



Using visual prompts enables children with Down syndrome to participate on a more equal footing with their peers

Working memory and Down syndrome

Tracy Packiam Alloway and **Patricia Murphy-Powell** outline strategies that help level the playing field for pupils with Down syndrome

Ten-year-old David has Down syndrome. His class is learning about different species of animals in different environments and his teacher has asked him to identify an animal that lives in a cold climate. While David is able to point to the correct answer, he cannot formulate the same response verbally.

One of his favourite parts of the day is story time, when pupils retell stories they have read to their classmates. David's written work shows that he has a good comprehension of the stories he has read. Frustrations arise when he is asked to demonstrate this orally. He has not forgotten what he has learned, and his inability to verbalise effectively causes him distress.

Meanwhile, although he tries hard to keep up with his classmates, he often fails to carry out all of the teacher's instructions. However, David does well when his teacher repeats these slowly

“ *Their visual processing skills are in advance of their verbal abilities* ”

and gives him extra time to complete the tasks.

Working memory

Working memory is the ability to remember and process information and is therefore fundamental to success in the classroom. Children use it to remember instructions, prioritise activities and pay attention to the teacher. It is also an important factor in predicting grades from the Early Years Foundation Stage to college.

Working memory impacts verbal and visual skills. Verbal skills allow us to

learn language, remember instructions and complete reading comprehension tasks. Visual-spatial working memory enables us to solve maths problems, spot sequencing patterns, make sense of images and find locations.

Although working memory keeps developing throughout a person's lifetime, the most dramatic growth takes place during the first 10 years. A typically developing five-year-old can remember and process two or three pieces of information; a 10-year-old can work with four things, such as a four-step instruction or a list of four unrelated words.

The impact of Down syndrome

Down syndrome is a genetic disorder affecting around one in 1,000 children worldwide. Like typically developing children, the working memory profile of a child with the condition varies from one individual to another, but research has established some patterns that can

inform the way we teach and support their learning.

One common pattern is a verbal working memory deficit – children with Down syndrome experience greater difficulty in remembering verbal information. Do they have difficulty in encoding information (getting information in) or with retrieving information (getting information out)? One view is that the former is true, so David's struggle to carry out the teacher's instructions may be linked to his difficulty in encoding the information when he first hears it.

Children with Down syndrome can also experience difficulty in recalling information. Their errors are unique in that they don't usually forget words when they are talking, but they incorrectly repeat words. This is evidenced in David's responses during story time – while children with general learning difficulties will have forgotten the story, David has retained the essence but keeps repeating words in the course of his account.

Verbal memory deficits in the classroom

Verbal memory is what we use to learn new words and understand the complexity of language and conversation. Deficits in verbal memory are linked to poor language acquisition and communication.

Sometimes recall deficits stem from a slow speech rate. The longer it takes children with learning difficulties to repeat or rehearse information, the more likely they are to forget it. However, research has established that this is not the case for children with Down syndrome, whose speech is typically no slower than that of their peers.

So where does their difficulty lie? It may be in how they are asked to recall information. When children can point to an answer, they perform much better than when they have to provide a verbal response. Thus when David is asked about animals in cold climates, he is able to answer accurately when he can avoid using language and can point instead.

Difficulties with communication and life skills

Kate is a secondary student with Down syndrome who is learning to interact with her typically developing peers and develop independent life skills.

Good communication is an essential life skill goal for individuals with Down syndrome to allow them to share their feelings and ideas with others, but various obstacles can stand in their way. In Kate's case, weakness in verbal memory often

leads to difficulties in expressing her thoughts and emotions effectively.

Incidental learning has been another challenge for Kate, especially when practising skills that will enable her to fend for herself in adulthood. At the moment, she is learning how to do her laundry and her mother has told her the specific steps to accomplish this task. Kate has heard these on many occasions and is frustrated by her inability to remember them. She has partial recall, but because she struggles to focus when instructions are being delivered, she is often unable to follow them through from beginning to end.

“They don't usually forget words when they are talking, but incorrectly repeat words”

Meanwhile, public transport is a great way for her to get to her volunteer position at the local library. She has travelled the route with her mother, and the bus driver has become a familiar person. However, there have been inconsistencies with her ability to respond to environmental stimuli such as sounds, sights and other sensory signals that would let her know how far she has travelled. Attention and memory also play a part in her difficulties, as the bus makes stops along the way; sequencing information is another aspect of learning that Kate finds hard.

Areas of strength

However, Kate has several strengths that can help her to compensate for her difficulties. One of these is her ability to process visual information, and she is working on strategies that make use of this asset to help her improve her communication.

She is not alone in having such strong visual tendencies. Research has shown that the visual processing skills of children with Down syndrome are in advance of their verbal abilities – the opposite of what we see in the typical developmental trajectory, where verbal memory skills are the ones that develop faster. This means that individuals with Down syndrome will encode information visually to boost recall.

Another strength that researchers have observed is an intact semantic knowledge.

Semantic knowledge is part of long-term memory or the library of knowledge that individuals accumulate. This includes maths facts ($6 \times 4 = 24$), spelling rules ('i' before 'e' except after 'c'), scientific and historical knowledge and the different sounds that phonemes make. Working memory, on the other hand, is like a librarian who pulls the appropriate item off the shelf when it is needed. For example, if you ask a student to name the reigning British monarch, it is their working memory that searches through their long-term memory and finds Queen Elizabeth II.

Ways of playing to these strengths

Reduce verbal recall

As the student with Down syndrome often makes errors when recalling information verbally, one strategy is to encourage the use of visual strategies instead.

In addition to using actions like pointing, there are many technological tools available that allow students to circumvent the need to respond verbally. Examples include touchscreen devices and clickers, which enable them to participate in classroom discussions without the anxiety or frustration of struggling to express themselves orally.

Encourage visualisation techniques

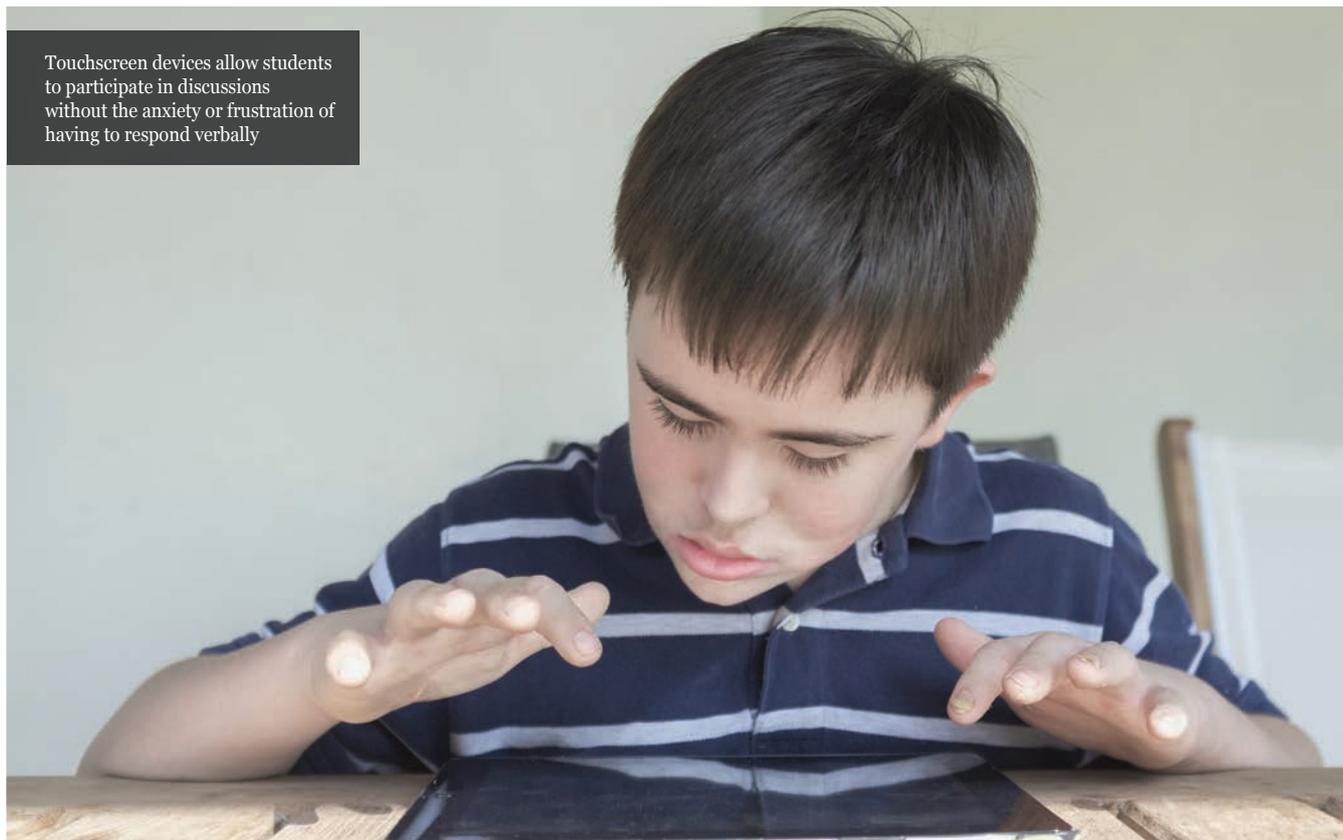
Research with struggling readers has found that visualisation techniques are very effective in supporting memory. Teachers can encourage students with Down syndrome to visualise a passage that they are reading, and then draw a picture to represent a summary of what they have read. This can strengthen the encoding process and enable them to keep up with their peers.

Make abundant use of visuals

A teacher from Florida shared one of her tips with me. Every time she asked the class to get their lunchboxes and stand by the door, six-year-old Carrie would wander aimlessly around the room while the other pupils lined up ready to go. The teacher had spent time making this instruction a part of the children's daily routine, so they knew exactly where to go to find their lunchboxes and what to do next. She regularly repeated the information, step by step, and yet Carrie still needed constant prompting.

Her solution was to give Carrie a photo of her lunchbox and stick a copy of this on the cubbyhole at the back of the class where it was kept. The photo helped

Touchscreen devices allow students to participate in discussions without the anxiety or frustration of having to respond verbally



Carrie stay on track: she knew what she had to do and where to go. It wasn't long before she was first in line having retrieved her lunchbox at record speed.

With older students, poor verbal working memory may lead them to bring the wrong textbook to class. A strategy here is to place the class timetable on the student's desk with a photo of the textbook beside each subject so they can match the right book to the right lesson.

Adapt the use of visual prompts to the needs of the student

One teacher has a magic whiteboard at the front of the class, and students often refer to it, going up and using the touchscreen to find out what the next lesson will be. As with many visual aids, all students find this helpful.

However, the student with Down syndrome may get confused by having to walk up to the board, point to the correct place on the timetable, and then go back to their desk to find the right book. In this case, the solution is to make these visual prompts directly accessible to the student. Include an arrow on the class timetable on their desk so they can move it to remind themselves of where they are and what is coming next. This will allow them to use their working memory to focus on the lesson instead of trying to figure out what book they need.

Draw on semantic knowledge

As students with Down syndrome have good semantic knowledge, this is a useful way to support how they encode information. One of the best ways to do this is to make it meaningful by mapping it onto things they already know.

“**Students with Down syndrome have good semantic knowledge**”

Let's take the fact that Harald Fairhair was the first King of Norway. Because this piece of information is so far removed from our historical identity, it is very hard to remember on its own. If we had to learn it for a test, most of us would struggle. However, creating links with random items from our existing bank of knowledge allows us to remember arbitrary information of this kind.

The first step is to create a connection with long-term memory, which includes our mental dictionary of language, such as our understanding of meaning and how words relate to each other. For example, the student may know that their pet dog is an animal and belongs to the subdivision of mammals. Think of long-term memory

as a web or a map of interconnected relationships. By encouraging students to draw on this rich resource, they can come up with creative and fun ways to support their working memory.

In the case of Harald, get them to use this facility to make up a story that will help them to remember the key facts. They might visualise a fair where they see a hairy king being announced by a herald (King Harald Fairhair), and then going on to win a pie-eating contest (coming first). Of course this story is bizarre, even weird, but that makes it easier to remember because it sticks out in the mind.

Although the sensory and perceptual skill impairments experienced by individuals with Down syndrome can impede the path to independence, they should not make it impassable as long as teachers and carers work to their students' strengths.



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