going children speak another language within their household (National Center for Education Statistics, 2012). Thus, bilingual children make up a significant portion of classrooms where their enhanced executive control and metalinguistic awareness can be essential assets for problem solving and literacy development. Socioeconomic conditions can help or hinder the overall academic performance of both bilingual and monolingual students, so specialized attention from educators may vary across individual needs within the classroom. Beyond childhood, bilingualism provides an increased communication capacity that is helpful for pursuing job opportunities. Therefore, individuals can benefit from their bilingualism at each stage of life.

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