Research Paper

# Cognitive Abilities in Monolingual and Bilingual Children: A Comparative Study in Azerbaijan, Iran

Zahra Ahmadbeigi[1], Jalil Babapour Kheireddin[1*], Touraj Hashemi Nosrat Abad[1]

*1. Department of Psychology, Faculty of Education and Psychology, Tabriz University, Tabriz, Iran..*

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## ABSTRACT

**Objective:** Recent research has revealed that bilingual and monolingual people differ from each other in various areas, one of which is cognitive ability. This study aims to compare executive functions, selective attention, visual short-term memory, and auditory short-term memory in monolingual (Persian) and bilingual (Azeri Turkish-Persian) children.

**Methods:** The statistical population of current case-control research included all monolingual and bilingual students (8-11 years old) in Tehran Province, Iran, from 2021 to 2022. Using the convenience sampling method, 56 monolingual primary school students (28 boys and 28 girls) and 56 bilingual primary school students (28 boys and 28 girls) were selected and matched regarding intelligence and socio-economic status. All members of the bilingual group learned their second language before entering elementary school. We used the computerized version of the Wisconsin card sorting test (WCST), the computerized version of the Stroop color and word test (SCWT), the Kim Karad visual memory test (KKVMT), Wechsler's digit span test (WDST), and Raven's colored progressive matrices (RCPM) test. The data were analyzed via descriptive statistics and multivariate analysis of variance (MANOVA).

**Results:** The results indicated that bilingual children's performance in executive functions, short-term auditory memory, and short-term visual memory was significantly higher than monolingual children ($P<0.05$). However, no significant difference was observed between the two groups regarding selective attention ($P>0.05$).

**Conclusion:** According to our results, bilingualism positively affected cognitive abilities. Moreover, bilingual children performed better in executive functions, visual short-term memory, and auditory short-term memory than monolingual children. However, no bilingualism effect emerged for selective attention.

*** Corresponding Author:**
*Jalil Babapour Kheireddin, Professor .*
***Address:** Department of Psychology, Faculty of Education and Psychology, Tabriz University, Tabriz, Iran.*
***Tel:** +98 (41) 33393297*
***E-mail:** babapourj@yahoo.com*

## Highlights

● Bilingualism is an essential social variable that affects children's cognitive development.

● Bilingual children performed better than monolingual children in executive functions and visual and auditory short-term memory, but both groups performed similarly in selective attention.

● Equal opportunities to use the mother tongue and the second language can lead to balanced bilingualism and increase the cognitive abilities of bilingual primary school children.

## Plain Language Summary

According to Vygotsky's theory, language is a crucial human skill and plays a significant role in intellectual development and bilingual children have an advantage over monolingual children because they can express their thoughts in different languages. However, the positive or neutral effect of bilingualism on cognitive abilities is still controversial. This study showed that bilingualism improves children's executive function, visual and auditory short-term memory, and selective attention.

## Introduction

Several thousand languages have emerged during the 20000 years of human life on Earth. The diversity of languages and the communication of people in different languages have led to the development of bilingualism. Bilingualism has become a growing social phenomenon with the advancement of technology, access to communication tools, such as the Internet, and increased immigration (Giovannoli et al., 2020). In Iran, about half of the people are bilingual and speak each other in various languages and dialects (Shoja Razavi, 2019). Since the official language of education in Iran is Persian, bilingual families should familiarize their children with Persian before they start school. Hence, their children usually become fluent in both languages and are called bilingual. Therefore, due to the extent of bilingualism in today's society, studying the various effects of learning a second language on people's verbal and non-verbal performance is of considerable practical and theoretical importance.

It is assumed that living in a bilingual or multilingual environment impacts brain development. Moreover, the human brain is significantly influenced by diet, environmental conditions, and sensory information (Kruchinina et al., 2012). As a result, studying the cognitive and neural bases of language learning by bilingual or multilingual people has gained considerable importance in recent decades (Durand Lopez, 2021). According to the linguistic relativity theory, the world around us appears in different languages in different ways, and people live not only in the world around them but also they live in their mother tongue world (Moeenian et al., 2014). Also, people who speak different languages have different cognitive systems that affect how they think (Sternberg & Sternberg, 2016). Among the new perspectives on language development, we can refer to the interactionist approach, which emphasizes the combination of internal and environmental abilities for language development. Social interactionist theory suggests that children's language experiences and the social skills they gain from social interactions lead to their language progress. Therefore, a constructive environment and proper interaction between family and peers can help to improve children's language skills (Ghani et al., 2022).

Regarding the impact of bilingualism on cognitive processes, two opposing viewpoints exist, including subtractive bilingualism and additive bilingualism. From a subtractive bilingualism perspective, a person learns a second language due to political and social pressure. The second language is usually a substitute for the mother tongue, which makes a person unable to have the necessary proficiency in both languages. According to the additive bilingualism view, both languages have equal social value and grow in parallel. In this situation, the person has good fluency in two languages, therefore bilingualism is associated with positive results (Vaezi et al., 2013).

Additive situations lead to the formation of balanced bilingualism. According to the balance theory of bilingualism, bilinguals succeed when they are balanced in both languages. In addition, Cummins considered the positive effect of bilingualism at additive threshold levels. According to this theory, three levels of bilingualism exist. At the first level, bilinguals are weak in both languages and experience negative cognitive consequences. At the second level, bilinguals have good fluency in the first language but are weak in the second; therefore, they are unlikely to experience positive or negative consequences. At the third level, bilinguals have reached the threshold of second-language fluency and experience the positive implications of bilingualism (Vaezi et al., 2013).

One of the cognitive components associated with learning a language and bilingualism is executive function, which is a set of cognitive skills with top-down control processes and includes planning, organizing, monitoring, and goal-directed behaviors (Donnelly et al., 2016). Executive functions control a range of human cognitive abilities, including inhibitory control, working memory, cognitive flexibility, and high-level cognitive functions, such as reasoning, planning, and problem-solving (Xue et al., 2019). It is assumed that exposure to a new language may lead to cognitive competition that can strengthen bilingual people's executive functions (Yow et al., 2017). Sorge et al. studied a sample of developing children (aged 8-11 years) who found that bilingualism and attention ability were strong predictors of performance on executive function tasks (Sorge et al., 2017). However, Paap et al. reported that over 80% of the comparisons made between monolinguals and bilinguals using nonverbal tasks were null and negative, and the advantages of bilingualism disappeared with a reduced sample size (Paap et al., 2015). Such studies led some researchers to claim that the advantage of bilingualism is not that strong and that previous results are contradictory (Ross & Melinger, 2017).

One of the most critical cognitive variables related to bilingualism is selective attention. Different types of attention exist, but selective attention is critical because it maintains one response and prevents another. Therefore, selective attention is necessary to maintain or remove information during processing (Kasuya-Ueba et al., 2020). Some studies reported a better performance for bilingual children regarding selective attention (Benaissa & Boudouh, 2020; Olguin et al., 2019). It seems that the increased processing demands of using two languages can increase the selective attention capacity of bilinguals; as a result, they can perform better in selective attention tasks (Phelps et al., 2022). The advantage of bilingual children in selective attention is based on the hypothesis that both languages are active simultaneously in the bilingual brain, and they can switch flexibly between two languages, inhibit non-target languages, and pay attention to the other language due to the situation (Wen et al., 2018). However, several studies reported no difference between monolingual and bilingual children in selective attention (Paap et al., 2018; Troesch et al., 2023). Paap et al. examined 141 subjects in selective attention tasks. They found that bilingualism had no effect on selective attention, and according to Bayes' factor analysis, the evidence supported the null hypothesis, indicating no difference between bilinguals and monolinguals (Paap et al., 2018).

Recently, research about bilingualism has focused on memory and its types. Researchers have presented different classifications of memory: Visual short-term memory is a short-term memory buffer that temporarily stores visual information (Phillips, 1974). Limited studies have investigated the effect of bilingualism and visual memory, which is responsible for recalling non-linguistic information. Schroeder showed that changing the language context between events positively affected visual memory. However, changing the language context within events did not improve bilingual people's visual memory (Schroeder, 2019). Despite the few studies about bilingualism and visual memory, some studies have indicated differences between bilinguals and monolinguals in visual-spatial tasks. Based on the research results of Grote and Kerrigan, having the same proficiency in both languages can lead to better performance in visual-spatial tasks (Grote, 2014; Kerrigan et al., 2017). In addition, Mohammadi et al. reported a significant difference between the monolingual and bilingual groups with specific learning disabilities in spatial working memory and working memory, and this difference was in favor of the bilingual group (Mohammadi et al., 2021). The advantage of bilingual children in visual-spatial tasks seems to support the idea that bilinguals encode information differently than monolinguals, suggesting a link between imagery and bilingualism (Grote, 2014; Ransdell & Fischler, 1991).

Another type of memory related to bilingualism is auditory short-term memory, which involves receiving, processing, and storing auditory stimulation. Researchers believe that a large part of language learning is performed through hearing, and bilingualism positively impacts the hearing system (Kuriakose et al., 2015). According to Baddeley's working memory model, the phonological loop is an auditory memory that works on analyzing, manipulating, and transforming verbal material and tasks; also, the visual-spatial screen is a visual memory that combines visual and spatial information from short-term and long-term memory (Baddeley, 2017). Studies have shown that bilinguals perform better than monolinguals in short-term auditory memory tasks (Sharifinik et al., 2021; Spinu, 2023). Ebrahimzadeh et al. showed that bilinguals performed better than monolinguals on visual-spatial tasks and digit span backward test; however, no difference was observed between the two groups on the forward digit span scores (Ebrahimzadeh et al., 2013).

Considering the conflicting results reported about the effects of bilingualism on cognitive functions and the lack of studies on visual and auditory short-term memory in bilingual children, the present study was conducted to compare executive function, selective attention, and visual and auditory short-term memory in monolingual (Persian) and bilingual (Azeri Turkish-Persian) children.

## Materials and Methods

The statistical population of this case-control study included all monolingual and bilingual primary school students aged 8 to 11 years in Tehran Province, Iran from 2021 to 202. Using the convenience sampling method, we selected 112 primary school students (56 monolingual and 56 bilingual). All participants were controlled in terms of intelligence and socio-economic status. The inclusion criteria included fluency of the monolingual group in the Persian language and lack of proficiency in a second language and equal fluency of the bilingual group in Azari Turkish and Persian. The exclusion criteria included the child's lack of consent to participate in the study and having oral, verbal, and sensory abnormalities (cleft palate, stuttering, color blindness) or brain and cognitive damage.

After receiving an ethics code, we collected data from two primary schools. We studied the school portfolios of students and selected some monolingual and bilingual students (they become fluent in both languages before entering primary school) with middle socio-economic status. Participants in two groups were compared using the Raven's colored progressive matrices (RCPM) test, and students who scored less than 90 were excluded from the research. Instructions to complete the tests were given to each student separately in a classroom with appropriate environmental conditions. All health protocols were followed during the research. The students were not forced to take part in the research. Also, all information relating to participants was kept confidential to maintain confidentiality.

### Study measures

#### Computerized Wisconsin card sorting test (WCST)

Berg and Grant used the computerized Wisconsin card sorting test (WCST) to assess executive functions. This test is one of the most essential neuropsychological tests to assess abstract reasoning, persistence, problem-solving, mental flexibility, and sustained attention. A total of 64 non-similar cards and four shapes on each card exist, including a plus, a triangle, a star, and a circle in four colors (blue, red, green, and yellow). The number of each shape on the card varies from one to four, and the test has three principles, including shape (4 types), number (4 types), and color (4 types); overall, 64 states exist. The students must repeat the rule learned in each phase of the experiment in successive periods, and if the classification rules are changed, the previous rule must also be changed. The validity score of this test was reported as 0.83 based on the agreement coefficient of the evaluators (Spreen & Strauss, 1998). In Iran, the Cronbach's α coefficient of the WCST test was 0.74, and the split-half reliability was reported as 0.87 (Shahgholian et al., 2012).

#### Computerized version of the Stroop color and word test (SCWT)

Ridley Stroop used the computerized version of the Stroop color and word test (SCWT) to evaluate various cognitive assessments, including selective attention, response inhibition, and cognitive flexibility. The first step in this test is to name the color, and the participants must match the colored square, which is alternately shown on the screen in one of the four colors (blue, green, yellow, and red), with one of the letters shown on the keyboard with a label. The second step is the word-reading stage, in which the participants have to match the color of the words that appear on the screen with one of the letters shown on the keyboard with a label. The third step is the execution step, in which 50 consonant and 50 dissonant colored words are randomly displayed on the screen, and the participants should pay attention to the color of the word and ignore its meaning. The reliability of the SCWT with the re-test method was between 0.80 and 0.91 (Lustig et al., 2007). The reliability of the Persian version of the SCWT test was reported to be between 0.80 and 0.90 (Mashhadi et al., 2009).

#### Kim Karad visual memory test (KKVMT)

Kim created the Kim Karad visual memory test (KKVMT) to examine short-term and long-term visual memory. This test contains a main page with 20 houses, and each house includes a colored picture, some of which are similar in shape, color, or direction, and a cardboard page with 20 white houses and 20 pieces of cardboard cards. Each card includes one of the colored pictures on the main page. To conduct the test, the experimenter puts the main page in front of the participants and asks them to look at it for one minute, then takes the main page and gives them the white page and 20 cardboard cards. The participants must arrange the cards in the order they see them. The participant gets 1 score for putting each picture correctly and 0.5 for putting each picture in the correct location but in the wrong direction. The Cronbach's α reliability coefficient for the group without hearing or visual impairment in the KKVMT was 0.85 (Groth-Marnat, 2008). The internal criterion validity coefficient of the KKVM test in Iran was equal to 0.5, and the reliability coefficient was 0.62 (Ali Rezaei Motlagh et al., 2003).

### Wechsler's digit span test (WDST)

The Wechsler's digit span test (WDST) (IV), published by Wechsler in 2003, is one of the Wechsler intelligence tests for children scales. In addition to measuring short-term memory, this test measures attention, sound sequencing, sound learning, immediate sound recalling, and the ability to change thought patterns. In this test, the participant must memorize and repeat the digits heard in order; in other words, the respondent must memorize a list of 3 to 9. The test stops if the respondent fails to repeat both attempts of the same section correctly. In the second stage, the participant must repeat the heard numbers (2 to 8 digits) in reverse order; if the participant fails to answer both attempts at the same section, the test stops. The maximum score for each section is 16, and the total score is 32. The re-test reliability coefficient for the WDST was 0.81 (Alloway et al., 2004). The re-test reliability of the WDST on the Iranian sample was 0.82, and the split-half reliability was 0.85 (Sadeghi et al., 2011).

### Raven's colored progressive matrices (RCPM) test

The Raven's intelligence quotient test consists of 60 matrices in which one part of the shape is removed, and the participants should find the removed part among the options. Raven in 1947 designed the colored form of this test to measure the reasoning ability of children aged 5-11 years and adults with intellectual disabilities. The Raven's colored progressive matrices (CPM) test consists of 36 geometric shapes in three sets (12 geometric shapes in each set). Six shapes under each geometric shape exist, and the children must complete the incomplete part of the geometric shape by choosing one of the six shapes. In this test, the candidate gets 1 score for a correct answer and 0 for an incorrect answer. The maximum score for this test is 36, and the minimum score is 0. Satler reported that the range of test re-test reliability for the RCPM test was between 0.71 and 0.91 (Sattler, 1988). Rajabi in Iran reported that the test re-test coefficients for this test were 0.87 for seven-year-old children, 0.85 for eight-year-old children, 0.40 for nine-year-old children, 0.39 for ten-year-old children, and 0.52 for eleven-year-old children, respectively (Rajabi, 2008).

## Results

First, the independent t-test was used to examine the differences between the two groups participating in intelligence, as shown in Table 1. Table 2 presents the descriptive statistics of the research variables. The multivariate analysis of variance (MANOVA) was used to assess the differences between the two groups in Table 3, and the between-subjects test was applied to compare the components of executive functions, selective attention, short-term visual memory, and short-term auditory memory in monolingual and bilingual children in Table 4. All data were analyzed using SPSS software, version 23.

According to the results reported in Table 1, no significant difference is observed in average intelligence between monolingual and bilingual children (t=-1.31, df=110, P<0.19)

**Table 1.** The central and dispersion indicators of students' intelligence

| Group | Mean±SD | No. | t | df | P |
|---|---|---|---|---|---|
| Monolingual | 104.21±6.58 | 56 | -1.31 | 110 | 0.19 |
| Bilingual | 105.82±6.33 | 56 | | | |
| Total | 105.01±6.58 | 112 | | | |

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**Table 2.** Central indicators and dispersion of executive functions, selective attention, short-term visual memory, and short-term auditory memory

| Variables | | Mean±SD | | |
|---|---|---|---|---|
| | | Monolingual | Bilingual | Total |
| Executive function | Categories completed | 5.34±0.97 | 5.68±0.60 | 5.51±0.82 |
| | % conceptual level responses | 100.00±0.00 | 100.00±0.00 | 100.00±0.00 |
| | Perseverative errors | 2.04±1.79 | 1.52±1.30 | 1.78±1.58 |
| | Trials to complete 1 set category | 8.36±2.74 | 7.25±1.16 | 8.00±2.87 |
| | Correct responses | 41.36±3.04 | 41.43±2.97 | 41.39±3.00 |
| | Total errors | 13.41±4.05 | 12.38±2.93 | 12.89±3.56 |
| | Trials administered | 54.77±5.65 | 53.80±4.68 | 54.29±5.27 |
| | Non-perseverative errors | 11.38±3.04 | 10.86±2.60 | 11.12±2.83 |
| | Failure to maintain a set | 0.30±0.46 | 0.0±0.00 | 0.15±0.36 |
| Selective attention | Conceptual level responses | 6.00±0.00 | 6.00±0.00 | 6.00±0.00 |
| | Error 01 | 0.41±0.56 | 0.28±0.49 | 0.34±0.53 |
| | Correct 01 | 46.78±1.38 | 47.05±1.28 | 46.91±1.33 |
| | Time rec 01 | 1079.23±1363.79 | 1054.10±163.79 | 1066.67±150.74 |
| | Error 02 | 0.98±1.32 | 0.53±0.68 | 0.75±1.07 |
| | Correct 02 | 43.55±4.92 | 45.46±2.50 | 44.50±4.00 |
| | Time rec 02 | 1125.98±180.55 | 1109.42±181.38 | 1117.70±180.34 |
| Short-term visual memory | | 5.91±1.64 | 7.74±2.12 | 6.86±2.08 |
| Short-term auditory memory | | 16.87±2.60 | 20.69±2.99 | 18.78±3.39 |

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Table 2 Presents a difference in mean scores between the two groups in all components of executive functions, selective attention, short-term visual memory, and short-term auditory memory.

As Table 3 presents, Wilkes' lambda results (P<0.00, F=3.82) represent that the hypothesis regarding the similarity of the performance of two groups in cognitive abilities is rejected. Therefore, a significant differ-

**Table 3.** The MANOVA results regarding the difference between monolingual and bilingual children

| Effect | Value | F | Hypothesis df | Error df | Sig. | $\eta_p^2$ |
|---|---|---|---|---|---|---|
| Pillai's trace | 0.37 | 3.82 | 15.00 | 96.00 | 0.00 | 0.37 |
| Wilk's Lambda | 0.62 | 3.82 | 15.00 | 96.00 | 0.00 | 0.37 |
| Hotelling's trace | 0.59 | 3.82 | 15.00 | 96.00 | 0.00 | 0.37 |
| Roy's largest root | 0.59 | 3.82 | 15.00 | 96.00 | 0.00 | 0.37 |

MANOVA: Multivariate analysis of variance.

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**Table 4.** Test of between- subject effects to investigate the difference between the two groups

| Components | Type III Sum of Squares | df | Mean Squares | F | Sig. | $\eta^2$ |
|---|---|---|---|---|---|---|
| Categories completed | 3.22 | 1 | 3.22 | 4.78 | 0.02 | 0.04 |
| % conceptual level responses | 0.00 | 1 | 0.00 | - | - | - |
| Perseverative errors | 7.50 | 1 | 7.50 | 3.03 | 0.04 | 0.05 |
| Trials to complete 1 set category | 34.32 | 1 | 34.32 | 7.71 | 0.00 | 0.06 |
| Correct responses | 0.14 | 1 | 0.14 | 0.01 | 0.90 | 0.00 |
| Total errors | 30.03 | 1 | 30.03 | 2.39 | 0.12 | 0.02 |
| Trials administered | 26.03 | 1 | 26.03 | 0.93 | 0.33 | 0.08 |
| Non-perseverative errors | 7.50 | 1 | 7.50 | 0.93 | 0.33 | 0.08 |
| Failure to maintain a set | 0.57 | 1 | 0.57 | 2.07 | 0.15 | 0.01 |
| Conceptual level responses | 0.00 | 1 | 0.00 | - | - | - |
| Error 01 | 0.43 | 1 | 0.43 | 1.55 | 0.21 | 0.01 |
| Correct 01 | 2.00 | 1 | 2.00 | 1.12 | 0.29 | 0.01 |
| Time rec 01 | 17650.32 | 1 | 17650.32 | 0.77 | 0.38 | 0.00 |
| Error 02 | 20.75 | 1 | 20.75 | 5.29 | 0.02 | 0.04 |
| Correct 02 | 102.22 | 1 | 102.22 | 6.70 | 0.01 | 0.05 |
| Time rec 02 | 7672.58 | 1 | 7672.58 | 0.23 | 0.62 | 0.00 |
| Short-term visual memory | 85.75 | 1 | 85.75 | 23.80 | 0.00 | 0.17 |
| Short-term auditory memory | 408.89 | 1 | 408.89 | 51.82 | 0.00 | 0.32 |

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ence was observed between monolingual and bilingual children. The between-subjects test was used to compare the performance of monolingual and bilingual groups in all components of executive functions, selective attention, visual short-term memory, and auditory short-term memory.

As the results of Table 4, there was a difference between monolingual and bilingual groups in some executive function components, including the perseverative error, trials to complete 1 set category, and categories completed, and this difference was in favor of the bilingual group ($P<0.05$). Also, there was a significant difference between monolingual and bilingual children in short-term visual memory and short-term auditory memory, which favored the bilingual group ($P<0.05$). Nevertheless, there was no significant difference between the two groups in all components of selective attention ($P>0.05$).

## Discussion

The present study showed a significant difference between monolingual and bilingual children regarding executive functions, short-term visual memory, and short-term auditory memory; however, the two groups did not differ in selective attention. This result can also be explained according to Vygotsky's theory, which emphasizes the role of language in cognitive development. He also claimed that children's intellectual development and character and personality formation depend directly on speech (Vygotsky et al., 1997). In addition, Vygotsky argued that bilingualism can lead to further cognitive development and metalinguistic abilities in bilingual children, creating more positive consequences for children than adults (Albert et al., 2002). Also, bilingual primary school children have more opportunities to use both their languages at home and school so that they can integrate information between both languages. As a result, the positive effects of bilingualism are observed. For this reason, it can be claimed that the extent to which the mother tongue is used in social interactions can play an influential role in creating the positive or negative consequences of bilingualism (Karami Nouri et al., 2008)

In terms of executive function, this result is consistent with the results of Benaissa and Boudouh, (2020); Czapka and Festman, (2021) and Tran et al., (2019) which indicated the advantage of bilingual children in executive functions. Research results about the advantages of bilingualism in executive functions are conflicting. Also, the tests used to measure the cognitive abilities of bilingual and monolingual individuals may have influenced the contradictory results of the studies. For example, simpler tests require less manipulation of information at the level of working memory and less ability to inhibit and control attention than more complex tests, and bilinguals and monolinguals may show no difference in these tasks (Golestani Fard et al., 2016). This study used the WCST to examine executive function, a challenging test for all age groups. Therefore, bilingual children are expected to perform better on this difficult cognitive test. In addition, bilingual children with more exposure to both languages perform better on executive function tasks (Crespo et al., 2019). Since all the bilingual children in the present study used their two languages alternately at home and school, it is expected to see the positive effects of bilingualism on executive functions.

According to the second result of the present study, no difference was observed between monolingual and bilingual children in selective attention. This result is consistent with the research results of Paap et al., 2018; Troesch et al., 2023 and Zoghi Paydar & Yousefi, 2023). Antón et al. (2014) found that bilingual and monolingual groups performed similarly in attention skills. However, differences were observed between them in middle and old age, while these differences were not observed in childhood. Park et al., (2018) in a longitudinal study on bilingual and monolingual children, showed that the two groups were similar in the components of executive function. However, after 1-2 years, bilinguals showed a significant difference in response inhibition. Therefore, some researchers argue that the advantage of bilingualism at older ages is more evident than in childhood, therefore bilingual students may perform better in selective attention as they age.

We also observed that bilingual children had better short-term visual memory. This result is somewhat consistent with the results of Durand Lopez, 2021; Grote, 2014 and Kerrigan et al., 2017 which reported better performance of bilinguals in visual tasks. Based on these studies, some aspects of visual memory, such as the storage and retrieval of verbal and non-verbal information (numbers and images), may be affected by learning a new language. Since in Baddeley's memory model, visual memory is the same as the visual-spatial screen and some research showed the advantage of bilingual children in working memory, it can be concluded that the advantage of bilinguals in working memory can affect the sub-components of this memory, including visual memory (Durand Lopez, 2021). It can also be assumed that bilinguals prefer non-verbal representations and rely more on visual or spatial strategies, which are less ambiguous than verbal strategies (Ransdell & Fischler, 1991).

The present study also showed that bilingual children had better short-term auditory memory than monolingual children. This result is consistent with the results of Ferreira et al., (2018); Sharifinik et al., (2021); Spinu, (2023) and Spinu et al., (2023) which showed the advantage of bilinguals in auditory memory. Motlagh Zadeh et al. have shown that bilingual people have a greater ability to store and recall auditory information than monolinguals (Motlagh Zadeh et al., 2018). In explaining the better performance of bilinguals in short-term auditory memory, we can refer to the hypothesis of language automatization, which claims that high proficiency in the second language creates a series of cognitive mechanisms and ultimately enhances a bilingual person's memory. Also, the gradual learning of a second language by increasing the process of automating the processing of the second language leads to the strengthening of executive function and cognitive flexibility (Vejnović et al., 2010). The corpus callosum also plays a vital role in communication between the two hemispheres, and therefore, the corpus callosum is involved in second language learning and hearing processes. A study conducted by Negin et al. showed that monolinguals have a smaller corpus callosum than bilinguals. In addition, based on the results of several studies, bilingualism has significant consequences for better cognitive performance and hearing ability (Negin et al., 2016). The auditory memory is the main system involved in learning and developing language skills. Therefore, it can be expected that bilingualism has a significant effect on auditory memory as well.

## Conclusion

The present study compares monolingual children with bilingual children in executive function, selective attention, short-term visual memory, and short-term auditory memory. The results of the research indicate that bilingualism may improve the performance of children in some cognitive abilities, including executive functions, as well as visual and auditory short-term memory. Considering the advantage of bilingual children in cognitive abilities over monolingual children, it seems necessary that teachers working with bilingual children provide them with multiple opportunities to use their mother tongue in the classroom to help them use their ability as a strength to improve their linguistic and cognitive skills. In addition, adequate support for a child's mother tongue at school and in society usually enhances their performance in the second language and leads to academic achievements.

### Limitations

The present study had limitations. First, due to the small sample size and since the survey was conducted on specific individuals (8 to 11-year-old Azeri Turkish and or Persian-speaking students in Tehran Province), the results should be generalized with caution. It should also be noted that some studies with a small sample size did not show the advantage of bilingualism. Secondly, some tests took a long time to complete, which may cause participants to be less accurate. Third, we had to use the convenience sampling method due to the restrictions caused by the COVID-19 pandemic and the limited access to monolingual and bilingual students in the schools. Further longitudinal studies are warranted because language is a dynamic and complex variable, and cross-sectional studies may not be able to explain the full range of effects of bilingualism on cognitive abilities. Future research should use tests that require less time to complete. Also, it is recommended that future studies select their samples using a random sampling method and with a larger number of participants. Finally, since few studies have investigated the effect of bilingualism on short-term auditory and short-term visual memory, it is suggested that more studies be conducted on these cognitive variables.

## Ethical Considerations

### Compliance with ethical guidelines

This study was approved by the Ethics Committee of Tabriz University (Code: IR.TABRIZU.REC.1401.055).

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### Authors' contributions

Conceptualization and methodology: All authors; Investigation, Sourcing and writing the original draft: Zahra Ahmadbeigi; Data analysis, review, and editing: Jalil Babapour Kheireddin and Touraj Hashemi Nosrat Abad; Supervision and project administration: Jalil Babapour Kheireddin.

### Conflict of interest

The authors declared no conflict of interest.

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