Improving Memory in Children with Down syndrome

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Summary

- Brief Overview of Memory in individuals with Down syndrome
- DSEI RCT, Method and Findings
- Memory assessments with MA matched TD children
- Implications and Future Directions
Short Term and Working Memory

- **Short Term Memory** = Storage of material only
  e.g. A phone number/list of items on a shopping list
- **Working Memory** = Storage and *manipulation* of material
  e.g. Adding up cost of items as you go in the supermarket, following sets of instructions.

Recent research has shown that Working memory skills are highly predictive of later academic success in children aged 7-11 with learning difficulties (Alloway, 2009).

Verbal working memory is also directly related to vocabulary learning in typical 3-5 year olds. and in children with Down syndrome (e.g. Gathercole & Baddeley, 1989).
Measuring Memory (AWMA)

Verbal STM – e.g. Word Recall
- Pen
- Dog Bike
- Car Shed Door

Verbal WM – e.g. Counting span

Visual STM – e.g. Block recall

Visual WM – e.g. Odd one out
Research has shown that Individuals with Down syndrome have a specific deficit in the verbal memory domain.

Their visual memory skills are often less impaired. (e.g. Chapman & Seung, 2005/Hick, Botting & Conti-Ramsden, 2005).
Memory and Down syndrome

This deficit in Verbal Memory can not be fully explained by:

1. **Hearing Loss**

2. **Speech Production Problems**

3. **Poor Language Knowledge**

1. **Provide visual support** – Improved performance but not sig. (Jarrold *et al* 2002).

2. **Reduce/remove need for speech output** – still impaired (Brock & Jarrold 2005).

3. **Match by receptive vocabulary** – Still impaired verbal memory (Brock & Jarrold, 2005).
Memory training

Rehearsal training:

Studies have found that some improvements were made, but were only modest gains and were not sustained – and indeed gains did not transfer to working memory (Comblain, 1994, Connors, 2008).

There is a clear need for effective, sustainable memory training programmes that are suitable for individuals with Down syndrome.
Cogmed JM – See Pearson website

- JM = 75 games.
- Developed for research.
- Focus is on visual memory.
- Adaptive training on a trial by trial basis constantly adapting to each individual's WM capacity.
1. Adaptive training that taxed working memory to its limits was associated with substantial and sustained gains in working memory, with *age appropriate levels* achieved by the majority of children compared with non adaptive training (*Children with low WM*). (Holmes, Gathercole & Dunning 2009)

2. When compared with Medication, Cogmed training showed greater benefits on all aspects of working memory (*Children with ADHD*). (Holmes & Gathercole 2009)
1. Working Memory training can improve cognitive functioning in pre-school children, with transfer effects of visuo-spatial training to the verbal domain of WM (Typical Pre-School Children) Thorell et al, 2008).

2. Cogmed has also been shown to help adults who have had a stroke & other adults with memory difficulties. (Westerberg, 2007).
Working Memory and the Brain

Training induces significant increases in WM-related activity in the prefrontal cortex. Westerberg (2007)

Training results in changes in the density of cortical dopamine D1 receptors, McNab & Varrone Feb 2009.
### Pilot

- 5 Children with Down syndrome
- Cogmed training completed at **home**.

1. PPVT (Peabody Picture Vocabulary Test)
2. 8 Subtests of the AWMA (Verbal & Visual STM/WM)
3. BRIEF parent version

### Main Study

- 24 Children with Down syndrome
- 21 Mainstream, 3 SEN.

- Cogmed training completed at **school**.
- RCT random assignment (G1 N= 12, G2 N=12)

1. KBITII (Kaufman Brief Intelligence Test)
2. 4 Subtests of the AWMA (Verbal and Visual STM/WM)
3. BRIEF P parent version (preschooler)

- 21 children completed training (Group 1 = 10, Group 2 N = 11).
Children randomly allocated to one arm of the intervention and baseline assessments (N=24)

**Intervention group Weeks 5-20**
- Allocated to group (n=12)
  - Received full intervention (n=10)
  - Did not receive intervention due to child or staff illness (n=2)

**Waiting List Control group Weeks 5-20**
- Allocated to group (n=12)
  - Received no intervention and continued with education as usual (n=12)

**Intervention group Weeks 20-40**
- Assessed during weeks 21-23 (n=10)
- Received no further intervention and continued with education as usual over weeks 24-40 (n=10)

**Waiting List Control group Weeks 20-40**
- Allocated to intervention (n=12)
  - Assessed during weeks 21-23 (n=10)
  - Received full intervention over weeks 24-40 (n=10)
  - Received partial intervention over weeks 24-34 (n=1)
  - Did not receive intervention (technical issues); lost to follow up (n=1)

**Intervention group Weeks 41-44**
- Final assessment (n=10)

**Waiting List Control group Weeks 41-44**
- Final assessment (n=11)
## Baseline Scores (raw)

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>MA</th>
<th>MA</th>
<th>Verbal STM</th>
<th>Verbal WM</th>
<th>Visual STM</th>
<th>Visual WM</th>
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<tbody>
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<td>13.09</td>
<td>8.82</td>
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## Cogmed Memory Scores

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<th>N = 21</th>
<th>STM</th>
<th>WM</th>
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<tr>
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<td>H</td>
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<td>Highest</td>
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</table>

* Pool, Hotel, Rollercoaster, Twister, Wheel Of Animals, Ferris Wheel, Bumper Cars
Raw Memory Scores
(pre and post training)

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
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<th>3</th>
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<th>2</th>
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<td>13.40</td>
<td>8.40</td>
<td>14.50*</td>
<td>10.10*</td>
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<td>2</td>
<td>12.91</td>
<td>7.45</td>
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<td>3</td>
<td>15.45</td>
<td>8.64</td>
<td>15.73*</td>
<td>10.36</td>
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</table>
Raw Memory Scores (VS STM) (pre and post training)
BRIEF-P – Executive Functioning
Measures EF in 5 key areas.

• **Working Memory** – Hold information in mind for purpose of completing/sticking with an activity.

• **Shift** – Move freely from one situation to another, solve problems flexibly.

• **Inhibition** – Controls impulses and behaviour at correct time/context.

• **Emotional Control** – Modulates emotional responses appropriately to situation.

• **Plan/Organise** – Anticipates future events/consequences.

High scores indicate difficulties in that area – average score for typical child is 50.
# Executive Functioning

<table>
<thead>
<tr>
<th></th>
<th>Time</th>
<th>Inhibition</th>
<th>Shift</th>
<th>Emotional Control</th>
<th>Working Memory</th>
<th>Plan/Organise</th>
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<td>60.28</td>
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Summary of RCT

- Cogmed training was feasible and improved short term visual memory for children with Down syndrome in our study.
- Cogmed training may be suitable for younger children with appropriate support – also depending on their existing memory skills.
- Children who completed Cogmed training had less problems on WM & SHIFT (BRIEF-P). But findings less clear.
- Gains are sustained – children likely need more frequent practise JM intervention programme less intensive than RM (75 activities v 200) – case study of RM showing continuing gains – especially in verbal memory.
Recommendations following RCT

- Cogmed Training should be done at home or school early in the day at regular intervals.
- Needs to be closely supervised by parent or caregiver especially at the start.
- Some sessions may take longer than 1 day to complete (especially for younger children)
- Parent/caregiver needs to ensure motivation is maintained throughout (effective use of rewards).
- Child may find it difficult in the first few weeks, but it will get easier and more enjoyable as it becomes more routine.
Limitations/future directions

- Further longitudinal work with a larger sample is clearly needed.
- The study found that visual training improved visual memory for children with Down syndrome – but no clear impact on verbal memory.
- Future research could explore the impact of verbal memory training activities on verbal memory skills.
- Not clear at this stage whether memory training transfers to other skills – more research is needed.
Follow on work:

- University of Surrey have been collecting baseline AWMA data on a MA matched typical group with us:

  1) To enable memory profile comparisons of different participant groups using AWMA).

  2) To enable us to see how much memory training has boosted raw & standard scores of children with DS to those seen in TD children of the same MA without intervention.
### Raw Memory Scores (STM)

**MA main trial : 65 m, TD CA : 70m**

<table>
<thead>
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<th>Visual</th>
<th>Verbal</th>
<th>Visual</th>
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<td>STM</td>
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Follow on work – initial findings

- Initial work suggests that Cogmed JM training boosted the short term visual memory skills of children with Down syndrome to be equivalent of children of a similar mental age (without Down syndrome).
- Verbal memory skills were still delayed, but there appeared to be some progression on verbal memory scores also (though less clear) – further work is needed to clarify this finding.
Contact + more information

- Email: Stephanie.Bennett@port.ac.uk
- See paper in AJIDD for more details.
- is.gd/cogmed – for Prezi presentation on this topic + video of Group 1 participant 3 months after training.
- See the Pearson website for more information about testing Cogmed JM.
- Interested in research collaborations - in particular memory training for individuals with developmental disability.