

Working memory and reading difficulties

الذاكرة العاملة وصعوبات تعلم القراءة

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Abstract:

This research paper aims to identify the most important cognitive processes that process information represented in working memory and determine the extent of their association with difficulty of learning to read by reviewing and analyzing some previous studies that addressed this topic. This study relied on the descriptive approach, and in the end the following results were extracted that: children with reading difficulties are affected by a decrease in the capacity of working memory and the reading process in children with reading difficulties is affected by the presence of disorders in the working memory systems, some studies also found statistically significant differences between normal pupils and those with reading difficulties in favor of normal children, it also concluded that there are a great difficulties in children with reading difficulties in working memory tests related to the phonological loop and the visual spatial sketchpad.

Keywords: memory, working memory, learning difficulties to read.

ملخص:

تهدف هذه الورقة البحثية إلى التعرف على أهم العمليات المعرفية التي تقوم بمعالجة المعلومات المتمثلة في الذاكرة العاملة وتحديد مدى ارتباطها بصعوبة تعلم القراءة من خلال استعراض وتحليل الدراسات السابقة التي تناولت هذا الموضوع. وتم الاعتماد في هذه الدراسة على المنهج الوصفي، وفي النهاية تم استخلاص النتائج التالية: أن التلاميذ ذوي صعوبات تعلم القراءة يتأثرون بانخفاض سعة الذاكرة العاملة وأن عملية

القراءة لدى الأطفال ذوي صعوبات القراءة تتأثر بوجود اضطرابات في أنظمة الذاكرة العاملة، وكذلك أسفرت بعض الدراسات إلى وجود فروق دالة إحصائية بين العاديين وذوي صعوبات تعلم القراءة لصالح العاديين، كما توصلت أيضا إلى وجود صعوبات كبيرة لدى الأطفال ذوي صعوبة تعلم القراءة في اختبارات الذاكرة العاملة المتعلقة بالحلقة الفونولوجية والمفكرة الفضائية البصرية. كلمات مفتاحية: الذاكرة، الذاكرة العاملة، صعوبات تعلم القراءة.

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1. Introduction

The Learning process requires different cognitive functions that interact with each other in order for learning to take place properly. The latter occurs through the interaction of previous experiences and information with new situations that the individual learns, and this process requires active use of memory, which is the repository in which the individual stores the situations, experiences, experiments and events he goes through and retrieves then when needed. Memory is closely linked to the learning process and is considered an essential component of learning, as it enables the storage of the information they learn. Then it has been divided into different types for a long time the, we find short-term memory and long-term memory. However, researchers in the field of cognitive and neuropsychology were not able to name the term short-term memory, as they found that it does not play an important role in receiving and temporarily retaining information without subjecting it to processing and maintenance. After the studies and research they conducted and found a new term known as working memory. The term short-term memory was replaced by working memory because it gives it a more accurate and realistic meaning in light of its functions, so the concept of working memory became more accepted than the concept of short-term memory.

Working memory is an active component that processes the information presented to it in an organized manner with the help of that present in long-term memory. Baddeley divided working memory into components because the processing it done with the help of these systems represented by the central outlet and two subsystems, as Baddeley called them, which are the visual spatial memory and the phonological loop. Then he added a new component represented by the event buffer, each of which has a fundamental role in the process of processing and storing information. Working memory is associated with many other cognitive aspects such as reading comprehension, learning skills, solving complex problems, and learning. That was an important process in our daily lives, through which knowledge is acquired from the external environment, and the school can be the most important of them. So the child learns new experiences and receives information that helps him in his academic lifetime and the information he deems important is fixed in his mind forever, but not all children can perform the task of retention as it should be. We find categories of people who find difficult to store information, which is the category of those with learning difficulties such as difficulty learning to read.

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Difficulties in learning to read constitute a large percentage of children who suffer from it, as it is represented by the abundance of errors while recognizing words and deleting or replacing a letter or adding letters that are not originally present in the sentence or word, the inability to extract a basic idea of the text with a lack of comprehension of the content of the text, and we also notice tension and confusion while reading with the loss of the reading place... etc.

Working memory plays a fundamental role in the emergence of reading learning difficulties. A child who has low working memory or low capacity working memory or disorders in one of its systems that helps the learning, this leads to reading learning difficulties and this indicates that the reading process in children with reading difficulties is affected by the presence of disorders in the working memory systems, and any defect in these systems will inevitably lead to reading difficulties in the child. Therefore, in this research paper, we will try to present theoretically some definition of working memory and its components then some previous studies that addressed the topic of working memory and reading learning difficulties and try to analyze them.

2. Definition of working memory:

➤ Working memory which was introduced in a paper by baddeley and hitch (1974) is defined as “a limited capacity system for temporary ad storage and manipulation of information for complex tasks such as comprehension, learning, and reasoning” (E. Bruce Goldstein, 2015, p 133)

➤ Baddeley (1999), Defined working memory is the most important concepts of cognition sciences as many aspects of human life depend on it. Instead of a single system, it is a group of interacting systems, each of which is capable of encoding, recording, storing and then retrieving information without this ability to store information; it is not possible to fully perceive it. (Bora, 2021)

➤ According to Baddeley and Hitch (1974) working memory is a term like some others in psychology that suffers because different children use it in subtly different ways. In its broadest sense, working memory refers to the use temporary storage mechanisms in the performance of complex tasks. So for example, in order to read and understand prose, we must be able to hold incoming semantic and syntactic relationships among successive words, phrases and sentences and construct a coherent them meaningful representation of the meaning of the text. In this view the ability to understand prose will depend on, among other things the capacity of a person’s working memory system. Such temporary storage of information is obviously necessary for the performance of a wide variety of other tasks from reading, such as mental arithmetic and verbal reasoning. (Charles Hulme and Susie Machenzie, 2014, p 21)

3. Definition of reading and learning difficulties to read:

3.1 Reading:

➤ according to Abdel A Aziz El Amine Belala, Boufoula Boukhemis (2022) is a mental process that is achieved through the availability of criteria including mental, cognitive,

biological, psychological and perceptual, apart from knowing the linguistic levels (phonological, grammatical, morphological, semantic and lexical) as reading is the basic skill in the educational process in terms of acquiring and learning the rest of the skills, we cannot acquire dictation or oral or written expression which require higher levels, without the reading process. (Abdel A Aziz El Amine Belala, Boufoula Boukhemis, 2022)

➤ Learner (2003) indicated that reading includes two main processes: decoding and comprehension. As for the decoding process, it includes translating printed words, recognizing the shape and understanding what is heard, and it enables the individual to read word correctly. And about the comprehension process it enables the individual to understand the meaning of single word through the context. (Rouba Mahmoud Al Dissy, 2019)

3.2 learning difficulties to read:

➤ Al zayat (1998), defined that the children with reading difficulties constitute a large proportion of the common cases among children with learning difficulties, and since a large amount of school learning depends on the ability to read difficulties in this area can have a devastating and destructive effect on the child's personality. (Mahmoud Aiwad Allah Salem, Madjdi Mohamed El Shahat, Ahmed Hassan Achour, 2003)

➤ According to Mirielle (2010), refers to the presence of difficulties in acquiring the skill of reading, this deficiency appears from the first moments of leaning to read, when the child learns to understand and translate phonemes and letter sound to decode words in general and it is a difficulty in identifying written words. The difficulty learning to read is not a disease but rather a symptom with multiple aspects that develop according to age, severity of disorder and each person's life circumstance. (Mirielle, Roberge, 2010)

4. Components of working memory in Baddele's model:

4.1 The central executive:

The central executive fulfills many different functions; some of its primary functions are regulatory in nature: it coordinates activity within working memory and controls the transmission of information between other parts of the cognition system. In addition, the executive allocates inputs to the phonological loop and sketchpad slave systems, and also retrieves information from long term memory. These activities are fuelled by processing resources within the central executive but which have a finite capacity. Cognition tasks that have been suggested to involve the central executive include mental arithmetic, recall of lengthy lists of digits, logical reasoning, random letter generation, semantic verification and the recollection of events from long term memory.

4.2 The phonological loop:

The phonological loop is a slave system specialized for the storage of verbal materiel. It comprises two components. And it stores represents materiel in a phonological code which decays with time. A process of articulatory rehearsal serves to refresh the decaying

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representations in the phonological store and so to maintain memory items. The rehearsal process is also used to recode nonphonological inputs such as printed words or pictures into their phonological form so that they can be held in the phonological store. In contrast, spoken speech information gains direct access to the phonological store without articulatory rehearsal. (Susan E. Gathercole, Allan D. Baddeley, 2009, p 05)

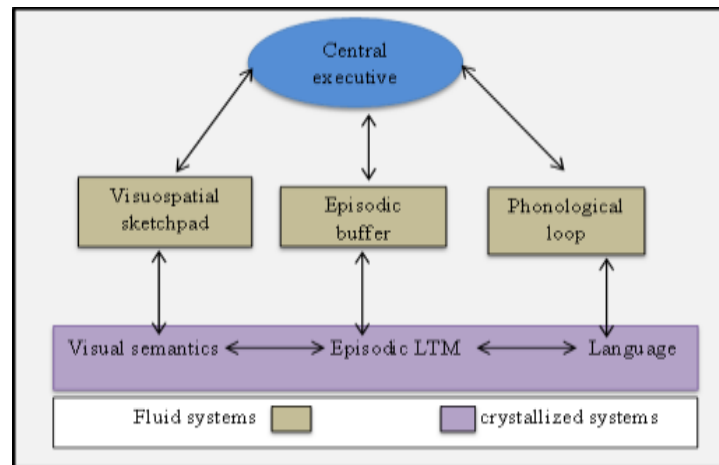
4.3 The visual spatial sketchpad:

Visuo-spatial memory system can be defined on the basis of the assumptions that receives information from either the senses or long-term memory, it is subject to a process by which information is lost over time, and it maintains information in a specific format that is related to characteristics of the visual and spatial material with which the system has to deal. Furthermore, in the working memory perspective, it is also necessary for the system to be able to elaborate the stored information, which may then be used in a variety of complex human activities such as orientation movement in space, mental imagery, drawing, and so on. (Cesare Cornoldi & Tomaso Vecchi, 2003, p 44)

4.4 The episodic buffer:

The episodic buffer assumed to be temporary representation accessible to conscious awareness. Rather than simply reflecting activated long-term memory, it is thought to play a constructive role in binding information together in chunks with the central executive; it is believed to play an important role in measures of working memory span. As such, it brings the Baddeley and Hitch model more in line with a range of alternative models that have tended to focus on executive processes, rather than on the subsystems but does so without abandoning the general model that has proved so fruitful in those areas. Its ultimate success, however, is likely to depend on its capacity to generate practical ideas and new knowledge. In the meantime, the episodic buffer serves the valuable function of moving the study of multi-component of working memory beyond the stage of fractionation and isolation of components, on the question of how the components work together and link into long-term memory. A better understanding of this system should enable us to identify and help children with limitations in one or more components of their working memory and may help people optimize the way they acquire new information and use it productively. (Susan J. Pickering, 2006, p25)

Figure 1: multicomponent model of working memory



(Baddeley, 2003, p835)

5. Working memory and reading difficulties:

An abundance of evidence in reading research implicates a deficit in phonological processing as the primary cause of reading difficulties. However, some readers with disabilities have no impairment in phonological processing, while nevertheless demonstrating very limited phonological short-term and verbal working memory spans. In such instances, weak short-term working memory makes it difficult to perform phonological process such as blending that are necessary for word identification. Clearly phonological processing ability is intertwined with phonological short-term memory. Consequently, difficulties with basic reading decoding skills are often associated with poor performance on short-term retention of phonological information such as digits and no words. Since the early (1960), a large number of studies have reported that poor performance on short-term memory tests is one of the most common characteristics of children with reading disabilities. For example, Speece (1987) found that 15 to 20% of these children displayed serious difficulties in digit span tasks. This means that children with reading disabilities are not able to efficiently use phonological short-term memory, sometimes because they are deficient in articulatory speed. Their reduced ability to temporarily maintain phonological memory codes reduces recall and impairs reading disabilities. There is evidence that the relationship between reading decoding and working memory reflects more than phonological processing ability and phonological short-term memory capacity. For example, Swanson (1992) found that when simple phonological short-term memory tasks are factored separately from more complex working memory tasks, short-term memory is not significantly related to word decoding skills, whereas working memory performance is. Such a finding indicates that deficits in verbal working memory and executive working memory also may be responsible for reading decoding problems. In particular, there is considerable evidence that individuals with reading difficulties have impaired verbal working memory. Simultaneous storage and processing of phonological information cannot be accomplished by the phonological store alone. Participation from executive working memory is required, especially when

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phonological processing during reading has not yet become automated. Further support for the role of working memory in reading disabilities comes from several studies that have found a deficiency in working memory capacity to be one of variables that differentiates between normal and dyslexic readers. (Milton J. Dehn, 2008)

6. Some previous studies that dealt with working memory among people with reading learning difficulties and analyzed them:

We will present a set of previous studies that dealt the subject of working memory and reading difficulties in the school environment, starting with the study of Amrani Amel (2013), which aimed to know the relationship between spatial structure and reading difficulty and between working memory and spatial structure disorders in children with reading difficulties, in addition to revealing the cognitive and non-cognitive factors through which the rate of emergence of this disorder can be predicted in the school. It was concluded that there are great difficulties in children with reading difficulties in working memory tests related to the sentence test that corresponds to the level of the phonological loop. It was also shown that they are unable to store and retrieve linguistic units and visual information in a short time, in addition to the presence of problems at the level of mental processing and the inability to perceive depth, etc. the components of working memory are related to spatial structure disorders in children with dyslexia. This is what Maxine (2000) pointed out in his study that children who suffer from language deficiency have problems in working memory and that these problems appear in the form of weakness in following directions and in the ability to infer when reading, difficulty in continuing a conversation on a specific topic, difficulty in solving mathematical problems, and weakness in understanding written texts. (Abu Al-Diyar, 2012, p 78)

We conclude from this study that working memory is responsible for the process of storing and retrieving information, and any defect in it leads to the inability to retain, whether at the level of the phonological loop, as the child's perception of words and sentences is linked to working memory, as well as a disorder at the level of The phonological loop leads to difficulty in reading, which is why children with dyslexia find it difficult to understand and recognize written sentences. On the other hand, we find the study of Bazrawi Nour El Hoda (2015), which aimed to try to identify the relationship between working memory capacity and reading learning difficulties by detecting the degree of influence and impact between them. It also aimed to reveal the possibility of the existence of statistically significant differences between normal children and children with reading difficulties in working memory capacity. The study concluded that there is a negative correlation between working memory capacity and reading learning difficulties, as well as the existence of statistically significant differences between normal pupils and those with reading learning difficulties in the direction of normal children. That is, the working memory capacity of those with reading learning difficulties is less than normal children.

Also, the study of Sari Mohammad and Zawawi Nasiri (2019) aimed to detect the level of working memory performance among children with reading difficulties and normal children. The study found that people with reading difficulties suffer from a disorder at the level of working

memory, and therefore there are statistically significant differences between normal pupils and those with reading difficulties in the level of working memory performance. And this study also concluded that pupils with dyslexia have difficulties in working memory represented by the storage unit, and the reason for this is the lack of working memory capacity. This is what the researcher Merinda et al (2020) indicated out with regard to the working memory capacity of children through recognition of words and their meanings and also retrieval them, and its results were identical to the two aforementioned studies "the study of Amrani Amal (2013) and the study of Bazrawi Nour Al-Huda (2015), that there is a relationship between the capacity of working memory and children's performance on working memory tests, especially auditory tests. The results of these studies were supported by the results of the study of Macdonald et al (2001), which concluded that there is a relationship between the capacity of working memory and understanding some ambiguous and non-ambiguous texts, and the sample consisted of two groups, the first group with high working memory capacity and the second with low working memory capacity, and the results of the study indicated that the number of errors in the group with high memory capacity in children through recognizing and understanding ambiguous and non-ambiguous texts was greater in understanding ambiguous sentences than the group with low capacity. The results reached by these researchers were consistent with the results of the study (2002, Evans) which found that children with language impairment suffer from weakness in the capacity of verbal working memory through their performance on the measures used in the study compared to normal children. (Abu Al-Diyar, 2012, p79)

It is clear to us from these studies that the capacity of working memory plays an important role in the performance of children who do not suffer from difficulties or problems in cognitive processes, such that if the capacity of working memory is high, the child's performance will be good, and if the capacity of working memory is low, the performance will be weak and low.

In the study of Fatna Daif (2016), which aimed to reveal the correlation between cognitive function disorders represented by working memory and attention with reading learning difficulties among children of the third and fourth grade primary school, and also to know the differences between the two study samples in the level of performance of working memory systems, and its results confirmed the existence of a strong correlation between attention deficit and reading learning difficulty among pupils with reading learning difficulties and the existence of an inverse correlation between working memory systems and reading learning difficulty, as well as the existence of differences between the group of normal children and their peers with reading difficulty learning to read that can be attributed to the difficulty in the phonological loop in favor of normal children, and this is what Fletcher (1985), showed, who concluded that children with reading difficulties have deficiencies in the level of memory for the verbal compound.

This study shows that attention deficit leads to difficulties in learning to read, meaning that children who show hyperactivity, impulsivity, and all the symptoms associated with attention deficit have difficulties in learning to read because of their inability to focus their attention.

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The reading process requires better focus so that the people's attention is not distracted and become vulnerable to making reading errors and unclear and incomprehensible reading, if any defect occurs at the level of cognitive functions such as attention and working memory, it may affect the reading function of children, especially those who are unable to read. Therefore, we find that the child does not have enough ability to focus his attention on what he hears or sees which leads to difficulty in reading. And this confirms that there is a strong relationship between attention deficit and working memory disorder and reading difficulty among children. The working memory systems represented by the digit memory test are also considered the directed arrangement for measuring the efficiency of the phonological loop and the spatial and visual memory. These tests enable us to know if the child has been able to store a series of words and numbers and has been able to retrieve them correctly and understand the text and other tasks required of him, then he is able to read correctly and the reading is clear, understandable and flowing without facing reading difficulties. However, if he is unable to store what is given to him and retrieve it as he is unable to understand the words and sentences, so he will face difficulties in reading and it will be incomprehensible with many mistakes and this indicates the weakness of his working memory that performs these tasks. In the same context, we find the study of Razika Louzai and Saida Brahimi (2016, 2017), which aimed to reveal working memory disorders and their impact on the reading process in children with dyslexia, in addition to testing the effectiveness of a proposed treatment program to reorganize working memory systems and its impact on the reading process and found that the reading process is affected by the presence of disorders at the level of working memory systems, and that the proposed program has a positive impact on the reading process and in improving the function of working memory systems. This indicates that the reading process in children with reading difficulties is affected by the presence of disorders in the working memory systems, and any defect in these systems will inevitably lead to reading difficulties to the child.

We also find the study of Amal Kaddouri Solaf Meshri (2019), which aimed to reveal whether there are differences between normal readers on the one hand and those with reading difficulties, phonological working memory, and visual attention. The study found a statistically significant difference between the average of normal readers and those with reading difficulties in phonological working memory (oral and visual), as well as a statistically significant correlation between reading ability and visual attention in deleting letters. Through the results reached in this study, it becomes clear to us that they are the same as the results of the two previously mentioned studies, the study of Fatna Daif (2016) and the study of Razika Louzai, Saida brahimi (2016, 2017), as children with reading difficulties have a weakness in visual attention, which causes them to be unable to coordinate in movement, through deleting letters. Visual attention is considered the main component of the reading process, and the child who cannot recognize letters and the inability to keep this expresses a disorder in the working memory that works on recognition and then storage, processing and retrieval. The child in this case suffers from disorders in one of the working memory systems, and thus he develops

difficulties in reading. These results obtained by the researchers were consistent with the finding results of the study of Bouakaz Yamina Ismail Laiss (2020), which aimed to investigate the differences between children with dyslexia and normal children in phonological awareness (auditory style, visual style) and its relationship to verbal working memory, and its results proved that there are statistically significant differences between children with dyslexia and normal readers in phonological awareness tests (auditory and visual style) in the tasks of deletion and phonetic substitution for the benefit of normal readers, and the results also indicated that the phonological awareness disorder consciousness in children with dyslexia is not auditory style but visual pattern, as well as it is also likely that there is a clear deficiency in phonetic representation in children with dyslexia.

This is what enabled us to conclude that the differences between normal and dyslexic children are due to the deletion and phonemic substitution in children with reading difficulties, on the opposite of what was shown in normal children who do not have this type of error, and that phonological awareness in children with reading difficulties is low compared to normal pupils, and their recognition of letters is very low compared to normal children, and this deficit is due to the inability to have phonological awareness, then that phonological awareness in those with reading difficulties is due to the visual pattern and not the auditory pattern, and this is due to the inability to recognize and retain letters and the reason to a disturbance in the level of working memory systems.

The study of Ben Tayeb Najat, Sahiri Zainab (2018), which aimed to study the relationship between weak working memory and reading difficulty in those are late in the school, and to reveal the differences in the level of working memory and reading difficulty between pupils who are academic delay and normal children. the result obtained indicated that there is a relationship between weak working memory and reading difficulty in those with academic delay, and the existence of statistically significant differences between people who are late in the school and normal people in the variables of reading difficulties and the level of working memory in both aspects the visual-spatial memory and the phonological loop. Then we find the study of Nabil Lamouri and Fatima Rayani (2021), which aimed to determine the relationship between working memory and reading and writing difficulties among fifth-grade, and the study yielded important result that there statistically significant differences between normal children and with reading and writing difficulties on the working memory test. The study of Abdelghani Jedidi and Nasser El-Din Zabedi (2021) aimed to highlight the role of phonological working memory in a child's acquisition of reading, and then its role as a determinant for diagnosing reading learning difficulties by studying the differences in performance on phonological working memory between normal children and those with reading learning difficulties. The results of the study revealed the existence of statistically significant differences between normal people and those with reading learning difficulties in performance on the phonological working memory test in favor of normal children. It is clear to us from these previous studies that there are statistically significant differences between normal pupils and those with reading difficulties in the working

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memory test. And this is because normal children do not have disorders in the level of working memory, unlike children with reading difficulties who have problems in the level of working memory, whether in the phonological loop, or the visual notebook, etc. This is what causes difficulties in reading and these systems in working memory have an effective role, and each system has its role, and any defect in it leads to learning difficulties.

7. Conclusion:

Working memory is a cognitive process responsible for temporarily storing information available for processing researchers differed in naming it. Some called it short-term memory, while others called it working memory, after the development of research in the field of memory it was called working memory because performs the task of encoding information and then storing it, which has a limited capacity in working memory and then retrieving it. Working memory plays a fundamental role in other cognitive processes because it is the center for processing information that comes from outside and this information retrieved from long-term memory. It is like a blackboard in which information is written before transferring it to long-term memory. Working memory is important in the learning process as learning depends on retaining information in the mind, children with weak working memory have learning problems, including difficulties learning to read, which is among the problems that children face in the school.

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