

THE IMPORTANCE OF WORKING MEMORY IN ACQUIRING SECOND LANGUAGE (L2)

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ABSTRACT

This paper highlights the importance of short term memory and its roles in linking the information acquired from sensory memory into long term memory. Short term-memory, also known as working memory, has significant contribution to transfer information as it is the location where many forms of complex thinking such as problem solving, contemplation, and language comprehension occur. In addition, the instrumental role of working memory in the acquisition of second language will be discussed.

Keywords: working memory, language acquisition

ABSTRAK

Makalah ini menyoroti pentingnya memori jangka pendek dan peranannya dalam menghubungkan informasi yang diperoleh dari memori sensorik ke memori jangka panjang. Memori jangka pendek dikenal juga sebagai memori kerja, memiliki kontribusi signifikan untuk mentransfer informasi karena merupakan tempat di mana banyak bentuk pemikiran kompleks seperti pemecahan masalah, kontemplasi, dan pemahaman bahasa terjadi. Selain itu, peran instrumental memori kerja dalam akuisisi bahasa kedua juga akan dibahas.

Kata Kunci: kinerja memori, penguasaan bahasa

A. INTRODUCTION

When a teacher teaches the students some learning material, they often forget things the teacher is explaining. There might be some reasons why it could happen. First, the students probably forget a thing because they are thinking about something else so they are not listening. Secondly, they do not think the idea is important so they ignore it, and then forget it. Last, they might not have time to

learn or store the material properly. Then, a question about what is going on in the brain so that things can be remembered or forgotten appears.

The brain is the organ that is responsible for what is called “mind”. It is the basis for thinking, feeling, wanting, perceiving, learning and memory, curiosity, and behavior. Memory is a fundamental mental process, and without memory people are capable of nothing but simple reflexes and stereotyped behaviors. Thus, memory is an essential component of learning. The role of memory in language learning has long been of interest to researchers in first and second language acquisition (Abu-Rabia, 2003; Baddeley, 1999; Daneman & Green, 1986; Juffs, 2006; Payne & Whitney, 2002). For further and more detailed information concerning memory and learning, some important points will be discussed in the following sections.

B. THEORY

1. Definition of Memory

Memory is defined as a behavioral change caused by an experience (Okano, Hirano, & Balaban, 2000). In addition, according to Kandel (2000), memory is the process of encoding, storing, and retrieving knowledge. This definition shows that memory is not a thing, but it is a process. In another definition, memory is a phase of learning which has three stages: acquiring, retaining the new acquisition for a period of time, and remembering (Sargent & Stafford, 1965). Another definition from Balsiger who states that memory is the mechanism through which all information is stored and retrieved, and it is a crucial component of learning success. Thus, from the abovementioned definitions, it is concluded that memory is an important element of learning which includes encoding, storing, and retrieving new knowledge and information, which are crucial for the success of learning.

Processes of encoding, storing and retrieving information in memory interact with different memory systems. Memory is thought to begin with the encoding or converting of information into a form that can be stored by the brain. This encoding process is also referred to as registering information in memory. The memory systems that are involved in the encoding or registration of information in memory are sensory memory and short-term memory (Thorne, 2003). Next section will discuss the differences of three memory systems: sensory memory, short-term memory, and long-term memory.

2. Three Types of Memory

Types of memory can be classified in a number of ways, depending on the criterion used. With duration as the criterion, at least three different types of memory can be distinguished: sensory memory, short-term memory, and long-term

memory (Anderson, 2000). First discussion will be about sensory memory. It takes the information provided by the senses and retains it accurately but very briefly. That information first coming to us is then stored for a very short period of time within the sensory register. There are five senses which are associated with the sensory register: visual, auditory, kinesthetic, tactile, and olfactory. Sensory memory lasts from a few hundred milliseconds to one or two seconds that it is often considered part of the process of perception. Nevertheless, it represents an essential step for storing information in short-term memory.

The second type of memory is short-term memory. It temporarily records the succession of events in our lives. It can register a face when seeing someone in the street, or a phone number we hear someone give. However, this information will quickly disappear forever unless we make a conscious effort to retain it. The cause of the loss of information is due to the presence of other new information (Pashler & Carrier, 1996, cited in Thorne, 2003). Short term memory is characterized by: (1) A limited capacity of up to seven pieces of independent information; (2) The brief duration of these items last from 3 to 20 seconds; and (3) Decay appears to be the primary mechanism of memory loss. Within short term memory, there are three basic operations: (1) Iconic memory, that is the ability to hold visual images; (2) Acoustic memory, that is the ability to hold sounds (held longer than iconic); and working memory, that is an active process to keep it until it is put to use. Working memory is the main point of this paper which will be related to its role in second language learning.

The process of transferring information from short term memory to long term memory involves the encoding or consolidation of information. It means that the brain organizes complex information first before it is encoded into long term memory. In this process of organization, the meaningfulness or emotional content of an item may play a greater role in its retention into long-term memory. Moreover, on a more concrete level, the use of chunking has been proven to be a significant aid for enhancing the transfer of information to long term memory. Chunking allows the brain to automatically group certain items together, hence the ability to remember and learn better.

The last process where information is stored and then retrieved is in long term memory. Long-term memory not only stores all the significant events that mark our lives, it lets us retain the meanings of words and the physical skills that we have learned. Its capacity seems unlimited, and it can last days, months, years, or even an entire lifetime. But it is far from infallible. It sometimes distorts the facts, and it tends to become less reliable as people age (Marzano, 1998).

Just as the sensory and short-term memory systems are associated with the process of encoding or registering information in memory, the long-term memory system is associated with the processes of storage and retrieval of information from

memory. Long-term memory storage is considered to be relatively permanent. The loss of information from long-term memory is referred to as forgetting.

For instance, in the normal school day, teachers provide students new information for around 45 to 60 minutes. A child might have a 45-minute English lesson on the use of present perfect tense. However, before this information has enough time to consolidate in long-term memory, the child moves on to learn physics about the law of Newton. This situation creates something that we call ‘forgetting’.

During the 1950’s, a good deal of research focused on the issue of whether we forget information simply because time has passed or whether forgetting occurs because what we are learning at the present time interferes with our ability to remember information we learned before (Baddeley, 1996, cited in Thorne, 2003). The phenomena of interference in long-term memory storage provide good rationale for what is commonly referred to as “block scheduling”. With block scheduling, students have approximately 4 classes of 90 minutes each. If teachers use the 90 minutes wisely (i.e., they do not simply lecture for 90 minutes instead of 45 minutes), they can provide students with opportunities to engage in activities that will actually enhance the consolidation of the new to-be-learned information in long-term memory.

Long-term memory is comprised of a number of interrelated subsystems (Thorne, 2003). The first is episodic memory which is the memory subsystem that stores information about the “episodes” or events in our lives—remembering what we did during last summer’s vacation or who our favorite teacher in school was. Impairments in episodic memory are the basis of classic amnesia (Baddeley, 1996). The second is semantic memory. It is the memory subsystem that stores memory of knowledge and concepts. Formal education can be thought of as filling up our semantic memory “store”. Facts such as the rules for capitalization and punctuation and what year Columbus discovered America are examples of the kinds of information that are stored in the semantic memory system. Though each of these types of memory has its own particular mode of operation, they all cooperate closely in the process of memorization.

3. Definition of Learning

According to Kandel (2000), learning is the process by which we acquire knowledge about the world. Another definition from Kimble (1961) is that learning refers to a more or less permanent change in behavior which occurs as a result of practice. A further definition says that learning is either a case of differential strengthening of one from a number of responses evoked by a situation of need, or the formation of receptor-effector connections *de novo*; the first occurs typically in simple selective learning and the second in conditioned reflex learning (Hull, 1943).

It appears that learning is the strengthening of existing responses or formation of new responses to existing stimuli that occurs because of practice or repetitions.

4. Memory and Learning

Memory and learning are so closely connected that people often confuse them with each other. Nevertheless, these two terms are different. As defined in the previous sections, learning is a process of forming new responses; while memory is the ability to remember past experiences.

Memory is essential to all learning because it stores and retrieves the information that we learn. Therefore, memory is merely the record from a learning process. Thus, memory depends on learning. But learning also depends on memory, because the knowledge stored in memory provides the framework to which new knowledge is linked by association. For example, if we know that a Mercedes is a car, so we know that a Mercedes has brakes, even if we have not actually seen it, because we know that all cars have brakes. This highly useful form of reasoning is called inference, and it is fundamentally based on knowledge that we have already stored in our memories. The more knowledge we have already acquired, the more we will be able to draw inferences.

Just as the relationship between remembering and learning exists, there is also a relationship between remembering and understanding. If we understand something, we are often able to remember it better. Once we understand, we may be able to know where to store the information in long-term memory, and then lead to effective retrieval. Furthermore, if we are able to retrieve previously learned information from long-term memory when we are presented with new to-be-learned information, we can associate between the two and, therefore understand the new information better. In this way, memory facilitates understanding (Thorne, 2003).

5. Working Memory (WM)

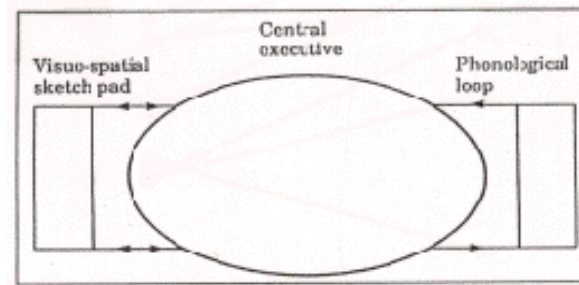
Researchers have viewed what was formerly known as short term memory as working memory (Baddeley, 1986; Carpenter & Just, 1989; Daneman & Carpenter, 1980; Just & Carpenter, 1992). The change in terminology results from the notion that this specific component of cognitive and linguistic processing is responsible not only for the storing of information but also for processing language input and output and integrating text components with one another and with previously acquired knowledge (Siegel & Ryan, 1989). Keeping an item in short-term memory for a certain amount of time lets you eventually transfer it to long-term memory for more permanent storage. This process is facilitated by the mental work of repeating the information, which is why the expression “working memory” is increasingly used as a synonym for short-term memory.

So, what is working memory (WM)? It is the location at which many forms of complex thinking such as problem solving, contemplation, and language comprehension take place (Carpenter & Just, 1989). According to many researchers (Engle & Conway, 1998; Gathercole & Baddeley, 1993; Just & Carpenter 1992), WM has a twofold function, a processing site and as an information storage site where the products of these processes are stored. While reading a text, the reader stores syntactic, pragmatic, and semantic linguistic information. The reader then uses this information to analyze and clarify the following parts of the text.

According to Baddeley and Hitch (1974) (as cited in Gathercole & Baddeley, 1993), WM consists of three components: the central executive, the visuospatial sketchpad and the phonological loop. The central executive acts as supervisory system and controls the flow of information from and to its 'slave-systems': The phonological loop and the visuo-spatial sketchpad. The phonological loop is capable of holding and manipulating language-based. The phonological loop can be divided into two further sub-systems - the phonological store and the articulatory process. The phonological store acts as an 'inner ear', remembering speech sounds in their temporal order, whilst the articulatory process acts as an 'inner voice' and repeats the series of words (or other speech elements) on a loop to prevent them from decay. The visuo-spatial sketchpad can be further subdivided into a visual component, dealing primarily with objects and their visible features, such as shape, color, and texture, and a spatial component, dealing with locations and movements in space.

Of particular interest to the field of second language acquisition are the central executive and the phonological loop. While the central executive is described as being an attentional control system which is linked to long-term memory, the phonological loop is capable of holding and manipulating language-based, as opposed to visuo-spatial (the visuo-spatial sketchpad), information. Baddeley and others (Abu-Rhabia, 2003; Daneman, 1991; Daneman & Carpenter, 1980; Daneman & Green, 1986) have not only found that the phonological loop is important to speech production and reading and listening comprehension; but they have also demonstrated that it plays a substantial role in the acquisition of language.

Baddeley and Hitch (1974) suggested the now commonly known tripartite model of working memory derived from research they were doing on the short-term/long-term memory controversy. Their model consists of a central executive and two separate slave systems as seen in the illustration below.



C. METHOD

1. Working Memory Capacity and Efficiency

Individuals vary in their working memory capacity. WM capacity increases with age during childhood. Young children typically have very small capacities that increase gradually until the teen age years, when adult levels are reached (approximately 2 to three times greater than that of four-year-old children). Differences in working memory capacity between young children can be very large. Individuals who have poor working memory capacities in childhood do not catch up with average children even by the end of childhood (Stern, 2008).

According to Just and Carpenter (1992), when addressing WM and individual differences one must address capacity and efficiency. Some people have more WM capacity than others, namely more attention than others, or they have more processing sources than others. Daneman and Carpenter (1983) suggest that these two functions of WM “compete for a limited capacity”.

Another distinction is the efficiency with which an individual processes information. Some people process information more efficiently than others. WM capacity is considered limited, and information may be lost due to this. Researchers contend that the different shares of processing and storage may be the source of individual differences in reading comprehension. A skilled reader is a more efficient processor, so s/he has more information storage capacity. That is, s/he has more attention left for information storage. Just and Carpenter (1992) claim that an English language (EL) speaker’s (listener’s/reader’s/writer’s) linguistic competence is dependent on his/her WM capacity.

2. Working Memory and Learning

WM is crucial to many learning activities in the classroom, because learners often have to hold information in mind while engaged in an effortful activity. For example, WM is required for such tasks as remembering the sentence we have to write while trying to spell the individual words, or the list of instructions given by the teacher while carrying out individual steps in the task. Learners with small

working memory capacities will struggle in these activities, simply because they are unable to hold in mind sufficient information to allow them to complete the task. Losing crucial information from working memory will cause them to forget many things: instructions they are attempting to follow, the details of what they are doing, where they are in a complicated task, etc. Because learners with small working memory capacity fail in many different activities on many occasions due to these kinds of forgetting, they will struggle to achieve normal rates of learning and so typically will make poor general academic progress. For these reasons, working memory is a "bottleneck" for learning.

Working memory is required for a multitude of tasks in school and in life. For example, in order to understand material read, we must remember what was at the beginning of the paragraph by the time we get to the end of the paragraph. Students taking notes during a lecture must remember what their teachers have just said and are saying while they are writing. We must remember directions while carrying them out, especially those with multiple steps. When students look up a word in the dictionary, they must remember the word while looking for the definition. They must remember the question in the back of their social studies chapter while searching the chapter for the answer to the question (Thorne, 2003).

During class discussions on certain topics, learners must remember what is being said while retrieving information about the topic from long-term memory. While writing the answer to an essay question on a test, they must remember the question in order to give the most important information rather than information that is only tangentially related to the topic. Working memory is also needed for many higher order thinking tasks such as analysis and synthesis and problem solving. During problem solving, we must remember the problem, generate multiple potential solutions and make decisions about which of these solutions is likely to produce the desired outcome. Research has shown that performance on higher level cognitive tasks such as problem solving, reasoning and reading is more accurately predicted by performance on working memory tasks than by performance on short-term memory tasks (Kail & Hall, 2001).

3. Working memory and second language acquisition

The literature on working memory and L2 acquisition has emerged later and is much more sparse than in L1 processing and acquisition (Osaka & Osaka, 1992; Osaka et al., 1993). However, since the early 1990s an increasing interest in the topic has developed (Mackey et al. 2002, Robinson, 2002; Williams & Lovatt, 2003).

In terms of language acquisition, working memory has been found to be instrumental in the acquisition of new vocabulary and in more global measures of acquisition. Daneman and Green (1986) found that it played a significant role in

determining how easily elementary school children extracted word meanings from context. Noting that readers use context to enrich their understanding of words that are only partly known, Daneman and Green (1986) also proposed that working memory may facilitate vocabulary growth in an indirect manner. Gathercole and Baddeley (1990) showed that subjects with a high-memory span were able to learn a new name in three trials, whereas subjects with a low span took more than five trials to do the same task. Abu-Rhabia (2003) presented significant relationships between WM measures and reading and writing in English as a second language in his study. In short, the literature provides convincing evidence for the importance of working memory to language acquisition and learning.

In the psychological literature, theories of working memory can be divided into two main approaches, each with their own constructs (or ways of operationalizing working memory) and tests that measure those constructs in individuals. The first is called 'phonological working memory' (PWM) (Gathercole & Baddeley, 1993). PWM tests measure the capacity of an individual to remember a series of unrelated items with covert 'inner speech' rehearsal (Ellis, 2001, cited in Juffs, 2006). This ability is measured by requiring participants to remember lists of unrelated digits, real words, or non-words; in some versions of this non-word repetition test, these non-words have phonemes that are not in the native language (L1). The second is reading span memory (RSM) (Daneman & Carpenter, 1980). Tests of RSM claim to measure the resources available to simultaneously store and process information. RSM tests require participants to read aloud lists of sentences written on cards (or on a computer) and then recall the final word of each sentence without covert rehearsal. The key difference between the tests for PWM and RSM is that the RSM requires both processing and storage, whereas the PWM only requires the participant to repeat polysyllabic words or repeat a string of unrelated words correctly.

Early research concerned the relationship among working memory measures in the L1 and the L2, and their correlations with proficiency scores on standardized tests (e.g. the TOEFL, Test of English as a Foreign Language, and the TOEIC, Test of English for International Communication). Some researchers found reliable relationships between L1 and L2 RSM memory test scores. Harrington & Sawyer (1992, cited in Juffs, 2006) found relationships between RSM and reading and grammar scores in their study, but Berquist (1997) did not, and suggested that PWM was a better predictor of proficiency.

Where PWM is concerned, Ellis (1996, 2001, cited in Juffs, 2006) in particular has been a strong advocate of the role of the phonological loop in acquisition across the life span. In a frequently cited paper, Ellis (1996, cited in Juffs, 2006) claimed that working memory as measured by a non-word repetition test was the best predictor of success in L2 learning: "To put it bluntly, learners'

ability to repeat total gobbledygook is a remarkably good predictor of their ability to acquire sophisticated language skills in both the L1 and the L2”.

However, the research results are somewhat perplexing in that they are inconsistent across levels of learners and L1 groups. Moreover, there are inconsistencies in the relationships between scores on the PWM and RSM, which for L1 speakers are not supposed to correlate. For example, Berquist found that PWM (word span) and RSM correlated, whereas Harrington & Sawyer (1992, cited in Juffs, 2006) did not. In addition, effects of PWM (word span) can be found in lower proficiency learners but not in higher ones, but no relationship with vocabulary knowledge was found (Cheung, 1996). Williams & Lovatt (2003) report that rate of learning is more related to PWM (word span) than the ultimate accuracy. Finally, Juffs (2006) did not find any relationship between PWM (word span) and measures of vocabulary and grammar on a standard test of vocabulary and grammar. For L2 learners, it is unclear whether PWM and RSM are related and which subdomains of language (vocabulary, morpho-syntax, etc.) and for which type of learner working memory capacity can make reliable predictions.

Based on a number of studies regarding working memory in learning processes, it can be said that working memory affects someone's proficiency and intelligence in language learning. A person with good proficiency and possesses competent skills of language will see no big difficulty in processing the learning materials from a teacher. This situation results from his ability in storing the information explained by the teacher, and retrieving it when it is needed, for instance, in the final examination.

D. RESULTS AND DISCUSSION

The implication from the correlation between working memory and language learning is that the use of working memory can enhance learners' linguistic knowledge. It means that when the learners are able to store information and rehearse it in classroom practices, their understanding of a language will increase. Before presenting some activities that might be useful for poor working memory learners, there are three cases where learners with low capacity of working memory are guided to be able to catch up in learning processes (Gathercole & Alloway, 2008).

Case 1 - Nathan

In class, Nathan often struggled to keep up with classroom activities. For example, when the teacher wrote on the board Monday 11th November and, underneath, The Market, which was the title of the piece of work, he lost his place in the laborious attempt to copy the words down letter by letter, writing

‘moNemarket’. It appeared that he had begun to write the date, forgot what he was doing and began writing the title instead.

Place-keeping errors such as repeating and/or skipping letters and words during sentence writing, or missing out large chunks of a task are common features of working memory overload. The first step for the teacher is to recognize this error as a working memory failure. The next step is to evaluate the working demands of learning activities. In particular, activities such as keeping track of the place reached in the course of multi-level tasks (e.g., writing a sentence down either from memory or from the white board) impose heavy storage demands on working memory.

An effective strategy for the teacher to use in order to avoid working memory-related failures is to reduce working memory loads in structured activities. This can be achieved in a number of ways, including:

- a. Breaking down tasks and instructions into smaller components.
- b. Writing the instructions in different colored ink in order to create a visual cue for the child to keep track of their place. This way, the child can see that the red ink represents the day of the week and the blue ink represents the activity title. By using visual cues to support working memory, the child has external supports to help him/her achieve success in these individual learning activities.

Case 2 - Jay

An activity in Jay’s class involved the teacher writing number sequences on the white board with some numbers missing. She counted the numbers aloud and asked the class what numbers she had missed out. In each case, there was more than one number missing (e.g., 0, 1, 2, 4, 5, 7, 8). In this activity, the child has to use his/her number knowledge to identify each missing number, and store them. On all occasions, Jay was unable to identify the missing numbers. The following is the example of activity which imposes heavy storage demands involving the retention of significant amounts of verbal material with a relatively arbitrary content.

The first steps for the teacher are: (1) monitoring the child’s working memory regularly in the course of such demanding activities, and (2) asking the child directly for details of what s/he is doing and intends to do next as children are often aware of when they forget information.

The second steps are: (1) repeating information that is crucial to ongoing activities, (2) asking the child to use a variety of tools that support memory, tools that are in common use in classrooms, and (3) providing the child with an opportunity to practice the use of memory aids in situations with minimal working memory demands in order to establish mastery of the basic skill.

Case 3 - John

On one occasion, the teacher gave the following instruction to John: ‘Put your sheets on the green table, put your arrow cards in the packet, put your pencil away and come and sit on the carpet’. John failed to put his sheet on the green table. The teacher asked John if he could remember where he was supposed to put it; he couldn’t, and needed reminding.

First, it is important for the teacher to ensure that the child can remember what he or she is doing. On many occasions, children with low working memory simply forget what they had to do next, leading to failure to complete many learning activities.

Children’s memory for instructions will be improved by using the instructions that are as brief and simple as possible. Instructions should be broken down into individual steps where possible. One effective strategy for improving the child’s memory for the task is frequent repetition of instructions. For tasks that take place over an extended period of time, reminding the child of crucial information for that particular phase of the task rather than repetition of the original instruction is likely to be most useful.

Finally, one of the best ways to ensure that the child has not forgotten crucial information is to ask them to repeat it back. It is imperative for teachers to use numerous strategies to help students recall information. By combining a variety of teaching techniques, teachers can ensure that each student, regardless of learning style, will recall information effectively. From some examples of students’ cases in working memory impairment above, the next will be some activities provided for language learners in classroom.

a. Active Reading

In this learning method, students use a highlighter while reading to highlight important terms. Students should write down key words, definitions or phrases in each chapter; doing so helps them better understand key concepts in the reading. In addition, students should organize information into an outline or graphic organizer, both of which help them recall information more easily. Active reading exercises in the classroom help transfer information from short-term memory to long-term memory.

b. Multiple Directions

Teaching both visually and verbally makes students more successful in both understanding and recalling information. One way teachers can determine whether students are retaining information is to encourage them to repeat the directions and define each term. For instance, instead of using only a visual reference to teach new

concepts, the teacher can also use an audiotape that explains the same information and have students repeat the information.

c. Retrieval Practice

To ensure that students are storing the most relevant information in each lesson, teachers can instruct them to create their own tests with questions and answers they make up. This teaching method engages students and allows them to participate in learning. It also enhances the memory retrieval process by allowing students to practice recalling information. Teacher and parents are able to determine whether the child is retaining the most relevant information in each chapter.

d. Handouts

Teachers help students retain information better when they combine lectures with handouts. These handouts may consist of an outline with several empty spaces; each student needs to listen carefully to the lecture to complete the blank fields in the outline. This exercise gives students a chance to identify pertinent information during the lecture and helps them to organize this information accordingly.

e. Develop Cues

Students improve their chances of recalling and retrieving information by using cues. Cues are abbreviations or acronyms that help students remember important information. For cues to be efficient, they must be present during recall. For instance, if students are learning about the directions on a compass, they can use the phrase "Never eat sour watermelons." Each word in the sentence represents a letter of a direction on the compass: N, E, S and W.

E. CONCLUSION

Working memory is very crucial in learning, in this case, learning a language. However, individuals might have different capacities of working memory. Some studies suggest that those with high working memory capacity perform better in learning activities than those with low capacity of working memory. A general recommendation for improving the learning successes of children with poor working memory skills is to develop in the children effective strategies for coping with situations in which they experience working memory failures. Strategies may include: (1) encouraging the child to ask for forgotten information where necessary, (2) training in the use of memory aids, and (3) offering encouragement to continue with complex tasks rather than abandoning them, even if some of the steps are not completed due to memory failure.

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