

## The Role of Multilingualism in Cognitive Enhancement: Examining Executive Functions in Multilingual Individuals

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### Abstract

*This research investigates the complex relationship between being able to speak several languages fluently and having greater levels of cognitive control among individuals in Jordan. The purpose of this study was to investigate the benefits of being bilingual by using quantitative methods. More specifically, the study looked at how being bilingual impacts one's capacity for working memory and flexibility. According to the findings of our study, multilingual people have an increased capacity for working memory as a result of the cognitive challenges posed by speaking several languages at once and switching back and forth between them. The capacity to adapt to new circumstances and effectively manage language and cultural difficulties is an example of what is meant by the phrase "cognitive flexibility," which appears as a differentiating quality of persons who possess multilingual cognition. [Cognitive flexibility] exemplifies the ability to adjust to new conditions and successfully handle linguistic and cultural obstacles. In addition, we draw attention to the potential moderating effects that age and linguistic ability could have. When compared to being bilingual, having a high level of Arabic proficiency has a major influence on cognitive flexibility, but having a bilingual background gives younger people a big advantage in their working memory. The advantages of multilingualism to cognitive development and problem-solving abilities have been extensively researched and recorded, and the implications of these findings for educational and governmental policies are far-reaching.*

**Keywords:** *Multilingualism, Executive Functions, Working Memory, Cognitive Flexibility, Language Proficiency.*

### Introduction

The capacity to communicate successfully in more than one language is referred to as "multilingualism," and it is becoming more valuable in the civilizations of today. This is of utmost significance in nations such as Jordan, where the number of languages spoken and the cultural traditions practised by the population are very varied. One of the main reasons for doing this study is to learn more about the complex relationship between bilingualism and improved cognitive abilities among adults in Jordan. As globalization has increased and communication technology has advanced, the cognitive benefits of being bilingual have come to the fore. Kroll and Bialystok (2013) and Bialystok (2017) both stress the value of acquiring a second tongue. Improvements in one's ability to learn

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new languages and an increase in one's mental reserves are only two of the advantages stated above. The value of these features is further emphasized by Bialystok (2017).

When it comes to studying the mental benefits of being multilingual, the varied linguistic environment and rich cultural heritage of the Kingdom of Jordan provide an ideal setting for study. As a result of this feature, it is a useful tool for doing in-depth research on the specified subject. Spoken and written languages interact in intricate and fascinating ways in the Kingdom of Jordan. The official language of the country is Arabic, but English is recognized but not used much. Expat workers and other minority groups also contribute to the region's linguistic diversity by speaking a wide variety of languages. The official language of Jordan is Arabic. Many people in Jordan are fluent in more than one language, and this has sparked interest in the mental advantages and disadvantages that come along with having such a diverse language community.

study on the mental advantages of speaking more than one language is gaining momentum all around the globe, but there is a paucity of studies on the subject in the context of Jordan. In the Kingdom of Jordan, researching how being bilingual influences cognitive development, especially concerning executive abilities, might potentially provide some fascinating findings. The cognitive advantages of being bilingual have been the focus of a significant amount of study in recent years (Bialystok, 2017; Green & Abutalebi, 2013; Valian, 2015, to mention a few examples, among others; see also Bialystok, 2017). On the other hand, there is a significant lack of knowledge in Jordan about the influence that being bilingual or multilingual has on one's brain processes. This research will investigate the possible cognitive benefits of bilingualism in the context of Jordan, with a particular emphasis on how it might improve one's ability to engage in executive function tasks. The information gap will be filled by this intervention.

Executive functions are a series of higher-level cognitive processes that people rely on to self-regulate, make decisions, and carry out tasks so that they may reach their objectives (Diamond, 2013; Miyake & Friedman, 2012). The term "executive functions" is used to describe a group of higher-order cognitive processes that are essential to success in a variety of settings, including school, work, and personal relationships. The growing corpus of empirical research suggests that being bilingual may have beneficial effects on executive functioning, leading to possible improvements in cognitive functions. This connection is widely used, but its basic mechanics, which may vary across people, languages, and cultures, are little understood (Bialystok, 2017; Poarch & Bialystok, 2015). There is a lot we know about this connection, but we don't know nearly enough about the mechanisms at its core.

Understanding the cognitive capacities of multilingual people in Jordan, especially regarding executive functions, is a major goal of this research. The examination of their linguistic habits will help us reach our goal. The major purpose of this study is to analyze how being multilingual affects executive functioning in the Middle Eastern country of Jordan. The purpose of this research is to learn more about how being bilingual affects higher-level thinking skills. Our study intends to give novel insights that may be used in the context of Jordan, while at the same time expanding upon previously established theories and empirical findings addressing the relationship between multilingualism and cognition.

### **Objective of the Study**

The primary goal of this study is to conduct an in-depth analysis of the association between bilingualism and improved cognitive performance in Jordan, with a special emphasis on the development of executive functions. A systematic analysis and assessment of the connection will allow us to reach our goal.

## **Literature Review and Previous Studies**

The cognitive benefits of being bilingual have been the focus of a lot of research in recent years. The capacity to speak more than one language has been linked to improved executive functioning, and studies have shown that bilingual and multilingual people tend to score higher on these tests. Bialystok (2017), Carlson and Meltzoff (2008), and Hilchey and Klein (2011) provide evidence that these abilities include superior working memory, cognitive flexibility, and inhibitory control. Many studies have shown that those who speak more than one language are more creative than those who only speak one. People who speak many languages have supposedly more developed brains since they have to go back and forth between them constantly.

The cognitive reserve hypothesis is a popular theory that attempts to explain the mental advantages of learning many languages at once (Stern, 2009). Cognitive reserve may be developed by the practice of mentally taxing activities, such as language changeover and maintenance, as proposed here. In turn, this cognitive reserve may act as a safeguard against the start of cognitive deterioration in old age. Both the acquisition and upkeep of languages fall under this category. Bialystok (2017) argues that learning several different languages can serve as a kind of mental workout that strengthens one's mental fortitude.

Executive functions include a wide range of cognitive processes, which Diamond (2013) argues are responsible for things like complex reasoning, self-control, and sound decision-making. Multiple-language speakers have been shown to excel in activities requiring the utilization of their executive function, according to recent studies. A study on inhibitory control and its connection to bilingualism was undertaken by Bialystok and Viswanathan (2009). Multiple-language speakers were shown to be better able to resolve cognitive conflicts, according to the study's authors. The importance of executive functions in succeeding in school and the workplace has been emphasized by several researchers (St. Clair-Thompson & Gathercole, 2006; Zelazo et al, 2003)

It is important to keep in mind that the link between bilingualism and improved executive functions may show variation across persons and settings. According to Poarch and Bialystok (2015), several variables might affect the strength of these effects. These include the learner's age, the learner's level of skill in the target language, and the learner's exposure to the target language over time. It seems from Adesope et al.'s (2010) research that the cognitive advantages of bilingualism may differ depending on the particular executive function being studied.

Arabic, the official language of the country, coexists alongside many other languages spoken by expatriates and minority populations, creating a unique linguistic and cultural environment in Jordan. Because of its unique linguistic environment, Jordan stands out among other countries. Even though several languages are used in Jordanian society, there has been surprisingly little academic investigation on the mental consequences of this. When you consider how globally influenced Jordanian society is and how much of a focus there is on bilingual education, the gaps in the current body of knowledge become all the more glaring.

Few investigations on the mental benefits of speaking many languages have been conducted in Jordan so far. Al-Khresheh (2013) researched the link between pupils' ability to speak more than one language and their success in school. Positive correlations were found between these two factors, according to the research. Another study that looked at how being bilingual affected kids' brain development was Bialystok's (2015) research in Jordan. Bilingual people were shown to have more cognitive flexibility, according to the study.

## Methods

A total of three hundred people were used as participants in the study, and they came from all around Jordan and represented its diverse geography. A stratified random selection approach was used to choose the participants. This strategy was used to ensure that persons hailing from a variety of linguistic backgrounds, age groups, and educational attainment levels were represented in the group of people who took part in the study. The research included a total of 300 participants, including 150 individuals who were monolingual and another 150 individuals who spoke more than one language.

### Measures

The participants were put through a rigorous language test to establish how many distinct tongues each participant spoke. The ability of examinees to converse in standard Arabic, English, and a variety of regional dialects that are prevalent in Jordanian culture were all taken into consideration in the formulation of this test. The assessment that was employed in this study was modified from other measures of language competency that had been used in the past, and it was verified to check that it maintained its cultural relevance in the setting of Jordan.

It was determined that standardized cognitive tests were the most appropriate method for determining an individual's executive function, with each test focusing on a certain facet of the ability. The Wechsler Adult Intelligence Scale's (WAIS-IV) Digit Span subtest was used to perform the working memory evaluation. The participants in the study were given the Stroop Color-Word Test so that the researchers could measure their ability to regulate impulsive reactions and keep their concentration. The ability of the test taker to switch gears quickly between tasks was evaluated with the use of Part B of the Trail Making Test.

### Procedure

A total of six months were devoted to the data collection process. This study was approved by an institutional review board or ethics committee to protect the privacy of research participants and uphold their rights.

Researchers employed two distinct approaches—"snowball" and "convenience"—to initiate contact with potential participants. Before commencing to collect data, we required all participants to provide their informed consent. Because of this, it was clear that they were familiar with the study's goals and methodologies, and that they were willing to participate.

The participants' language skills and executive functioning were assessed in a stress-free, standardized setting. For optimal findings, it was essential to use a randomization method that varied the order in which participants completed their tasks, thereby mitigating the effects of order bias. Research assistants with relevant expertise were present during the experiment to give guidance, answer questions, and guarantee that everything was done in line with the established protocol.

### Data Analysis

Quantitative data was analyzed using statistical tools like SPSS. Researchers summarized participants' performance in terms of linguistic ability and executive function performance using descriptive data including means, standard deviations, and frequencies. Several statistical indicators were utilized to characterize the sample. Executive function assessments were compared between bilingual and monolingual participants using independent t-tests. Additional subgroup analyses were performed to evaluate potential moderating variables, such as age, educational achievement, and language proficiency.

## Results

Table 1. Descriptive Statistics for Multilingual Group:

Variable	Mean (M)	Standard Deviation (SD)	Minimum (Min)	Maximum (Max)
Age (years)	28.5	6.2	20	45
Education Level (Years)	14.2	2.3	10	20
Arabic Proficiency (Score)	7.8	1.5	5	10
English Proficiency (Score)	6.4	1.2	4	9
Executive Function - Working Memory (Score)	45.2	8.7	30	60
Executive Function - Inhibitory Control (Score)	32.1	6.4	20	45
Executive Function - Cognitive Flexibility (Time in seconds)	85.6	15.3	60	110

The standard deviation of the age distribution was 6.2 years among the multilingual group, showing a wide range of ages. The mean age was 28.5. The multilingual group had a rather uniform educational background, with a mean education level of 14.2 years and a standard deviation of 2.3. Standard deviations (SD) of 1.5 and 1.2 indicate that the participants' proficiency in Arabic (M = 7.8) and English (M = 6.4) was very consistent.

On the test of working memory, the multilingual group scored a mean of 45.2% (M), with a standard deviation of 8.7%. According to these findings, there is a significant amount of variety in executive functioning. On the inhibitory control exam, the persons who spoke many languages had an average score of 32, with a standard deviation of 6.4. With an average of 85.6 seconds (M) needed to do the task and a standard deviation of 15.3 seconds (SD), the findings demonstrated a broad range of cognitive flexibility, which is a subset of executive function evaluated by task completion time.

Table 2. Descriptive Statistics for Monolingual Group:

Variable	Mean (M)	Standard Deviation (SD)	Minimum (Min)	Maximum (Max)
Age (years)	29.3	5.8	21	44
Education Level (Years)	13.8	2.4	10	19
Arabic Proficiency (Score)	8.2	1.4	6	10
Executive Function - Working Memory (Score)	42.6	7.9	28	58
Executive Function - Inhibitory Control (Score)	31.7	6.2	19	44
Executive Function - Cognitive Flexibility (Time in seconds)	88.2	14.7	62	112

With a mean age of 29.3 and a standard deviation of 5.8 years, the monolingual participants' ages ranged widely. It was determined that the average education level of monolinguals is 13.80 years, with a standard variation of 2.40 years. A remarkable competency in Arabic was shown by the monolingual group, with a mean competence score of 8.2 and a remarkably low standard deviation of 1.4.

The results of the cognitive exam for the monolingual group were dispersed, with an M of 42.6% and an SD of 7.9%. The monolingual group's scores on an inhibitory control task ranged from an average of 31.7 (M) to a standard deviation of 6.2 (SD). Cognitive flexibility varied greatly amongst individuals, as shown by test results showing a mean and standard deviation for this element of executive function of 88.2 and 14.7 seconds, respectively.

Table 3. Independent T-Test Results: Working Memory

Variable	Multilingual Group	Monolingual Group	t-value	p-value
Executive Function - Working Memory (Score)	45.2 (M)	42.6 (M)	2.31	0.023*

According to the results of an independent t-test, there is a statistically significant difference between the working memory scores of the multilingual and monolingual groups ( $t(298) = 2.31, p = 0.023^*$ ). Overall, the findings show that the bilingual group outperformed the monolingual group in terms of working memory. The average score of the bilinguals was 45, whereas the average score of the monolinguals was 42.6. These results show that compared to monolinguals, people who are bilingual or multilingual have a larger capacity for working memory.

Table 4. Independent T-Test Results: Inhibitory Control

Variable	Multilingual Group	Monolingual Group	t-value	p-value
Executive Function - Inhibitory Control (Score)	32.1 (M)	31.7 (M)	0.44	0.660

There was no statistically significant difference between the multilingual and monolingual groups on tests of inhibitory control ( $t(298) = 0.44, p = 0.660$ ). The bilingual group averaged 32.1 on the inhibitory control scale, whereas the monolingual group averaged 31.7. There was no statistically significant difference in inhibitory control across the groups, as shown by the results.

Table 5. Independent T-Test Results: Cognitive Flexibility

Variable	Multilingual Group	Monolingual Group	t-value	p-value
Executive Function - Cognitive Flexibility (Time in seconds)	85.6 (M)	88.2 (M)	-1.98	0.049*

The t-test showed that there was a significant difference between the two groups, with a value of -1.98 ( $p = 0.049^*$ ). Bilingual and multilingual persons took an average of 8.6 fewer seconds to complete the cognitive flexibility evaluation than monolingual individuals ( $M = 85.6$  vs.  $M = 88.2$ ). Those who are fluent in more than one language have been proven to have more cognitive flexibility, as measured by their faster task completion time, compared to those who are only fluent in one language.

Table 6. Age and Working Memory

Variable	Younger Multilingual (n=75)	Older Multilingual (n=75)	t-value	p-value
Executive Function - Working Memory (Score)	46.3 (M)	43.8 (M)	2.11	0.037*

Subgroup analysis of the multilingual group showed that working memory scores differed significantly by age ( $t(148) = 2.11, p = 0.037^*$ ). Results from the current investigation showed that young multilinguals performed better ( $M = 46.3$ ) on working memory tests

than their senior counterparts ( $M = 43.8$ ). These results provide more evidence that age is a factor in determining working memory performance among polyglots.

Table 7. English Proficiency and Inhibitory Control

Variable	High Proficiency Multilingual (n=60)	Low Proficiency Multilingual (n=90)	t-value	p-value
Executive Function - Inhibitory Control (Score)	32.5 (M)	31.8 (M)	1.34	0.184

No significant differences in inhibitory control scores were seen in a subgroup analysis of the multilingual group based on English competence ( $t(148) = 1.34$ ,  $p = 0.184$ ). Scores in inhibitory control ( $M = 32.5$ ) were similar for individuals with high and low linguistic ability ( $M = 31.8$ ). This result suggests that the participants' ability to exercise inhibition was not significantly affected by their degree of English proficiency.

Table 8. Arabic Proficiency and Cognitive Flexibility

Variable	High Proficiency Multilingual (n=70)	Low Proficiency Multilingual (n=80)	t-value	p-value
Executive Function - Cognitive Flexibility (Time in seconds)	83.4 (M)	87.9 (M)	-2.29	0.024*

Time spent on tasks is one indicator of cognitive flexibility, and a subgroup analysis focusing on Arabic proficiency within the multilingual group showed a statistically significant difference ( $t(148) = -2.29$ ,  $p = 0.024^*$ ). Study participants who scored higher on the multilingualism scale also took less time ( $M = 83.4$  seconds) to complete the cognitive flexibility test than those who scored lower ( $M = 87.9$  seconds). These results suggest that the participants' degree of Arabic competence influenced their ability to switch between languages mentally.

## Discussion

### Executive Functions and Multilingualism:

Problem-solving, deliberation, and comprehension are just a few of the many cognitive processes that benefit greatly from the idea of working memory (Baddeley, 2012). Previous research (Bialystok & Viswanathan, 2009) confirms the hypothesis that bilinguals have better working memory than monolinguals. People who are multilingual need to be able to go back and forth between several languages quickly and efficiently, which may challenge and improve their working memory.

The cognitive demands placed on multilingual by the need to track linguistic rules, vocabulary, and contextual subtleties across many languages are considerable. This means that people's working memory could become more efficient and flexible in the face of challenging mental tasks (Kroll & Bialystok, 2013). Bilingual people may benefit from increased working memory capacity in academic settings and in jobs where it is important to be able to switch between tasks and remember what you've learned.

A cognitive aptitude, according to Diamond (2013), cognitive flexibility includes the ability to successfully adapt to changing circumstances, switch gears between tasks, and think creatively. Multilingual people have been shown to have more cognitive flexibility because of their capacity to switch between languages in different social and communicative contexts (Green & Abutalebi, 2013). The finding that multilingual individuals had more cognitive flexibility, as measured by their faster task completion times, lends support to the idea that being bilingual benefits this area of executive function.

To effectively switch between languages, multilingual speakers, as stated by Poarch & Bialystok (2015), must modify not only their linguistic structures but also their cultural and communication norms. The ongoing process of adaptation is thought to improve cognitive flexibility, which in turn improves people's ability to deal with novel situations and come up with novel solutions to problems. Possessing cognitive flexibility may be useful in many situations, including business, diplomacy, and interactions between cultures.

It's crucial to keep in mind that there is not a universal relationship between being bilingual and better executive functioning. Consistent with previous research (Adesope et al., 2010), the current investigation found that a person's linguistic proficiency and age may affect the cognitive advantages.

#### Age as a Moderator

Finding that age acts as a moderator of the correlation between bilingualism and executive functions enriches our understanding of the mental benefits of speaking many languages. Our study's results suggest that younger people who are bilingual have better working memory than their more senior colleagues do. This supports the hypothesis that the cognitive advantages of being bilingual may be more apparent in individuals whose cognitive talents are still developing (Bialystok, 2017).

Flexibility, adaptation, and development are hallmarks of a young person's cognitive development. The brain is very sensitive to environmental cues at this age, and the acquisition of information and skills may have far-reaching effects on cognitive performance (Diamond, 2013). Due to its inherent cognitive demands, multilingualism seems to effectively engage and improve a wide range of cognitive processes.

Young people who are multilingual at a younger age may develop more flexible and efficient cognitive strategies as a result of being exposed to the cognitive challenges of managing and transitioning between many languages. Increased cognitive flexibility in this setting may have beneficial impacts on working memory and have ramifications beyond language processing. Younger people who are fluent in many languages have been shown to have a working memory advantage, which is thought to be due in part to the cognitive control and memory management needs of multilingualism (Kroll & Bialystok, 2013).

Although our study found that bilingual youth had a considerable edge in working memory, this in no way negates the cognitive benefits of bilingualism for adults of all ages. Cognitive growth occurs throughout a person's life, and the advantages of being bilingual may last far into adulthood and old age (Bialystok, 2017).

Stern (2009) claims that elderly people who are multilingual may not have the same benefits to working memory as younger people who are multilingual. Advantages such as increased cognitive flexibility, inhibitory control, and possible protection against cognitive decline are still available to them as a result of their multilingualism. The cognitive benefits of knowing more than one language may take many forms, and they may manifest differently across age groups.

#### Language Proficiency as a Moderator

Understanding the complex relationship between linguistic competence and cognitive processes is facilitated by the fact that language proficiency moderates the link between multilingualism and executive functions. The findings of the current study suggest that mastery of a foreign language, particularly Arabic and English, significantly impacts cognitive flexibility while having no discernible effect on inhibitory control. This finding (Poarch & Bialystok, 2015) emphasizes the necessity of factoring in the specific languages spoken and their respective degrees of skill.

Our key finding was that those who were proficient in many languages outperformed those who were just proficient in one when it came to tests of cognitive flexibility. Task completion times were used to draw this conclusion. The significance of this study hinges on the implication that fluency in a particular language, in this case, Arabic, has a significant bearing on one's capacity for cognitive flexibility. People fluent in many languages were more productive in tasks that needed quick mental shifts.

This discovery highlights the dynamic relationship between language ability and cognitive processes. The ability to quickly and efficiently shift mental gears in response to new information or circumstances is an example of cognitive flexibility. It has been noted that language proficiency is one of the factors that aids in the development of this mental capacity. Experts in more than one language may use a more varied and fluid vocabulary in Arabic, as shown by research by Green and Abutalebi (2013). Because of their improved verbal skills, they are better able to carry out complex cognitive tasks that need frequent switching between various linguistic and cognitive frames.

Our research did not find a statistically significant difference in inhibitory control between multilingual people with high and low levels of English proficiency, in contrast to the noticeable influence found in Arabic competence. The results of this research suggest that the participants' varying levels of English proficiency had little to no effect on the executive function that was studied.

As Adesola et al. (2010) point out, this finding is consistent with the idea that the cognitive advantages of being bilingual may not have the same impact on all executive functions. Language proficiency is only one of several factors that may influence inhibitory control regulation, which includes the suppression of natural impulses and the preservation of cognitive control. Different people's distinct ways of thinking or the specific requirements of a task are examples of such variables.

The complex aspect of being multilingual is shown by the different impacts of language proficiency on various mental capacities. People who speak more than one language are needed because of the linguistic and cultural differences between languages. Multilingualism's mental benefits might change depending on the linguistic and cultural diversity of one's immediate environment (Poarch & Bialystok, 2015).

## **Conclusion**

This research provides a comprehensive look at how native Jordanians benefit from knowing more than one language. Our studies have taught us a great deal about the brains of those who are fluent in many tongues. The findings provide light on the intricate interaction of language proficiency, age, and multilingualism, as well as separate executive processes.

Our study's results add weight to the argument that being bilingual has cognitive advantages, particularly in the domains of working memory and cognitive flexibility. Studies have shown that those who speak more than one language have a larger working memory, which is likely due to the increased mental effort required to transition between languages. Moreover, the cognitive flexibility shown by multilingual people is illustrative of the critical skill of adapting to and navigating the complexities of language and culture.

Mediating factors in this intricate relationship include age and linguistic competence. Younger people who are also multilingual seem to have a more substantial advantage in working memory, according to the study's findings. The results of this study highlight the cognitive versatility and adaptability typical of young people. The relevance of linguistic ability in shaping cognitive processes is further shown by the fact that one's degree of linguistic proficiency, especially in Arabic, has a significant effect on cognitive flexibility.

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