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Are there ways to optimize the effects of Working Memory Training?



Charles Shinaver, PhD
 Peter Entwistle, PhD

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Presenter: Charles Shinaver, Ph.D.
 Cognitive Consultant
 (888) 748-3828, x110
 (800)627-7271 x 262355
 (317) 641-7794
charles.shinaver@Pearson.com

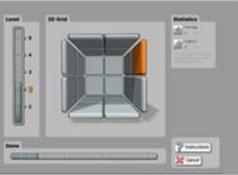
Chat box:
 Peter Entwistle, PhD
 Cognitive Consultant
 888-748-3828, x111
 202-333-3210
Peter.entwistle@pearson.com




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Agenda

Are there ways to optimize CWMT?



- The target of CWMT is WM.
- CWMT Claims & Evidence.
- Severity of disorder, comorbidity & Rx.
- Rx may matter.
- Far transfer challenge.
- Assess Working Memory.
- [Meta-Analysis of WM training.](#)
- Moderating Variables.
- Variable Protocol.
- Metacognitive training.
- Parent training & CWMT.
- CWMT + English Language Learning, etc.
- Mindsets.
- Staying true to CWMT coaching.



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Optimizing CWMT requires clarity about expectations.

Clarity about what CWMT can do, may do and what it is unlikely to do is imperative for optimizing CWMT.

Data drives our claims and comments about this, but this is informed by both clinical experience and experience actually using CWMT with clients.

The first issue, however, is the salience of working memory (WM) deficits for your client population. If this is not a deficit in your client then the relevance of CWMT is negligible. *As obvious as this seems various researchers employ CWMT with samples that do not have a deficit in WM.*

The second issue is the frequent aspiration toward far transfer, but the lack of consideration of the complex factors that influence far transfer. We will attempt to shed light upon the complex considerations and factors which may facilitate and/or limit both near and far transfer.

Finally, we assume fidelity to the training AND coaching method. *Again, seems obvious, unfortunately in the research literature investigators have taken liberties with the coaching method. Typically that has not gone well.* We suggest that you adhere to the coaching method. It is possible you may do 'more' than the coaching method, but certainly don't do less.



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How do you determine whether a client is appropriate for CWMT?

Optimizing CWMT requires clarity about why you might do CWMT with a client.

CWMT targets working memory (WM) deficits.

CWMT does not target far transfer; intelligence, hearing, understanding speech in the context of noise for those with hearing loss, reading, math, etc. *Again seems obvious, but often when far transfer is not found in research investigators claim CWMT is ineffective.* Illogical? Over-reaching? Put care and thoughtfulness into what you claim CWMT might do... (We have guidelines about that.)

Focusing solely on far transfer and we get ahead of ourselves. Will CWMT improve reading or math? Will CWMT improve language acquisition? Well, how's their vocabulary? Phonological awareness? Hearing? Numeracy? Syntax? Processing speed? Intelligence? So many factors impact far transfer that need to be considered. *Ignoring them is unwise.*

The core clinical question salient to CWMT does not have to do with far transfer. It is this: Does poor working memory have a negative impact upon this client?

No. Don't do CWMT. Yes. Do CWMT.



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What do we claim CWMT does?

CWMT Claims & Evidence V 4. Extended version.

- 1) CWMT 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 (1, 3, 7, 13, 18, 25-27, 33, 34, 36, 45, 50, 52, 53, 62, 64, 66, 72) – 19 studies.
 - c) adults and old adults (5, 15, 22, 28, 37, 38, 46, 47, 68, 70, 71) – 11 studies.
- 2) CWMT 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.
- 3) Improvements in working memory following CWMT are associated with changes in functional brain activity
 - a) seen as **changes in the neurochemistry** (9) – 1 studies.
 - functional activity related to working memory** (2, 4, 22, 59), - 4 studies.
 - and **functional connectivity at rest** (52) – 1 study.
- 4) Learning outcomes in **reading** (13, 35, 45, 69) -4 studies and **math** (34, 43, 45, 69) - 4 studies improves for **many students** following CWMT <http://www.CWMT.com/research> "Claims & Evidence"



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CWMT Claims & Evidence V 4. Extended version.

5) In clinical trials, CWMT has been shown to **improve attentional problems** in **many** with ADHD
 a) as evident in rating scales (3, 11, 47, 72) – 4 studies.
 b) or measured with objective measures (25, 72) – 2 studies.

6) Research studies of CWMT report **improved cognitive functioning in daily life** (28, 47, 71, M3, M5) – 5 studies.

7) Adults with acquired brain injury **report reductions of symptoms** after CWMT in clinical trials (5, 15, 37, 38) – 4 studies.

8) **Improvements on measures of cognitive control** have been demonstrated in studies after CWMT (1, 3, 41, 72, M5) – 5 studies.

<http://www.CWMT.com/research> "Claims & Evidence"



Far transfer challenge.

What is the mechanism of change? Limiting, Moderating & Facilitating Factors?

INDIVIDUAL FACTORS:

"Mindsets": growth-oriented VS static mindset.
 Student **motivation**.
 Domain general & Domain specific deficits.
 Impulsivity, hyperactivity, comorbidity.
 Etc.

Facilitating Factor?

Near Transfer: Executive Functions (EF)?

Sustained Attention, Following Instructions.

"Domain specific knowledge and/or skills" without teaching or training it why would better WM automatically improve skills in a specific domain?

Following CWMT with a domain specific intervention that builds upon better WM and improved sustained attention may be necessary to result in far transfer. CWMT Plus.

It may be the case that near transfer to improved executive functions is necessary to facilitate far transfer.

Limiting Factors? Domain Specific knowledge (vocabulary?)
 Domain general skills (processing speed?)

FAR TRANSFER CHALLENGE: Reading comprehension? & Math? Language acquisition?

Working memory

CWMT is not a silver bullet. It is part of the process. Possibly the beginning...

Far Transfer Challenge.

Skill/behavior 'Far Transfer'

Reading comprehension Math skills Language development

May need improved domain specific & domain general skills improved. CWMT Plus?
 WM necessary but not sufficient?

Generalized Effects 'Near Transfer'

Improved Cognitive control Reduced Cognitive Failure Reduced Inattention Symptoms Attention/Concentration

Executive functions

Working memory

Improving Executive Functions: Facilitating Factor?

Planning Initiate Task monitoring Organize

*Severity & Comorbidity: Limiting Factors?
 Is Rx needed to optimize CWMT effects?

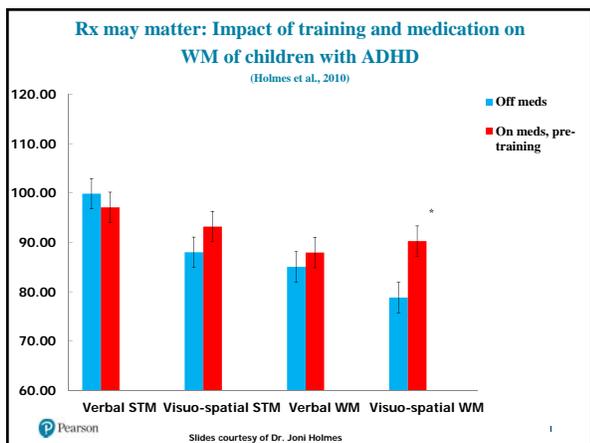


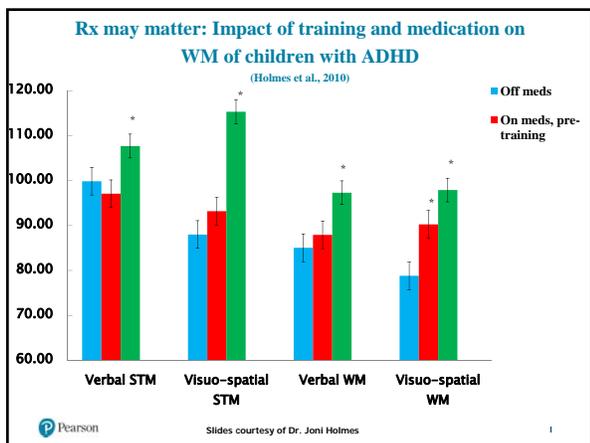

Relevant to ADHD & possibly other disorders.
CWMT Far Transfer Factors to Consider.
(Cogmed Claims & Evidence, May, 2015)

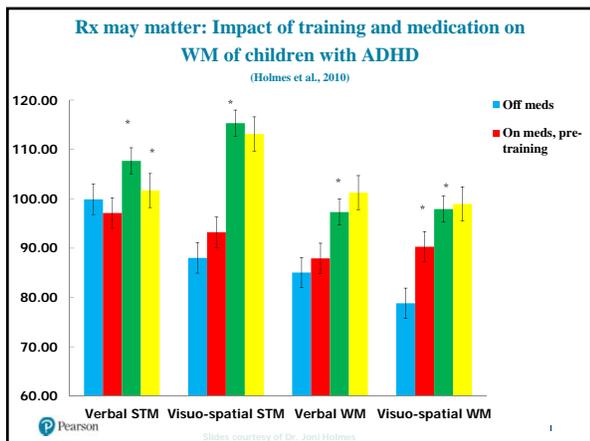
Far Transfer Empirical Facts:

1. 4/5 studies finding far transfer post CWMT appear to be subjects who were in the mild to moderate severity range.
2. 4/5 studies finding far transfer post CWMT the subjects were within a 9-12 year old age range.
3. The 5th study included a range of 7 to 14 years & falls within the moderate severity range.
4. 3/5 studies finding far transfer included arguably ADHD-I.
5. 1/5 studies finding far transfer included ADHD-C, but in that study 70% were taking Rx.
6. 1/5 studies finding far transfer were only identified by "low academic achievement". Selecting children only based upon low academic achievement may not be an effective strategy since several factors other than low WM may be contributing to poor academic achievement.

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Summary

(Holmes et al., 2010)

Significant but distinctive gains in working memory in children with ADHD, no IQ effect.

Pharmacological intervention, (Rx):

- Significant gains in visuo-spatial reflects predominant influence of medication on right hemisphere structures associated with visuo-spatial WM (Bedard et al., 2004)

Behavioural intervention:

- Significant gains in non-trained working memory tasks, which extended across all four aspects of working memory (low-average to average range) for up to 6 months.

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Since our target is WM: Accurately Assess Working Memory (WM)

- Questions: Is this a screening (to identify candidates) or are you trying to assess the impact of the WM program?

For a more general assessment of individuals for CWMT the following areas are recommended:

- Cognition
- Working Memory
- Executive Functions
- Sustained Attention
- Behavior

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Screening or Measuring Impact?

Screening is a **broader** process and one might place an emphasis upon **efficiency** due to the **larger number of students** involved. So a tool that can identify deficits quickly with a larger sample is important – a screening tool.

Selection is more specific than screening but efficiency may be a major consideration. With CWMT there are **two primary factors** to consider:

- Does the student have a WM deficit?
- Are there any other **student factors that would impede completion of CWMT**?

Which students specifically are **constrained by a working memory deficit, an attention deficit and/or an executive functioning deficit**?



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Assessing WM & Far Transfer

Working Memory: Visual Spatial Working Memory & Verbal Working memory are the first and primary targets of the intervention.
A direct measure of WM is preferable.

Attention: Sustained attention is a far transfer of the intervention and a secondary target.
Direct measures may be optimal here too.

Academic Achievement: **Secondary target of CWMT.** A passage of time is often needed as student's increased working memory capacity is better utilized in learning. Also, given years of skill acquisition have been missed there is likely a need for specific skill training in an academic area to facilitate improved academic achievement. Finally, given that the intervention is short it is preferable to have two forms of achievement measures.

Several factors can either inhibit or facilitate far transfer.

The passage of TIME. DIRECT OPPORTUNITY FOR SKILL ACQUISITION.

Forms A & B of academic measures are preferable.



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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 CWMT, but did include CWMT studies).

CRITICAL CONCLUSION: CWMT "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 and working memory 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.**

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

Several moderators (e.g. duration of training sessions, supervision during training, etc.) had an influence on transfer effects.



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Transfer Effects Measured

(Schwaighofer, Fischer & Buhner, 2015)

Constructs & Examples of Tests (with study authors).

Verbal STM: Digit recall forward (St Clair-Thompson et al., 2010), word span test (Nutley et al., 2011)

Visuospatial STM: Span-board task (Klingberg et al., 2005); grid task (Lilienthal et al., 2013); Corsi blocks task (Hubacher et al., 2013)

Verbal WM: Listening recall (van der Molen et al., 2010); reading span (Richmond et al., 2011)

Visuospatial WM: Shape recall test (Alloway et al., 2006); symmetry span (Redick et al., 2013)

Nonverbal Ability: Raven (Chein & Morrison, 2010); Culture Fair Test, scale 3 (Borella et al., 2010)

Verbal Ability: Composite score of the subtests similarities and vocabulary from the Wechsler Abbreviated Scale of Intelligence (Dunning et al., 2013); Regensburger Word Fluency Test (Penner et al., 2012)

Word Decoding: Average of word decoding speed and quality of coding from the test battery LOGOS (Egeland et al., 2013); Nelson Denny reading rate (Thompson et al., 2013)

Mathematical Abilities: Arithmetic test (Van der Molen et al., 2010), national Standard Assessment Test (Holmes et al., 2013)

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Near & Far Transfer Effects Meta-Analysis

(Schwaighofer, et al., 2015)

Near- and Far-Transfer Effects Following WM Training

| Transfer Effect | 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 -LT) | 42/11 | 0.55***/0.35* |
| Visuospatial WM (short-term/long-term) | 19/6 | 0.63***/0.41* |
| 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) | 15/8 | 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.

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Moderator Variables

(Schwaighofer, Fischer & Buhner, 2015)

| Moderator: | Description: |
|--------------------------------|--|
| Age: | Sample age (in years) |
| Training dose | Total amount of training (in hours) |
| Session duration | Duration of single training sessions (in minutes) |
| Frequency of training per week | No. of training sessions per week (in days) 1, 3, 4-6 days |
| Training interval | Time interval between single sessions (in days; excluding weekends) 1 or 2 days |
| Modality | Trained modality of WM Verbal or visuospatial domain or both domains |
| Supervision | If training is monitored by a person (e.g., experimenter) or if a person is just present or if no person is present |
| Instructional support | Supervision vs. mere presence vs. no presence Additional instructional support beyond the explanations at the beginning or not |
| Feedback | Instructional support or not If feedback beyond mere knowledge of results was provided or not Elaborated feedback or not |
| Location | Location of training: Training in laboratory vs. training in school vs. Training at home |

Underlined, bold: moderator variables found to have a significant impact.

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Significant Moderator Variables

(Schwaighofer, Fischer & Buhner, 2015)

| Moderator variable: | Area of Effect | Effect Size: | Significance: |
|------------------------|-------------------|--------------|---------------|
| Training Dose | Visuospatial STM | .30 | p<.01 |
| Session Duration | Verbal STM | .10 | p<.05 |
| Supervision | Verbal WM | .17 | p<.01 |
| Supervision | Visuospatial WM | .16 | p<.05 |
| Location (home>school) | Visuospatial STM | .24 | p<.05 |
| Location (school>lab) | Verbal WM | .19 | p<.01 |
| Location (lab>school) | Nonverbal Ability | .20 | p<.01 |

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

Training dose Total amount of training (in hours).
Larger dose larger effect.

Session duration Duration of single training sessions (in minutes).
Longer sessions larger effect.

Supervision If training is monitored by a person (e.g., experimenter) or if a person is **just present or if no person is present**

Location Location of training: Training in laboratory vs. training in school vs. Training at home

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Significant Moderator Variables: Elaboration

(Schwaighofer, Fischer & Buhner, 2015)

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 CWMT training is important and possibly significantly so.

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“Titration or dosing CWMT”? Integrating the Meta-Analysis data with The Variable Protocol

The variable protocol of CWMT includes adjustments to the frequency per week and duration of training.

The preceding meta-analysis data is consistent with the conclusion that one can vary the frequency of training sessions per week and not significantly reduce the effects. The meta-analysis while it did find that session duration did have a significant effect on verbal STM with an effect size of .10 it does not make it clear if there is a 'cut-off' in terms of "training dose" or "length of training sessions".

In the case of CWMT the "training dose" or overall amount of training is roughly similar across the different protocols because as one shortens the length of sessions or reduces frequency of training per week the number of weeks of training extends. Also, the variable protocol only goes down to a minimum of 3 training sessions a week. The meta-analysis even considered training 1 day a week and did not find that the number of days one trains had a significant effect (surprising to me).

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

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Variable Protocols (Cogmed RM & Cogmed QM)

| | | |
|---|------------------------------|-------------------------------|
| 25 min. per session* | 35 min. per session* | 50 min. per session* |
| 5 days per week for 8 weeks | 5 days per week for 6 weeks | 5 days per week for 5 weeks** |
| 4 days per week for 10 weeks | 4 days per week for 8 weeks | 4 days per week for 7 weeks |
|  | 3 days per week for 10 weeks | 3 days per week for 9 weeks |

* Indicates total training time including breaks
 ** Standard protocol supported by published peer-reviewed research

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Schedule for coach calls

| | 25 min | 35 min | 50 min |
|--------------------|---------------------|--------------|--------------|
| CPI Session | Training Day | | |
| CPI baseline 1 | 1 | 1 | 1 |
| CPI baseline 2 | 2 | 2 | 2 |
| | 5 | 5 | 5 |
| | Coach Call 1 | Coach Call 1 | Coach Call 1 |
| CPI Day 3 | 10 | 10 | 10 |
| | Coach Call 2 | Coach Call 2 | Coach Call 2 |
| CPI Day 4 | 20 | 17 | 15 |
| | Coach Call 3 | Coach Call 3 | Coach Call 3 |
| CPI Day 5 | 30 | 23 | 20 |
| | Coach Call 4 | Coach Call 4 | Coach Call 4 |
| CPI Day 6 | 40 | 30 | 25 |
| | Coach Call 5 | Coach Call 5 | Coach Call 5 |

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Basis for Variable Protocols:

Analysis of 3,629 protocols of Beta Data

Pilot results with 70 children training on the shorter versions were promising.

Shorter training blocks were established by reducing the number of exercises included in each block. The number of trials per exercise was kept the same.

Beta released: 25 minutes per training block and one of approximately 35 minutes.

Data from 3,629 completed CWMT trainings (UK, USA, AU, NL) of RM and QM were used. JM does not have a variable protocol.

Note: JM is already very short at only 15 or 20 minutes per training session.

The data was analyzed to investigate the effects of the new training protocols.

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Variable Protocol Baseline Data

| Protocol | n | Age | Start Index | SU | LU | AU |
|----------|------|------------|------------------|----------------|----------------|-----------------|
| 25 min | 169 | 13 (12) | 68.56 (12.56) | 3.88 (1.43) | 3.5 (0.91) | 10.85 (6.2) |
| 35 min | 585 | 13 (9) | 72.53 (12.45) | 4.57 (1.57) | 3.81 (0.98) | 13.56 (7.52) |
| Standard | 2875 | 15 (12) | 72.33 (11.80) | 4.62 (1.83) | 3.96 (1.08) | 15.57 (8.17) |

Table 1. Baseline descriptives for trainees of the different protocols. Average and standard deviation are presented for Age, Start Index, and the three CPI tasks: Shape Up (SU, previously called Working Memory), Listen Up (LU, previously called Following Instructions), and Add Up (AU, previously called the Math Challenge).

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Variable Protocol CPI Improvement

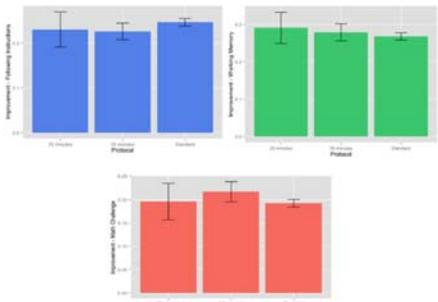


Figure 1. Improvements on the three CPI tasks divided over the training protocols. Error bars represent 95% confidence interval.

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Variable Protocol Cogmed Questionnaire

| | 25-min | 35-min | Standard | F-statistic | p-value |
|-------------------------------|-------------------------|------------------------|-------------------------|-------------|---------|
| Improved Attention (<18 only) | 45%(48) n= 21 | 40% (49) n= 188 | 49% (58) n= 1176 | 0.29 | 0.59 |
| Training experience | 5.69 (0.78) n= 27 | 5.59 (0.85) n = 240 | 5.53 (0.87) n = 1475 | 5.02 | 0.03 |

Table 2. Self-ratings on improvements of attention in every-day life and training experience.

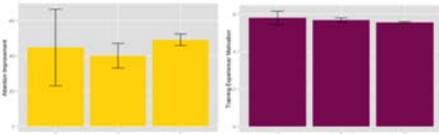


Figure 2. Showing self-rated improvements of inattention in every-day life to the left and self-rated training experience and motivation after training to the right. Error bars show 95% confidence intervals.

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Results of Variable Protocols:
Suggest optimizing by reducing frequency if necessary.

There were no significant differences on gains on the three CPI tasks with the different protocols. (WM, following instructions and math fluency). Considered measures of transfer or generalization.

Standard protocol did result in greater gains on the training index (training gain within the program). (Similar to the Longer-the-better principle from Schwaighofer, et al., (2015).

There was also a age interaction with the training index. (unlike Schwaighofer, et al., (2015), but similar to Melby-Lervag and Hulme (2013).

The correlation between age and index was strongest for the standard protocol (p.001), weaker for 35 minutes (p<.008) and not significant for the 25 minute protocol (p<.98).

There was a significant difference on trainees baseline scores with higher baseline performance associated with the standard protocol with the assumption being they are likely better equipped to tolerate more lengthy training. Self-rated improvements in everyday attention were equal across protocols.

•Shorter training protocols were generally associated with more positive ratings of training experience. However all 3 were rated positively overall.

One can and should weigh whether reducing frequency per week may increase compliance.

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Strategy training & CWMT?

CWMT from the beginning, has discouraged "strategy use".
 I would clarify that what has been categorized as "cheating" would fall into a different category in my mind. Like writing down numbers or other approaches did not solely involve using your own mind.

From the beginning I have disagreed with the stipulation of "no strategy use", except 'cheating'. (I would argue that the strategy use versus increased capacity debate is illusory. It is possible to both improve strategy use and increase WM capacity.)

CWMT offers not only the opportunity for "massed practice" of WM challenging tasks. It allows for the solidification of effective strategies to improve WM capacity as they are applied repeatedly to adaptive tasks.

Intriguingly, a group of researchers decided to address the question of whether explicitly teaching strategy use may improve far transfer.

What follows are their results...

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Meta-Cognitive Strategy Training added to CWMT enhances effects for Special Education children.
 (Partanen, et al., 2015)

N=64, Special Educational Needs children with Lower performance on auditory WM, math, reading and writing. **Randomly assigned** to WM training, WM training + Meta-cognitive strategy training or control group. "A blinded researcher with no participant randomly assigned treatment to meeting time by a coin flip." **Mothers were blinded to treatment condition.**

Results: Significant difference in WM performance during training in favor of meta-cognitive intervention.

Transfer: Visual spatial WM at posttest and 6 month follow up only for meta-cog. Group.

Teacher of meta-cognitive strategy group received an additional day of training for using this approach.
 The children in this group 3 times a week after doing CWMT for that day the teacher engaged the children in a "semi-structured metacognitive strategy-training lesson organized as a group dialogue" (p. 133) (45 minutes long).

Training included using a printout for the children of one of the CWMT tasks. The printout was used for reflective exploration and dialogue.

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Meta-Cognitive Strategy Training added to CWMT enhances effects for Special Education children.
(Partanen, et al., 2015)

5 Activities were included in strategy training all which according to Partanen, et al., (2015) have their basis in research on this topic:

1. Label the central objects and elements of the WM training tasks.
2. Set a goal.
3. **Identify and formulate strategies for success and failure for the tasks.**
4. **Share planning and execution strategies for self-monitoring activities.**
5. **Reflect upon the relation between WM training and situations outside training to facilitate transfer to areas of school learning or leisure time.**

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Meta-Cognitive Strategy Training added to CWMT enhances effects for Special Education children.
(Partanen, et al., 2015)

Questions that facilitate the 5 Activities:

1. **Label the central objects and elements of the WM training tasks.**
"What do you see here in this task? What can you call the different things you see?" (Partanen, et al., 2015).
2. **Set a goal.**
"What is the task about? What are you expected to do? What is the goal here?" (Partanen, et al., 2015)
3. **Identify and formulate strategies for success and failure for the tasks.**
"How can you succeed in this specific task? What strategies can be important? What should you avoid?" (Partanen, et al., 2015)
4. **Share planning and execution strategies for self-monitoring activities.**
"How can you plan for this task? How can you prepare yourself? How can you be attentive or endure?" (Partanen, et al., 2015)
5. **Reflect upon the relation between WM training and situations outside training to facilitate transfer to areas of school learning or leisure time.**
"This task, what might it be good for? Does it remind of something in school or at leisure time? In what way could you use what you learn in the training?" (Partanen, et al., 2015)

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**Fallacy of "brief CWMT" as a "placebo comparison group".
Placebo assumed to lack efficacious elements.**

Rx: 2/3 doses of Adderall, Concerta or Ritalin are not "placebo controls". They are not sugar pills. They may or may not be effective but they have the efficacious elements. Only a few questions remain: Is it the right dosage? Does this patient respond well to this Rx?

Psychotherapy: 2/3 dose of psychotherapy is not considered a "placebo" control for a full number of psychotherapy sessions? Is this brief therapy? Is this the efficacious dosage?

Mawjee, et al., (2014) attempted to provide "**adequate control for non-specific effects of training, such as the participant's level of arousal, engagement, motivation and expectancy for change**" and so used what was dubbed: 'brief Cogmed', also known as 'nonadaptive' Cogmed.

Same Cogmed in all respects with a ceiling of 3 items. Same number of trials. Same number of sessions. Same number of activities. Maybe it is a 2/3 dose of Cogmed? Maybe it is a 1/2 dose? Same components different dosage.

This is not a placebo. It is not a sugar pill, lacking in all efficacious elements. It is low dose Cogmed.

Arguably this makes Mawjee, et al., 2014 study a study of different 'dosing' levels of Cogmed.

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Dosing Cogmed.
(Steeger, et al., 2015)

Steeger, et al., (2015) incorporates criticism we have made by designating what has often been called 'nonadaptive' Cogmed as "**low-dose**, nonadaptive, active control condition".

Cogmed (CWMT) was referred to as "high-dose Cogmed".
A critical distinction given the misnomers of "nonadaptive Cogmed" or a "placebo". Low dose Cogmed is adaptive, it just has a ceiling of 3 items. *As such, we would agree that "low-dose Cogmed" is a more accurate description.*

Similarly, as we have argued before, the "low-dose Cogmed" may result in significant improvement of WM.
According to the data most promising intervention here was "low-dose Cogmed" combined with BPT-control.

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Parents equal engaged & No parental bias to Cogmed
(Steeger, et al., 2015)

Steeger, et al., (2015) reported that "ANOVAs revealed no differences in mothers' program attendance or weekly homework completion/interest as a function of Cogmed Condition, BPT Condition, or their interaction." **Moms in both group were equally engaged in all treatments.**

Randomization and mother blindness to treatment group: Children were randomly assigned to treatment groups. Mothers were blinded to treatment group membership. In a rather thorough approach to confirm this blindness at posttest, mothers were asked "for perceptions of whether their adolescents had received a more or less effective version of Cogmed-RM." Investigators crossed "actual treatment by perceived efficacy of treatment" (p. 14). Here is what they concluded:

"For blindness to CWMT condition, the observed data fit the no knowledge model, $\chi^2(1, N = 73) = 0.35, p > .05$. The no knowledge model constrained the expected frequencies in each of the four cells to be equal. Moms did not know which Cogmed group they were in. Cell frequencies were as follows:

received treatment CWMT/perceived more effective CWMT (19); received treatment CWMT/perceived less effective CWMT (17); received control CWMT/perceived less effective CWMT (20); received control CWMT/perceived more effective CWMT (17).

None of the other models (i.e., full knowledge, positive bias, or negative bias) fit the observed data, $\chi^2 > 66.50, p < .05$, for all three models.

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Data indicates: No knowledge of Cogmed treatment group & positive bias toward both BPT interventions found.
(Steeger, et al., 2015)

Based upon research data the mothers had no knowledge of which Cogmed treatment their children received. So parenting ratings related to the effectiveness of Cogmed will not be dismissed based upon bias, right? They didn't know which version they got.

Yet, for **BPT** the data was found to show a "**positive bias model**". This would have suggested for **both BPT treatments** that there would be a bias toward "**perceived effective BPT**".

So, one expects positive results in rating scales by parents of BPT regardless of whether it was the treatment or control of BPT. *So those might be dismissed based upon bias.*

The Alabama Parenting Questionnaire was administered to parents (mothers) to assess their practices in 4 domains: involvement, positive parenting, poor monitoring/supervision and inconsistent discipline. This is a self-rating measure the parents completed.

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Parent Training + Different Doses of Cogmed.

(Steeger, et al., 2015)

Both high dose Cogmed interventions (CWMT & CWMT+BPT) resulted in significantly improved WM.
 No significant outcomes for treatment or control of BPT on parent-related outcomes.

Strikingly CWMT-control ('nonadaptive CWMT' - low dose CWMT) + BPT indicated an overall "pattern of greatest improvements" on parent ratings of "WM deficit, behavioral regulation problems & global executive deficit." THINGS THAT MAKE YOU GO: "HMMMM."

CWMT + BPT did not result in increased treatment gains. **"However, potential effects of combined treatment may have been masked by greater perceived benefits arising from lack of struggle in the nonadaptive, CWMT active control condition."**

"HMMMM." Is this introducing bias to dismiss the validity of parent rating scales that the data established should not be biased since parents couldn't tell which Cogmed group they were in?

Yet there were several significant main effects for time.



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What to make of main effects for time?

Both low and high dose Cogmed work? Or neither work?

(Steeger, et al., 2015)

- Perceived difficulty of maintaining compliance was harder for high dose Cogmed ($p < .01$). Maintaining compliance was easiest in the low dose Cogmed/ Treatment BPT condition. (Maybe parents effectively applied skills to being a training aide.)
- Main effect for time for WM assessed as forward digit span, backward digit span, forward spatial span, backward spatial span ($p < .01$).
- Mothers subjective (but blinded) of adolescent WM deficit indicated a main effect for time. Low dose Cogmed with BPT showed the greatest decrease ($p < .05$).
- Teacher reports of adolescent WM deficit also showed a main effect for time ($p < .05$).
- One main effect for time in all groups was significant for mother's report of reduced inattentive symptoms ($p < .001$) $\eta^2 = .57$ and H/I symptoms ($p < .001$) $\eta^2 = .42$.
- Teachers also reported a main effect for time for reduced inattentive symptoms ($p < .001$) $\eta^2 = .15$ and reduced H/I symptoms ($p < .001$) $\eta^2 = .14$.

Does it really make sense that with just the passage of time that in a period of 9 weeks, 2 weeks before Cogmed, 5 weeks of intervention and post assessment within 2 weeks that all these children with ADHD would have significantly improved on: WM (forward DS, Backward DS, Forward SS, Backward SS), mother's rating of WM deficit, teacher report of WM deficit and both parent and teacher ratings of reduced inattentive symptoms and H/I symptoms?

If so it appears all schools should simply wait 9 weeks to see such changes. If so there is no need for intervention.
Or, is it more plausible that low-dose Cogmed AND high-dose Cogmed have a significant impact?



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Parenting outcomes.

(Steeger, et al., 2015)

"Parenting behavior outcomes included maternal involvement, positive parenting, poor monitoring/supervision, and inconsistent discipline. **Contrary to hypothesis, there was no significant two-way interaction between BPT Condition and Time for maternal involvement, $F < 1$.**"

They did find a main effect for time on maternal poor monitoring/supervision ($p < .05$) and maternal inconsistent discipline ($p < .01$). There was also a main effect for time on reduced adolescent oppositional behaviors and reduced mother-adolescent conflict ($p < .01$). Also, no two or three way effects were found for these groups.

If one accepts the bias finding influencing these ratings then all results related to parenting might be reasonably dismissed as contaminated by bias.

Or, is it possible that mothers improved on monitoring/supervision and more consistent discipline and the adolescents reduced oppositional behavior?

Is it possible that all the significant gains noted on the previous slide resulted in the youths being better behaved so that it was more achievable for moms to be better at monitoring/supervision and more consistent with discipline and this may have resulted in less oppositional behavior? HMMM...



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Why did 'low-dose Cogmed' & BPT result in the greatest far transfer?

(Steeger, et al., 2015)

1. Their explanation: "Although our interpretation of unanticipated findings (i.e., greatest improvements on several outcomes for the control CWMT/treatment BPT group) is necessarily preliminary and must be taken with caution, we note that other recent CWMT evaluations using nonadaptive controls have found similar trends indicating improvements in the control condition (Chacko, Bedard, et al., 2013; van Dongen-Boomsma et al., 2014)." These 2 studies are worth some further consideration on following slides.



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Cogmed Plus: WM training and English Language Learning

(Hayashi, et al., 2015)

n=108 randomly assigned to 4 groups of undergraduate students.

Range of majors. All considered EFL of intermediate proficiency based upon Test of English for International Communication scores of 400-550.

All had at least 6 years of English Language Teaching

All required to take 4 English classes over 2 years.



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WM training and English Language Learning

(Hayashi, et al., 2015)

4 groups:

1. English Language Teaching (ELT) (n=26), 5 weeks 2/wk English lessons for 90 minutes.
2. Working memory Training (WMT) (n=36), 5 weeks, 5 days/wk CWMT. 30-40 minutes.
3. ELT + WMT (n=21), both training for 5 weeks.
4. Control group. (n=25), testing sessions only.

All participants got book vouchers for participation.



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WM training and English Language Learning
(Hayashi, et al., 2015)

Expectation: ELT+ WMT will get more pronounced effects (Clarke et al., 2010)
 Many studies find that WM plays a critical role in foreign language learning.
 A 5-week ELT syllabus, modeled on Sato (2001), was developed for this study.
 •Sato developed a semester-long (approximately 3months) EFL syllabus designed to improve **critical thinking skills**, as measured by **written composition** tasks, within the context of global issues (e.g., environment, poverty and health).

Sato incorporated various forms of **collaborative learning** such as **role play, pair work, group discussions and presentations**. This intervention *led to an increase in opinions and ideas expressed effectively in the written text* by the experimental group, in comparison to the control group.

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WM training and English Language Learning
(Hayashi, et al., 2015)

Assessments:
Reading Span Test (RST) English (Walter, 2000) as a measure of WM L2, both storage and processing. Used with adolescent and adult EFL learners providing support for its reliability and validity. A measure viewed as underlying reading and language performance.
Reading Span Japanese: (J-RST) (Osaka, 2002). WM underlying L1 reading. Modeled on RST by Daneman and Carpenter (1980) widely used in studies of Japanese EFL.
Digit Span (verbal short term memory), **Digit Span backward** (verbal working memory)
Tapping Span forward and backward conditions from the CAT. **Measured Visual Spatial short term memory and working memory.**
Raven's Standard Progressive Matrices Plus was administered to asses nonverbal ability.
 Groups did not differ on linguistic or cognitive measures prior to the interventions with the exception of CAT Japanese DS backward, with the WMT group scoring higher than the WMT+ELT group.

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WM training and English Language Learning
(Hayashi, et al., 2015)

Differences were most pronounced on CAT subtests.
 ELT & control groups: didn't differ significantly on these measures pre/post-test.

WMT+ELT made the largest gains in:
 Verbal short term memory measured by the Japanese DS forward task.
 Verbal working memory measured by Japanese and English DS backward compared to the control group.
 All tests of verbal short term and working memory and visual spatial short term and working memory between pre & post tests.

There was not significant improvement on RST.
WMT: This group demonstrated significant gains on all measures but the English measure of Verbal working memory (English DS backward).
 NONE of the interventions were associated with gains in foreign language knowledge.

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Marginal Effects on RST & J-RST

(Hayashi, et al., 2015)

J-RST MARGINAL EFFECTS:
 Marginal effect on J-RST for time $p=.06$
Marginal effect for group where WMT-ELT scored higher than WMT group post, test $p=.05$. (Postulates the combo intervention may result in more efficient use of WM in language processing.)
 Marginal effect for Time on total number of words correctly recalled $p=.045$.
 (English) RST: Significant difference in span as a function of time $p=.02$.
Commentary: "CWMT WMT includes a range of exercises such as 'Numbers', 'Letters' and 'Pop-up' (see the section on CWMT Working Memory Training), none of which is designed to tax working memory in the same way as reading for comprehension would, with reference to the task-specific view of working memory capacity (e.g., Daneman, 1991; Finardi & Prebianca, 2006). According to this view, working memory capacity varies depending on the task in which working memory is involved. In this regard, it is reasonable to assume that learners perhaps drew on different pools of cognitive resources between the RST and the CAT subtests."

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WM training and English Language Learning

(Hayashi, et al., 2015)

3 month follow up: WMT & ELT gains in in verbal short-term (English) and Japanese verbal working memory were maintained 3 months later vs. control group. English verbal working memory approached significance.
 •It was unexpected that retention in verbal tasks but not visual spatial tasks since VS tasks dominate CWMT.

Ravens' SPM+ measure of nonverbal intelligence showed retention also.
 No significant group or interaction effects were found.
 CWMT training was conducted in Japanese. So, L1 CWMT has extended to performance on L2 as well as L1.
 •Consistent with the view that WM is independent of language structure.
 Small sample limits ability to generalize the results.

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Follow up Effects

(Hayashi, et al., 2015)

J-RST EFFECTS:
 Significant effect on J-RST for time $p=.001$ for span scores & $p=.006$, for total words recalled $p=.003$, & logicity judgment $p=.003$.
RST:
 Significant difference as a function of time on span scores, $p<.001$, total words recalled $p=.001$, & logicity judgment $p=.001$.
Japanese verbal short-term WMT+ELT ($p=.001$) and WMT groups improved their scores significantly ($p=.007$) while scores of other groups remained comparable to what they were originally.
Japanese verbal working memory: time group interaction: ($p=.004$). WMT + ELT and WMT each significantly higher compared to the control group.
English verbal short memory time X group interaction ($p=.004$). WMT+ELT significantly higher than control group ($p=.01$).
English verbal working memory: WMT+ELT approached significance $p=.05$ compared to the control group.
TS: Significant time X group interaction ($p=.006$) all groups except ELT group increased significantly.

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Mindset: Carol S. Dweck: the power of people's beliefs.

A person's mindset can have effects on a his functioning. (Dweck, 2009). This can be in a variety of areas whether it is intellectual, academic, creative. Etc.

In the case of CWMT the key issue is whether a person has a mindset that if he or she works hard at training that he or she be able to improve their working memory capacity.

Or, if in contrast, a person has the mindset that working memory (WM) is a fixed capacity and no matter how hard he works it will not improve.

Resilience is necessary in life to overcome obstacles. Yeager & Dweck (2012) found that those students that come to believe that their "intellectual abilities are qualities that can be developed (as opposed to qualities that are fixed) tend to show higher achievement across challenging school transitions and greater course completion rates in challenging math courses."

So it is with CWMT. Does your client believe he or she can improvement their WM with doing the hard work of CWMT?



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Error, Praise, Action and Trait Effects of Feedback on Cognitive Performance & Motivation.

(Appelgren, et al., Thesis 2015, Karolinska Institutet)

Cogmed-specific study. The information below is related to how one might conduct coaching sessions:

Trait feedback: Praising a person's trait: "You are clever."

Action feedback: "Your choice was correct."

Impact of Trait feedback: Reduced motivation, increased stress and impacted negatively on performance.

Impact of Action feedback: Increased motivation, positively affected performance and did not increase stress. *This supports our long held view that coaching should include specific review of individual days of training and the actions taken during training.* Also, when positive feedback was given in excessive amounts negative effects were found.

Coaching that focuses upon the specifics of the trainees behavior is preferable based upon this.

This is important to keep in mind related to the type of verbal feedback you give clients in coaching sessions.



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Error, Praise, Action and Trait Effects of Feedback on Cognitive Performance & Motivation.

(Appelgren, et al., Thesis 2015, Karolinska Institutet)

CWMT is demanding. Some lose motivation to finish. How does compliance relate to motivation?

"Studies have shown that subjective views on intelligence influence motivation, where individuals believing that intelligence can increase with training, that is, an incremental mind-set, tend to try harder after setbacks and that high-intrinsic motivation relates to higher academic performance."

Questionnaires measured "the extent to which mind-set and intrinsic motivation influenced compliance to complete a WM training program of a minimum of 20 sessions of WM training."

Only 53 out of 112 recruited participants, (13 years old ($SD = .61$)) completed the training. *..results showed that mind-set and motivation significantly predicted compliance to training, with high motivation and incremental mind-set being associated with more completed sessions.* Copyright © 2015 John Wiley & Sons, Ltd.

Can you evoke an incremental mindset in trainees to optimize treatment?



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Tapping into an incremental mindset: Script “Super zone”

How about a young boy named Michael Jordan who really loved playing basketball. Even though he was a good player - the coach didn't let him play on the best team in school. He was cut from the high school team his sophomore year. But Michael Jordan kept practicing and working hard, each and every day He persevered through everything, one day becoming the greatest basketball player in the world!

Michael Jordan has said: "I've failed over and over and over again in my life and that is why I succeed." It can be good to keep stories like these in mind, so that at times when you are struggling with something, you remember that we all need to go through challenge and failure to learn and become better. It's when things are hard, that we learn and grow the most. Remember that we talked about how scientists have shown that the brain needs challenge to grow stronger? That's why CWMT will keep challenging you so that your brain can grow stronger! To get the most out of your training you are supposed to work at a level that is hard enough for you to miss almost every other attempt - even when you do your best! However, if you miss several in a row, it could be a sign that your brain needs some more energy, and it might be good to take a short break and this is something the program will help remind you of. While taking your short breaks - it could be good to think of the stories you just heard, about other successful people who have struggled and that struggling is an essential part of learning! In this level meter, you can see how many you will need to remember in your next attempt. You will see two lines that are showing your super zone.

Try your hardest to stay within your super zone. That is when you are getting the best possible training! And remember, it's not about getting it right or wrong - it's about trying your best and reaching for the super zone and your goals! When you finish each training block, you can play the reward game RoboRacing and race with Stan the Robot against other robots on different tracks. The more you train within Your Super Zone - the more points you'll gain for Stan... ..which lets you race more times! You can also look at graphs to see how much you have improved in each exercise. This is also where your Coach can see how you did in the training, and help support you though the training!

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Staying true to the Cogmed Model.

Effective work by the training aide and the coach matter throughout CWMT. As found in the reviewed meta-analysis, just being present during training is not enough for the training aide. Some level of awareness about the progress of the days training and feedback related to actual behavior is motivating.

Reinforcement should be revisited if it is not working. It should be delivered daily or weekly and it should result in increasing the frequency of the desired behavior: doing Cogmed. If not it should be changed.

Coaching should be specific and behavioral. It should include specific review of actual Cogmed data. Email coaching is NOT encouraged. Coaching should be over the phone or face to face.

Optimizing coaching includes the notion of Cogmed Plus that fits with your practice or facilities. Optimal coaching includes consideration of severity of disorder, comorbidity, Rx and how to balance these issues properly which certainly includes consideration of whether a variable protocol should be used. Optimal coaching can also include some type of meta-cognitive strategies as noted previously. As I will show on the next few slides the impact of CWMT takes time. Persistence by all involved is critical.

Optimal coaching can facilitate optimal results.

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CWMT: 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)

Take note that changes begin to be registered at about 3 or more weeks into training.

As such the role of the coach in supporting the motivation of the trainee is very important.

Realize: “Transfer increased linearly with amount of training time & Correlated with improvement on trained tasks.”
WM, FI & Math significantly Improved

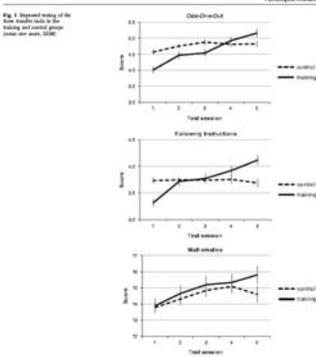


Fig. 3. Reported finding of the meta-analysis on the transfer of training and cognitive control from WM, FI & Math.

 Pearson 1

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

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

Fig. 2 Standardized change (SD) T5 - T1 (SDs) for the two groups

One often neglected issue with Cogmed is one can learn how to learn or how to acquire a skill. It requires hard work over a sustained period of time. This can provide a model and spring board for what it takes to master other Cognitive skills like learning a language or playing an instrument...

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Summary of key concepts to consider:

- The target of Cogmed is to improve WM. Cogmed consistently delivers on this promise.
- Several other transfer effects have been found: Improved attention, effects upon brain functioning, improvement on attentional problems, improved cognitive functioning in daily life, reduced symptoms, improved cognitive control and for "many" or some improvements in reading and math have also been found.
- Far transfer challenge includes several facilitating and limiting variables that can limit transfer: motivation, domain specific skills, domain general skills, mindsets, hyperactivity, comorbidity, etc. Do not overpromise.
- Severity of disorder, comorbidity & Rx are all factors that must be considered to optimize Cogmed and likely must be addressed to facilitate far transfer.
- Training dose, session duration, supervision and location are all factors that mediate the effects of Cogmed.
- Thoughtful consideration of utilizing the variable protocol for your specific client is critical in optimizing Cogmed effects.
- Strategy training like the meta-cognitive strategies may enhance the transfer or generalization of Cogmed.
- Parent training may enhance the effects of Cogmed, but dosing issues should be thoughtfully considered.
- Cogmed Plus should be seriously considered for optimization.
- Consideration at the beginning of Cogmed what interests a client has that can be further pursued with better working memory is how I suggest optimizing the frame for Cogmed. What would you like to learn or do after Cogmed? Play an instrument? Learn a language? Learn a dance routine? Think of a reward for the completion of Cogmed that fits your interests but challenges you cognitively. Think about what such thing could be the reward for doing Cogmed.

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Presenter: Charles Shinaver, Ph.D.
 Cognitive Consultant
 (888) 748-3828, x110
 (800)627-7271 x 262355
 (317) 641-7794
charles.shinaver@Pearson.com

Presenter:
 Peter Entwistle, PhD
 Cognitive Consultant
 888-748-3828, x111
 202-333-3210
Peter.entwistle@pearson.com

COGMED
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