

# The Neurocognitive Approach to Language Teaching Through the Interaction Between Working Memory Components and Bilingualism: A Narrative Review of the Evidence

المقاربة المعرفية لتدريس اللغة من خلال التفاعل بين مكونات الذاكرة العاملة  
والثنائية اللغوية: مراجعة سردية

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## Abstract :

**Objectives:** The study aimed to carries out a narrative review to analyze and summarize the results of the evidence related to working memory in monolingual and bilingual children. **Methods:** An electronic database search on ScienceDirect, PubMed, Google Scholar, and Semantic Scholar was conducted to identify articles investigating working memory and bilingualism. To select research published in peer-reviewed journals until 2023; out of 30 studies, 10 met the selection criteria. **Results:** The evidence varied in terms of the positive and negative influence and interaction of working memory and bilingualism, but there is a correlation between verbal-visuospatial working memory and inhibition abilities that contribute to working memory processing capacity.

**Keywords:** Bilingualism; Working memory; Inhibition; Teaching foreign languages.

## ملخص

هدفت الدراسة إلى إجراء مراجعة سردية لتحليل وتلخيص نتائج ابحاث المتعلقة بالذاكرة العاملة لدى الأطفال احادي وثنائي اللغة. تم إجراء بحث إلكتروني شامل في قواعد البيانات ScienceDirect و PubMed و Google Scholar و Semantic Scholar. لانتقاء الابحاث المنشورة في مجلات محكمة الى غاية 2023، من بين 30 دراسة تم انتقاء 10 تحققت فيها معايير الانتقاء. تباينت النتائج من حيث التأثير والتفاعل الإيجابي والسلبي لمكونات الذاكرة العاملة والثنائية اللغوية، ولكن هناك ارتباط بين الذاكرة العاملة والقدرات الانتباهية التي تساهم في قدرة الذاكرة العاملة على المعالجة. كلمات مفتاحية: ثنائية اللغة؛ الذاكرة العاملة؛ القدرات الانتباهية؛ تدريس اللغات الأجنبية.

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## 1- Introduction

The family and social environment are considered one of the most influential factors in a child's language acquisition through forms of linguistic and non-linguistic communication and interaction in the child's environment. According to what Forest & Syksou (1994) emphasized, the environment is considered the public space in which the close relationship between language and various forms of interaction processes is acquired. Perhaps one of the most prominent researchers and theorists who spoke about the role of social interaction and its effects on the acquisition of language in the individual in the modern era was the Soviet scientist Vygotsky, who pointed out the relationship between language and thought and how it develops in the child. Among the various theories explaining a child's cognitive development, we find that Vygotsky (1978) is one of the most prominent early theorists who highlighted the role of language in cognitive and social development and the structural impact of language on the development of human knowledge. According to Vygotsky, language helps us avoid impulsive behaviors by playing an important role in developing self-control behaviors such as restraint and planning, in addition to the interaction of language and thought evolutionarily and developmentally. He believes that language is determined by two interconnected functions: the symbolic function necessary for logic and the formation of concepts, and the communicative function. According to what was mentioned, the basic properties of language partly determine many linguistic and non-linguistic behaviors, such as categorization, working memory, perception, and reasoning. Based on what is included in these theories, it can be recognized that bilingual children's use of two different languages, especially verbal encoding, enhances their executive functions. (Mehrani & Zabihi, 2017). Jalali-Moghadam (2015) believes that research has shown that bilingualism produces various cognitive effects. These effects are generally considered positive and contribute to improving the level of cognitive processing. There are studies that show evidence and proof that support the idea that there are benefits and cognitive advantages of bilingualism in various fields such as: Problem Solving Bialystok (1992, 2006), Metacognitive awareness Ransdell; Barbier; Niit (2006), Vorstman; Swart; Ceginkas; Berg (2009), Attentional control Bialystok; Craik ; Klein ; Viswanathan. M (2004). Mehrani & Zabihi (2017) and Bialystok (2001) believe that the abilities of bilingual children, enhanced by the presence of different linguistic representations, can play an important role in improving executive function skills such as cognitive flexibility, attentional control, and working memory. Jalali-Moghadam (2015) believes that research has shown that bilingualism produces various cognitive effects. These effects are generally considered positive and contribute to improving the level of cognitive processing. Some studies show evidence and proof that support the idea that there are benefits and cognitive advantages to bilingualism in various fields, such as problem-solving. Bialystok (1992, 2006), Metacognitive

Awareness Ransdell; Barbier; Niit (2006); Vorstman; Swart; Ceginskas; Berg (2009), Attentional Control Bialystok, Craik, Klein, and Viswanathan, M. (2004) Mehrani & Zabihi (2017) and Bialystok (2001) believe that the abilities of bilingual children, enhanced by the presence of different linguistic representations, can play an important role in improving executive function skills such as cognitive flexibility, attentional control, and working memory. Many studies have shown inhibition and selective attention, which is the ability to select, direct, and control attention by directing it to related stimuli and ignoring unrelated stimuli, which Baddeley (1992) considers it the executive center responsible for coordinating between the phonological component and the visual-spatial component. Regarding this ability, most studies indicate that there is a positive mutual interaction between the development of attentional abilities and bilingualism. Regarding the two sub-components of phonological and visuospatial working memory, in contrast to the central and executive component, which is selective attention, since the evidence findings were not consistent, some studies concluded that there was no difference in their results between bilinguals and monolinguals in working memory. The importance of the study appears through the importance of working memory in language learning, the importance of bilingualism and its impact on cognitive functioning, and the interaction of language and cognition. To what extent do the components of working memory interact with language learning?

Our study aimed to conduct a narrative review to summarize and analyse the results of research related to working memory, bilingualism, and the interaction between them in terms of the mutual influence between working memory and language learning and teaching.

## **2- Methods**

The study approached the analytical method of literature review, where evidence data related to the study were collected for analysis and discussion.

### **2-1 Search Strategy:**

Electronic searches were performed using ScienceDirect /PubMed/Google Scholar/ Semantic Scholar databases combining the following search terms: "Working memory"; "Bilingualism", "Multilingualism", "Second language learners", "Verbal working memory", "Phonological loop", "Information processing". Databases were reviewed using search terms. In addition, the reference list of the included articles was carefully hand-searched to further identify other studies of possible interest. References of each included article were carefully scrutinized to further identify other studies of possible interest. No standardized approach was used since our aim was to produce a narrative review.

## **2-2 Selection Criteria:**

All the studies on working memory and foreign language learning and teaching published until 2023 have been included. Studies were included according to the following criteria: Studies were included according to the following criteria: (a) being an original paper published in a peer-reviewed journal, (b) being an English language paper, (c) recruited and reported data for Schooled children. Studies were excluded if they (1) focused on Adults; (2) investigated Executive functions other than working memory; (3) All the studies, meta-analyses, and review articles on working memory and foreign language learning and teaching.

## **3- Results**

We searched the databases mentioned above at the end of October 2023 and obtained more than 30 studies after the initial screening of titles and abstracts. Articles without inclusion criteria and with no working memory, bilingualism, and foreign language learning and teaching content were excluded. 10 articles in total were included in the final review.

### **3-1 The interaction between working memory and bilingualism data:**

Elma Blom et al. (2017) studied the cognitive advantage of children with different linguistic backgrounds. The study aimed to reveal the possible effect on executive functioning in children with different linguistic and social backgrounds and to examine the differences in executive functions (verbal and visuospatial working memory) between four linguistic groups: Monolingual as a group control and three bilingual groups with different linguistic and social backgrounds homogeneous in age, sex, intelligence, and educational level of parents. 176 children were divided into 4 language groups (monolingual Dutch, bilingual Frisian-Dutch, bilingual Limburg-Dutch, and bilingual Polish-Dutch) at the age of 6-7 years. They found that there is no bilingual effect on verbal and visuospatial working memory.

Mehrani & Zabihi (2017) conducted a comparative study of the working memory ability of monolingual and bilingual children. The study aimed to investigate the effect of bilingual experience on executive processing in children by comparing performance on the executive functions battery between monolingual and bilingual children. The study sample was 67 kindergarten children, with an average age of 5 years, bilingual Persian and Turkish speakers, and monolingual, Persian speakers. The study concluded that the average scores of the bilingual children in inhibition control abilities were higher than the average of the monolingual children, and the average scores of the children of the two groups in working memory were very close. This means that there is no difference in performance on working memory, and there is no effect of bilingualism on performance on the working memory task.

McVeigh, Wylie, and Mulhern (2017) studied verbal and visuospatial working memory among bilingual children in an educational immersion program. The study aimed to investigate short-term memory and working memory among a group of bilingual children in a minority language education program and monolingual children and to study the differences between them. The youngest and oldest age groups in the two study groups The study sample consisted of 121 children from primary schools in Northern Ireland, aged 7-9 years. The sample consisted of 55 bilingual children studying in the Irish language education program and learning English at school, and 66 monolingual children. Verbal tasks were administered in English and Irish to bilingual children, and the study found that there were no statistically significant differences between monolingual and bilingual children and between the youngest and oldest age groups in performance on working memory and short-term verbal and visuospatial working memory tasks and that there was no effect of bilingualism on short-term memory, verbal and visuospatial working memory.

Kardooni et al. (2016) conducted a study to evaluate the role of bilingualism in auditory verbal working memory, which aimed to compare monolingual and bilingual children in the performance of auditory verbal working memory. The study sample was 111 Iranian children, with an average age of 11 years, studying in the fifth and sixth grades of primary school. The sample was divided into 55 bilingual children (Arabic and Persian speakers) and 56 monolingual children (Persian speakers). It was concluded that the performance of bilingual children in auditory verbal working memory was better than the performance of monolingual children and that bilingualism had a positive role in auditory verbal working memory.

Hansen et al., (2016) contributed to revealing the development of working memory in monolingual and bilingual children and the influence of the second language on executive functioning, control, and updating, as well as linguistic processing (reading, vocabulary, and lexical access); The study sample consisted of 76 monolingual children and 76 bilingual children in language immersion (emerging bilingualism), distributed across the four academic levels. Vocabulary, naming speed, reading, and working memory tasks were administered. The study found an advantage for bilinguals over monolinguals in the working memory task (updating and executive control) in the younger group and no differences between the older ones. In contrast, there was an advantage for monolinguals in the naming speed task, whereas bilinguals were slower in accessing the lexicon and reading. There was a correlation between naming speed and reading over working memory.

Blom et al. (2014) studied the advantage of bilingualism in working memory. The study aimed to reveal whether bilingual children outperform monolinguals on tasks of verbal and visuospatial working memory. The study sample consisted of 68 bilingual children who were Turkish and Dutch

speakers and 52 children who were Dutch speakers. At the age of 5 and 6 years. They found that bilingual children outperform monolinguals on tasks of verbal and visuospatial working memory, and they found that bilingual children showed cognitive abilities in tests of verbal and visuospatial working memory, especially on tasks that require processing and not just storage. The results indicate that the cognitive advantages of bilingualism are present in socioeconomically disadvantaged bilingual groups.

Abdelgafar & Moawad (2014) studied the differences in executive functions between monolingual and bilingual children. The study aimed to reveal the differences between monolingual and bilingual children in executive functions. The study sample was 50 Saudi children aged between 7 and 10 years, divided into two groups: 25 monolingual children (Arabic speakers) and 25 bilingual children (Arabic-English speakers). The visual memory and immediate memory tasks were administered. The study found that there were no statistically significant differences between the two language groups in executive function tasks. There are no statistically significant differences regarding the interaction between language and age. There were no statistically significant differences between the groups on the verbal fluency task or the various memory tasks.

Engel de Abreu (2011) study aimed to investigate the extent to which bilingualism affects working memory in bilingual children and to verify the hypothesis that bilingual children can show more effective working memory abilities than monolingual children. The study sample included 44 children from Luxembourg schools aged between 6 and 8 years, 22 monolingual children, and 22 bilingual children. Both groups were homogeneous in age, gender, socioeconomic status, and non-verbal intelligence. The Automated Working Memory Assessment, Alloway (2007) Battery tests (numerical recall task, the reverse digit recall task, the ordinal digit recall task), and the nonword repetition task (LuNRep, Engel, 2009) were administered. The study concluded that there are no statistically significant differences between monolingual and bilingual children in performance on working memory tasks (numerical recall, reverse number recall task, and ordinal number recall), and in the nonword repetition task, monolingual children outperformed bilingual children.

Bonifacci, Giombini, Bellocchi, and Contento (2011) contributed to revealing differences between monolingual and bilingual children on a battery of working memory tasks. The study sample consisted of 36 children between the ages of 6 and 12 years. The study found that there were no differences between the two groups and no effect of bilingualism on verbal working memory.

Hutchison (2008) contributed to revealing whether bilingualism represents an advantage in children's performance on executive function tasks and compared the performance between monolingual and bilingual children on executive function tasks (working memory). The study sample consisted of 56 children with an average age of 5 years. The study sample consisted of two groups: 27 German-English-speaking bilingual children and 29 English-speaking monolingual

children. The study found that there were no statistically significant differences between monolingual and bilingual children in performance on executive function tasks (short-term memory and working memory), even taking into account the level of language proficiency.

#### **4- Discussion**

In this narrative review, our study aimed to investigate the interaction of working memory and learning and teaching foreign languages through bilingualism in children to contribute to the role of language learning in developing working memory, executive functions, and processing capacity in the information processing system, which contribute to language learning. When we examine the results of the studies, we find that three studies found a bilingual advantage in working memory and seven studies did not find an advantage. This leads to inconsistency in the results of studies. The results of the studies were inconsistent; Some studies concluded that there was no difference in their results between bilinguals and monolinguals in working memory. Some studies have tested the hypothesis that bilinguals may show more effective efficiency in working memory than monolinguals, and this is because of what the environment and experience of bilingualism provide in training cognitive control by resisting interference and conflict between the target and non-target language. They found that there were no differences and no effect of bilingualism on working memory. Bonifacci et al. (2011) concluded: Blom et al. (2017); Abdelgafar & AbdelMatloub (2014); Mehrani & Zabihi (2017) indicated that there were no differences in performance between monolinguals and bilinguals on phonological and visual working memory tasks. On the other hand, Engle (2002) and Kane, Bleckley, Conway, & Engle (2001) found that on some tasks, especially those requiring a high degree of attention, bilinguals often show an enhancement in working memory performance. Mehrani & Zabihi (2017) believe that these results have led some researchers to assume that bilinguals may develop working memory efficiency due to their ability to develop a language palm while using another language. However, Merrienboer & Sweller (2005) emphasized that dual language activation in bilinguals may impose demands and burdens on their working memory systems. Therefore, it may result in less efficiency in processing information while completing working

memory tasks. (Mehrani & Zabihi, 2017, p. 423). Beck (2014) believes that research shows the role of bilingualism and the acquisition of a second language and the extent to which it may affect executive functions, including attentional abilities, verbal and visual working memory, and the existence of a connection between them.

## 5- Conclusion

We find in the literature and studies that there is great controversy about the effect of bilingualism on working memory, especially the verbal aspect. Adesope et al. (2010) argue that there are two contradictory hypotheses about the relationship between bilingualism and working memory. firstly, the need to process two languages simultaneously can impose greater demands on working memory; This hypothesis suggests that bilingualism may hinder efficient processing of information in working memory due to the cognitive load imposed on working memory, according to Lee, Plass, & Homer (2006); Sweller & Chandler (1994); van Merriënboer & Sweller (2005); Here, bilingualism can be a negative factor. Conversely, bilinguals' developing ability to inhibit one language while using another language may increase the efficiency of working memory capacity because working memory resources are appropriately processed through this inhibitory processing, according to Bialystok et al. (2004); Bialystok, Craik, & Luk (2008); Fernandes, Craik, Bialystok, & Kreuger (2007); Just & Carpenter (1992); Michael & Gollan (2005); Rosen & Engle (1997). Here, bilingualism can be a positive and compensatory factor for cognitive deficiency. Within the limits of our study, we recommend a systematic review and meta-analysis of working memory and bilingualism research, and conducting more research in the Algerian environment, to explore results more relevant to the Arab environment. There are similarities between research on cultural and linguistic diversity among members of the study sample and the research design through comparison between linguistic and cultural groups. The English language was the dominant second language in the study communities, and it focused on the advantages of bilingualism. Research on cognitive functions and bilingualism is still limited in the Algerian environment. It needs contribution and exploration to investigate the results of the evidence.

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