Improving Memory in Children with Down syndrome – Research Update

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Summary

• What is Memory and how can it be measured?
• Memory in individuals with Down syndrome
• Training memory in Down syndrome
• Memory training using Cogmed in other populations
• DownsEd Pilot Study, Method and Findings
• Implications of Pilot Study and Future Directions

Short Term Memory 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, 2007)

<table>
<thead>
<tr>
<th>Verbal STM – e.g. Forwards digit</th>
<th>Verbal WM – e.g. Counting span</th>
</tr>
</thead>
<tbody>
<tr>
<td>» 7</td>
<td><img src="visual_wm.png" alt="Visual WM" /></td>
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<tr>
<td>» 6 4</td>
<td></td>
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<tr>
<td>» 8 5 4</td>
<td></td>
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<tr>
<td>» 4 3 1 8</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Visual STM – e.g. Block recall</th>
<th>Visual WM – e.g. Odd one out</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="visual_stm.png" alt="Visual STM" /></td>
<td><img src="visual_wm.png" alt="Visual WM" /></td>
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</table>

### Memory and Down syndrome

Research has shown that Individuals with Down syndrome have a specific deficit in the verbal memory domain.

Their visual memory skills are often relatively unimpaired. (e.g. Chapman & Seung, 2005/Hick, Botting & Conti-Ramsden, 2005).

This graph shows data from our pilot study (N=5):

![Graph](graph.png)
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 and Down syndrome

**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/RM – See www.cogmed.com

- 5-8 weeks training period.
- Designed by psychologists and computer games designers.
- Adaptive training on a trial by trial basis constantly adapting to each individual's WM capacity.

Cogmed Research

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)
Cogmed Research 2

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.
Method

- Five children with Down syndrome aged 8-10 took part in this memory training pilot study (M = 9.2).
- Cogmed training completed at home with aid of parents.
- Children were assessed prior to intervention using:
  1. PPVT (Peabody Picture Vocabulary Test)
  2. 8 Subtests of the AWMA (Verbal & Visual STM/WM)
  3. BRIEF parent version
  4. Cogmed parent Questionnaire.

Before and after Memory Training Scores (Standardised)
Before and after Memory Training Scores (Standardised)

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
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<tbody>
<tr>
<td>Word Recall</td>
<td>63.3</td>
<td>71</td>
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<tr>
<td>Counting Recall</td>
<td>79.2</td>
<td>82.5</td>
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<tr>
<td>Block Recall</td>
<td>75.3</td>
<td>86.8</td>
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<tr>
<td>Odd one Out</td>
<td>83.2</td>
<td>90</td>
</tr>
</tbody>
</table>

Parent Feedback – BRIEF questionnaire

- Before the intervention parents reported their children to have most difficulty in the areas of Working Memory and Shift.

- Below are notable changes in parent’s responses to items on BRIEF.

  **Child 1**  Less emotional outbursts and gets less stuck on one particular topic.

  **Child 2**  Finds it easier to accept different ways to solve problems. Now doesn't get out of seat at the wrong times. Always remembers what they were going to get, when sent to get something.

  **Child 3**  More able to accept different ways to solve problems, doesn't think too much about the same topic. Is more able to initiate tasks on own. Now doesn’t talk at the wrong time.

  **Child 4**  Finds it easier to deal with new situations, now talks at the right time and is able to put brakes on actions’. Can now stay on topic when talking.

  **Child 5**  Finds it easier to deal with new situations, has less trouble finishing tasks/homework. Has a tidier bedroom, and is tidier generally.
Outcomes of Pilot Study

• Cogmed Training should be done at home or school early in the day at regular intervals e.g. 3 times a week and 1 or 2 times at the weekend.
• Needs to be closely supervised by parent or caregiver.
• Some sessions may take longer than 1 day to complete.
• Parent/caregiver needs to ensure motivation is maintained throughout (effective use of rewards).
• Plan rewards and use sticker chart to chart progress.
• Child may find it difficult in the first few weeks, but it will get easier and more enjoyable as it becomes more routine.

Implications

• This is only a small pilot project – further work is clearly needed in this area.
• Cogmed training was feasible and beneficial for children in with Down syndrome in our study aged 8+.
• Cogmed training may be suitable for children younger than 8 with appropriate support.
Future directions

• Northumbria/York collaboration: Use AWMA (Alloway, 2007) & Cogmed JM/RM to further investigate STM/WM in children and young adults with Down syndrome.

• MRI research if initial work is successful - to show if there is indeed plasticity following memory training in children with Down syndrome.

• Research into Alzheimer’s and DS – whether computer intervention of this kind may prevent some aspects of cognitive decline later in life.

• Integrating new research findings into existing intervention - Need to take what we know about computer training and feed into practical intervention (adaptive/timings etc.).

References


• Gioia GA, Isquith PK, Guy SC, Kenworthy L. Behavior Rating Inventory of Executive Function 2000; Odessa, FL: Psychological Assessment Resources.
• Stephanie.Bennett@downsed.org

• www.cogmed.com

• Working Memory and Learning, A practical guide for teachers – Susan Gathercole & Tracy Alloway (2008, Sage)

References


• Holmes J, Gathercole SE, Place M, Dunning DL, Hilton KA, Elliott JG. Working memory deficits can be overcome: Impact of training and medication on working memory in children with ADHD. Applied Cognitive Psychology 2009; Doi .10.1002/acp.1589.


Recruitment for Studies (Travel expenses paid).

<table>
<thead>
<tr>
<th>Study</th>
<th>Topic</th>
<th>Age</th>
<th>Location</th>
<th>Contact Information</th>
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<tr>
<td>1</td>
<td>Speech and language development.</td>
<td>18-20 months old</td>
<td>Reading University</td>
<td><a href="mailto:Emasonapps@gmail.com">Emasonapps@gmail.com</a> 07919 307523</td>
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<tr>
<td>2</td>
<td>Sleep, memory and attention.</td>
<td>6-12 years old</td>
<td>Middlesex University</td>
<td><a href="mailto:a.ashworth@mdx.ac.uk">a.ashworth@mdx.ac.uk</a> 020 8411 6221</td>
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<td>3</td>
<td>Route learning and visual perception.</td>
<td>8-18 years old</td>
<td>University of London</td>
<td><a href="mailto:E.Farran@ioe.ac.uk">E.Farran@ioe.ac.uk</a> 0207 612 6272</td>
</tr>
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