Cogmed: Research and Clinical Evaluation Overview

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Occupational Therapy and Training Manager
19th Nov 2013

Agenda

- Cogmed Foundations
- Published Research Overview
- Research Collaborators Pipeline
- New Research Pipelines
- Critical Response

Cogmed Foundations
Cogmed and the world of academic research:
An important relationship

Original idea, prototype and funding from Karolinska Institute
- Company founded by research team: Klingberg, Westerberg and developers

Company was funded by Karolinska Development AB (2001- 6/28/2010)
- A fund investing only in products stemming from academic research

Klingberg works closely with Cogmed
- Now professor of Cognitive Neuroscience at Karolinska

The research published to date generates much interest
- Cogmed gets research proposals from around the world

Research collaborations are a key part of strategy
- Simple relationship: no payments from Cogmed, publishing freely

Published Research Overview

- Thorell et al., 2008
- Bergman-Nutley et al., 2011
- Söderqvist et al., 2011
- Klingberg et al., 2002, 2005
- Holmes et al., 2010
- Mezzacappa et al., 2010
- Beck et al., 2010
- Dahlin, 2011, 2013
- Green et al., 2012
- Gray et al., 2012
- Egeland et al., 2013
- Chacko et al., 2013
- Kronenberger et al., 2010
- Løhaugen et al., 2011
- Roughan & Hadwin, 2011
- Bennett et al., 2013
- Westerberg, 2007
- Lundqvist et al., 2010
- Johansson & Tornmalm, 2011

39 published studies cover range of ages & profiles

- Randomized, Placebo controlled, Double blinded
- Independent researchers
Will working memory training generalize to improve off-task behavior in children with Attention-Deficit/Hyperactivity Disorder?

Green et al. 2012

“This placebo-controlled, randomized, and double blinded study of WM training for children with ADHD is the first, to our knowledge, that demonstrates improved performance in an ecologically valid laboratory measure of observable ADHD-associated behaviors.”

Population & Sample Size: N = 26 children with ADHD, ages 7 – 14 years
n = 12 children in adaptive Cogmed training group
n = 14 children in non-adaptive Cogmed training group

Design: Randomized, placebo controlled, double-blinded, test-retest
T1 = baseline, T2 = post-test
Will working memory training generalize to improve off-task behavior in children with Attention-Deficit/ Hyperactivity Disorder?
Green et al. 2012

Restricted Academic Situations Task (RAST)
- 5 categories of behavior associated with ADHD scored at 30 sec intervals
- Given toys to play with for 5 minutes; examiner puts toys to the side, participants asked to complete easy maths packet for 15 minutes while videotaped
- Good indicator of behavioral responses to ADHD stimulant medication
- Consistent with externalizing teacher ratings and actometer measures of ADHD
- Objective measure and sensitive to moment-to-moment changes in “off-task” behavior

Results for RAST:
I. Children in adaptive training group improved significantly over children in non-adaptive training group firstly on:
1) Non-trained tasks of WM (Digit Span and Letter-Number Sequencing; WISC-IV)

Will working memory training generalize to improve off-task behavior in children with Attention-Deficit/ Hyperactivity Disorder?
Green et al. 2012

Results:
1. Children in adaptive training group improved significantly over children in non-adaptive training group firstly on:
1) Non-trained tasks of WM (Digit Span and Letter-Number Sequencing; WISC-IV)
Results:

2) And secondly on frequency and type of off-task behavior (looking away from task and playing with an object unrelated to task; RAST)

II. No significant differences between the groups on fidgets, vocalizes, and out-of-seat measures (RAST)

III. No significant improvements on parent ratings of behavior (Conners’ Parent Rating Scale-Revised; CPRS-R)

Will working memory training generalize to improve off-task behavior in children with Attention-Deficit/ Hyperactivity Disorder?

Green et al. 2012

The present study results establish that memory training has the potential to transfer to educationally relevant measures of academic ability, even when conducted under real-life conditions in schools.

Trial 1

Population & Sample Size: N = 22 mixed ability children, ages 8 – 10 years (Year 4) in adaptive Cogmed RM training group

* Children were trained in a single group of 22 children at the beginning of each school day and supervised by their teacher and a teaching assistant

Design: Field trial, blind raters, test-retest

T1 = baseline, T2 = post-test

90% of children completed the full Cogmed training protocol.

Results:

I. Children significantly improved at T2 on non-trained tasks of visuo-spatial and verbal STM and visuo-spatial and verbal WM (Automated Working Memory Assessment; AWMA).

II. Children with low baseline WM made greater gains than children with high baseline WM on non-trained tasks of visuo-spatial STM and verbal WM (AWMA).
Taking working memory training from the laboratory into schools
Holmes & Gathercole, 2013

Population & Sample Size:

- **N = 100 children with low academic performance, ages 9 – 11 years (Year 5 and 6)**

Academic Performance Determined by the UK Standard Assessment Test (SAT):
- **English:** reading, writing, speaking, listening skills
- **Maths:** use and apply maths, complete tests of number of algebra, shape space and measures and handling data
- Combined with **teacher observations** to inform judgments about a child's progress measured against Assessing Pupils' Progress Grids
- There are **10 levels** each with 3 sublevels a, b, and c. Children expected to progress through 3 sublevels each school year.
- By end of Year 6 (age 11), children expected to reach 4c.
Trial 2

Results:

I. Children in Year 5 Cogmed training group significantly improved compared to the control group on a standardized measure of maths (SAT). Note: Control group had a drop in performance across the school year.

II. Children in Year 6 Cogmed training group significantly improved compared to the control group on both a standardized measure of math and English (SAT).

III. 84% of Year 6 Cogmed training group reached nationally expected levels of attainment in English at the end - compared with 72% of non-trained students.

Table 3. Mean scaled scores (50) in statement as a function subject and school year for Trial 2.

|          | Train | Comp   | | Train | Comp   |
|----------|-------|--------| |-------|--------|
| English | 4.9 (1.50) | 2.3 (1.28) | | 5.7 (1.44) | 3.1 (2.06) |
| Maths   | 3.39 (1.97) | 1.9 (1.90)  | | 2.1 (1.31) | 1.7 (1.90) |

Summary:

- Compliance in 2 field trials employing Cogmed in the school setting with Teachers as Coaches was greater than 80%.

- Consistent with previous research - children improved on all assessed measures of memory, with greatest gains in verbal and visuo-spatial WM and visuo-spatial STM.

- Younger children improved on standardized maths measure, but drop in control group performance makes this finding difficult to interpret.

- Older children improved on standardized maths and English measures compared to children who did not train.

Research Collaborators Pipeline and New Research Pipelines
State of Ongoing Research Collaborations

<table>
<thead>
<tr>
<th>Category</th>
<th>Child/Adolescent</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADHD</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Aging</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Brain Injury</td>
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<td>3</td>
</tr>
<tr>
<td>Cancer</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Development</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Environment</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Genetics</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Hearing</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>LD / Low IQ</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Neurological</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Psychiatric</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Typical/WM</td>
<td>10</td>
<td>7</td>
</tr>
</tbody>
</table>

Total: 46 9 32 14

Need to move faster...

Benefits to independent collaborators pipeline:
- Thoughtful research designs
- Wide range of abilities assessed
- Presentations & peer-reviewed publication

Limitations to independent collaborators pipeline:
- Small samples
- Special populations & research questions
- Laboratory control
- Duration (2 to 5 years)

Methods to expand while maintaining evidence base:
- Internal Pearson funded research
- School Research Partners Program
- Clinical Evaluations
- Cogmed Training Web data collection

Internal Pearson Research
School Research Partners Program

**Aim 1:** To evaluate the use of Cogmed Working Memory Training in the educational environment in order to establish the training protocol most effective for students of various cognitive profiles, including how well Cogmed improves capacity for learning.

**Aim 2:** To collaborate with school personnel in collecting academic, behavioral, and cognitive data, at pre-, post-, and up to 24 months post-training time points to further evaluate the long term impacts of Cogmed Working Memory Training on students.

**Design:** Randomized, active or waitlist controlled, single-blinded, test-re-test.

### COGMEFOLLOWED BY INTERVENTION VS. INTERVENTION ALONE

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Group B</td>
</tr>
<tr>
<td>Cogmed waitlist</td>
<td>Cogmed Intervention</td>
</tr>
</tbody>
</table>

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School Research Example

**Institution:** Johannes Gutenberg University Mainz & University of Zurich

**Investigator(s):** Professor Dr. Ernst Fehr, Henning Mueller

**Population & Sample Size:** N = 1,150 typically functioning children, ages 6-7 years from 24 schools (2-4 classes per school, 15-24 children per class)

**Design:** Randomized, active controlled, blinded, test-re-test, 6 & 12 month follow up

<table>
<thead>
<tr>
<th>Self Regulation Treatment</th>
<th>Self Regulation Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cogmed</td>
<td>290</td>
</tr>
<tr>
<td>Attention</td>
<td>80</td>
</tr>
<tr>
<td>Typical classroom</td>
<td>270</td>
</tr>
</tbody>
</table>

**Assessment:** WM, Fluid Intelligence, Math, Reading, Self-control, Impulsiveness, Attention (Parent and Teacher assessment), Mental health and emotional stability (SDQ)

// to Murdoch Research Institute (Quach, Wake, Roberts, et al.) – see published protocol
Three distinct practices in Singapore, the Netherlands, and Canada (750 children)
- 80% of children improved inattentive symptoms by 30% on average (DSM-IV Parent Rating Scale)

In two distinct practices in Singapore and the Netherlands 80% of adults improved inattentive symptoms by 36% on average (DSM-IV Self Rating Scale) (N = 120).

In a practice in Canada, 83% of all participants improved on the measure of ADHD with a 19% reduction in symptoms (N = 29). Note: included hyperactivity.

The Canadian sample showed an 18% improvement in cognitive failures on the CFQ.

Three Cogmed research studies have used the CFQ with a total of 82 participants and have reported an average 18% improvement after training (Westerberg et al., 2007, Lundqvist et al., 2010, Johansson & Tornmalm, 2011).

### History of Cogmed at ADD Austin

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Started</td>
<td>7</td>
<td>24</td>
<td>47</td>
<td>50</td>
<td>33</td>
<td>29</td>
<td>190</td>
</tr>
<tr>
<td>Completed</td>
<td>6</td>
<td>21</td>
<td>42</td>
<td>48</td>
<td>32</td>
<td>20</td>
<td>169</td>
</tr>
<tr>
<td>Compliance %</td>
<td>86%</td>
<td>88%</td>
<td>89%</td>
<td>96%</td>
<td>97%</td>
<td>69%</td>
<td>89%</td>
</tr>
</tbody>
</table>
Clinical Evaluation Series Part II  
ADD Austin  
Roberta Tsukahara

**Goal 1:** What is the durability of the training effect at 6 month and 12 month follow up for adults and children?

**Goal 2:** What is the impact on WM, attention, and behavior for children and adults that use Cogmed in the “real world” setting?

**Time Points:** T1 = Pre-training, T2 = Post-training, T3 = 6 month follow up, T4 = 12 month follow up

Standard Cogmed protocol (30 to 40 minutes per day, 5 days per week, 5 weeks recommended)

**Incentive to return** for additional testing - Amazon gift cards at 6 and 12 months. Same fee whether or not collected data. Collected data submitted to Cogmed for statistical analysis (Excel spreadsheet, Dropbox)

### Sample

#### Child Sample Size (N)

<table>
<thead>
<tr>
<th>Females</th>
<th>Males</th>
<th>Post-training</th>
<th>6 month Follow-Up</th>
<th>12 month Follow-Up</th>
<th>Age (SD)</th>
<th>Training days</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>41</td>
<td>70</td>
<td>27</td>
<td>16</td>
<td>11.26 (2.93)</td>
<td>24.93 (0.35)</td>
</tr>
</tbody>
</table>

#### Adult Sample Size (N)

<table>
<thead>
<tr>
<th>Females</th>
<th>Males</th>
<th>Post-training</th>
<th>6 month Follow-Up</th>
<th>12 month Follow-Up</th>
<th>Age (SD)</th>
<th>Training days</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>25</td>
<td>45</td>
<td>23</td>
<td>15</td>
<td>36.02 (14.90)</td>
<td>24.93 (0.34)</td>
</tr>
</tbody>
</table>

Table 1: Frequencies of the participants at the different time points, along with age and number of trained days.

- Heterogenous sample - clinically relevant problems; majority ADHD or comparable
- No use of WM screener – determination based on interviews; quality of referral; NP testing by us or another psychologist
- Control for selection bias: No significant difference found between post-testing only group and follow up groups

### Children Working Memory

- WISC IV Mean Working Memory Scaled Scores
  - Pre-training
  - 6 month Follow-Up
  - 12 month Follow-Up

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### Children Working Memory Retention

<table>
<thead>
<tr>
<th></th>
<th>Post-training</th>
<th>6 Month Follow Up</th>
<th>12 Month Follow Up</th>
<th>Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Span</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward</td>
<td>67</td>
<td>26</td>
<td>16</td>
<td>100%</td>
</tr>
<tr>
<td>Backward</td>
<td>67</td>
<td>27</td>
<td>16</td>
<td>76%</td>
</tr>
<tr>
<td>Digit Span</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward</td>
<td>66</td>
<td>26</td>
<td>15</td>
<td>26%</td>
</tr>
<tr>
<td>Backward</td>
<td>67</td>
<td>28</td>
<td>14</td>
<td>82%</td>
</tr>
<tr>
<td>Letter Number Sequencing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>20</td>
<td>15</td>
<td>59%</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td>76%</td>
</tr>
</tbody>
</table>

### Children Attention

#### Test of Variable Attention

32% of children who fit an ADHD profile on the TOVA ADHD Total score prior to training no longer met that profile after training.

![Graph showing ADHD Total and Response Time Variability scores](image)

### Children Parent Rated Behavior

#### Disruptive Behavior Rating Scale

![Graph showing different behaviors](image)
Children Parent Rated Behavior Retention
Disruptive Behavior Rating Scale

<table>
<thead>
<tr>
<th>ADHD Total</th>
<th>Inattention</th>
<th>Hyperactivity/Impulsivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-training</td>
<td>6 months</td>
<td>12 months</td>
</tr>
<tr>
<td>% of Improvers (number)</td>
<td>80% (56)</td>
<td>81% (22)</td>
</tr>
<tr>
<td>% Retention</td>
<td>117%</td>
<td>152%</td>
</tr>
<tr>
<td>% of Non-Improvers (number)</td>
<td>20% (14)</td>
<td>19% (5)</td>
</tr>
</tbody>
</table>

Mean Behavior Rating Inventory of Executive Function

<table>
<thead>
<tr>
<th>Working Memory</th>
<th>Plan/Organize</th>
<th>Monitor</th>
<th>Inhibit</th>
<th>Shift</th>
<th>Organization of Materials</th>
<th>Structural Control</th>
<th>Initiate</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>70</td>
<td>69</td>
<td>70</td>
<td>69</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Post-training</td>
<td>6 months</td>
<td>12 months</td>
<td>6 months</td>
<td>12 months</td>
<td>6 months</td>
<td>12 months</td>
<td>6 months</td>
</tr>
<tr>
<td>125%</td>
<td>109%</td>
<td>109%</td>
<td>149%</td>
<td>127%</td>
<td>94%</td>
<td>93%</td>
<td>125%</td>
</tr>
</tbody>
</table>

Average: 134% 159%
Adults Assessments

**Battery**
- Wechsler Adults Intelligence Scale (WAIS-IV, 2008)

**Subscales**
- Longest Spatial Span Forward and Backward
- Longest Digit Span Forward and Backward
- Longest Letter Number Sequencing

**Test of Variables of Attention (TOVA)**
- ADHD score, Response Time Variability, Omission, Commission

**Cognitive Failures Questionnaire (CFQ)**
- (Broadbent, Cooper, FitzGerald, & Parks, 1982)

**Training Evaluation (DSM-IV Attention)**
- Attention Summary Score

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### Adult Working Memory Retention

<table>
<thead>
<tr>
<th></th>
<th>6 Month</th>
<th>12 Month Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longest Spatial Span Forward</td>
<td>40</td>
<td>103%</td>
</tr>
<tr>
<td>Longest Spatial Span Backward</td>
<td>40</td>
<td>112%</td>
</tr>
<tr>
<td>Longest Digit Span Forward</td>
<td>42</td>
<td>52%</td>
</tr>
<tr>
<td>Longest Digit Span Backward</td>
<td>42</td>
<td>111%</td>
</tr>
<tr>
<td>Longest Letter Number Sequencing</td>
<td>42</td>
<td>67%</td>
</tr>
</tbody>
</table>

Average: 91% 117%
56% of adults who fit an ADHD profile on the TOVA ADHD Total score prior to training no longer met that profile after training.

Summary

- Small clinical sample (no control group)
- Retention of effects at 12 months with some evidence of continued improvement, especially of behavior
- Hyperactivity/Impulsivity improvement
- Importance of longitudinal data collection despite challenges
Taking off...

- Published
- Ongoing
- Internal
- School
- Clinical Evaluations

Evidence → Claims

Based on this evidence aligning with claims...

can the criticisms stand up?

- Melby-Lervåg & Hulme
- Shipstead et al.

Critical Response

- WM is important and domain-general.
- WM is impaired in diverse clinical populations.
- Randomized, placebo controlled studies are needed.
- Combination of diverse group of sample populations, ignoring distinctions between individuals with and without WM deficits.
- Combination of diverse age range of age groups.
- Comparison of heterogeneous research methods.
- Cognitive measures used to assess change combined into arbitrary categories.
- Failure to include relevant measure of reading.
- Failure to include analysis of behavioral rating data and to distinguish between developmental disorders.
- Study inclusion and exclusion criteria applied inconsistently.
Benefits of working memory training for inattention in everyday activities: a meta-analysis
Megan Spencer-Smith and Torkel Klingberg (Submitted, 2013)

Working memory (near transfer)
Smith & Klingberg (Submitted)

Study          Age     Status  Control Measure       Std Mean Diff 95% CI
Brehmer 2012a  20-30    healthy  non-adaptive Span board back 1.70 (1.05, 2.08)
Brehmer 2012b  60-70    healthy  non-adaptive Span board back 0.64 (0.21, 1.83)
Green 2012     7-14     ADHD    non-adaptive WM Index 1.18 (0.34, 2.01)
Grunewaldt 2013 5-6      VLBW    wait-list Spatial span back -0.21 (-1.03, 0.61)
Hardy 2013     8-16     cancer  non-adaptive Symbolic WM 0.50 (0.46, 1.46)
Klingberg 2005  7-12     ADHD    non-adaptive Span board 1.03 (0.36, 1.69)
Roughan 2011   7-15     SIB      passive Composite WM 3.74 (1.02, 6.47)
Westerberg 2007 34-65    Stroke  passive Span board 0.31 (-0.61, 1.26)

Total effect  0.83 (0.65, 1.28)

Heterogeneity  CH²=21.27, df=7, p=0.003; I²=47%
Overall effect  Z=6.55, p<0.00001
Inattention in everyday activities
Smith & Klingberg (Submitted)

<table>
<thead>
<tr>
<th>Study</th>
<th>Age</th>
<th>Status</th>
<th>Control</th>
<th>Std Mean Diff SMD CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beck 2010</td>
<td>7-17</td>
<td>ADHD wait-list</td>
<td>-0.71 (-1.28, -0.15)</td>
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<tr>
<td>Brehmer 2012a</td>
<td>20-30</td>
<td>healthy non-adaptive</td>
<td>-0.67 (-1.38, -0.14)</td>
<td></td>
</tr>
<tr>
<td>Brehmer 2012b</td>
<td>60-70</td>
<td>healthy non-adaptive</td>
<td>-0.45 (-1.00, 0.30)</td>
<td></td>
</tr>
<tr>
<td>Green 2012</td>
<td>7-14</td>
<td>ADHD non-adaptive</td>
<td>-1.06 (-1.89, -0.23)</td>
<td></td>
</tr>
<tr>
<td>Grunewaldt 2013</td>
<td>5-6</td>
<td>VLBW wait-list</td>
<td>-0.35 (-1.24, 0.54)</td>
<td></td>
</tr>
<tr>
<td>Hardy 2013</td>
<td>8-16</td>
<td>cancer non-adaptive</td>
<td>-0.96 (-1.37, 0.06)</td>
<td></td>
</tr>
<tr>
<td>Klingberg 2005</td>
<td>7-12</td>
<td>ADHD non-adaptive</td>
<td>-1.24 (-2.02, 0.30)</td>
<td></td>
</tr>
<tr>
<td>Roughnan 2011</td>
<td>7-15</td>
<td>SIB passive</td>
<td>-1.34 (-2.30, -0.18)</td>
<td></td>
</tr>
<tr>
<td>Westerberg 2007</td>
<td>34-65</td>
<td>Stroke passive</td>
<td>-1.01 (-2.01, 0.02)</td>
<td></td>
</tr>
</tbody>
</table>

Total effect -0.67 (-0.91, -0.43)

Heterogeneity $\chi^2=4.90$, df=8, p=.77; $I^2=0%$

Overall effect Z=5.51, p<0.00001

Inattention by Measure
Smith & Klingberg (Submitted)

1. Specific measures

<table>
<thead>
<tr>
<th>Study</th>
<th>Age</th>
<th>Status</th>
<th>Control</th>
<th>Measure</th>
<th>Std Mean Diff SMD CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beck 2010</td>
<td>7-17</td>
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<td>DSM Viant</td>
<td>-0.71 (-1.28, -0.15)</td>
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<tr>
<td>Klintberg, 2005</td>
<td>7-12</td>
<td>ADHD non-adaptive</td>
<td>Connors IATT</td>
<td>-1.06 (-1.89, -0.23)</td>
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</tr>
<tr>
<td>Grunewaldt, 2013</td>
<td>5-6</td>
<td>VLBW wait-list</td>
<td>DSM ADHD</td>
<td>-0.35 (-1.24, 0.54)</td>
<td></td>
</tr>
<tr>
<td>Roughnan, 2011</td>
<td>7-15</td>
<td>SIB passive</td>
<td>DSM Att Control</td>
<td>-1.34 (-2.30, -0.18)</td>
<td></td>
</tr>
</tbody>
</table>

Subtotal effect -0.69 (-0.99, -0.40)

Heterogeneity $\chi^2=3.67$, df=5, p=.60; $I^2=0%$

Overall effect Z=4.58, p<0.00001

Test for differences between measures $\chi^2=0.08$, df=1, p=.77; $I^2=0%$

2. General measures

<table>
<thead>
<tr>
<th>Study</th>
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<th>Measure</th>
<th>Std Mean Diff SMD CI</th>
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<td>Brehmer, 2012a</td>
<td>20-30</td>
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<td>VLBW wait-list</td>
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Subtotal effect -0.69 (-0.99, -0.40)

Heterogeneity $\chi^2=3.67$, df=5, p=.60; $I^2=0%$

Overall effect Z=4.58, p<0.00001

Test for differences between measures $\chi^2=0.08$, df=1, p=.77; $I^2=0%$

Inattention by Age Group
Smith & Klingberg (Submitted)

1. Children

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<tr>
<td>Beck 2010</td>
<td>7-17</td>
<td>ADHD wait-list</td>
<td>DSM Viant</td>
<td>-0.71 (-1.28, -0.15)</td>
</tr>
<tr>
<td>Klintberg, 2005</td>
<td>7-12</td>
<td>ADHD non-adaptive</td>
<td>Connors IATT</td>
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Subtotal effect -0.62 (-1.02, -0.23)

Heterogeneity $\chi^2=1.15$, df=2, p=.56; $I^2=0%$

Overall effect Z=3.07, p=0.002

2. Adults

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Subtotal effect -0.71 (-1.03, -0.39)

Heterogeneity $\chi^2=3.78$, df=5, p=.058; $I^2=0%$

Overall effect Z=4.34, p<0.00001

Test for differences between age groups $\chi^2=0.12$, df=1, p=.72; $I^2=0%$

Inattention in everyday activities

1. Specific measures

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Subtotal effect -0.67 (-1.03, -0.39)

Heterogeneity $\chi^2=3.78$, df=5, p=.058; $I^2=0%$

Overall effect Z=4.34, p<0.00001

Test for differences between measures $\chi^2=0.08$, df=1, p=.77; $I^2=0%$

2. General measures

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Subtotal effect -0.67 (-0.91, -0.43)

Heterogeneity $\chi^2=4.90$, df=8, p=.77; $I^2=0%$

Overall effect Z=5.51, p<0.00001

Test for differences between measures $\chi^2=0.08$, df=1, p=.77; $I^2=0%$
Cogmed Working Memory Training

Peer reviewed, published research papers (N =39) show:

- 26% improvement in visuo-spatial WM
- 23% improvement in verbal WM
- Robust effect on WM (d = 0.67) and attention (d=0.67)
- Transfer to tasks crucial for successful learning such as following instructions (Holmes et al., 2009), on-task behavior (Green et al.,2012), and everyday life (Westerberg et al., 2007; Sundqvist et al., 2010; Johansson & Tornmalm, 2012)
- Improved math (Holmes et al., 2009; Holmes & Gathercole, 2013; Klingberg et al. 2013 (submitted)); reading comprehension (Bahin, 2010), and English curriculum scores (Holmes & Gathercole, 2013). More evidence needed.

Clinical evidence from 4 distinct practices around the world show:

- 80% of participants improve inattentive symptoms by 30%
- 30% improvement in working memory
- Gains maintained between 6 and 12 months

Results hold for preschoolers to older adults, across wide range of clinical and typical populations training at home, in clinic, or at school

Questions