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EXPLORING THE FRONTIERS OF WORKING MEMORY: AN INTEGRATIVE REVIEW

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ABSTRACT
Working memory refer to the processes of information maintenance and executive control necessary for planning and performing tasks such as reasoning, comprehension, and learning. Understanding how this type of memory works and its relationship with auditory skills can contribute to rehabilitation of individuals with learning difficulties. The present study was conducted by searching for published works available in the databases PubMed, NCBI, MEDLINE, Scielo, and Google Scholar, with useful information for explanation and understanding of the topic. Among the studies selected for the present review, there are notable and inspiring research and discoveries. Over the years, the topic has been widely studied and researched, including its relation to childhood, the brain, and the biochemical and molecular processes that occur within it, as well as the adjacent auditory and phonological repercussions. Considering the importance of working memory in academic performance, it is essential to use available tests in students, aiming to expand the range of strategies that can improve their conditions and study capabilities. Further studies in this direction are needed in the educational context to guide the next steps of educational professionals and the future of students.

Keywords: Working memory. Model. Brain. Auditory processing. Phonological. Executive control.

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INTRODUCTION

There is a consensus in the literature that factors such as maintaining perceptually received information and controlling it are involved in knowledge acquisition. Understanding how this type of memory works and its relationship with auditory skills can contribute to rehabilitation of individuals with learning difficulties.

Retaining information to make it quickly retrievable is directly related to everyday tasks. According to Baddeley (2006), the human memory can be subdivided into short-term and long-term memory. There are several factors responsible for processing information from the environment (Tulving, 1972), resulting in its storage for a short or long period. In 2010, the same author (Baddeley, 2010) stated that short-term memory has been the subject of numerous studies and applications in recent years, particularly in the fields of psychiatry and education.

The term "working memory" was used by Miller et al. (2018) to refer to the processes of information maintenance and executive control necessary for planning and performing tasks such as reasoning, comprehension, and learning.

Thus, working memory capacity does not refer to memory itself, as it involves individual differences in executive attention. Engle (2001) describes studies that demonstrate the importance of these differences in everyday situations that involve distractions and task interference.

In this context, it is important to note that different memory capacities influence academic performance and development (Baddeley, 2006), and are related to cognitive activities such as reasoning tasks and verbal comprehension, including mathematical abilities (Cowan & Alloway, 2008; Alloway & Copello, 2013).

In this review, we characterized the main aspects of working memory to enhance understanding of the subject and promote the application of strategies for its improvement. Additionally, we sought to correlate it with auditory skills whenever possible.

METHODS

The present study was conducted by searching for published works available in the databases PubMed, NCBI, MEDLINE, Scielo, and Google Scholar, using the following keywords: *working memory* AND *model* AND *brain* AND *auditory processing*.

The inclusion criteria defined for article selection were as follows: articles published in English, Portuguese, or Spanish, with useful information for explanation and

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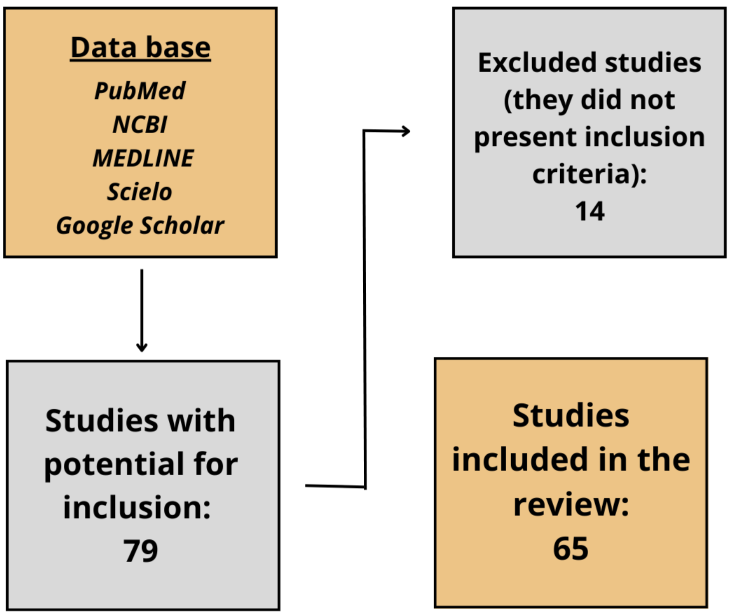
understanding of the topic, and accessible full-text content. No time limit was set for the search, and 65 studies were selected. Figure 1 below represents the process of literature search and study selection used in the present review.

Figure 1. Schematic representation of the selection process for inclusion of articles used in this review.



LITERATURE REVIEW

MAIN FINDINGS IN THE DATABASE SEARCH

Table 1 below demonstrates how many scientific studies were found in each database, while Table 2 brings together the main themes observed and some of the authors responsible for the publications, providing an overview of the subjects that will be addressed in this literature review.

Table 1 - Specification of the number of papers found and selected for the present study, according to the searches in databases

Data base	Number of scientific productions found and selected
PubMed	28
Google Scholar	23
NCBI	8
Scielo	4
MEDLINE	2

Table 2 - Main themes found and some corresponding authors

Authors	**Theme of the studies**
Gathercole et al., 2003; Alloway & Passolunghi, 2011; Aquino & Borges-Paraná, 2019; Swanson & Jerman, 2007	Assessment of working memory in school/academic/reading development
Baddeley, 2006; Atkinson & Shiflrin, 1968; Engle, 2001; Miller et al., 2018; Cowan & Alloway, 2008	Memory system characterization and its control processes
Pires et al., 2015; Steinbrink & Klatte, 2008	Relationship between working memory and phonological performance
Bauer, 2006; Howe & Courage, 1997; Rovee-Collier et al., 1989	Childhood memory
Guijo et al.,2018; Lunardelo et al.,2023; Iliadou & Bamiou, 2012; Maerlender et al., 2004; Yamaguchi & Bortz, 2021	Auditory processing and working memory capacity
Kandel, 2006; Moscovitch et al., 2006; Rueda et al., 2005; Scoville & Milner, 1957	Memory and associated brain regions

Among the studies selected for the present review, there are notable and inspiring research and discoveries. For instance, the study conducted by Alloway and Passolunghi with a sample of 206 children investigated the contribution of working memory and verbal ability (measured by vocabulary) to mathematical skills in children. The results indicated that more efficient memory is associated with higher IQ and better performance in mathematical tasks (Alloway & Passolunghi, 2011).

When it comes to memory and auditory processing, these findings become increasingly promising and intriguing. Pires et al. published a research study in the CoDAS journal aiming to investigate working memory systems, declarative memory, and procedural memory in children with central auditory processing disorder (CAPD) who had low performance in phonological awareness assessment. The sample included 30 children aged 9 to 10 years, divided into two groups: the control group, consisting of 15 typically developing children (8 females and 7 males), and the experimental group, comprised of 15 children with CAPD who had low performance in phonological awareness assessment (9 females and 6 males). The children in the experimental group exhibited inferior performance in the assessment of memory systems, suggesting that in children with CAPD, phonological processing is related to the memory systems under study (Pires et al., 2015).

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Additionally, Magimairaj and Nagaraj (2018) present new frameworks to understand auditory processing skills in children, based on integrated evidence from cognitive science, auditory science, and language science.

The following sections will present the main topics obtained from reading and understanding these selected studies for the present review.

WORKING MEMORY MODELS

Multiple Component Model

Various theoretical models have defined working memory as a specific cognitive process, while others have described its corresponding anatomical structures. Baddeley's componential theory assumes that the working memory system consists of separate storage for the maintenance of different types of information. In 1974, the existence of two storage systems was evidenced: a phonological short-term system and a long-term semantic system (Baddeley & Hitch, 1974; Baddeley, 2012).

Initially, Baddeley's theoretical model proposed three components, as depicted in Figure 2. The "central executive" is the component responsible for controlling and coordinating the other two elements of working memory. It regulates attention, inhibits irrelevant information, and allows relevant information to be stored and processed appropriately, directing attention to targets. The "visuospatial sketchpad," on the other hand, enables the temporary storage of visual and spatial information, such as object location and shape. The third component is the "phonological loop," which is responsible for the temporary storage of verbal or auditory information. It consists of two subcomponents: the "phonological store," which stores verbal or auditory information for a few seconds, and the "articulatory rehearsal mechanism," which allows this information to be maintained through a loop of repetition to aid in information retention (Baddeley & Hitch, 1974).

Figure 2. The three main components of working memory proposed by Baddeley and Hitch's theory in 1974

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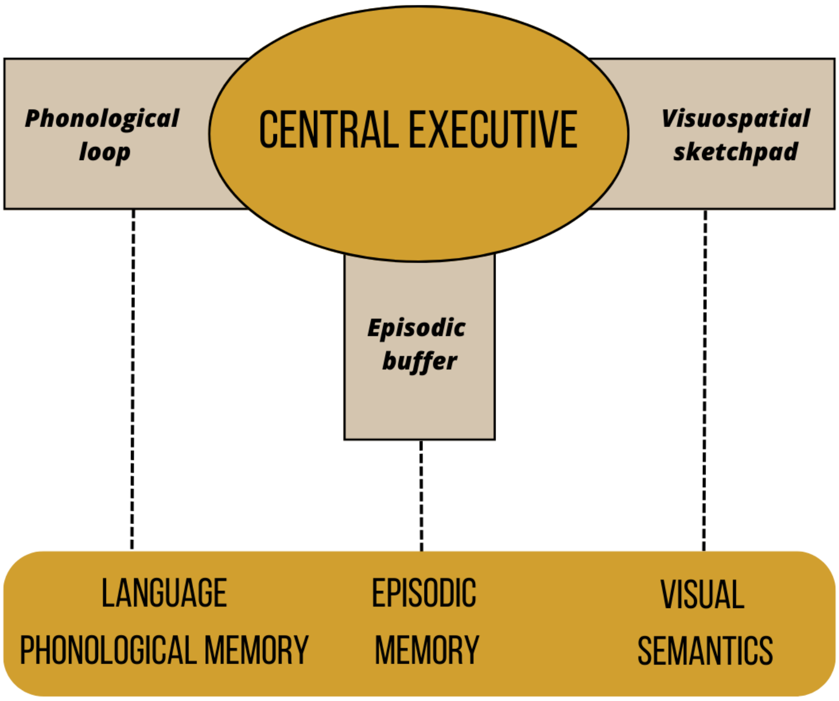
This theory is widely accepted and is useful for understanding the limited capacity of working memory and how it is utilized in everyday tasks, such as temporarily remembering phone numbers or following verbal instructions in a task.

Posteriorly, a fourth component was added to this theoretical model, the "episodic buffer," which holds multimodal representations of information such as semantics and integrates information from different loops to form a coherent whole, while also linking working memory to long-term memory (Figure 3) (Baddeley, 2012). The introduction of this new element established a connection between the bottom-up approach focused on understanding peripheral systems first and the predominant top-down approaches in North America that prioritize the analysis of executive and attentional aspects of working memory (Cowan, 2005; Engle et al., 1999). As a result, the concept has been widely accepted and continues to be frequently referenced. However, for it to be theoretically productive, it is crucial to use it to formulate interesting and feasible research questions, which has been a challenge in recent years.

Figure 3. Introduction of the fourth component to Baddeley's theoretical model



The multicomponent model has been particularly valuable in advancing our understanding of how children learn and acquire language (Swanson & Jerman, 2007; Baddeley & Hitch, 1993; Gathercole & Baddeley, 1993).

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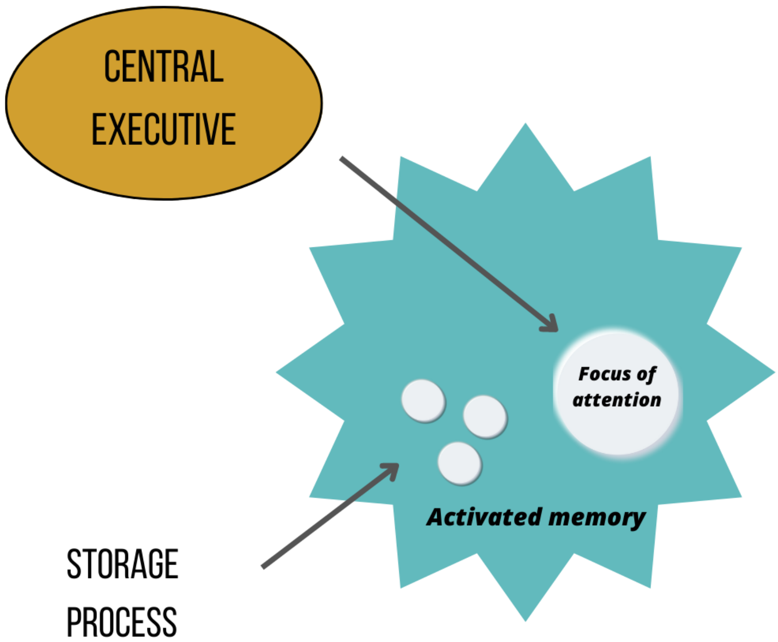
Embedded Processes Model

The Cowan´s Embedded Processes Model of working memory focuses on the interaction between working memory and long-term memory. According to this theory, working memory consists of a limited-capacity central processing unit that coordinates information across various specialized storage systems. These systems include a phonological buffer for verbal information, a visuospatial representation for visual information, and an executive system that controls access to long-term memory (Figure 4). Cowan's theory also posits that working memory capacity is limited and depends on the availability of attentional resources. Based on this, Cowan proposes that working memory is a transient state of activation of long-term memory rather than a separate entity (Cowan, 1995; Cowan, 2008), as mentioned earlier.

Figure 4. Cowan's Embedded-Processes Model



The performance of working memory

Individual differences in working memory performance may be associated with differences in three different mechanisms: attention control, which is the ability to maintain relevant information despite the presence of distractions; the number of items that can be stored according to memory capacity; and the ability to retrieve information from long-term memory and bring it into the focus of attention (Unsworth, et al., 2013).

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Working memory is involved in mental processes such as attention, learning, reasoning, problem-solving, and decision-making (Wang & Gathercole, 2013). Over the past 20 years, numerous studies have investigated the hypothesis that working memory is a process that underlies the ability to learn (Gathercole et al., 2003; Alloway & Passolunghi, 2011; Rohde & Thompson, 2007). Learning requires the manipulation of information, interaction with long-term memory, and simultaneous storage and processing of information (Dehn, 2008). There is evidence in the literature of impairments associated with working memory and various disorders that may appear in childhood and adolescence, such as ADHD, dyslexia, genetic syndromes, sleep problems, depression, schizophrenia, bipolar disorder, autism, stress, among others (Wang & Gathercole, 2013; Barendse et al., 2013; Talarowska et al., 2013).

In cases where it is intended to develop a measure (test) that assesses a function and/or component of the cognitive model, obtaining empirical and psychometric data is essential. It is necessary to determine if the data generated in a cognitive model are statistically confirmed.

CHILDHOOD MEMORY

Memory in childhood is a fascinating topic that has been studied by many researchers in developmental psychology. During the early years of life, children are capable of forming memories of specific events and sensory experiences, even if these memories are fleeting and ephemeral (Howe ate al., 2000). These memories are formed through the process of encoding, which involves transforming sensory information into cognitive representations that can be stored in memory.

As children grow, long-term memory begins to develop. This is the capacity to store information for longer periods of time and is responsible for retaining memories of significant experiences and important events in a child's life (Rovee-Collier, 1989). Various factors can influence childhood memory, including a child's age, brain maturity, attention, stress, and sleep. Additionally, memory can be enhanced through practice and the use of memorization strategies such as repetition, organization, and information association (Bauer et al., 2000).

Younger children tend to remember emotionally significant events better, while older children remember information that is related to their personal interests and hobbies (Courage & Howe, 2002). It is important to note that memory in childhood can be influenced by external factors such as stress and trauma. Studies like those conducted by Howe & Courage (1997) and Terr (1983) show that children who have been exposed to traumatic situations may have difficulties in forming and retaining memories of specific events and emotional experiences.

According to developmental psychology studies, most individuals do not have conscious memories before the 2 or 3 years old. This is because the ability to remember past events depends on the maturation of specific brain areas responsible for memory formation and retrieval. Additionally, during the early years of life, experiences are primarily processed at the sensory and emotional levels without the need for conscious memory registration. However, it is important to highlight that some individuals may have fragmented memories or flashes of events that occurred before the age of 3 (Bauer, 2007; Simcock & Hayne, 2002). This phenomenon is known as infantile amnesia, which has been recognized for a long time but is still not widely studied. The difficulty in conducting these studies lies in the unreliability of infant memories, as they can be influenced by later information provided by others or even by the child's imagination and fantasy. Therefore, it is important to exercise caution when interpreting these memories and not treat them as absolute facts (Bauer, 2006).

Rovee-Collier et al. (1989) studied infant memory for several decades, reporting that babies have long-term memory starting from three months years old. Furthermore, it was found that they can forget information that is not relevant or meaningful to them. For example, if a baby sees an object multiple times in a specific context, they may remember that object. However, if the same object is shown in a different context, the baby may not recognize it because it lacks meaning or relevance to them.

Parents and caregivers can help develop children's working memory by providing activities that stimulate information retention, such as memory games, puzzles, and reading aloud. Additionally, relevant cues or associations to aid in recalling important information are also valid strategies (Gathercole et al., 2003; Rueda et al., 2005; Diamond, 2013). Overall, working memory is crucial for cognitive development and learning in early childhood, enabling children to perform increasingly complex tasks as they grow and develop.

MEMORY AND THE BRAIN

Over the past two centuries, the study of learning and memory has predominantly consisted of philosophy and psychology. However, in the late 20th century, scientific

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advancements allowed for a new step: understanding the biological mechanisms involved in these processes (Squire & Bayley, 2007; Squire, 2009), through various theories and models that seek to correlate how memory works in the brain and how information is stored and retrieved. The study of the brain then evolved and gave rise to a new interdisciplinary field, neuroscience, encompassing knowledge from genes to cognition. The so-called molecular neuroscience has become established, encompassing the understanding of the function of neural cells within universal biological themes (Kandel, 2000).

Brenda Milner (1957) made a significant breakthrough in the discoveries involving memory and the brain when she described her findings in an epileptic patient known as H.M. The legacy of this work involves pillars that guide studies to this day, such as the fact that memory is a distinct brain function, not linked to other cognitive abilities. Subsequently, it was defined that memory as a whole is composed of different systems and operational principles (Squire, 2004). One of the most influential models in this regard is the Atkinson-Shiffrin Model, proposed by Richard Atkinson and Richard Shiffrin in 1968. According to the authors, memory is divided into three systems: sensory memory, short-term memory, and long-term memory. Information enters sensory memory through the senses, is transferred to short-term memory, and can later be stored for the long term (Atkinson & Shiffrin, 1968).

Eric Kandel is a prominent modern neuroscientist who has become known for his discoveries on the cellular and molecular processes underlying the formation and maintenance of memory. His pioneering work showed that short-term memory is stored in sensory neurons and long-term memory in motor neurons. He also discovered that the formation of long-term memory requires the activation of intracellular signaling pathways and the synthesis of new proteins. More recently, Kandel has focused on understanding how neuroplasticity, the brain's ability to change in response to new experiences, contributes to memory and learning. He argues that aging should not be seen as an inevitable decline in memory and cognition but as an opportunity to promote neuroplasticity and maintain brain health throughout life (Kandel, 2006).

Structures such as the hippocampus, entorhinal cortex, and fornix play important roles in this context (Moscovitch et al., 2006). Morris et al. (2003) discusses the importance of the hippocampus, presenting the fundamental role of synaptic plasticity in the "specific neurobiological theory of hippocampal function," where memory traces are encoded and stored automatically in this brain structure (Morris et al., 2003). The maintenance of hippocampal functional integrity is also identified as an independent predictor of successful memory aging, through preserved dopamine system functioning and minimal tau protein deposition (Nyberg & Pudas, 2018).

The prefrontal cortex is essential for strategies related to organization and monitoring (Squire, 2009), and it is also associated with decision-making (Bechara et al., 2000) and the resolution of conflicts in cases of false memories. In such cases, when the memory of an event is altered by inaccurate information, hippocampal representations of misinformation compete with the original information in the cortex to create false memories — events that people falsely experienced but never actually occurred. This topic has been extensively addressed by Elizabeth Loftus, culminating in a recent study demonstrating the weakening of true memory in the hippocampus using magnetic resonance imaging (Loftus, 2005; Shao et al., 2023).

WORKING MEMORY AND AUDITORY PROCESSING

Auditory processing is defined as the decoding of stimuli throughout the auditory nervous system, including factors such as sound localization, laterality, recognition of auditory patterns, and speech perception. The clinical assessment of these abilities is conducted through various tests by speech-language pathologists (Magimairaj & Nagaraj, 2018).

In cases of deficits in auditory perception, there is a condition known as auditory processing disorder, where individuals have difficulties in recognizing patterns, storing, filtering, or classifying existing signals (Riccio et al., 2005). Children with this disorder have normal hearing, but concurrent distractions and noises become obstacles, making the understanding of signals more complex (Moossavi et al., 2014).

Several studies (Iliadou & Bamiou, 2012; Maerlender et al., 2004; Conway et al., 2001) correlate aspects of auditory processing with working memory. There are reports that individuals with high working memory capacity perform better on auditory processing tasks, while children with impaired working memory have imprecise auditory perception and reduced auditory laterality (Moossavi et al., 2014). Pires et al. (2015) reported that children with auditory processing disorder had difficulties in certain cognitive aspects, including the working memory system[13]. Therefore, understanding how this type of memory functions and relates to auditory skills can contribute to the rehabilitation of individuals with learning difficulties.

It is known that age has a direct relationship with memory capacity, as older individuals have lower working memory, which is also influenced by education and socioeconomic level. Regardless of whether they have hearing loss or not, older individuals will experience greater auditory effort (Guijo et al., 2018; Vasconcelos, 2020).

Baddeley and Hitch developed tests to assess phonological working memory (Baddeley & Hitch, 1974), which, when used in a group of children by Murphy et al. (2013), showed a strong correlation with auditory processing, especially in the left ear. There is also a positive correlation between working memory performance and temporal processing (Lunardelo et al., 2023).

Research involving the relationship between these two fields encompasses various topics such as language, music, and cognition in general. Steinbrink & Klatte (2008) describe that children with reading and spelling problems use less efficient phonological strategies in serial recall tasks. Klatte further demonstrates in another study that the effects of acoustic conditions directly impact children's development and well-being in school, as the group in classrooms with reverberation reported higher internal noise load and performed poorly on phonological processing tasks (Klatte et al., 2010).

In general, musicians tend to show better performance in memory tasks (Yamaguchi & Bortz, 2021), benefiting from greater ability to hear speech in noise and remember sounds, involving sensory and cognitive skills. It is still debated whether this is due to musical training or predisposing characteristics of the individual (Kraus, et al., 2012).

DISCUSSION AND CONCLUSION

Operational memory refers to the process of maintaining and executive control of information, essential for performing daily tasks. Working memory is the core function by which we free ourselves from reflexive input-output reactions to gain control over our own thoughts. It has two types of mechanisms: online maintenance of information and its volitional or executive control. Classical models proposed persistent spikes for maintenance but did not explicitly address executive control. Synaptic weight changes between sparse bursts of spikes strengthen the maintenance of working memory. Executive control operates through the interaction between gamma oscillations (30-100 Hz) in the superficial cortical layers (layers 2 and 3) and alpha and beta oscillations (10-30 Hz) in the deep cortical layers (layers 5 and 6). Deep-layer alpha and beta are associated with top-down information and

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inhibition. It regulates the flow of bottom-up sensory information associated with superficial-layer gamma (Miller et al., 2018).

Theoretical models help us understand the functioning of these processes, with the most well-known and accepted being Baddeley and Hitch's Multiple Components Model (1974). Over the years, the topic has been widely studied and researched, including its relation to childhood, the brain, and the biochemical and molecular processes that occur within it, as well as the adjacent auditory and phonological repercussions.

The idea that memory is composed of distinct systems has a long history but became an experimental investigation topic only from the mid-20th century onwards. Starting around 1980, evidence from normal individuals, amnesic patients, and experimental animals converged on the view that a fundamental distinction could be made between a type of memory that is accessible to conscious recall and another type that is not. Squire's work (2004) moved thinking beyond dichotomies to a biologically grounded view that memory consists of multiple separate systems supported, for example, by the hippocampus and related structures, the amygdala, neostriatum, and cerebellum. This article traces the development of these ideas and provides a current perspective on how these brain systems operate to support behavior.

The memory consolidation hypothesis proposed 100 years ago by Müller and Pilzecker continues to guide memory research. Available evidence suggests that slow consolidation of memories by new memories serves an adaptive function, allowing endogenous processes that modulate memory strength over time. The review conducted by McGaugh (2000) examines the progress made in the last century in understanding emotional dependence in the formation of enduring memories. It highlights how significant experiences reorganize the processes that create our memories over time and how adrenal hormones, such as epinephrine and cortisol (or corticosterone in rats), and stress molecular mechanisms play an important role in memory consolidation regulation.

Cognitive development is also an extremely important and studied topic. Courage & Howe (2002) report on early cognition, in which a sudden change in capacity at the end of the second year of life has traditionally been assumed. These areas include deferred imitation, self-recognition, language, and categorization. Unlike many conventional theories, evidence shows robust continuities in all domains of early cognitive development. Where there is evidence of behavioral reorganization enabling a new level of performance,

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dynamic systems analyses indicate that even these can be driven by underlying processes that are continuous.

Based on the findings in the literature on the topics discussed in this review, we emphasize the importance of research in the area of auditory processing. One of the main studies in this field found here is Riccio et al.'s work (2005), which suggested that measures of auditory processing (AP) are sensitive measures of attention, resulting in a high comorbidity between auditory processing disorder (APD) and attention deficit hyperactivity disorder (ADHD). The results indicated significant correlations among the AP measures, as well as with some measures of attention, memory, and behavioral ratings. The results suggest that while AP measures include elements of attention and memory, these measures also appear to assess processes not captured by other measures.

On the other hand, the study by Guijo et al. (2018) aimed to review the literature on behavioral methods for assessing auditory effort and working memory capacity recommended for individuals with hearing impairments. It described previous publications to provide an overview of the research conducted so far, as behavioral methods used to measure auditory effort are still understudied in the audiological research field due to the feasibility and reliability of this method compared to patient self-report methods and the cost-effectiveness compared to psychophysiological assessment methods. Iliadou & Bamiou (2012) investigated the clinical utility of the Children's Auditory Processing Performance Scale to assess auditory ability in 12-year-old children and found that the group of individuals with auditory processing disorder performed worse than the other group.

Considering the importance of working memory in academic performance, it is essential to use available tests to evaluate students’ performance, aiming to expand the range of strategies that can improve their conditions and study capabilities. It is known that skills can be developed through exercises and stimuli (Aquino & Borges-Paraná 2019), so further studies in this direction are needed in the educational context to guide the next steps of educational professionals and the future of students.

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CONFLICTS OF INTEREST/COMPETING INTERESTS

The authors had no conflicts of interest to declare.

ETHICS APPROVAL

Not applicable

CONSENT TO PARTICIPATE

Not applicable

CONSENT FOR PUBLICATION

Not applicable

AVAILABILITY OF DATA AND MATERIALS

Not applicable

CODE AVAILABILITY

Not applicable

REFERENCES

1. Alloway, T. P., & Passolunghi, M. C. (2011). The relationship between working memory, IQ, and mathematical skills in children. Learning and Individual Differences, 21(1), 133–137. https://doi.org/10.1016/j.lindif.2010.09.013

2. Alloway, T. P., & Copello, E. (2013). Working Memory: The What, the Why, and the How. The Australian Educational and Developmental Psychologist, 30(2), 105–118. https://doi.org/10.1017/edp.2013.13

3. Aquino, J. L., & Borges-Paraná, C. M. O. (2019). Avaliação neuropsicológica da memória operacional em escolares. Revista Psicopedagogia, 36(109), 3-9. Retrieved in October 3, 2023 from http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S0103-84862019000100002&lng=pt&tlng=pt.

4. Atkinson, R. C., & Shiffrin, R. M. (1968). Human Memory: A Proposed System and Its Control Processes. Psychology of Learning and Motivation, 2(1), 89–195. https://doi.org/10.1016/s0079-7421(08)60422-3

5. Baddeley, A. D., & Hitch, G. (1974). Working Memory. Psychology of Learning and Motivation, 8(1), 47–89. https://doi.org/10.1016/S0079-7421(08)60452-1

6. Baddeley, A. D., & Hitch, G. (1993). The recency effect: Implicit learning with explicit retrieval? Memory & Cognition, 21(2), 146–155. https://doi.org/10.3758/bf03202726

7. Baddeley, A. D. (2006). Working Memory: An Overview (pp. 1-31). In Working Memory and Education, Amsterdan: Elsevier Press. http://dx.doi.org/10.1016/B978-012554465-8/50003-X

8. Baddeley, A. (2010). Working memory. Current Biology, 20(4), R136–R140. https://doi.org/10.1016/j.cub.2009.12.014

9. Baddeley, A. (2012). Working Memory: Theories, Models, and Controversies. Annual Review of Psychology, 63(1), 1–29. https://doi.org/10.1146/annurev-psych-120710-100422

10. Barendse, E. M., Hendriks, M. P., Jansen, J. F., Backes, W. H., Hofman, P. A., Thoonen, G., Kessels, R. P., & Aldenkamp, A. P. (2013). Working memory deficits in high-functioning adolescents with autism spectrum disorders: neuropsychological and neuroimaging correlates. Journal of Neurodevelopmental Disorders, 5(1). https://doi.org/10.1186/1866-1955-5-14

11. Bauer, P. J., Wenner, J. A., Dropik, P. L., & Wewerka, S. S. (2000). Parameters of remembering and forgetting in the transition from infancy to early childhood. Monographs of the Society for Research in Child Development, 65(4), i–204.

12. Bauer, P. J. (2006). Constructing a past in infancy: a neuro-developmental account. Trends in Cognitive Sciences, 10(4), 175–181. https://doi.org/10.1016/j.tics.2006.02.009

13. Bauer, P. J. (2007). Toward a neuro-developmental account of the development of declarative memory. Developmental Psychobiology, 50(1), 19–31. https://doi.org/10.1002/dev.20265

14. Bechara, A. (2000). Emotion, Decision Making and the Orbitofrontal Cortex. Cerebral Cortex, 10(3), 295–307. https://doi.org/10.1093/cercor/10.3.295

15. Conway, A. R. A., Cowan, N., & Bunting, M. F. (2001). The cocktail party phenomenon revisited: The importance of working memory capacity. Psychonomic Bulletin & Review, 8(2), 331–335. https://doi.org/10.3758/bf03196169

16. Courage, M. L., & Howe, M. L. (2002). From infant to child: The dynamics of cognitive change in the second year of life. Psychological Bulletin, 128(2), 250–277. https://doi.org/10.1037/0033-299.128.2.250

17. Cowan, N. (1995). Attention and memory: An integrated framework. Oxford University Press.

18. Cowan, N. (2012). Working Memory Capacity. Psychology Press. https://doi.org/10.4324/9780203342398

19. Cowan, N. (2008). What Are the Differences between long-term, short-term, and Working memory? Progress in Brain Research, 169(1), 323–338. https://doi.org/10.1016/s0079-6123(07)00020-9

20. Courage. (2008). The Development of Memory in Infancy and Childhood. Psychology Press.

21. Dehn, M. J. (2008). Working memory and academic learning: Assessment and intervention. John Wiley & Sons Inc.

22. Diamond, A. (2013). Executive Functions. Annual Review of Psychology, 64(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

23. Engle, R. W., Kane, M. J., & Tuholski, S. W. (1999). Individual Differences in Working Memory Capacity and What They Tell Us About Controlled Attention, General Fluid Intelligence, and Functions of the Prefrontal Cortex. Models of Working Memory, 102–134. https://doi.org/10.1017/cbo9781139174909.007

24. Engle, R. W. (2001). What is working memory capacity? The Nature of Remembering: Essays in Honor of Robert G. Crowder., 297–314. https://doi.org/10.1037/10394-016

25. Gathercole, S. E., Pickering, S. J., Knight, C., & Stegmann, Z. (2003). Working memory skills and educational attainment: evidence from national curriculum assessments at 7

and 14 years of age. Applied Cognitive Psychology, 18(1), 1–16. https://doi.org/10.1002/acp.934

26. Gathercole, S. E., & Baddeley, A. D. (1993). Working memory and language. Lawrence Erlbaum Associates, Inc.

27. Guijo, L. M., Horiuti, M. B., Nardez, T. M. B., & Cardoso, A. C. V. (2018). Listening effort and working memory capacity in hearing impaired individuals: an integrative literature review. Revista CEFAC, 20(6), 798–807. https://doi.org/10.1590/1982-021620182066618

28. Howe, M. L., & Courage, M. L. (1997). Independent Paths in the Development of Infant Learning and Forgetting. Journal of Experimental Child Psychology, 67(2), 131–163. https://doi.org/10.1006/jecp.1997.2395

29. Howe, M. L., Courage, M. L., Vernescu, R., & Hunt, M. (2000). Distinctiveness effects in children's long-term retention. Developmental Psychology, 36(6), 778–792. https://doi.org/10.1037/0012-1649.36.6.778

30. Iliadou, V., & Bamiou, D. E. (2012). Psychometric evaluation of children with auditory processing disorder (APD): comparison with normal-hearing and clinical non-APD groups. Journal of speech, language, and hearing research: JSLHR, 55(3), 791–799. https://doi.org/10.1044/1092-4388(2011/11-0035)

31. Kandel, E. R. (2000). Neuroscience: Breaking Down Scientific Barriers to the Study of Brain and Mind. Science, 290(5494), 1113–1120. https://doi.org/10.1126/science.290.5494.1113

32. Marks, A. R. (2006). In search of memory the emergence of a new science of mind. Journal of Clinical Investigation, 116(5), 1131–1131. https://doi.org/10.1172/jci28674

33. Klatte, M., Hellbrück, J., Seidel, J., & Leistner, P. (2010). Effects of Classroom Acoustics on Performance and Well-Being in Elementary School Children: A Field Study. Environment and Behavior, 42(5), 659–692. https://doi.org/10.1177/0013916509336813

34. Kraus, N., Strait, D. L., & Parbery-Clark, A. (2012). Cognitive factors shape brain networks for auditory skills: spotlight on auditory working memory. Annals of the New York Academy of Sciences, 1252(1), 100–107. https://doi.org/10.1111/j.1749-6632.2012.06463.x

35. Loftus, E. F. (2005). Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. Learning & Memory, 12(4), 361–366. https://doi.org/10.1101/lm.94705

36. Lunardelo P. P., Fukuda M. T. H., Stefanelli A. C. G. F., Zanchetta S. (2023). Behavioral assessment of auditory processing in adulthood: population of interest and tests - a systematic review. CoDAS, 35(2). https://doi.org/10.1590/2317-1782/20232022044pt

Revista ARACÊ
ISSN: 2358-2472

37. Maerlender, A. C., Wallis, D. J., & Isquith, P. K. (2004). Psychometric and Behavioral Measures of Central Auditory Function: The Relationship Between Dichotic Listening and Digit Span Tasks. Child Neuropsychology, 10(4), 318–327. https://doi.org/10.1080/09297040490909314

38. Magimairaj, B. M., & Nagaraj, N. K. (2018). Working Memory and Auditory Processing in School-Age Children. Language, Speech, and Hearing Services in Schools, 49(3), 409–423. https://doi.org/10.1044/2018_lshss-17-0099

39. McGaugh, J. L. (2000). Memory--a Century of Consolidation. Science, 287(5451), 248–251. https://doi.org/10.1126/science.287.5451.248

40. Miller, E. K., Lundqvist, M., & Bastos, A. M. (2018). Working Memory 2.0. Neuron, 100(2), 463–475. https://doi.org/10.1016/j.neuron.2018.09.023

41. Moossavi, A., Mehrkian, S., Lotfi, Y., Faghihzadeh, S., & sajedi, H. (2014). The relation between working memory capacity and auditory lateralization in children with auditory processing disorders. International Journal of Pediatric Otorhinolaryngology, 78(11), 1981–1986. https://doi.org/10.1016/j.ijporl.2014.09.003

42. Morris, R. G. M., Moser, E. I., Riedel, G., Martin, S. J., Sandin, J., Day, M., & O'Carroll, C. (2003). Elements of a neurobiological theory of the hippocampus: the role of activity-dependent synaptic plasticity in memory. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 358(1432), 773–786. https://doi.org/10.1098/rstb.2002.1264

43. Moscovitch, M., Nadel, L., Winocur, G., Gilboa, A., & Rosenbaum, R. S. (2006). The cognitive neuroscience of remote episodic, semantic and spatial memory. Current Opinion in Neurobiology, 16(2), 179–190. https://doi.org/10.1016/j.conb.2006.03.013

44. Murphy, C. F. B., La Torre, R., & Schochat, E. (2013). Association between top-down skills and auditory processing tests. Brazilian Journal of Otorhinolaryngology, 79(6), 753–759. https://doi.org/10.5935/1808-8694.20130137

45. Nyberg, L., & Pudas, S. (2019). Successful Memory Aging. Annual Review of Psychology, 70(1), 219–243. https://doi.org/10.1146/annurev-psych-010418-103052

46. Pires, M. M., Mota, M. B., Pinheiro, M. M. C., Pires, M. M., Mota, M. B., & Pinheiro, M. M. C. (2015). The memory systems of children with (central) auditory disorder. CoDAS, 27(4), 326–332. https://doi.org/10.1590/2317-1782/20152015018

47. Riccio, C. A., Cohen, M. J., Garrison, T., & Smith, B. (2005). Auditory Processing Measures: Correlation with Neuropsychological Measures of Attention, Memory, and Behavior. Child Neuropsychology, 11(4), 363–372. https://doi.org/10.1080/09297040490916956

48. Rohde, T. E., & Thompson, L. A. (2007). Predicting academic achievement with cognitive ability. Intelligence, 35(1), 83–92. https://doi.org/10.1016/j.intell.2006.05.004

49. Rovee-Collier, C., Earley, L., & Stafford, S. (1989). Ontogeny of early event memory: III. Attentional determinants of retrieval at 2 and 3 months. Infant Behavior and Development, 12(2), 147–161. https://doi.org/10.1016/0163-6383(89)90003-9

50. Rueda, M. R., Rothbart, M. K., McCandliss, B. D., Saccomanno, L., & Posner, M. I. (2005). From The Cover: Training, maturation, and genetic influences on the development of executive attention. Proceedings of the National Academy of Sciences, 102(41), 14931–14936. https://doi.org/10.1073/pnas.0506897102

51. Scoville, W. B., & Milner, B. (1957). Loss of recent memory after bilateral hippocampal lesions. Journal of Neurology, Neurosurgery & Psychiatry, 20(1), 11–21. https://doi.org/10.1136/jnnp.20.1.11

52. Shao, X., Li, A., Chen, C., Loftus, E. F., & Zhu, B. (2023). Cross-stage neural pattern similarity in the hippocampus predicts false memory derived from post-event inaccurate information. Nature Communications, 14(1), 2299. https://doi.org/10.1038/s41467-023-38046-y

53. Simcock, G., & Hayne, H. (2002). Breaking the Barrier? Children Fail to Translate Their Preverbal Memories into Language. Psychological Science, 13(3), 225–231. https://doi.org/10.1111/1467-9280.00442

54. Squire, L. R. (2004). Memory systems of the brain: A brief history and current perspective. Neurobiology of Learning and Memory, 82(3), 171–177. https://doi.org/10.1016/j.nlm.2004.06.005

55. Squire, L. R., & Bayley, P. J. (2007). The neuroscience of remote memory. Current Opinion in Neurobiology, 17(2), 185–196. https://doi.org/10.1016/j.conb.2007.02.006

56. Squire, L. R. (2009). Memory and Brain Systems: 1969-2009. Journal of Neuroscience, 29(41), 12711–12716. https://doi.org/10.1523/jneurosci.3575-09.2009

57. Steinbrink, C., & Klatte, M. (2008). Phonological working memory in German children with poor reading and spelling abilities. Dyslexia, 14(4), 271–290. https://doi.org/10.1002/dys.357

58. Swanson, H. L., & Jerman, O. (2007). The influence of working memory on reading growth in subgroups of children with reading disabilities. Journal of Experimental Child Psychology, 96(4), 249–283. https://doi.org/10.1016/j.jecp.2006.12.004

59. Talarowska, M., Zboralski, K., & Gałecki, P. (2013). Sprawność pamieci operacyjnej a nasilenie depresji po 8 tygodniach farmakoterapii [Correlations between working memory effectiveness and depression levels after pharmacological therapy]. Psychiatria polska, 47(2), 255–267.

60. Terr LC. Chowchilla revisited: the effects of psychic trauma four years after a school-bus kidnapping. (1983). American Journal of Psychiatry, 140(12), 1543–1550. https://doi.org/10.1176/ajp.140.12.1543

Revista ARACÊ
ISSN: 2358-2472

61. Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson, Organization of memory. Academic Press.

62. Unsworth, N., Brewer, G. A., & Spillers, G. J. (2012). Working memory capacity and retrieval from long-term memory: the role of controlled search. Memory & Cognition, 41(2), 242–254. https://doi.org/10.3758/s13421-012-0261-x

63. Vasconcelos, R. (2020). Estudo da memória operacional em idosos sem perda auditiva e sem sinais de demência e suas relações com o nível socioeconômico e escolaridade [Master dissertation]. UNIFESP.

64. Wang, S., & Gathercole, S. E. (2013). Working memory deficits in children with reading difficulties: Memory span and dual task coordination. Journal of Experimental Child Psychology, 115(1), 188–197. https://doi.org/10.1016/j.jecp.2012.11.015

65. Yamaguchi V. D., Bortz G. (2021). Working memory in Music: Main Theoretical Milestones and Some of the Challenges in its Study. Revista Musica Hodie. 21. https://doi.org/10.5216/mh.v21.67358