



Improving Memory in Children with Down syndrome

Improving Memory in Children with Down syndrome – Research Update

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Summary

- Memory in individuals with Down syndrome
- Training memory in Down syndrome
- Memory training using Cogmed in other populations
- DSEI RCT, Method and Findings
- Implications 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).

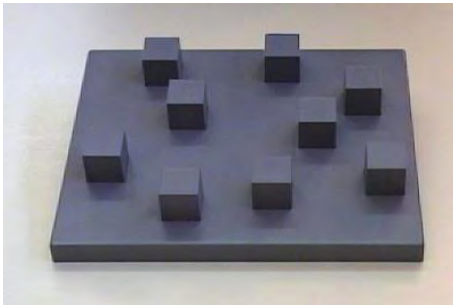
Verbal working memory is also directly related to vocabulary learning in typical 3-5 year olds. and in children with Down syndrome (e.g. Gathercole & Baddeley, 1989).

Measuring Memory (AWMA, 2007).

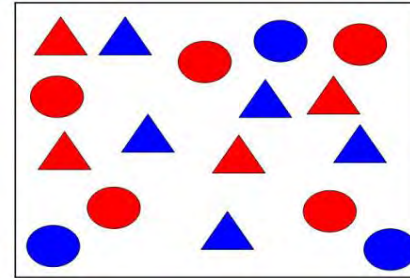
Verbal STM – e.g. Forwards digit span

- 7
- 6 4
- 8 5 4
- 4 3 1 8

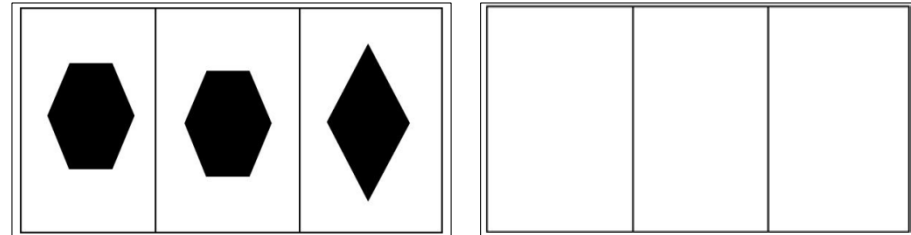
Visual STM – e.g. Block recall



Verbal WM – e.g. Counting



Visual WM – e.g. Odd one out

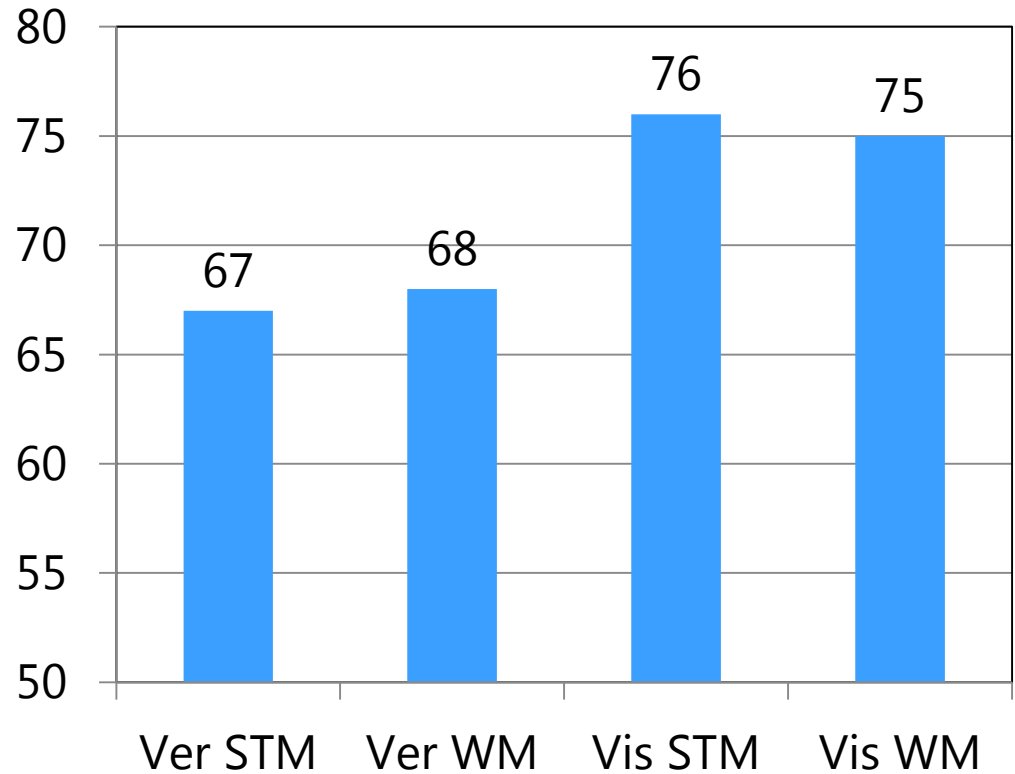


Memory and Down syndrome

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

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

This graph shows baseline AWMA data from our current study (N=25)
M CA 8.6 (range 7-12)
M MA 5.4 (range 4-8)



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:

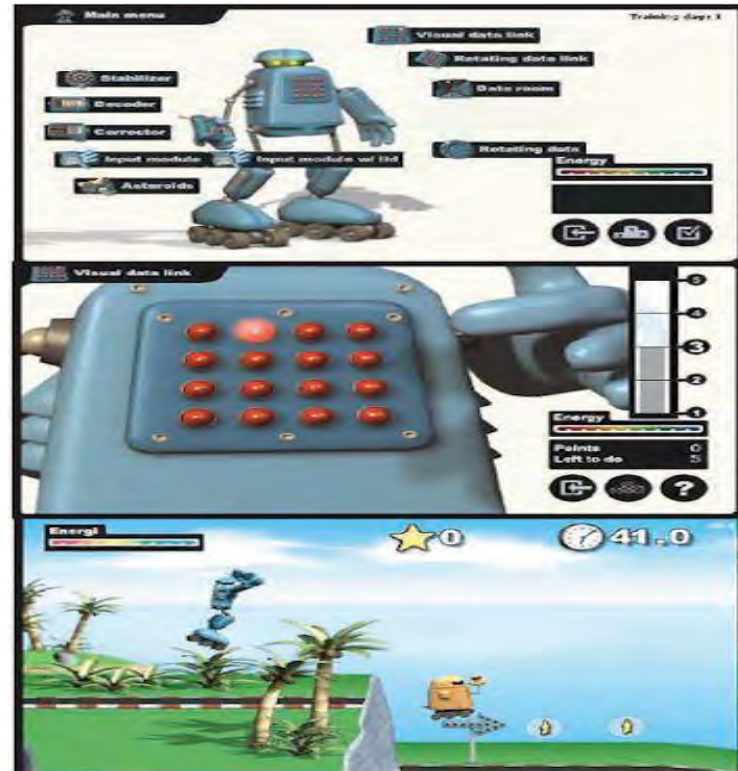
Studies have found that some improvements were made, but were only modest gains and were not sustained – and indeed gains did not transfer to working memory (Comblain, 1994, Connors, 2008).

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



- JM = 75 games.
- RM = 200 games.
- Designed by psychologists and computer games designers.
- Adaptive training on a trial by trial basis constantly adapting to each individual's WM capacity.



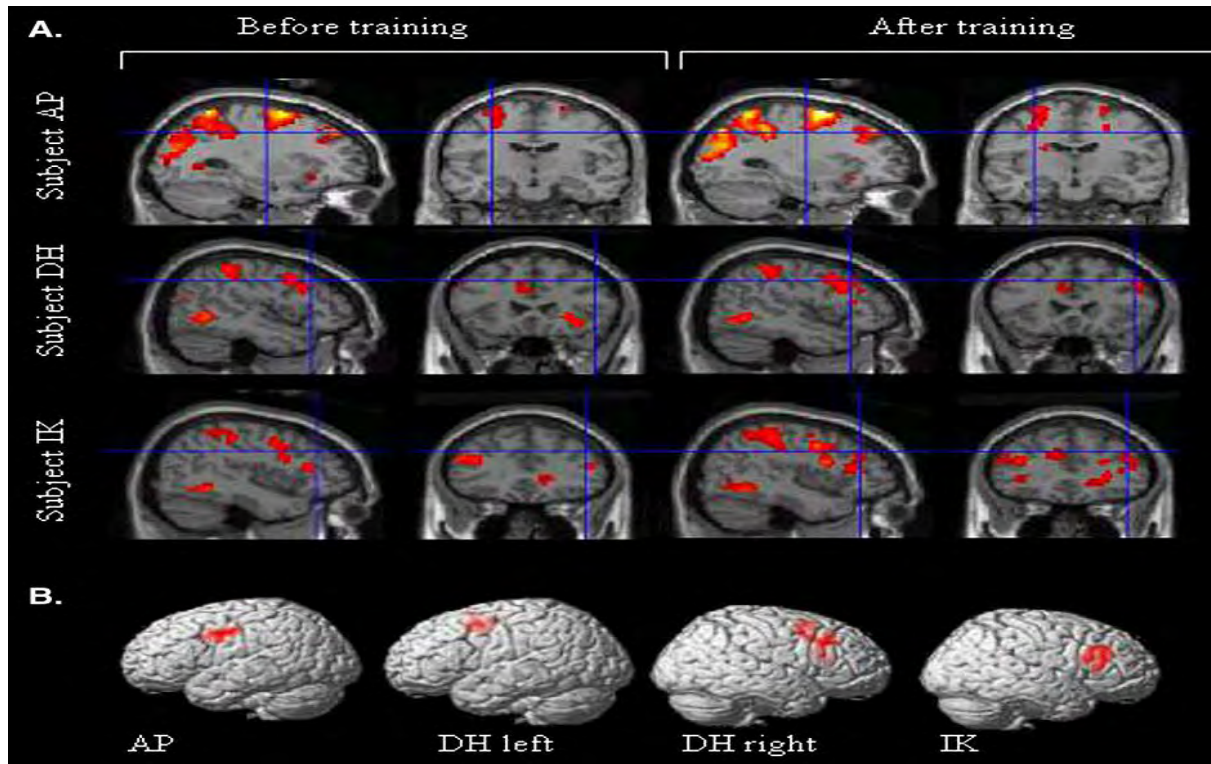
Cogmed Published Research

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 Published 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.

Cogmed Ongoing Research includes:

Preschoolers

ADHD
Children with Cochlear Implants

School children

ADHD
Low Working Memory
Anxiety
Brain Tumour Survivors
Learning Difficulties (maths, language)
22q.112 deletion syndrome

Adults

Brain Injury
Substance Misuse
Geriatric Depression
Cancer Survivors

<http://www.cogmed.com/ongoing-presented-research>

Pilot

5 Children with Down syndrome

Trisomy 21. Mainstream Schooling.

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. KBIT 2 (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).

Baseline Scores

	CA	MA V	MA NV	Verbal STM	Verbal WM	Visual STM	Visual WM
Group 1	113.60	63.80	68.90	13.10	7.50	11.60	6.90
Group 2	113.64	65.64	66.00	13.09	8.82	13.64	8.73

Cogmed Memory Scores (post training)

N = 21	STM					WM	
Task*	P	H	R	T	W	F	B
Start	3.51	3.37	3.21	3.32	3.57	3.32	3.40
Highest	4.51	4.59	4.18	4.24	4.67	4.35	4.30

* **P**ool, **H**otel, **R**ollercoaster, **T**wister, **W**heel Of Animals, **F**erris Wheel, **B**umper Cars

Raw Memory Scores (pre and post training)

		Verbal		Visual	
	Time	STM	WM	STM	WM
Group 1	1	13.10	7.50	11.60	6.80
Group 1	2	13.40	8.40	14.50*	10.10*
Group 1	3	15.10	8.80	15.20	11.20
Group 2	1	13.09	8.82	13.64	8.73
Group 2	2	12.91	7.45	12.27	8.91
Group 2	3	15.45	8.64	15.73*	10.36



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BRIEF-P – Executive Functioning Measure

Measures EF in 5 key areas.

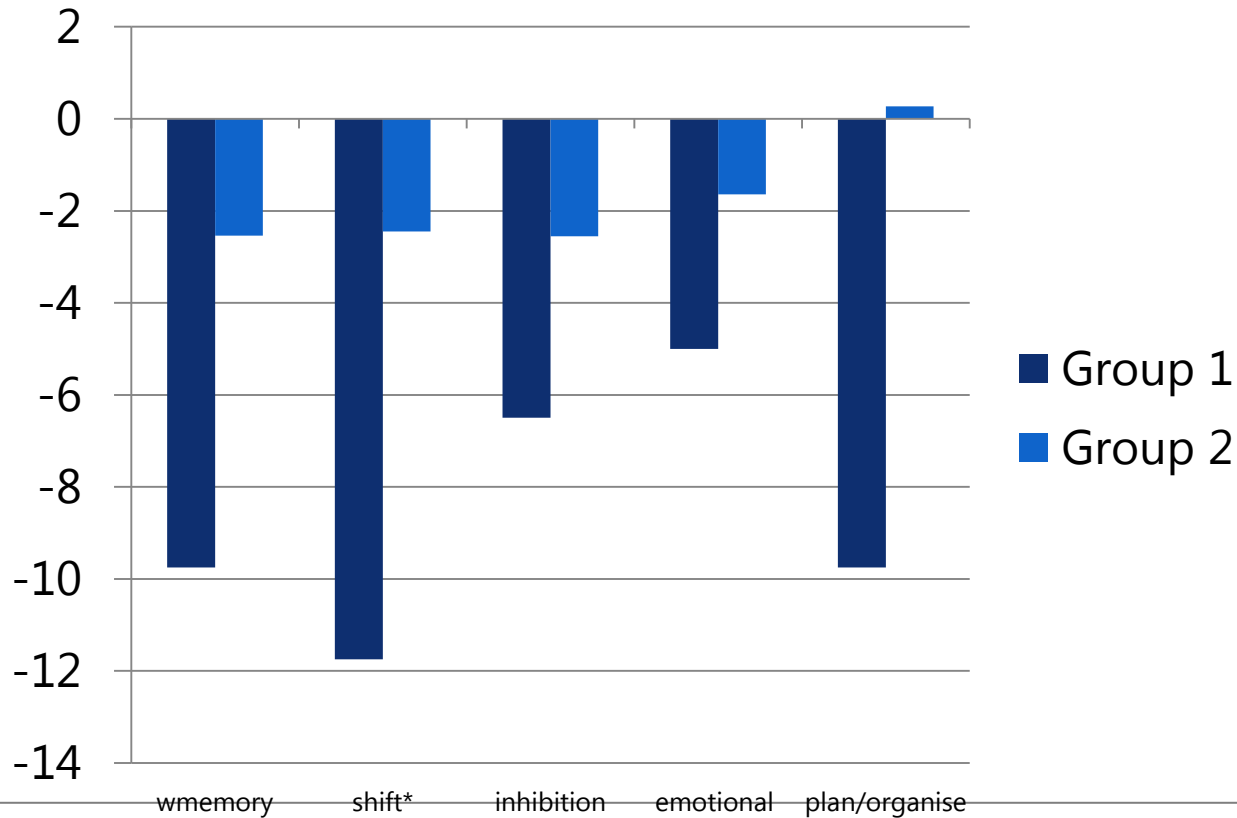
- **Working Memory** – Hold information in mind for purpose of completing/sticking with an activity.
- **Shift** – Move freely from one situation to another, solve problems flexibly.
- **Inhibition** – Controls impulses and behaviour at correct time/context.
- **Emotional Control** – Modulates emotional 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

	Time	Inhibition	Shift	Emotional Control	Working Memory	Plan/Organise
Group 1	1	71.10	70.50	61.30	80.10	68.80
Group 1	2	65.20	60.60*	57.80	71.70*	61.10
Group 2	1	67.73	61.18	61.27	76.36	65.00
Group 2	2	62.90	56.63	57.09	72.18*	62.09

BRIEF-P – Standardised Score Change



Summary

- 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).
- Gains are sustained – children likely need more frequent practise JM intervention programme less intensive than RM (75 activities v 200) – current case study of RM showing continuing gains.



Outcomes of work so far

- 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 (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.

Future directions

- **University of Surrey Neuroscience Team** 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.
- Bid under review for larger **RCT of Cogmed RM** with teenagers with Down syndrome (CA: 15-20) with Holmes– outcomes language and speech.
- Bid under review for multi site **RCT of an adapted version of Cogmed RM** for children with Down syndrome in UK and US (CA: 10-17) with Kronenberger – outcomes reading comprehension, mathematical reasoning, attention, EF.

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