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Bilingualism and Cognitive Functioning in ADHD: Exploring the Impact on Executive Abilities

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ABSTRACT

Purpose: Bilingualism is a common practice worldwide. It was believed that bilingualism might affect cognitive skills in children with Attention Deficit and Hyperactivity disorder (ADHD). This study aimed to investigate the effect of bilingualism on the cognition of Egyptian children with ADHD. **Methods:** The study included 40 Egyptian children 5-7 years of age, all diagnosed with mild to moderate ADHD, recruited from the phoniatric clinic at the National Research Center. They were divided into two groups, 20 each. Group 1 goes to 2 similar Experimental language schools where the kids study Arabic and English. In comparison, Group 2 goes to three similar national Arabic schools where the children study only Arabic subjects. The 40 students are average students as per their school report. There was no history of delayed language development or speech and language therapy. Two Language assessment tools were administered: Preschool Language Scales Fifth Edition (PLS-5) to assess the English language and Receptive Expressive Arabic Language Scale (REAL Scale) to assess Arabic language development for Group 1; only the REAL Scale was applied to Group 2 to assess their Arabic language development. IQ was applied to both groups. **Results:** There was no systematic advantage or disadvantage of bilingualism on cognitive performance in children with ADHD. **Conclusion:** Early English language learning does not affect cognition in Children with ADHD

Keywords: Children, bilingualism, attention deficit and hyperactivity disorder (ADHD), Egypt

1. Introduction

Language development is when a child expands their vocabulary, lengthens and complicates sentences, and uses words to convey concepts. The child's age, exposure to language, and social interactions all impact this dynamic process. In contrast to monolingualism, bilingualism suggests that two language systems coexist within the same person (Grosjean, 1992). Today, most people are regularly exposed to two or more languages, making them bilingual (Marian and Shook, 2012).

Increasing research has been done on the consequences of bilingualism on language and cognition (Kroll *et al.,* 2014; Bialystok *et al.,* 2012; Bialystok, 2017). Bilingualism was thought to increase a child's risk of language delays and learning disabilities. However, other research contradicts this idea (Kroll *et al.,* 2014). On the other hand, many studies have shown that bilingualism may improve cognitive control more than monolingualism in school-age children and adults (Adesope *et al.,* 2010). Studies in the United States reported no significant effect of bilingual education programs on standardized test performance compared to English-only programs (Guo and Koretz, 2012; Chin and Daysal, 2013).

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental condition characterized by impulsivity, hyperactivity, and inattention that inhibit development. Symptoms typically start in early childhood and affect many aspects of life, including social relationships and academic performance (Kaiser and Roberts, 2013). A complicated interaction between hereditary and environmental factors

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causes ADHD by changing the structure and function of the brain, particularly in regions related to executive functioning. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria are used to diagnose ADHD. Behavioral therapy and medicines are sometimes used in combination for treatment (Green *et al.,* 2014).

Bilingualism and Attention-Deficit/Hyperactivity Disorder (ADHD) are two factors that significantly affect cognitive development, especially concerning executive functions (Engelhardt *et al.,* 2013). Executive functions include a range of cognitive processes like working memory, cognitive flexibility, and inhibitory control. Bilingualism has been demonstrated to enhance certain aspects of executive functioning because of the ongoing need to manage several language systems. However, ADHD, which results in issues with impulse control and attention regulation, is often associated with impairments in these same executive functions. The association between bilingualism and ADHD is complex since the cognitive benefits of bilingualism may compensate for some executive function deficits associated with ADHD (Oram *et al.,* 2005).

2. Methods

2.1. Study Sample

The study included 40 Egyptian children 5-7 years of age, all diagnosed with mild to moderate ADHD, recruited from the phoniatric clinic at the National Research Center. They were divided into two groups, 20 each. Group 1 goes to 2 similar experimental language schools where the kids study Arabic and English. In comparison, Group 2 goes to three similar Arabic national schools where the children study only Arabic subjects. The 40 students are average *with no academic challenges*, per their school reports. There was no history of delayed language development or speech and language therapy. Two Language assessment tools were administered: Preschool Language Scales Fifth Edition (PLS-5) to assess the English language and Receptive Expressive Arabic Language Scale (REAL Scale) to assess Arabic language development for Group 1; only the REAL Scale was applied to Group 2. IQ was applied to both groups.

2.2. Assessment tools

1. The study started with a cross-sectional analysis of information on socioeconomic characteristics and parental contributions. Socioeconomic factors included the child's age, gender, and birth weight; the number of siblings; the mother's age and job; parental education levels and language proficiency; and the region of residence.
2. Assessing language development: Two assessment tools were administered to Group 1 to assess the study group's English and Arabic language development. The first tool is the Preschool Language Scales Fifth Edition (PLS-5), and the second is the Receptive Expressive Arabic Language Scale (REAL Scale). Both assessments were administered to Group 1 in two different settings, one week apart, in a supportive and friendly test environment; children were comfortable and relaxed. Only the REAL Scale was applied to Group 2 in one setting. Both assessments were administered in a 1:1 setting in a quiet, well-lit, adequately ventilated room away from distraction or disruption. The assessor is familiar with the study group as the assessor spent two school days with the children before the assessments.

- PLS-5 (Preschool Language Scales, 2020) is an English standardized language test used for children aged birth through 7 years and 11 months to assess language development and identify children with a language delay or disorder. The test aims to identify receptive and expressive language skills in attention, gesture, play, vocal development, social communication, vocabulary, concepts, language structure, integrative language, and emergent literacy. The PLS-5 helps the clinician determine strengths and weaknesses in these areas to determine the presence and type of language disorder (e.g., receptive, expressive, and mixed) and eligibility for services and to design interventions based on norm-referenced and criterion-referenced scores. The test was applied to each child in one sitting; the administration time varies from 45 minutes to 1 hour. Practice items are included for many items throughout the test and allow the child to rehearse the required item task. Some children needed additional support during practice, such as demonstrating or modeling the correct responses and explaining why the answer was correct; no other cues were given to the children. Except for EC56 (repeat nonwords) and EC57 (repeat sentences), some directions and repeated stimuli for some children were applied once during the test.

- REAL Scale (Osman, 2014) is structured to assess the Arabic language. It is a battery of several tests to evaluate receptive and expressive language skills in Arabic-speaking children aged five to 12 years 11 months (Table 1). It was administered in one setting for around 90 minutes. Some children had 10 minutes break, and others did not need a break. REAL Scale is a valid Arabic test in which correlation studies were carried out between tested parameters and the participants' ages to indicate the validity of the REAL Scale construct. As for convergent validity, receptive tasks and expressive tasks were also correlated.
- Additionally, receptive subtests were highly correlated with expressive ones, to some extent, when they were used to measure the language skills of a typically developing child. Cronbach's alpha of the REAL scale subsets ranged from 0.673 to 0.901. The test-retest stability coefficient ranges from 0.775 to 0.975 for the different subsets. A percentile rank of 70 or more indicates satisfactory Arabic language development.
- A Standardized Arabic adaptation of the Stanford Binet test 5th edition SB5 (Bain and Allin, 2005) was performed by a psychologist with 9 years of experience to assess their intelligence quotient. It has five scales: fluid reasoning, knowledge, quantitative reasoning, visual-spatial reasoning, and working memory.

Scores of both tools are valid as the assessor adhered to administration procedures, especially rules for prompting the child and repeating test stimuli. Children's behavior was observed during test administration. All scores were recorded correctly, and the assessor followed interpretation guidelines to interpret the scores.

2.3. Statistical methods

Statistical analysis was done using IBM© SPSS© Statistics version 22 (IBM© Corp., Armonk, NY, USA). Numerical data were expressed as mean, standard deviation, median, and range as appropriate. Qualitative data were expressed as frequency and percentage. A comparison of repeated measures was made using a paired t-test. A p-value < 0.05 was considered significant.

3. Results

The age of the studied group was 6.0 ±0.6 years, ranging from 5 to 7 years. Tables 1 and 2 show the results of assessing the English and Arabic language development of Group 1, and Tables 3- 7 show the Arabic language development of Group 2. These results indicated normal language development of Arabic and English in all children.

Table 1: English language assessment with preschool language scales in group 1

	Mean±SD	Range
Standard Scores		
Auditory Comprehension	99±2	96-102
Expressive Communication	100±2	97-103
Total language	101±6	96-119
Estimated age (months)		
Auditory Comprehension	67±3	60-74
Expressive Communication	66±4	60-72
Total language	66±3	60-72

Results indicated normal language development of English Language in Group 1

Table 2: Arabic language assessment with receptive expressive Arabic language scale in group 1

	Mean±SD	Range
Receptive Language Score		
Raw score	159±6	139-163
Total Scaled	125±5	109-129
Percentile Rank	90±5	75-95
Expressive Language Score		
Raw score	210±7	192-223
Total Scaled	119±3	111-124
Percentile Rank	89±5	70-95
Total Language Score	369±12	331-386
Total Scaled	123±4	111-128
Percentile Rank	89±6	70-95

Results indicated normal language development of Arabic Language in Group 1

Table 3: Arabic language assessment with receptive expressive Arabic language scale in group 2

	Mean±SD	Range
Receptive Language Score		
Raw score	159±6	139-163
Total Scaled	125±5	109-129
Percentile Rank	90±5	75-95
Expressive Language Score		
Raw score	210±7	192-223
Total Scaled	119±3	111-124
Percentile Rank	89±5	70-95
Total Language Score	369±12	331-386
Total Scaled	123±4	111-128
Percentile Rank	89±6	70-95

Results indicated normal language development of Arabic Language in Group 2

Table 4: The Stanford-binet intelligence scales scores of group 1

	Mean±SD	Range
Factor Indices		
Fluid Reasoning	104±10	92-124
Knowledge	103±14	73-139
Quantitative Reasoning	100±11	79-118
Visual-Spatial Reasoning	99±9	82-118
Working Memory	96±7	79-113
Domains		
Nonverbal IQ	106±12	81-126
Verbal IQ	100±8	85-113
Full-scale IQ	102±9	90-120

The scores of the Stanford-Binet Intelligence Scale of Group 1. Notably, the scores on all components of the SB scales and the full-scale IQ were average scores in all children of Group 1.

Table 5: The Stanford-binet intelligence scales scores of group 2

	Mean±SD	Range
Factor Indices		
Fluid Reasoning	104±10	92-124
Knowledge	103±14	73-139
Quantitative Reasoning	100±11	79-118
Visual-Spatial Reasoning	99±9	82-118
Working Memory	96±7	79-113
Domains		
Nonverbal IQ	106±12	81-126
Verbal IQ	100±8	85-113
Full-scale IQ	102±9	90-120

The scores of the Stanford-Binet Intelligence Scale of Group 2. Notably, the scores on all components of the SB scales and the full-scale IQ were average scores in all children of Group 2.

Table 6: Correlation of PLS-5, Real Scale, and stanford binet scale scores

		PLS-5 Group 1	Real Scale Group 1	Real Scale Group 2
Age	**r**	-0.049	0.064	-0.086
	p	0.839	0.789	0.717
Fluid Reasoning	**r**	0.387	-0.091	0.268
	p	0.092	0.703	0.253
Knowledge	**r**	0.454	0.126	0.080
	p	0.045	0.596	0.737
Quantitative Reasoning	**r**	0.268	-0.189	0.313
	p	0.253	0.424	0.179
Visual-Spatial Reasoning	**r**	0.054	-0.261	0.287
	p	0.822	0.266	0.219
Working Memory	**r**	-0.104	0.091	-0.139
	p	0.663	0.703	0.559
Nonverbal IQ	**r**	0.395	-0.035	0.216
	p	0.085	0.882	0.361
Verbal IQ	**r**	0.248	-0.138	0.252
	p	0.292	0.562	0.284
Full-scale IQ	**r**	0.410	-0.021	0.209
	p	0.072	0.929	0.378

No difference between children in Group 1 and Group 2 in correlation with cognition

Table 7: Relation between child sex and cognition scores in Group 1 and Group 2

SSI score	Male n=13	Female n=7	p-value
Before Treatment	28±4	28±4	0.643
After Treatment	11±8	15±8	0.351
Change	18±8	13±7	0.157
Percentage of change	62.4±26.5	48.2±27.6	0.275

Data are presented as mean±SD

4. Discussion

It is very common for schools to begin teaching foreign languages early, as the age of acquisition strongly predicts successful foreign language learning (Enever, 2012). English is the most common foreign language; it is the "lingua franca" of the world (Butler and Le, 2018). In Egypt, public schools

have introduced English as a mandatory subject since grade 7. Recently, schools taught English in grade 1. On the other hand, private schools introduce foreign language instruction as early as preschool.

Some studies suggest that multilingual individuals with ADHD may experience executive function problems, possibly as a result of the additional mental effort that multilingualism requires (Engel de Abreu, 2012). Other research indicates that bilingualism does not affect the cognitive profile of individuals with ADHD (Adesope *et al.,* 2010). This study looks at the effect of bilingualism on the cognitive abilities of children with ADHD in order to shed light on this relationship using new research.

To the best of our knowledge, the current study is the first to investigate the impact of bilingualism on cognition in Egyptian children aged 5-9 years. All children were from a typically developing population. Forty children were divided into two groups, 20 each, in which the two groups' languages were compared to the cognitive skills of ADHD children. In the present study, the language assessment of group 1 showed typical language development in both Arabic and English (Butler, 2015 and Song, 2018). Group 2 also showed typical language development.

Recent studies have investigated the possible cognitive impacts of bilingualism in children with Attention-Deficit/Hyperactivity Disorder (ADHD). However, research shows that bilingualism does not affect how well people with ADHD think (Bialystok *et al.,* 2017). According to the current study, cognitive abilities like executive functioning, working memory, and attention management did not correlate with bilingual language skills in ADHD children (Köder and Perera, 2021).

These results are in line with earlier research that examined cognitive and language skills in bilingual children with ADHD in a systematic manner, such as Köder and Perera (2021). Their meta-analysis showed no statistically significant changes in cognitive flexibility, working memory, or attention between monolinguals and bilinguals with ADHD. This means bilingualism does not improve or worsen cognitive control in children with ADHD. Similarly, Bialystok *et al.* (2017) looked at executive control in monolingual and bilingual children with ADHD and concluded that bilingual children with ADHD do not benefit from the multilingual benefits in executive function shown in neurotypical groups. The findings support the idea that there is no correlation between bilingualism and cognitive abilities related to ADHD, as bilinguals with ADHD perform cognitive tasks like monolinguals (Bialystok *et al.,* 2017 and Mor *et al.,* 2015).

These results could be explained by the fact that ADHD widely impacts executive functions unrelated to linguistic skills. Working memory, impulsivity, and attention problems are characteristics of ADHD. Therefore, the cognitive needs of bilingualism might not have an additional impact on these fundamental deficiencies. Additionally, because of the underlying executive function problems, bilingual cognitive benefits, including increased cognitive flexibility, are not evident in children with ADHD (Sharma *et al.,* 2022).

The findings in this study confirm that bilingualism is unjustified to add more cognitive load to children with ADHD. Also, parents and teachers shouldn't assume that bilingualism could help decrease the cognitive challenges faced by children with ADHD (Sorge *et al.,* 2017). This study contributes to the current data, which indicates that bilingualism has no evident positive or negative impact on cognitive functions in children with ADHD. The lack of a correlation highlights the importance of taking a different approach when considering bilingual education for children with ADHD, ensuring that language acquisition choices are founded on social and cultural factors rather than cognitive concerns. Future studies should investigate potential interactions between ADHD-related cognitive deficiencies and certain factors, like language-switching demands or bilingual education, based on interventions

5. Conclusion

The study's findings show that bilingualism does not impact cognition in children with ADHD. Its bilingual language ability has no effect on working memory, executive functioning, or attention. According to these findings, bilingual education in ADHD populations does not impair or improve cognitive capacities. As a result, social and educational factors, not cognitive ones, should guide language learning options for children with ADHD.

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