

Differences in Cognitive Abilities between Monolingual and Bilingual People: A Two digital experimental approach

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Abstract: Due to educational requirements, a growing number of people in contemporary society are starting to learn languages other than their mother tongue. For a very long time, numerous viewpoints have been used to analyze the advantages and disadvantages of this occurrence. This study evaluates the variations in attention and task switching performance between monolinguals and bilinguals from the standpoint of cognitive ability to decide whether a bilingual study is required. The experiment was designed to answer the following research question: How does bilingualism assist in the improvement of cognitive skills in young adults? According to the study, bilinguals are more attentive and switch tasks more efficiently than monolinguals. Two digital experiments, the Wisconsin Card Sorting Test and the Test of Variables of Attention, are utilized to look into the cognitive differences between bilingual and monolingual participants. The expected outcomes should support the hypothesis. Once the data is accessible, it will be further evaluated using a t-test to investigate the differences and correlations between the data sets to reach conclusions.

Keywords: Bilingualism, Monolinguals, Attention

1. Introduction

It is commonly accepted that more than half of the world's population is bilingual [1]. Approximately 20 percent of people in the U.S. and Canada speak a language other than English at home. Therefore, it is important to research and evaluate the advantages of bilingualism from a variety of angles.

This study aims to investigate the differences in attention and task switching performance between monolingual and bilingual people. A monolingual group would suggest the use of one language as its people's primary language, whereas a bilingual group suggests two. At the beginning of the reform and opening up, with the introduction of ethnic languages into schools and the fervor of "education should be oriented towards modernization, the world and the future", experiments on bilingual education were launched. Different regions and ethnic groups have designed different experiments in bilingual education in response to their own situations, problems and prospects for development, and the balance of bilingualism has gradually come to the attention of the academic community. Bilingual education has not only answered the call, but is also highly valued. Therefore, the study of bilingual balance has become inevitable. The term 'bilingual education' was first used in China only in the context of minority education, but in practice there is a general doubt about the relationship between the mother tongue and the foreign language in bilingual education, and whether the mother tongue and the foreign language can maintain a balanced development in the process of bilingual education.

Through combing through the research results, which are mainly related to contemporary papers on bilingual balance, we summarize the basic distribution of literature on bilingual balance in China, the characteristics of research and the shortcomings in educational research, and make an outlook, with a view to clarifying the connotation of bilingual balance and helping the development of minority education while guiding practice.

Attention, in psychology, refers to the concentrated function of awareness. Some phenomenon is easily understood while some other turn out to be sort of exclusion of other stimulus. It is the process of focusing mental capacity on something. Attention could be divided into two categories: selective attention and divided attention. During the early stages of attentional selection, participants do not perceive unattended objects: the limit is entry to perception. However, during the late selection, participants do perceive objects, but percept does not enter the consciousness or we forget them very quickly. On the other hand, divided attention refers to the ability of attention to be divided between multiple "targets". Overall, divided attention will decrease efficiency because the overall demand for resources is greater than the number of mental resources available, but attentional demands decline with more practice, forming automaticity.

On the other hand, task switching refers to an executive function that involves the ability to unconsciously shift attention between one task and another. When switching from one task to another is required, performance on the tasks is disrupted. This disruption is characterized by a slower performance and a decrease in accuracy on a given task A on a trial that follows the performance of a different task B as opposed to performance on task A when it follows another trial of task A. The switch cost describes the variance in accuracy and performance between a task repeat and a task switch.

2. Literature Review

Bilingual learning has become a popular research topic in the past sixty years. Many scholars have studied the influence of various factors on cognitive ability from different perspectives, such as aging, language proficiency, and brain anatomy, and have come to conclusions [2-5].

At first, scientists disagreed about the abilities of bilinguals [6]. In 1962, Peal and Lambert proposed that the intellectual experience of two language systems seems to leave us with "psychological flexibility", which means that bilinguals not only have advantages in the processes of inhibition, selection, conversion, and maintenance of attention, but also own benefits in working memory, representation, and retrieval [7].

As a result, the scholar's views on bilingualism have shifted from negative to positive. Worrall's bilingual study, published in 1972, demonstrated significant advantages for enhancing bilingual children's ability to solve language problems based on metalinguistic awareness, to represent language as processes, and to solve non-linguistic problems requiring the inhibition of misleading information [8]. It was also proved in a 1998 study by Bialystok and Majumder [9, 10].

After so many years of research, scholars have analyzed the impact of language and other factors on monolingual or bilingual people's cognitive ability from three different aspects.

The first to be investigated is how age relates to the cognitive abilities of monolingual or bilingual people. Age-caused similarity and counterparts exist as many observable facts. There are declines many scholars have paid attention to. Most of these declines are believed to have something to do with aging problem. That is why these kinds of dysfunction are also called age-related declines. Those circumstances are in the meantime, noted as cognitive circumstances. Scholars have searched for patterns to depict them. There are simple and choice reaction times, for instance, and several concepts related to aging problem and memories. Working memory and episodic memory are among them [11, 12]. According to M. J. Sliwinski's study, global challenge and the group of people under the scope of modern globalization was age-sensitive, while age-constant are contrast to it [13]. After making

the whole condition as one and united research object, many studies held that the older generation were not, as people always think about, that low-efficient when talking about the data and observable results through cognitive task sets; therefore, the correlation between age and task-switching performance is quite weak.

Second, scholars have found that language proficiency also affects the performance of cognitive ability [14, 15]. Some scholars investigate several cognitive tasks with different scopes. The most worthwhile point for these local or global scopes would be further categorized as switching costs in bilinguals who vary in their second language proficiency. The research by C. H. Tse and J. A. Arriba are quite successful by examining the relationship through a special cognitive task which is called later as a Stroop task [4]. Their findings suggest that those people with talent or proficiency in their ability of language learning can pass much more challenging task than those who are not showing any second language proficiency. The reconfiguration is one vital figure, and updating abilities might be some other ones [16, 17]. This conclusion shows that people who have received a relatively better education will have the better cognitive ability, so when recruiting subjects, they should have similar language backgrounds and be in the same language learning environment.

Finally, brain anatomy has contributed more convincing explanations on the whole discovery [9, 10]. Therefore, it is necessary to investigate and understand the relationship between brain regions and cognitive ability.

Research by Prof. Marian suggested that, there are areas in the frontal region, according to brain anatomy are the explainer for the difference discovered in cognitive tasks [18]. The findings of the study demonstrate that, in contrast to competition across languages, phonological competition within a single language requires the use of various brain regions. Depending on the source of competition, bilinguals use different sizes and types of neural networks to address phonological conflicts. That will be a solid foundation for this research to start with.

3. Method

This study will look into monolingual and bilingual viewpoints on bilingual learning, as well as how monolingual and bilingual affect people's cognitive capacities. Bilingualism is expected to improve people's cognitive abilities in a variety of ways, including attention span, patience, and the cost of task switching.

3.1. Participants

First, a self-administered online questionnaire was provided to each participant at random. A total of 185 questionnaires were distributed on WeChat on August 3rd, 102 of which were monolingual and 83 of which were bilingual. Furthermore, the majority of the participants (62.16%) were undergraduates, with the remainder mainly students in high school (22.7%).

To confirm the experiment's validity, participants were asked whether they had suffered from neurological damage. Only two of them experienced depression, and the others had no neurological or mental disorder.

3.2. Questionnaire Design

The electronic questionnaire used in this research is divided into two versions, which are suitable for monolingual participants and bilingual participants, respectively.

For monolingual participants, the questionnaire contains 3 questions. The specific questions designed for monolingual participants ask about the participant's mother tongue, their family background(e.g. whether they have bilingual family members), and their opinion on the common belief of Bilingualism Speakers have better cognitive abilities.

On the other hand, bilingual participants were asked to answer 5 questions. The specific questions designed for bilingual participants also about their second language, the age participants started to learn their second language, their second language proficiency, frequency of using their second language at home and their opinion on the belief of bilingual learning is necessary.

In addition, both monolinguals and bilinguals need to answer 7 questions about their cognitive ability. Some of these questions refer to the following website: <https://psychologytoday.tests.psychtests.com/bin/transfer>. The questions designed mainly ask about how easily participants are distracted by cellphones or other people's conversations, how often they wander while working or studying, and whether they jump from task to task because they can't seem to focus long enough to finish one, the energy spent to switch from one job to another, how to deal with boring, repetitive tasks, the frequency of rereading a paragraph when reading, and the duration of patience.

3.3. Ethical Concerns

Under normal circumstances, this experiment does not contain issues that easily offend participants. Taking into account the conditions of some of the participants, the questionnaires were still distributed anonymously. In addition, this experiment also informs the participants at the beginning of the questionnaire that the data collected is only used for experimental purposes.

4. Results

4.1. Monolinguals

Almost all of the monolingual participants were native speakers of Mandarin. Among them, more than 60% of monolinguals have bilingual family members, and the rest do not.

Nearly 70% of monolinguals believe that there is no difference in ability between monolinguals and bilinguals, while the other about 30% of the participants believe that the difference is mainly in attention, imagination, and memory.

4.2. Bilinguals

Nearly 50% of the bilingual participants learn a foreign language at the age of 5–10, that is, in primary school. The second language of the participants was almost all English, and the remaining exceptions were Japanese, Korean, or Russian.

Also, more than half of bilinguals think their second language level is good, followed by those who think their level is not too bad (22.89%) and very good (20.48%).

In addition, 48.19% of bilinguals often use their second language at home, while another 20.48% of the participants only use their second language sometimes.

It is worth mentioning that all bilinguals consider bilingual learning necessary. Most of the reasons given by the participants revolved around three points: 1. Facilitate communication and learning 2. Improve self-learning ability and broaden knowledge 3. When applying for jobs, bilinguals will have more advantages than their monolingual peers.

4.3. Monolinguals and Bilinguals

When asked if they were easily distracted, 5.88% of monolinguals said they were always distracted, but more than 50% were only rarely distracted, and 16.67% were rarely distracted. In contrast, only 2.41% of bilingual people have been constantly distracted. Similarly, more than 50% of bilingual people are only rarely distracted, and the proportion of people who are rarely distracted is larger than that of monolingual people, at 19.28%.

Secondly, most monolinguals only catch themselves daydreaming at work or studying sometimes (27.45%) or rarely (45.1%). The other 16.67% said they rarely daydream during work time, while the other 2.94% of monolinguals daydream very frequently. Similarly, most bilingual subjects catch themselves daydreaming at work or study sometimes (22.89%) or rarely (40.96%), but the percentage of bilinguals who rarely daydream during work time was 7.43% higher than that of monolinguals. At the same time, none of the bilinguals thought they daydreamed very frequently.

In addition, more than 85% of monolinguals would occasionally jump to another task when they were unable to concentrate on the previous one, and 83.33% of them had small time costs for switching between tasks. By contrast, only 76% of bilinguals choose to jump or occasionally jump to another job because they cannot concentrate, which is nearly 10% smaller than that of monolinguals, and 91.57% of them think that they can switch quickly between tasks.

For boring and repetitive tasks, 32.35% of the monolinguals can complete the work with great concentration, 54.9% of the monolinguals think that repetitive work is somewhat difficult for them, and 12.75% think that repetitive work is difficult to complete and cannot be done without feeling irritable. Relatively speaking, bilinguals perform better in this regard. Nearly half of the bilinguals can complete their work with great concentration, and the remaining 46.99% have only minor issues, while the number of people who think repetitive work is difficult to complete is even smaller, accounting for only 3.61%.

When it comes to individual patients, the responses of monolinguals and bilinguals vary widely. According to the data, 41.18% of monolinguals say that they are easy to lose patience, and only 12.75% of the rest say that they are not easy to lose patience. In contrast, only 22.89% of bilinguals think that they are easy to lose patience with, and the gap between this figure and monolinguals' on the same issue is nearly 20%. Also, 32.53% of them are not easily distracted.

5. Discussion

According to experimental data, bilingualism brings positive effects, including shorter response times, higher accuracy, longer attention retention times, and lower cost of switching tasks. These cognitive improvements stem from differences in the brain regions that are active in monolingual and bilingual speakers. According to a previous study, the left striatum and left inferior frontal gyrus are activated in non-linguistic switching tasks for bilinguals, whereas monolinguals activate the right inferior frontal gyrus.

5.1. Neurological Benefits

Bilingualism has neurological advantages that last from childhood to old age, as the brain interprets information more efficiently and prevents cognitive deficits. Furthermore, the potential benefits of attention and aging are not limited to bilingual speakers - they are also evident in people who learn a second language later in their lives. Bilingual people benefit from improved cognitive control, which is just one of the many advantages that come with bilingual experience. Bilingualism has been linked to improved perceptual processing, as well as better memory, concentration, and creativity, despite some linguistic limitations.

In addition, according to Mercado's study which proves the positive relation between bilingualism and neural plasticity, neuroscience research on bilinguals ultimately makes the case for strengthened pathways in the brains and improved neural efficiency. The brain networks for both languages are always active, which results in strengthened pathways in the brain. In addition, the Dimensional Card Change Sorting experiment demonstrated by children in the Mercado study proved that bilingual brains work faster.

5.2. Neurological Disorder

According to research by M. F. Mendez, bilingualism may affect cognitive and neural reserve, the timing of the onset of dementia symptoms and psychopathology, and linguistic competency in dementia. His research shows that executive control of two languages increases cognitive reserve, and language control increases neural reserve in the left frontal and nearby regions. The onset of dementia symptoms is delayed in bilingual AD patients compared to monolingual AD patients, but, surprisingly, bilingual patients' hippocampus and mesio-temporal atrophy are much worse. Bilinguals, on the other hand, do poorly on language measures, and those who have neurodegenerative diseases have trouble keeping and controlling their second language.

5.3. Enhancing Attention

By activating brain areas and attention networks that are only commonly used by bilinguals and stimulating the production of neurotransmitters, it can effectively help monolinguals enhance their concentration, attention, and other cognitive abilities.

According to Posner, Rothbart, and Tang, there are two main brain training strategies to achieve this. First, network training entails practicing a cognitive task that is intended to work on particular attention-related brain networks. Second, state training employs exercises designed to create a brain state that may affect other networks and attention. Networks are involved in state training as well, although it excludes cognitive exercises created particularly to train a network. A state that appears to enhance cognition, attention, and mood can be achieved through both aerobic exercise and meditation practice, as physical activity immediately raises dopamine, norepinephrine, and serotonin levels in the brain.

5.4. Bilingualism and Social Benefits

Bilinguals scored higher on the social interaction scale, according to Vives, Repke, and Costa's research. As a result, they claim that bilinguals not only reported higher social flexibility, but also more frequent social interactions (social flexibility mediated the effect on the frequency of social interactions). The study by Fischer, Manstead and Zaalberg summarized research on social context effects, which show that the presence and expressiveness of other people affect both emotional state and experience. These effects are most obvious for positive emotions, which are amplified in the presence of others. Bilinguals may be less likely to develop mental illnesses such as depression.

On the other hand, being bilingual provides valuable social benefits such as the opportunity to experience a culture through its native language or connect with somebody you would otherwise not be able to communicate with. Overall, the cognitive, neural, and social benefits observed in bilinguals emphasize the importance of considering how bilingualism shapes cognitive abilities and structures, and ultimately how language is expressed in people's minds. In a world where the majority of speakers experience daily lives in more than one language, it is proved that the advantages of bilingualism outweigh the disadvantages, so bilingual education is indeed indispensable.

6. Conclusion

To conclude, bilinguals are better in cognitive abilities such as attention and task switching than monolinguals, while at the same time, they are socially benefited. The advantages of bilingual learning outweigh the disadvantages, so bilingual education is necessary. First, bilingualism brings neurological advantages that last from the person's childhood to old age. Bilingualism has been linked to improved perceptual processing as well as better memory, concentration, and creativity, despite some linguistic limitations. Also, it is proved that bilinguals have strengthened pathways in their

brains and improved neural efficiency since the plasticity of their nerves. Second, bilingualism is also beneficial from a social point of view. Bilinguals have higher social flexibility and more frequent social interactions, meaning that they are less at risk of developing mental illnesses. In addition, bilingualism helps people understand different cultures, communicate with the world, build connections, and help society develop. In contrast, studies have demonstrated that bilingual Alzheimer's patients have a delayed onset of dementia symptoms and that bilingual patients have much more severe atrophy in the hippocampus and mesio-temporal lobe. When ill, bilinguals experience linguistic problems. But overall, the disadvantages of bilingualism are less than the benefits it brings.

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