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Baddeley & Hitch's model of working memory and its role in language comprehension

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INTRODUCTION

There is much more going on in short-term memory than simply storing information. Today we know that it is part of a more complex system with a special and complex retention system, which is in close collaboration with long-term memory and consists of interacting subsystems [1]. This system constitutes working memory; it is involved in a large part of cognitive functions, and is responsible for the temporary retention of information, but also its active handling [2]. A multitude of positive correlations have been recorded between comprehension tasks and working memory functions [3, 4], and between phonological coding, central processing and auditory language comprehension projects. [5]. In this way, the position that underlines the function of understanding language is strengthened, as a dynamic and active process of managing representations at multiple levels, in which working memory of limited spatiotemporal scope plays a key role [6].

The structural model of short memory

According to a general model, memory function consists of three individual functional building blocks or systems: sensory recording, short-term, and long-term memory. For the structure of short-term memory there are two main views, that it belongs to the long-term memory system but with the main purpose of short-term retention, and the view that it is a special and complex retention system that is in close cooperation with the long-term memory system and consists of interacting subsystems [7]. Part of the research on short-term memory has focused on whether it is a separate distinct storage area and has examined its characteristics, structure, and priorities. Since the early 1970s, attention has turned to the functionality of this type of memory, and its dynamic interaction with long-term memory. Working memory can be thought of as a system that involves the active manipulation of information in conscious memory. It allows us to retain meaning in long sentences, do mental arithmetic, follow instructions given to us, as well as more specialized instructions, such as remembering the traffic sign warning while driving, or even more specialized ones such as parallel handling of signals from air traffic controllers. In all these cases, the information is only needed for a short time, once the activity is completed, most of it, or all of it, is likely to be lost, unless it is transferred to long-term memory, the main function of working memory is to maintain at the same time of information for immediate handling [7]. [1] And his colleague's analyzed short-term memory in the information processing system and after a lot of research evidence came to the hypothesis that it functions as working memory, which holds, associates and processes information. Today we know that it is an essential factor in the operation of basic cognitive processes, such as: understanding, vocabulary acquisition, reading, arithmetic operations, reasoning, problem solving, etc. [8-10].

Comparison of memory models.

Contrary to the shift of research towards long-term memory, which was done with the theoretical model of levels of processing, and the definition of memory as a system of retention and reconstruction of verbal information [11], the work of Baddeley & Hitch focused on short-term memory with the main difference being that their proposal concerns its study and interpretation in a much broader context. In the model they propose, a key advantage is that the system is interested both in active access to information and in its temporary storage, thus being involved in all complex cognitive processes (eg, language comprehension) [12].Secondly, it may explain some of the short-term memory impairments in brain-damaged patients [10]. If the brain damage affects only one of the subsystems of working memory, then selective dysfunctions are observed. Third, the model refers to verbal recall and processing. Which is closer to reality than Atkinson & Shiffrin's proposal, but does not clearly clarify the exact role of the central processor, which has a limited capacity, and has proven quite difficult to measure accurately, while details of its operation remain unknown? [13].

Interacting subsystems.

The model of working memory implies different independent but involved sub-systems, the central system is called the central processor (central executive) [Figure 1], and has a control-attention role, and is responsible for coordination, cognitive processing of information, gathering and processing of data from subsystems (phonological-articulatory system, visual-spatial notebook) and long-term memory [2]. It is the

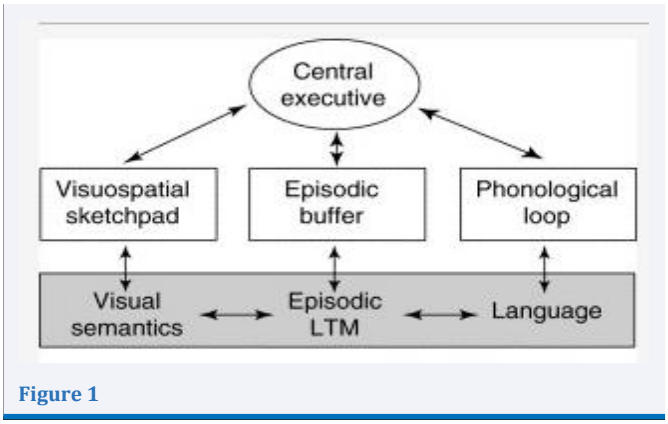

Figure 1

most important and most interesting element of the model; it is less studied and has been less understood than the other subsystems. The phonological-articulatory loop is specialized in the temporary retention and processing of spoken information based on their internal repetition, thanks to the operation of a retention subsystem and an articulatory processing subsystem, it is involved in a number of cognitive processes (vocabulary acquisition, text comprehension, etc) [14-16] and has been more researched than the central processor and the visuospatial system. The visuo-spatial sketchpad enhances the function of the central processor, specializes in the temporary retention and processing of visuospatial information as a kind of inner eye, and operates based on the visual-spatial code, i.e. the images (shape, size, color, etc.) [2]. In this system it can be interfered with an experimental condition of visual information processing, where the interfered information is of the same nature, for example it can be interfered with the visual-spatial information we receive while driving from understanding the movements of a football match that we hear simultaneously on the radio [1, 17, 14]. The evidence for the existence of the visual village notebook is considerably less than those for the phonological circuit.

The revised model of working memory.

The original model of working memory was confirmed by the multitude of researches and studies, but it created its own revision since it was open and flexible from the beginning. A multitude of phenomena that emerged both from the normal population, but also from the improved neuropsychological methods imaging of the brain function of individuals with lesions, led to a partial revision of the model and the addition of an additional functional subsystem, the episodic buffer, a system of limited capacity, which stores information from both the other subsystems, but also from the long-term episodic memory [18]. A basic principle for the recall of information from this subsystem is attention (conscious awareness). The revised model differs fundamentally from the original one, in the fact that it is based on integrated information, instead of the isolation and separation of subsystems, thus creating a better basis for the executive function of working memory [18].

The role of the model for understanding in language.

There are a number of studies that deal with the role and existence of a correlation between working memory and language, in particular for language comprehension; Baddeley & Gathercole concluded that the phonological circuit of working memory aims to preserve verbal elements that can be used during language processing [19]. The central processor is involved in the processing of semantic and syntactic information as well as the storage of the information resulting from this processing [20, 2], namely the comprehension of language in text form, which involves the transfer and integration of information, appears to rely on semantic rather than verbal encoding, as well as central processor functions such as coordination and retrieval of information from long-term memory [9, 21]. Studies with toddlers find positive correlations between auditory comprehension tasks. Texts that require the creation of inferences, and projects that evaluate the functioning of the phonological circuit [22, 23] Also, positive correlations have been reported between reading comprehension tasks and tasks that assess central processor function in school-aged children [3, 4]. Recent research highlights positive correlations between phonological tasks encoding, central processor, listening comprehension of word-sentences, and making inferences about pictures [5]. In 2003 Baplekou examined the relationships of working memory with listening comprehension in preschool and early school age and distinguished correlations of the phonological circuit, the central processor and listening comprehension of text, concluding that memory performance is directly related to listening comprehension , and that performance on comprehension questions correlates with performance on most central processor tasks.

Comprehension-language-reading.

Research results in the obvious importance of the articulatory circuit for learning to read [11]. Children with difficulties in learning to read, but with normal intelligence, and the same supportive environment, have a problem in the memory field [24].Regarding the ability to read and understand, one of the initial hypotheses formulated is that of [25], according to which the comprehension of sentences requires their temporary retention for processing, although the case of an Italian patient, of P.V., showed that she could understand sentences much longer than those she could remember [10]. The hypothesis of Butterworth [26], was quite opposite, according to it, language comprehension is independent of short-term memory capacity. They came to this conclusion from the study of a patient who, while reading words quite normally, had great difficulty in reading simple pseudo-words, i.e. she presented difficulty in learning to read, and showed that she had learned with a look-say method) [27]. This case established the hypothesis that normal short-term memory is necessary for learning to read, but did not so much support the view that listening comprehension depends on the normal memory domain. Newer research concludes that phonological awareness, and its temporary recording, plays a decisive role in understanding, but mainly for complex or specialized informational material [14]. A study of working memory in a group of children with language problems, normal non-verbal intelligence, but delayed development in language

skills, showed that there was a two-year delay in relation to normal age-expected vocabulary performance, and a four-year difference in the pseudo word simple repetition test (test with high phonological demands circuit), which differed in length and degree of difficulty, concluding that the phonological circuit and the difficulties it presents are clearly correlated with language problems [28]. That is, the working memory and mainly the phonological circuit play a central role in the repetition of pseudo words, and the acquisition of language – understanding [28].

Mnemonic field of working memory and comprehension

Daneman and Carpenter attempted to measure the overall capacity of working memory with a test in which subjects had to simultaneously store and manipulate information. This test, known as working memory span, included sentences in which the last words should be retained and recalled linearly, several experimental variations were made, and the measurement of the working memory span of a group of students correlated with reading comprehension, showed a high correlation [14]. The relationship between working memory and comprehension was studied more broadly in another study by [30], in which three groups of students with high, medium, and low working memory mnemonic domains had to read texts in which there were obvious inconsistencies based on the ambiguity of of words. According to the results, the group with a high mnemonic field had 75% accuracy of understanding the conclusion, and the group with a low mnemonic field had 25%. That is, people with a high mnemonic field of working memory, had the ability to transfer information and manipulate it to have higher levels of understanding [30].

Central processing and understanding

Cases that reached conclusions about the role and function of working memory in comprehension, also come from children aged 7-8 years with a normal level of vocabulary for their age, and the ability to read simple words, but low performance in reading and understanding text, which formed the sample of Oakhill's research [29, 20]. Oakhill examined the comprehension and recall of information in children who were given stories and asked to verify or not sentences, that is, whether or not they were present in the original text. The results showed that high-comprehension children showed better gist and gist memory, but did not differ in verbatim recall, indicating that the differentiation is not primarily in the articulatory circuit of working memory, but in the central processor [12]. [30], also studied the processing and responses to ambiguous stories by two groups of children (high - low comprehension), who read texts with inconsistent content, concluding that clear differences in comprehension are found in the ability of working memory, and primarily not in the capacity of the modular circuit or the visuospatial notebook, but in the central processor.

CONCLUSIONS

The effects and direct correlation of working memory with basic cognitive processes such as comprehension, vocabulary acquisition, reading, etc. is evident from the amount of research and data that have emerged in recent years. What we must not forget, however, is that even high correlations do not imply absolute proof. There is a strong case that a number of factors such as attention, motivation, interests, pre-existing vocabulary level, etc. are heavily involved. A full understanding of the model and all its parameters is not yet achieved, but is in progress. Working memory is a broad field of research and while the proponents of the model [1] consider it to play a key role for most cognitive functions, other researchers [31] are more restrained and underline the points of the model that have not yet been clarified, such as for example the full operation of the central processor, which - as I personally believe - will be explored more in the near future. The clear correlation of working memory with language comprehension through the multitude of research is clear, although we must always be ready for new revisions, under the weight of the data that emerges every day. The model is characterized by its flexibility, research continues.

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