

ADHD and Working Memory

Research has shown that children with ADHD are four times more likely to exhibit behaviours associated with working memory impairments, writes Dr Tracy Packiam Alloway

Working Memory: An Introduction

Working memory refers to our ability to remember and process information over a short period. The best way to think of working memory is as the brain's

'Post-it note'. We make mental scribbles of bits of information we need to remember. This is not only used to remember information but to process or work with that information as well. For example: we use it to remember someone's name and phone number or directions while driving. Without it we would literally be lost: we wouldn't know how to get to that important meeting at a new location and would forget important phone numbers and contacts. Working memory is critical for a variety of activities at school, from complex subjects such as reading comprehension, mental arithmetic, and word problems to simple tasks like copying from the board and navigating around school.

Working memory increases during childhood. Figure 1 shows how much information we can remember as we get older. For example, the average 5 year old can remember two items, while an average 10 year old can remember 3 or 4 items.

Working Memory and Learning

There are three key facts about the impact of working memory on learning.

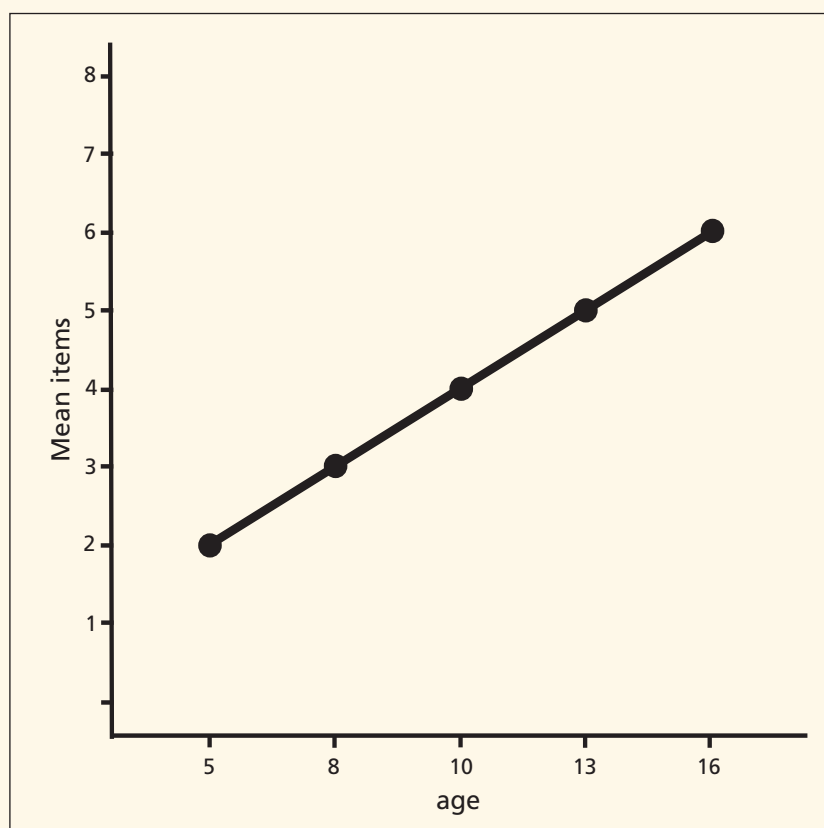


Figure 1.

Working memory is the #1 predictor of learning success. A large number of scientific studies have demonstrated that while cognitive skills such as IQ and phonological skills are important to learning, working memory is the number one factor in predicting learning outcomes in 5 to 16 year olds.

Scientific research shows that 1 in 10 children have a low working memory. In a study of over 4000 children, I found that 10% to 15% of children have working memory impairments that lead to learning difficulties.

A child with a low working memory will not 'catch up' with their peers. Without intervention, they will continue to struggle in all areas of learning. In a recent study, I found that teenagers who were diagnosed with low working memory two years earlier were still performing very poorly in school compared to their peers.

Working memory is also important in the classroom as children often have to hold information in mind while engaged in an effortful activity. Such activities include writing a sentence while trying to spell the individual words. They could also be a set of instructions they have to remember while completing the individual steps in the task. Children with working memory deficits struggle in these activities because they are unable to hold enough information in mind to complete the task. Losing crucial information from working memory causes them to forget many things: instructions they have to follow, the details of a workbook activity and information they have to write down.

ADHD and Working Memory

As part of a recent government-funded study, 85 children with a clinical diagnosis of combined-type ADHD were tested using two standardised assessments of working memory. The first question I addressed was whether children with ADHD exhibit classroom behaviours that correspond with a working memory impairment. Classroom teachers judged how frequently a child exhibits problem behaviours associated with working memory deficits using the Working Memory Checklist for Children (WMRS). A high score on this checklist indicates that a child is likely to have working memory problems that will affect their academic progress. The items of the WMRS were constructed from descriptions of common classroom behaviours

that discriminated against children with low and typical working memory skills. Examples include: 'The child raised his hand but when called upon, he had forgotten his response'; 'She lost her place in a task with multiple steps'; and 'The child had difficulty remaining on task'.

There were two groups of children: those with ADHD, and a corresponding group of children with typical working memory functions. Teachers rated how typical each behaviour was of a particular child, using a four-point scale ranging from (0) *not typical at all* to (1) *occasionally* to (2) *fairly typical* to (3) *very typical*. The results indicated that children with ADHD were four times more likely to exhibit behaviours associated with working memory impairments compared to those without ADHD.

The next issue was to identify the cognitive profile of children with ADHD using the Automated Working Memory Assessment (AWMA). The AWMA is a computer-based assessment of working memory skills developed specifically for educators. This tool requires minimal training as test administration and scoring is fully automated. The testing sequence is pre-set, test scores are calculated by the computer program and the student's learning profile is generated on completion.

Figure 2 illustrates the memory profile of children with ADHD using the AWMA. The y-axis represents standard scores where 100 is the mean and 15 points below that indicates impaired working memory performance as represented by the dotted line.

Children with ADHD performed within the normal range in verbal short-term memory. This corresponds with the view that the verbal short-term memory problems sometimes found in children with ADHD are not fundamental features of the disorder *per se*, but are likely to be associated with co-morbid disorders such as reading. Children with ADHD did not have any deficits in visuo-spatial short-term memory.

In working memory, children with ADHD had deficits in both verbal and visuo-spatial tasks, with particularly low scores in visuo-spatial working memory. One explanation is that visuo-spatial tasks are less automatic, and so demand more mental effort than verbal ones. This is especially true for dynamic tasks, such as tracking visual sequences

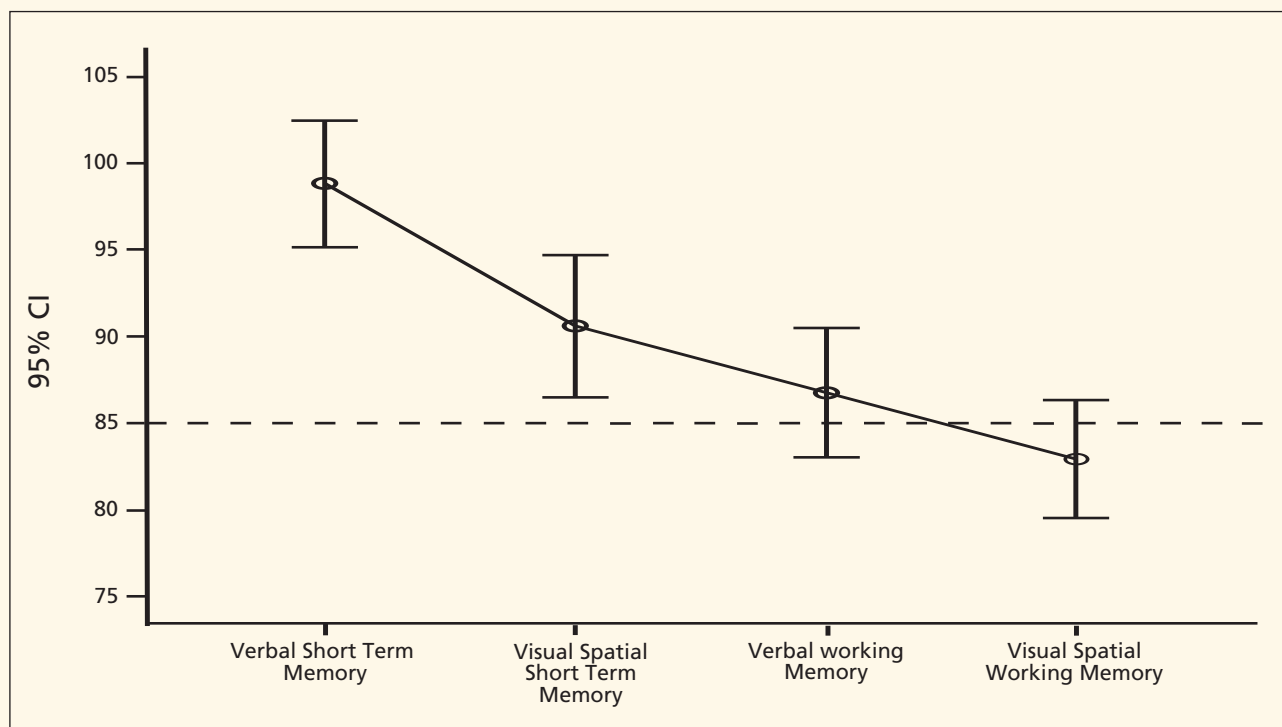


Figure 2.

and mentally rotating objects. Another explanation is that visuo-spatial memory tasks involve the right hemisphere, which has been implicated as an area of deficit in children with ADHD.

Testing working memory in children with ADHD

As a result of working memory deficits, children with ADHD often perform very poorly in key areas of learning such as reading and maths. Early diagnosis is therefore critical. While ADHD is clinically diagnosed, behavioural and cognitive profiles of working memory can provide reliable and useful early indicators of learning difficulties. Visuo-spatial working memory in particular was found to accurately distinguish those with ADHD from typically developing children. This test from the AWMA takes less than 5 minutes to administer and offers educators an informative first step in supporting a student's learning.

Training working memory in children with ADHD

There is exciting research emerging on the benefit of training working memory in children with ADHD. One particular program, *JungleMemory* is a fun and interactive computer program based on cutting-edge science. The games are scientifically

proven to increase working memory in key learning activities, like reading and math. It trains both verbal and visual memory for a complete brain workout, and includes bonus features to motivate the students. It has been featured on a BBC Radio program and is currently being trialled in typically-developing children. Further details can be found at: junglememory.com

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For information on research in working memory and learning, please contact Tracy Alloway by email (t.p.alloway@durham.ac.uk). Her website contains up-to-date information on research articles and projects: dur.ac.uk/t.p.alloway

Resources

*Automated Working Memory Assessment (AWMA), published by Pearson Assessment
w: pearson-uk.com/AWMA*

*Working Memory Rating Scale (WMRS), published by Pearson Assessment
w: pearson-uk.com/WMRS*

*Working Memory Training, published by Memosyne Ltd.
w: junglememory.com*