

Associations between spatial abilities and mathematics in people with Down syndrome

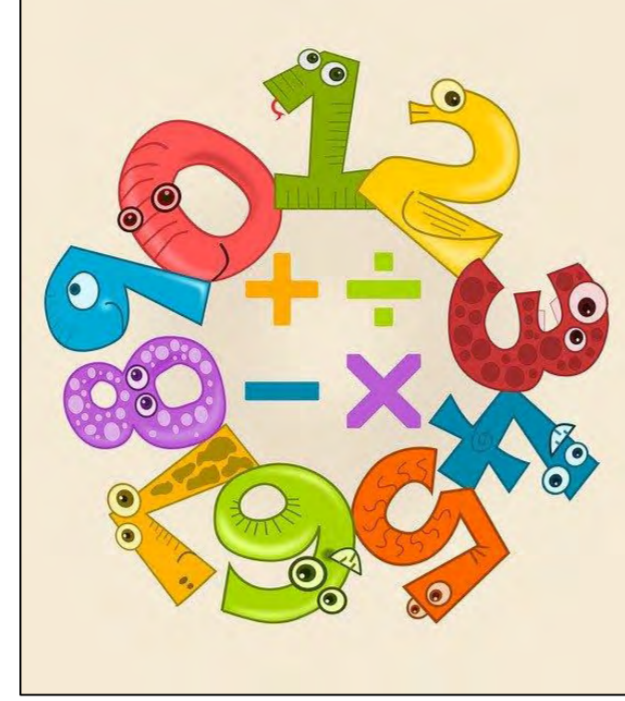
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Overview

- Spatial skills are a relative strength for individuals with Down syndrome (DS). What if we could monopolise on this strength to improve skills in other domains, e.g., maths?
- This foundational research will provide the information needed to design spatial training for individuals with DS.
- The project is still in the design phase (no data has been collected yet).
- We would love your feedback!



Background & Research Questions

Spatial Skills in people with Down syndrome

- Spatial skills are vital for everyday life, e.g., following a route, stacking a dishwasher, putting shoes on the right feet
- Evidence that people with DS have relative strengths in spatial skills compared to verbal skills (Davis, 2008). However, most research is focused on spatial memory, one small sub-component of spatial thinking (Yang, Connors & Merrill, 2014).
- Spatial thinking is multi-dimensional, i.e., it is comprised of sub-domains (Uttal et al., 2013). It is unknown whether individuals with DS have relative strengths in all/some of these sub-domains?
- Need cognitive profiles of spatial thinking in those with DS

Research Question 1: What are the strengths and weaknesses across different spatial sub-domains of spatial thinking in people with Down syndrome?

Links between Spatial and Math skills

- There is a robust association between spatial abilities and mathematics performance in typically developing children (Gilligan et al., 2018; Mix et al., 2016)
- Math outcomes can be improved with spatial interventions in typical groups (Hawes et al., under review; Mix et al., 2020).
- It is unknown whether spatial ability is associated with math performance in people with DS?
- Given that individuals with DS have relatively poorer verbal compared to spatial skills, we predict that the role of spatial strategies in mathematics will be particularly important in DS.

Research Question 2: Are spatial skills associated with mathematics performance in people with Down syndrome?

Possible Implications

- If spatial and math skills are associated in those with DS, there is potential for spatial training interventions to improve both spatial and mathematical skills in people with DS.

“Targeting Cognitive strengths (spatial) over weaknesses (verbal)”

Proposed Design

Participants

- 35 participants with Down syndrome aged 10-35 years and 120 typically developing children aged 4-10 years.

Procedure

- Part 1:** Online verbal and non-verbal IQ tests using zoom
- Part 2:** Online parent questionnaires
- Part 3:** Face to face meeting where spatial and maths activities are completed (both computer and paper based)

Tasks & Measures

Spatial Tasks

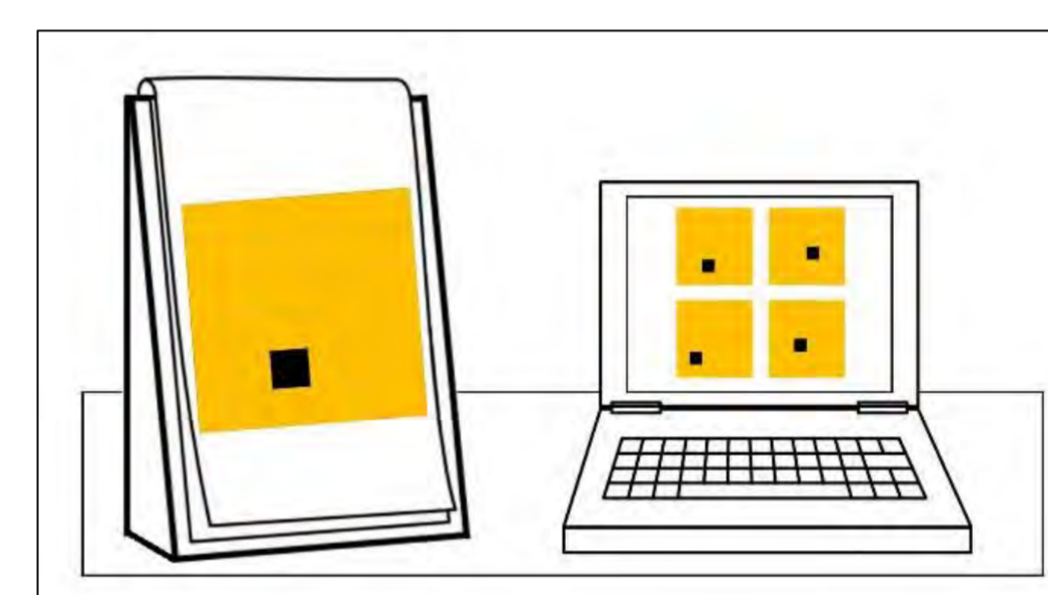
Intrinsic Spatial skills (Within object skills)

- Mental Rotation: Rotate objects in your mind
- Transformation: Join shapes together in your head
- Mental Folding: Imagine folds to a piece of paper

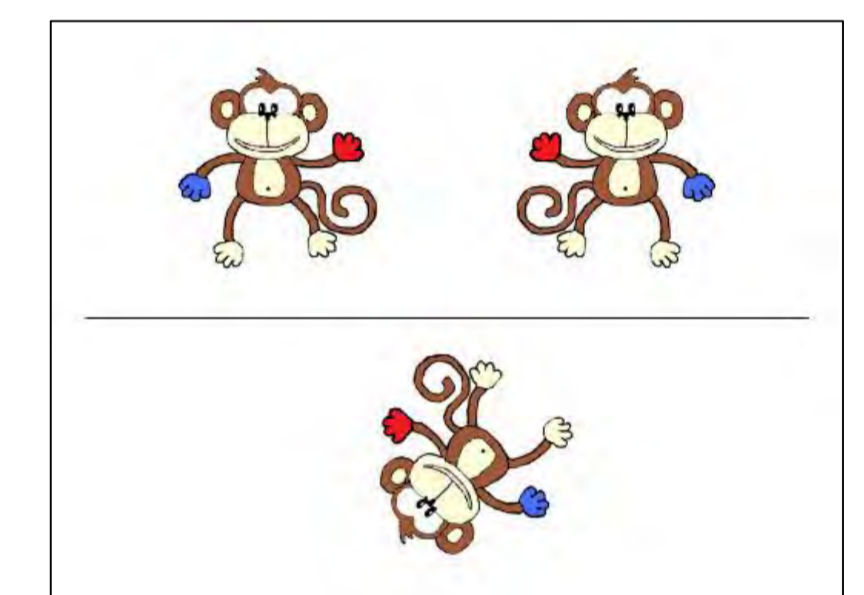
Extrinsic Spatial skills (Between object skills)

- Scaling: Compare two spaces presented at different scales
- Perspective Taking: Imagine scenes from another perspective
- Exploration: Navigate through a virtual maze to find stars

Spatial Scaling Task



Mental Rotation Task



Math Tasks

Non-symbolic number skills

- Choosing which side of a screen has more dots on it

Symbolic number system

- Symbolic number comparison: Choosing which of two digits is larger, e.g., 4 vs. 7
- Counting: Asked to put a specific number of items into a box

Arithmetic

- Early arithmetic: Simple addition and subtraction items
- Standardised test of arithmetic: WIAT-II Test (designed for children aged 4 years and older)

Geometry

- Geometry test with questions on shapes, angles, co-ordinates taken from White Rose maths

Reasoning

- Standardised test of math reasoning: WIAT-II Test (designed for children aged 4 years and older)

What's Next?

- Project is approaching the end of the design phase.
- Feedback: Do you have any recommendations? Thoughts about the project? Related research ideas? We would love to hear from you
- Take part: We will be recruiting participants for this project in the coming months. If you are interested in learning more or would like to sign-up, please get in touch with us.

Contact Katie at k.gilligan@surrey.ac.uk

Abbreviated References: Davis (2008), <http://dx.doi.org/10.1037/1045-3830.23.2.271>; Gilligan, Hodgkiss, Thomas & Farran (2018), <https://doi.org/10.1111/desc.12786>; Mix et al., (2016), <https://doi.org/10.1037/xge0000182>; Mix et al., (2020), <https://doi.org/10.1037/edu0000494>; Uttal et al., (2013), <https://doi.org/10.1037/a0028446>; Yang, Connors & Merrill (2014), <http://dx.doi.org/10.1016/j.ridd.2014.04.002>