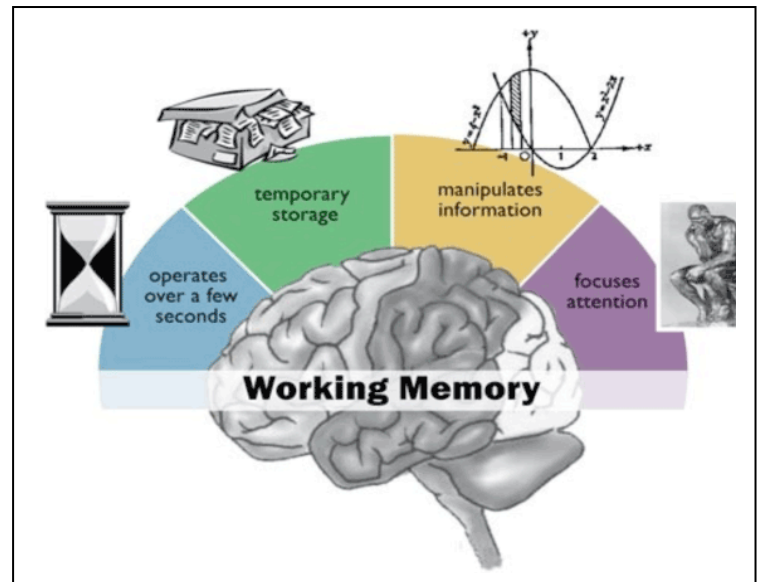


SEND Bulletin No.13



Working Memory

Psychologists use the term 'working memory' to describe the ability we have to hold in mind and mentally manipulate information over short periods of time. Working memory is often thought of as a mental workspace that we can use to store important information in the course of our mental activities.

A good example of an activity that uses working memory is mental arithmetic. Imagine, for example, attempting to multiply 43 and 27 together, and spoken to you by another person, without being able to use a pen and paper or a calculator.

First of all, you would need to hold the two numbers in working memory. The next step would be to use learned multiplication rules to calculate the products of successive pairs of numbers, adding to working memory the new products as you proceed. Finally, you would need to add together the products held in working memory, resulting in the correct solution. Without working memory we would not be able to carry out this kind of complex mental activity in which we have to both keep in mind some information while processing other material.

When do we use working memory?

Mental arithmetic is just one example of an activity that relies on working memory. Other examples from everyday life include:

- remembering a new telephone number, a PIN number, web address or a vehicle registration number while we are trying to find a pen and paper to write it down or to use it in some other way
- following spoken directions such as 'Go straight over at the roundabout, take the second left and the building is on the right opposite the church'
- calculating how much the bill will be at the supermarket checkout for the items we have in our basket
- remembering the unfamiliar foreign name of a person who has just been introduced to you for long enough to enable you to introduce them to someone else

- measuring and combining the correct amounts of ingredients (e.g. rub in 50g of margarine and 100g of flour, and then add 75g of sugar) when you have just read the recipe but are no longer looking at the page.

You may notice from these examples that we typically use working memory as a sort of mental jotting pad in situations when there is no other external record such as written notes or a calculator.

Are there limits to working memory?

Yes. It is unfortunately true that working memory is limited in a number of ways, and can easily fail us when we need it. In particular, we need to continue to pay attention to what is being held in working memory if it is to persist over even short periods of time. Here are some of the situations that often lead to the loss of information from working memory.

- **Distraction.** An unrelated thought springing to mind, or an interruption such as a telephone ringing or someone speaking to us, can be sufficient to divert attention the contents of working memory so that its contents are rapidly lost.
- **Trying to hold in mind too much information.** There is a limit to how much information can be held in working memory. For example, most of us would not be successful in attempting to multiply the numbers 739 and 891 in our heads, simply because the amount of information that has to be stored in the course of this calculation exceeds the capacity of most people's working memory.
- **Engaging in a demanding task.** Activities that require difficult mental processing, such as applying the rules of multiplication during mental arithmetic, reduce the amount of space in working memory to store information. This can result in a loss of other information that is already held. Once information has been lost from working memory it is gone for good. The only possible way forward is to start again the process of entering information into working memory. In mental arithmetic, for example, the sum would have to be re-calculated from the beginning.

Does working memory capacity vary between people?

Yes. There is a personal limit to working memory, with each individual having a relatively fixed capacity that may be greater or less than that of others. So, a particular activity may be well within the capacity of one person but exceed that of another.

Working memory capacity also increases with age during childhood. Young children typically have very small capacities that increase gradually until the teenage years, when adult capacities are reached that are more than double that of 4-year-old children. Differences in working memory capacity between different children of the same age can be very large indeed. For example, in a typical class of 30 children aged 7 to 8 years, we would expect at least three of them to have the working memory capacities of the average 4-year-old child and three others to have the capacities of the average 11-year-old child, which is quite close to adult levels.

Typically, individuals who have poor working memory capacities in childhood do not catch up with those of their peers. Although their working memory capacities increase with age, they do not do so at the same rate as other individuals so that, as they grow older, they lag behind more and more.

Why is working memory important in classroom learning?

Many of the learning activities that children are engaged with in the classroom, whether related to reading, mathematics, science, or other areas of the curriculum, impose quite considerable burdens on working memory. Activities often require the child to hold in mind some information (for example, a sentence to be written down) while doing something that for them is mentally challenging (such as spelling the individual words in the sentence). These are the kinds of activities on which children with poor working memory struggle with most, and often fail to complete them properly because they have lost from working memory the crucial information needed to guide their actions.

As a result, the children may not get the learning benefit of successfully completing an activity, and this slows down their rates of learning. Children with poor working memory also have problems following lengthy instructions to do one thing after another, because they forget the instruction before the whole sequence of actions has been completed. As a consequence, the child will often not engage properly with the normal pace of ongoing classroom activities. Often it appears that the child has not paid attention, when in fact they have simply forgotten what it is that they have to do.

Working memory is also needed to help us remember where we have got to in a complicated mental activity. Consider the case of a child with low working memory capacity attempting to follow the teacher's instructions to write down a sentence she has just spoken. The child not only needs to hold the sentence in working memory for sufficiently long to guide his or her attempts

to write the individual words, but needs to remember how far they have got in this attempt, and to find the next word in working memory. Although to skilled writers this seems like an easy task, children with poor working memory capacities find this extremely difficult, and often either skip or repeat words and letters as they lose their place in this demanding mental activity.

Characteristics of children with poor working memory

Typically, children with poor working memory:

- are well-adjusted socially
- are reserved in group activities in the classroom, rarely volunteering answers and sometimes not answering direct questions
- behave as though they have not paid attention, for example forgetting part or all of instructions or messages, or not seeing tasks through to completion
- frequently lose their place in complicated tasks that they may eventually abandon
- forget the content of messages and instructions
- make poor academic progress during the school years, particularly in the areas of reading and mathematics
- are considered by their teachers to have short attention spans and also to be easily distracted.

Why is working memory crucial for learning?

Working memory is important because it provides a mental workspace in which we can hold information whilst mentally engaged in other relevant activities. The capacity to do this is crucial to many learning activities in the classroom. Children often have to hold information in mind whilst engaged in an effortful activity. The information to be remembered may, for example, be the sentence that they intend to write while trying to spell the individual words. It could also be the list of instructions given by the teacher while carrying out individual steps in the task.

Children 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. In these situations, their working memory is overloaded. 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 have got to in a complicated task, and so on. Because children with poor working memory fail in many different activities on many occasions due to working memory overload, they are likely to struggle to achieve normal rates of learning and so will typically make poor general academic progress.

For such children, an educational approach in which the teacher monitors the child's classroom learning activities and modifies them if necessary in order to ensure that he or she is working within their working memory capacity rather than being overloaded. This will help the child to complete and succeed in these activities, and so will build up knowledge and skills across time in a way that will facilitate learning.

In addition to this bulletin I have attached a guide to supporting students with working memory problems in the classroom.

If you have any particular items you would like information on or any interesting information or resources which you would like to share with your colleagues via this fortnightly bulletin please e-mail them to me:

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Many thanks

Anne