

Mathematical abilities in Williams syndrome: Difficulties and educational best practice

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Our research has focused on mathematical skills in children and adults with Williams Syndrome (WS) and compared their skills to typically developing children and adults as well as those with Down Syndrome (DS). In addition, we have reviewed existing studies that have previously examined mathematical skills in WS. For more information about our work, see details below. This blog is based on our own research as well as the findings of our review.

What do we mean by mathematics?

First of all, mathematics is a really complex subject with many components. Mathematics is made up of many different types of concepts and skills. To be successful in mathematics we must know things like being able to recognize and name digits, know the meaning of number words, understand the meaning of counting, knowing how numbers fit together in a system and realising the relationship between operations, such as that addition is the reverse of subtraction. We must also have good skills, such as being able to count accurately, carrying out addition and subtraction procedures and tackle word problem solving.

What do people with WS find difficult?

Our own research has shown that all people with WS struggle with mathematics. All verbal children and adults do learn the counting names and are able to count to 20. However, few are able to count onwards from a number different to 1 or to count backwards, due to poor working memory skills. Therefore, people with WS may “get lost” in the number word list when being asked to do something that they are not used to doing or when they get distracted. So, although we sometimes hear that people with WS are good at counting, we should put that in context: Yes, the knowledge of counting names in WS tends to be better than most children with DS, but they do struggle with numbers beyond 100 as well as counting tasks that really push working memory skills.

Secondly, many children with WS struggle to understand the meaning of counting or what counting is for: When you count items in a set, it is so that you know what size that set is. Yet, many people with WS make errors when counting. Partly, these errors can be explained by a lack of pointing when counting the items and a lack of keeping track of items that have already been counted compared to those items that have not yet been counted. However, even when asked to give a number of objects (a task that does not involve pointing or working memory), many people with WS give a random number of items showing that they struggle to understand *what* counting is for.

People with WS usually display poor visuo-spatial skills, this means that they struggle with orientation of numbers and letters and therefore digit recognition can be tricky for some, especially when double (e.g. 21) or triple digits are involved (e.g. 341). These poor visuo-spatial skills may also impact on counting skills and being able to divide up counted and not-yet-counted objects.

People with WS are quite good at estimating small numbers and are able to recognize the number of objects (up to 5) quite quickly. However, their estimation of larger numbers is poor and a number of studies have now shown that their ability does not exceed that of 8-9 year old typically developing children. For example, when being shown 9 red dots and 14 blue dots, people with WS find it very difficult to say which set has more without counting. Yet, this is a task that young typically developing children find quite easy. In addition, people with WS find it difficult to understand how numbers relate to each other, or to estimate where numbers go on a number line. This all suggests that their organisation of how numbers and quantities are organized in their brain is different and might cause mathematical difficulties.

When it comes to addition and subtraction, many children and adults with WS manage to solve simple sums that use single digits and do not exceed the number 16. However, we have no research about more complex sums. As we know that people with WS struggle with double digit recognition, these larger sums might be a challenge for them. Overall, across all aspects of mathematics, except for small number estimation, people with WS may show difficulties throughout their lives.

What can you do about it?

Our review of existing research has shown that there are no intervention studies that have assessed how to improve mathematical skills in people with WS. There are no studies that have evaluated what works in the classroom in terms of mathematical practice for children with WS. So we can only make an informed guess based on what we know about mathematical abilities in typically developing children and studies that have examined what works for other children that have mathematical difficulties.

- 1) Improving number names: Although the knowledge of number names is delayed, children with WS are able to learn the number names and songs can particularly help children with WS. Actually there are a number of studies that suggest that the verbal abilities might, to a certain extent, help children with WS compensate for their non-verbal mathematical difficulties.
- 2) Pointing: Children with WS rarely point, especially younger ones. So try and find opportunities for children to point at things (by putting objects out of reach for example or by showing them two things one of which they really like and ask them to point to what they want). Also praise them and respond when they point. Pointing can help them when counting things later on.
- 3) Number line skills: Understanding how number relate to each other is very important for solving mathematical problems. There is good evidence to suggest that playing very simple board games- like snakes and ladders, helps children understand the number line (i.e. that numbers go from 1-10, with small numbers on the left and large numbers on the right). Playing games in which children have to put numbers in right order or amounts/sets of objects from small to large may also help.
- 4) Set sizes: Practicing comparing small sets of objects may help estimation skills. Share out two small sets of sweets and ask them to guess who has more! This will be motivating but also useful.
- 5) Cardinality: Task a bag of toys and ask children with WS to take out a specific number of items and give them a sticker each time they give the correct number of items. As children find this very difficult it is OK to start with numbers 1 and 2.

- 6) Digit recognition: As digit recognition difficulties are partly caused by visuo-spatial issues using larger font size, more space between sums (and even better just to have 1 per work sheet) as well as using colour to show how the digits go together (in 12 both numbers are blue but in 1 and 2 each number is a different colour) can help people with WS.

Also children with WS have working memory difficulties and will find it hard to keep track of items counted or to manipulate information in their minds only. So teaching them strategies of how to break sums down, how to keep track of items counted (line items to be counted up!) and encourage the use of fingers might really help them.

As with all learning in WS, it can take a very long time for people with WS to show true understanding and repetition is key. In addition, we know that some days people with WS can show good understanding of something and the next time it seems like they have forgotten everything (due to anxiety, lack of motivation, lack of concentration, sleep, who knows?!). Therefore, what works one day may not work on another day but luckily maths is all around us and thus, it should be easy to implement some maths activities in your daily routines. But also, motivation is key so using their favourite topic to cover some maths questions will really help them (e.g., How many people fit in that plane/train? Is that more than on the other plane/ train? How long it is the extension of that Hoover? Is that longer than the other one?).

Some examples of maths in daily life:

- When driving in the car there are a lot of digit recognition games you can play: speed limits, road numbers, car registrations, they all contain different digits!
- When shopping you can talk about the amount of items in your trolley, how that compares to people around you and how much you think you need to pay. This game is good for large number estimation.
- When a child or adult with WS asks for something (sweets, money, anything to eat like three fishfingers, four beans, one potato) ask them to count out the number of items.
- If your child likes to line up toys, you could for example stick stickers with numbers or quantities (a number of dots) on these toys and use these and your child's fondness of lining up toys to improve their understanding of how numbers relate to each other.

There are many more examples of how you can incorporate maths teaching in daily life, without the need to sit at a table and complete some worksheets. If you have any good examples, do get in touch!

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