Cogmed’s Core Efficacy: Training Working Memory

Agenda
Cogmed’s Core Efficacy: Training Working Memory
- Cogmed improves working memory.
- Proof?
- 5 Arguments for Cogmed’s core efficacy.
- Why the resistance to Cogmed?
- The far transfer challenge.
- Baddeley’s model of WM
- Why does improved WM matter?
- Limiting factors
- Meta-Analysis of WM training.
- Staying true to the Cogmed model.
- Summary
Cogmed’s Core Efficacy:
Training Working Memory

Cogmed is a working memory training program.
Working memory is the target of the program.

1st argument that improved working memory is the core efficacy of Cogmed:
Research has found that Cogmed is an effective approach for improving working memory, both visual spatial working memory (VSWM) and verbal working memory (VWM).

This finding is thought provoking.
Its implications are complicated and potentially far-reaching.
We believe that many professionals are still attempting to figure out how to make use of this finding while others still doubt its veracity.
Previous to the first Cogmed study in 2002 working memory (WM) was not considered malleable.

Cogmed’s 2 most supported claims.

1) Cogmed leads to sustained improvements in working memory, from childhood to adulthood (M2, M5), as seen in
   a) preschoolers (6, 16, 41, 42, 61) – 5 studies.
   b) children and adolescents (3, 7, 10, 19, 20, 27, 29, 30, 48, 52, 55, 62, 64, 66, 72) – 15 studies.
   c) adults and old adults (5, 15, 22, 28, 37, 38, 46, 47, 68, 70, 71) – 11 studies.
A total of 35 studies support the first claim. Certainly quality of studies must be considered but typically higher quality studies come later so one would expect that quantity may be related to quality.

The volume of research that found that Cogmed improved working memory is the 2nd argument that leads us to the conclusion that it is the core efficacy of the program.

2) Cogmed leads to sustained improvements in attention (M3, M5) seen in both
   a) subjective measures of attention (3, 11, 14, 18, 38, 31, 47, 66, 72) – 9 studies.
   b) and objective measures of attention (5, 6, 15, 22, 25, 28, 66, 72) – 8 studies.
A total of 17 studies support the second claim.


“Proof” is not as simple as one might presume?
Is it just the number of studies that will convince us? 35 vs. 17 vs 5 studies? Is that compelling?
Is it the scientific nature of the studies (e.g. sample sizes, RCTs, effect sizes, etc.)?
Are meta-analyses definitive?
Can researchers’ biases affect even meta-analyses? (e.g. Yes, study selection, etc.).
Is evidence of brain changes convincing? Several fMRI & DTI studies are they sufficient? If we see evidence of increased connectivity and activation will that along with behavior changes convince us that Cogmed works?
Are there many cases in science in which there is a complete vacuum of dissent?
Does science move forward anyway?
What is needed to show clinically or educationally meaningful change? (e.g. my client, my child...).
Putting in context the term: Evidence-based.

Early stages of research: Pilot studies with no controls move on to larger sample sizes, passive controls and then to active controls in RCT’s. Then meta-analyses. To get just one meta-analysis within a field suggests a more advanced level of development in that database.

Does ‘evidence-based’ mean 100% consensus within a field? Science is quite a bit more messy than that.

When an innovation makes it through one level it typically will get even more scrutiny the longer it survives. Scrutiny intensifies it does not diminish.

Science is not bereft of politics. As anyone who has completed a doctoral degree knows knowledge is quite political. There are politics within academic departments and within fields of inquiry.

It is unusual, rare and unexpected for scientific scrutiny and criticism to simply vanish. (Consider global warming, the relationship of vaccines and autism, etc.).

However, scrutiny often provokes more research and in turn the research answers more nuanced questions.

35 Controlled studies, but how many RCT’s?

How many meta-analyses?

How many of these studies are blinded, randomized controlled trials (RCT’s) (e.g. what most consider to be the gold standard of research)? 14.

“This has since been replicated by independent research groups worldwide in studies of high methodological rigor (blinded, randomized controlled trials) (16, 25-27, 33, 41, 50, 62, 64, 66, 68, 70, 71, 75)” (Söderqvist, & Nutley, 2016, Cogmed claims and evidence). This is 14 RCT’s.

Additionally 4 independent meta-analyses have also found Cogmed has improved working memory (M1, M2, M4, M5). 5 meta-analyses by co-authored by the original Cogmed investigator Klingberg (Spencer-Smith M, Klingberg T, 2015). (Söderqvist, & Nutley, 2016, Cogmed claims and evidence).

The quality of evidence finding Cogmed improved working memory is the 3rd argument supporting the contention that improved working memory is the core efficacy of Cogmed.

Working memory training has caught on but Cogmed typically has the largest effect sizes.

“One published meta-analysis showed that improvements in WM following Cogmed were of large effect sizes (d = 1.79 in verbal and d = 0.86 in visuo-spatial) (M2).”

Furthermore, in comparison with other WM training programs, the effects seen after Cogmed were larger than all other interventions. This finding has since been reproduced in a larger meta-analysis with more than 100 studies (M5). Thus, the research evidence for Cogmed has consistently demonstrated significantly improved WM.” (Cogmed Claims & Evidence – Extended Version V 4. Söderqvist & Nutley).

The size of the effect upon on working memory is the 4th argument in favor of improved working memory as the core efficacy of Cogmed.
Effect size conceptualized

Effect size (standard mean difference) = \( \frac{\text{mean of experimental group} - \text{mean of control group}}{\text{Pooled Standard Deviation}} \)

This is reported typically as a Cohen’s d or ‘d’. So an effect size of .3 means that the score of the average person in the intervention group was .3 standard deviations above the average person in the control group. Similarly an effect size of .8 would mean that the average person in the intervention group would exceed the scores of 79% of the control group. Cohen suggested one way of understanding effect size (1988):

<table>
<thead>
<tr>
<th>d</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>.2</td>
<td>Small (2/10 of a standard deviation unit)</td>
</tr>
<tr>
<td>.5</td>
<td>Moderate (5/10 of a standard deviation unit)</td>
</tr>
<tr>
<td>.8</td>
<td>Large (8/10 of a standard deviation unit)</td>
</tr>
</tbody>
</table>

Even a small effect size is a significant difference between groups. However, the meaning of effect size varies by context.

Effect size meaningfulness varies depending upon context. Consider some contexts.

<table>
<thead>
<tr>
<th>Context</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individualized instruction</td>
<td>0.10</td>
</tr>
<tr>
<td>Achievement</td>
<td></td>
</tr>
<tr>
<td>Substance abuse education</td>
<td>0.12</td>
</tr>
<tr>
<td>School-based substance abuse education</td>
<td></td>
</tr>
<tr>
<td>Delinquency</td>
<td>0.17</td>
</tr>
<tr>
<td>Treatment programmes for juvenile delinquents</td>
<td></td>
</tr>
<tr>
<td>Delinquency</td>
<td>0.17</td>
</tr>
<tr>
<td>Inquiry-based vs traditional science curriculum</td>
<td>0.30</td>
</tr>
<tr>
<td>Achievement</td>
<td></td>
</tr>
<tr>
<td>Therapy for test anxiety (for anxious students)</td>
<td>0.42</td>
</tr>
<tr>
<td>Mainstreaming vs special education (for primary age, disabled students)</td>
<td>0.44</td>
</tr>
<tr>
<td>Medication</td>
<td>0.52</td>
</tr>
<tr>
<td>Targeted interventions for at-risk students</td>
<td>0.63</td>
</tr>
</tbody>
</table>

“Effect size meaningfulness varies depending upon context. Consider some contexts.”

How long do effects last?

WM improvements have been found to be sustained from 2 to 12 months based upon 11 follow up studies (3, 7, 14, 18, 33, 37, 41, 47, 61, 71) and two meta-analyses (M2, M5). Effects last from 2 to 12 months. Effects that last are the 5th argument that improved working memory is the core efficacy of Cogmed.
Substantial empirical support for the claim that Cogmed improves working memory (WM).

As can be seen here 5 arguments that improved working memory is the core efficacy of Cogmed.

1. Working memory is the target of Cogmed.
2. Volume of data that support this finding.
3. The quality of the data with 14 RCT's and 5 meta-analyses.
4. The effect sizes of improved working memory are moderate to large.
5. The longevity of the effects from 2 to 12 months.

Why is there resistance to Cogmed?

The conclusion that Cogmed results in improved working memory has evoked resistance. Why?

Is it because previously working memory was not thought to be malleable?
Is it that many scientists are stuck in out-dated models?
Is it really that the data is insufficient in volume or quality?
Is it because the mechanism for change is not clearly defined?
Is it because Cogmed is judged based upon far transfer to other areas of functioning instead of improved working memory?

We believe a preoccupation with far transfer is a critical consideration.

What is transfer of learning?

Far transfer vs near transfer in learning?

Transfer of learning was described as: “the application of skills, knowledge, and/or attitudes that were learned in one situation to another learning situation (Perkins, 1992).”

http://www.nwlink.com/~donclark/hrd/learning/transfer.html

“Near versus far transfer: Near transfer occurs when the training context and trained behavior are almost identical to the application context and application behavior. For example a student learns an arithmetic rule with problems on a worksheet and then applies the same rule in the same way on the same day to similar problems in a math workbook. However, he becomes confused when expected to use the rule in a word problem. With far transfer, the two situations are interestingly different. For example, the student who has learned a basic arithmetic rule proceeds to apply it later in a variety of word problems with no cues. Or knowledge of Spanish facilitates the learning of French. Far transfer (sometimes referred to as “high-road” transfer) often requires insight or judgment not required by near transfer.”

http://www.projectseam.net/tutorial/transfer_of_training_or_generalization.html

Can computerized cognitive training really transfer to real life?
Near transfer and far transfer related to Cogmed?

Near transfer: Improved working memory on tasks that are independent of the originally trained tasks.

Far transfer: Improved application or utilization of working memory to other tasks like reading comprehension or mathematics.

How working memory is measured in Cogmed studies becomes critical to establish whether there was ‘near transfer’ or not?

In other words, are the measures of working memory sufficiently independent and standardized to believe that working memory actually improved?

Measuring working memory in Cogmed studies.

“[The outcomes that have been used to assess WM have included tasks that are similar to the trained ones for instance Digit span backwards for verbal WM and Block tapping task for visuo-spatial WM, only presented in a different manner (e.g. physical blocks) and using a verbal response to answer (for digit span)].” (Söderqvist, & Nutley, 2016, Cogmed claims and evidence).

This ‘non-trained’ way to assess working memory supports the claim of near transfer – that working memory actually improved.

Still not enough? There have been other ways to measure working memory following Cogmed.

“The effects have also been shown on tasks that are more dissimilar to the trained ones, sometimes including a more complicated processing operation than simply reproducing or reversing a sequence (7, 8, 16, 31, 43, 46, 64). This ensures that the WM increases seen after training are not entirely task specific but transfer to tasks that do not allow use of the same strategies as those potentially used during training.” (Söderqvist, & Nutley, 2016, Cogmed claims and evidence).

We believe there is enough support to conclude that Cogmed results in improved working memory.

Far transfer introduces a multitude of factors that complicate the picture.

Consider, again, the complexity of the example of far transfer in an educational context:

“[With far transfer, the two situations are interestingly different. For example, the student who has learned a basic arithmetic rule proceeds to apply it later in a variety of word problems with no cues. Or knowledge of Spanish facilitates the learning of French. Far transfer (sometimes referred to as “high-road” transfer) often requires insight or judgment not required by near transfer.” http://www.projectlearnet.org/tutorials/transfer_of_training_or_generalization.html]

In the case of Cogmed far transfer might be considered to be improved reading comprehension or mathematics.

Improving reading comprehension or math is a rather complicated proposition...
**Working Memory**


- **Processes**: All stimuli we encounter - updating.
- **Delegates**: Different parts of our brain to take action - shifting.
- **Keeps us updated on what’s happening**—& **focused on what matters**.
**Do you have any room left on your desk?**

**Working Memory: The Mental Workspace**

“...working memory as a mental workspace in which products of ongoing processes can be stored and integrated during complex and demanding activities (Just & Carpenter, 1992).”

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**Why is Working Memory Important?**

**The Foundation for learning.**

**WM: Where learning takes place**

Problem solving and comprehending texts

Interface between input and output

Consider working memory:

“putting memory to work”.

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**Why is working memory important from a student’s point of view?**

Working memory is used for:

- Controlling attention
- Resisting distraction
- Organization
- Complex thinking
- Problem solving
- Remembering tasks
Distinguishing Working Memory from Short-Term Memory

**Short Term Memory:**
Information can be held in STM for about 7 seconds
Holding a small amount of information in the mind in an active, readily available state for a short period of time.
Rehearsal, or repeating information can extend the interval.
If information is not acted upon, it will be lost after 15 to 20 seconds
Slots where information is stored temporarily.

**Working Memory vs. Short-Term Memory**
WM involves active, conscious *processing and storage*
STM consists of *passive storage* & automated subconscious processes
WM controls STM components
STM can hold more items than you can process in WM
WM & STM operate independently of one another

**Baddeley’s Model of Working Memory (1)**
Working Memory is *a system for the temporary holding and manipulation* of information during the performance of a range of *cognitive tasks* such as comprehension, learning, and reasoning* (Baddeley, 1986, p. 34)
Baddeley’s Model of Working Memory (2)

### Phonological Loop

**Stores** and **rehearses** speech-based information and is necessary for the acquisition of native and second-language vocabulary.

1. **Short-term phonological store**: **auditory memory traces** subject to rapid decay: ‘*inner ear*’ remembering speech sounds in their temporal order.

2. Articulatory rehearsal component sometimes called the **articulatory loop**. Acts as the "**inner voice**" and repeats the series of words on a loop to prevent them from decaying.

### Visuo-spatial Sketchpad

Encodes, stores, organizes, and manipulates visual images and visual-sensory information.

1. **Visual Cache**: Stores information about form & color.
2. “**Inner Scribe**”: deals with spatial and movement information. Also rehearses info. In the visual cache and transfers it to the central executive.
Central Executive

Attentional controlling system:
Maintains task activities and blocks task interference

Episodic Buffer

Links information across domains to form integrated units of visual, spatial, and verbal information with time sequencing ‘episodes’ like a movie scene.

It has links to long-term memory and semantic meaning.

Why does working memory matter?

What are the implications of a WM deficit?
In school?
In college?
At work? Especially professional work?
At home?
In leisure?
As we age?
With family? Especially the care of children? Or the elderly?
Why Working Memory is so salient for ADHD. Why Working Memory is so salient for ADHD. How VSWM became the target for Cogmed.

**Multiple points of failure over normal development in those with poor working memory.**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Problem</th>
<th>Weakness</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-8</td>
<td>Behavior problems</td>
<td>Failure in high school</td>
<td>Fitting in</td>
</tr>
<tr>
<td>10-15</td>
<td>Falling behind</td>
<td>Staying focused</td>
<td>Learning to read</td>
</tr>
<tr>
<td>16-20</td>
<td>Failure in high school</td>
<td>Self-mgmt.</td>
<td>Getting into college</td>
</tr>
<tr>
<td>20-55</td>
<td>Cannot prioritize</td>
<td>Time mgt.</td>
<td>Graduating</td>
</tr>
<tr>
<td></td>
<td>Struggles at work</td>
<td>Staying sharp</td>
<td>Promotion</td>
</tr>
<tr>
<td></td>
<td>Dead end career path</td>
<td></td>
<td>Achieving goals</td>
</tr>
</tbody>
</table>


How does ADHD affect learning? More errors, slower learning, no automaticity.

(Phung-Pollock & Kanzian, 2010)

- When a task has a low WM demand, children with ADHD still make more errors and learn it more slowly.
- When a task has a high WM demand, children with ADHD don’t get to automaticity.

Result of these struggles: A distinct trajectory of less academic achievement.
Far Transfer Complications: WM correlates with reading comprehension but is not the only factor.

Across school-age development: Meta-analysis on reading comprehension found large correlations for overall intelligence (r=.56) and reading decoding (r=.68) while short-term/working memory was moderate (r=.41) as was rapid naming (r=.35) (Finn, 2015, dissertation).

Struggling Adult Readers: Meta-analysis on reading comprehension with effect sizes >.50 for: morphological awareness, language comprehension, fluency, oral vocabulary knowledge, real word decoding and WM (Tighe & Schatschneider, 2016).

The role WM plays varies somewhat over development and it is only one factor that correlates to reading comprehension among others.

WM and math meta-analyses show correlations but variation for ages also.

David (2012) found large effect sizes in which those with math learning difficulties had poor central executive WM and visual spatial WM, but this was accentuated in younger ages. He also found a moderate effect between phonological WM and math.

Swanson & Jerman (2006) found that average achievers outperformed children with math disabilities (MD) on: “verbal problem solving, naming speed, verbal working memory (WM), visual – spatial WM, and long-term memory (LTM).”

Again, the impact of WM varied over age.

Secondly, several factors distinguished average performers from those with math disabilities and these factors need to be considered.

WM matters: A surprising range of mental health disorders have deficits in WM accompanying them.

DISORDERS WITH WELL KNOWN WM DEFICITS: ADHD, TBI, stroke, LD, children with learning difficulties, specific language impairment.

LESS OBVIOUS DISORDERS WITH WM DEFICITS: schizophrenia, anxiety, depression, intellectual disabilities, autism, Asperger’s, Parkinson’s, pain disorders (including chronic pain), fetal alcohol disorder, suicidal behavior, OCD, PTSD, bipolar disorder, First episode psychosis, children with externalizing behavior problems, alcoholism, chronic opioid use, prodromal psychosis, chronic fatigue syndrome, cocaine users, multiple sclerosis.

KEY:
• BOLD: Those in bold actually have meta-analyses done on using computerized cognitive training to address them.
• ITALICS: Those in italics have meta-analyses related to the patient population and working memory deficits.
The structure of working memory abilities across the Adult Life Span. WM matters for normal aging. (Hale, et al., 2011)

Another set of data points which highlight the importance of working memory.

What about attention?
How is attention defined and measured?

How do we define it?
What does it include?
What types of attention are there?
How do we measure them?
How is attention different from WM?
Does everyone with an attention problem have ADHD?
How is ADHD defined today?

Attention: how do you define it?

• notice taken of someone or something; the regarding of someone or something as interesting or important. e.g. "he drew attention to three spelling mistakes"

• the action of dealing with or taking special care of someone or something. e.g. "the business needed her attention"

• a person's interest in someone, especially when unwelcome or regarded as excessive.

• a position assumed by a soldier, standing very straight with the heels together and the arms straight down the sides of the body.
What does “attention” mean in psychology?

Attention is the behavioral and cognitive process of selectively concentrating on a discrete aspect of information, whether deemed subjective or objective, while ignoring other perceivable information.

Attention has also been referred to as the allocation of limited processing resources.

Types of Attention?

- **Selective attention**: Can you pay attention to one thing that is important?
- **Alternating attention**: Can you switch from one thing to another?
- **Divided attention**: Can you keep your mind on 2 things at the same time?
- **Sustained attention**: Can you remain focused on something over time and avoid distractions?

As is seen by this brief review attention is a complex construct worthy of a full webinar for its consideration.

Limiting factors: Disorder severity & level of comorbidity are factors we have found necessary to consider.

- **Optimize COGME**: Fidelity to the program and judicious selection of clients for the program. Also, critical is to thoughtfully frame expectations which includes consideration of several factors.
- **Judicious selection of clients requires careful consideration of disorder severity, comorbidity, Rx and whether other interventions are needed during or after COGME**
- **Pearson has previously given rule outs of things like oppositional defiant disorder (ODD), conduct disorder (CD), anxiety, depression, photo-sensitive epilepsy, etc. However clinicians need to use their own clinical judgment about whether any particular client might be successful with COGME**
- **Research has provided rather useful data to address some of these questions. In the case of ADHD, hyperactivity/impulsivity or combined type ADHD is considered a more severe disorder than inattentive type ADHD. We have found that mild to moderate severity of disorder, mild comorbidity facilitates far transfer. In some cases Rx may facilitate far transfer.**
Far Transfer (red) is more likely among those with mild to moderate severity, mild comorbidity & consideration of Rx, gains in storage in WM, but not storage/manipulation: italics & underlined.

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Rx may matter: Impact of training and medication on WM of children with ADHD
(Holmes et al., 2010)

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(Holmes et al., 2010)
Meta-Analysis of WM training & Moderating Variables
(Schwaighofer, Fischer & Buhner, 2015)

Meta-analysis to examine near and far transfer effects following working memory training (not exclusive to Cogmed, but did include Cogmed studies).

CRITICAL CONCLUSION: Cogmed “stood out because it yielded a larger mean effect size than noncommercial training programs.” (Not an uncommon finding, by the way)

47 studies with 65 group comparisons found near transfer to improved short-term memory (both verbal and visual spatial) and working memory (both verbal and visual spatial) skills sustained at follow up with effect sizes ranging from $g=0.37$ to $g=0.72$ for immediate transfer and $g=0.22$ to $g=0.78$ for long-term transfer. These are significant findings ranging from the small to moderate level.

Several moderators had an influence on transfer effects.

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Meta-Analysis of WM training & Moderating Variables
(Schwaighofer, Fischer & Buhner, 2015)

Far transfer effects to other cognitive skills were significant, but small: nonverbal ($g=0.14$) and verbal ($g=0.16$) and not sustained at follow up. (Smaller far transfer effect sizes – not uncommon).

Some would consider smaller transfer effects as ‘self-evident’ since it is ‘far transfer’.

Others are dismissive of WM training programs because of smaller, but significant effects in far transfer.

We contest this dismissal in that Cogmed improves the target of WM which results in what we consider to be improved ‘learning capacity’.

What will you do with greater learning capacity?
Near & Far Transfer Effects Meta-Analysis
(Schwaighofer, et al., 2015)

NEAR TRANSFER:
No (k) Effect Sizes (g):
Verbal STM (short-term/long-term) 32/9 0.37***/0.22*
Visuospatial STM (short-term/long-term) 25/7 0.72***/0.78***
Verbal WM (short-term/long-term) 42/11 0.55***/0.35*
Visuospatial WM (short-term/long-term) 19/6 0.83***/0.41***

FAR TRANSFER:
Nonverbal ability (short-term/long-term) 45/11 0.14*/0.02
Verbal ability (short-term/long-term) 29/5 0.16**/0.26
Word decoding (short-term/long-term) 14/5 0.08/0.21
Mathematical abilities (short-term/LT) 15/6 0.09/0.08

Note: STM = short-term memory; WM = working memory.
*p < .05, **p < .01, ***p < .001.
Nonsignificant findings in word decoding & mathematical abilities.
Small significant findings in nonverbal ability & verbal ability.
Note slightly larger differences in visuospatial areas than in verbal areas.

Moderator Variables found to show significance.
(Schwaighofer, Fischer & Buhner, 2015)

<table>
<thead>
<tr>
<th>Moderator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training dose</td>
<td>Total amount of training (in hours) Larger dose larger effect. (Cogmed, even using the variable protocol, tends to be viewed as a larger dose.)</td>
</tr>
<tr>
<td>Location</td>
<td>Location of training: Training in laboratory vs. training in school vs. Training at home</td>
</tr>
<tr>
<td>Supervision</td>
<td>If training is monitored by a person (e.g., experimenter) or if a person is just present or if no person is present Supervision vs. mere presence vs. no presence</td>
</tr>
<tr>
<td>Session duration</td>
<td>Duration of single training sessions (in minutes) Longer sessions larger effect.</td>
</tr>
</tbody>
</table>

Notably absent of significant effects: frequency of training per week, modality and instructional support.

Significant Moderator Variables
(Schwaighofer, Fischer & Buhner, 2015)

<table>
<thead>
<tr>
<th>Moderator variable</th>
<th>Area of Effect</th>
<th>Effect Size</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training Dose</td>
<td>Visual/ Spatial STM</td>
<td>.30</td>
<td>p&lt;.01</td>
</tr>
<tr>
<td>Location (home&gt;school)</td>
<td>Visual/ Spatial STM</td>
<td>.24</td>
<td>p&lt;.05</td>
</tr>
<tr>
<td>Location (school&gt;lab)</td>
<td>Verbal WM</td>
<td>.19</td>
<td>p&lt;.01</td>
</tr>
<tr>
<td>Location (lab&gt;school)</td>
<td>Nonverbal Ability</td>
<td>.20</td>
<td>p&lt;.01</td>
</tr>
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</tr>
<tr>
<td>Session Duration</td>
<td>Verbal STM</td>
<td>.10</td>
<td>p&lt;.05</td>
</tr>
</tbody>
</table>
Supervision: If training is monitored by a person (e.g., experimenter) or if a person is just present or if no person is present.

What we call the ‘training aid’ is important in terms of transfer effects for both visuospatial WM ($g=.16, p<.05$), and verbal WM ($g=.17, p<.01$).

Supervised training was distinguished from someone being “merely present”. However, the difference was not significant after Bonferroni correction. Yet, the investigators considered their hypothesis partially supported.

Arguably, functioning as a training aid as described in Cogmed training is important and possibly significantly so.

Cogmed supervision is done by training aides. (Schwaighofer, Fischer & Buhner, 2015)

“Titrating or dosing Cogmed”? Integrating the Meta-Analysis data with The Variable Protocol

The variable protocol adjusts frequency and duration of training.

The meta-analysis shows frequency of training can vary and not significantly reduce effects.

Session duration did have a significant effect on verbal STM with an effect size of .10 but it is not clear if there is a ‘cut-off’ in terms of “training dose” or “length of training sessions”.

Cogmed “training dose” or overall amount of training is roughly similar across the different protocols because as one shortens the length or frequency of training the number of weeks extends.

This leaves the issue of “length of training sessions” for consideration in the Variable protocol data.

Variable Protocols (Cogmed RM & Cogmed QM)

<table>
<thead>
<tr>
<th></th>
<th>25 min. per session*</th>
<th>35 min. per session*</th>
<th>50 min. per session*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 days per week</td>
<td>5 days per week</td>
<td>5 days per week</td>
<td>5 days per week</td>
</tr>
<tr>
<td>for 8 weeks</td>
<td>for 6 weeks</td>
<td>for 5 weeks</td>
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<tr>
<td></td>
<td>4 days per week</td>
<td>4 days per week</td>
<td>4 days per week</td>
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<tr>
<td>for 10 weeks</td>
<td>for 8 weeks</td>
<td>for 7 weeks</td>
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<tr>
<td></td>
<td>3 days per week</td>
<td>3 days per week</td>
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<tr>
<td>for 10 weeks</td>
<td>for 9 weeks</td>
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</tbody>
</table>

* indicates total training time including breaks  ** Standard protocol supported by published, peer-reviewed research
Staying true to the Cogmed Model.

Effective work by the training aide and the coach matter throughout Cogmed.

The training aide needs to be engaged in monitoring and observing training.

Revise reinforcement if it is not working. Deliver daily or weekly.

Coaching is specific and behavioral. Coaching should be over the phone or face to face.

Consider severity of disorder, comorbidity, Rx and how to balance these issues properly with the variable protocol.

Optimizing coaching by adding your version of Cogmed Plus.

Cogmed: Beginning of change? Transfer increased linearly with amount of training time & correlated with improvement on trained tasks. WM, FI & Math improved (Bergman-Nutley & Klingberg, 2014)

Changes register at ab or more weeks into trial

As such, coach support essential.

Improve more within the program and get greater transfer.

T5-T1 showed the biggest difference between groups seen here:

How much Cogmed? Transfer increased linearly with amount of training time & correlated with improvement on trained tasks. WM, FI & Math improved (Bergman-Nutley & Klingberg, 2014)

Learning how to learn.

Cogmed requires hard work over a sustained period of time.

This can model what it takes to master other skills. Skills like learning a language or playing an instrument...
Implications of Cogmed’s core efficacy of improving working memory? Cautious optimism.

A surprising number of areas of functioning are correlated with working memory.

Excitement: Greater working memory capacity is a key to many areas of learning. WM is relevant to normal aging, several mental health diagnoses, reading and math achievement, etc.

Caution: Far transfer is a challenge. Several factors mediate and limit far transfer: Domain general abilities (IQ, processing speed, etc.) and domain specific skills (e.g., vocabulary, phonological awareness, grammatical knowledge, etc.) as well as developmental and individual factors, etc.

= Cautious Optimism. While the potential of greater working memory capacity is very exciting, the factors limiting and mediating far transfer are sobering and merit caution in making claims. Furthermore, research evidence is very complicated to digest.

Patience and caution are warranted as is planning to address potential limiting factors.

Summary of key concepts & ideas:

- Cogmed’s target: Improve WM. Cogmed consistently delivers on this promise.
- 5 Arguments for improved working memory as the core efficacy of Cogmed:
  1. Working memory is the target of Cogmed.
  2. Volume of data that support this finding.
  3. The quality of the data with 14 RCT’s and 5 meta-analyses.
  4. The effect sizes of improved working memory are moderate to large.
  5. The longevity of the effects from 2 to 12 months.
- The variation of measures used to assess WM also suggest Cogmed improves it. Cautious optimism warranted.
- Inhibiting factors like severity of disorder, comorbidity & Rx should be considered.
- Training dose, session duration, supervision and location mediate Cogmed effects.
- Meta-analysis of WM training programs generally find larger effect sizes for near transfer than far transfer.
- Consideration of the variable protocol may be important:
- Stay true to the Cogmed coaching model.
- For far transfer complement Cogmed with domain specific education/training: Cogmed Plus.

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