

Whole-Class Cogmed:

Integrating the reality that typically developing students have been found consistently to benefit from Cogmed too.

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Agenda

- What do we mean by “whole-class Cogmed”?
- Obstacles Overcome.
- Does WM matter for Typically Developing (TD) children?
- Visual Spatial Working Memory basis for Cogmed does it contradict the rationale for “whole-class” Cogmed?
- Working Memory Capacity is Salient to learning in typically developing children too.
- Cogmed-Specific Studies of Typically Developing Children

What do we mean by “whole-class” Cogmed?

- 1. Delivery Mechanism:** Doing Cogmed with an entire class simultaneously.
Typically Developing children: Improved working memory is also salient for typically developing students.
Mixed-ability classes: Mixed ability classes could do Cogmed together.
- 1. Individually/small Group Delivery:** Cogmed with one trainee and one training aid or possibly in a very small group of about 5 or fewer.
- 2. Headphones:** Using headphones allows children to do Cogmed simultaneously and with some forethought to the seating arrangement to not be a distraction to one another.
- 3. Obstacles to Overcome for “whole-class” Cogmed (with large groups):**
 1. Tracking several students simultaneously.
 2. Initial session challenge.
 3. Time to do Cogmed.
 4. Different schools different devices (e.g. PC, MAC, Ipad, Android, etc.)

Trends Reporting is at a district, school, class or student level.

TRENDS: ACCOUNT

SHOW LATEST: 1 Month 3 Months 6 Months Custom

Goose Creek School...

Goose Creek School Di... 104 (71.7%) 6.5 19.1 115 (79.3%) 139 (95.9%) 145 278

Account	Compliant	Blocks Behind	Trained Blocks	Motivated	Valid	Total Started	Total Created
Alamo Elementary	1 (8.3%)	17.1	6.3	10 (83.3%)	10 (83.3%)	12	19
Ashbel Smith School	16 (100%)	3.6	23.9	10 (62.5%)	16 (100%)	16	18
Austin Elementary	13 (68.4%)	1.8	21.6	16 (84.2%)	19 (100%)	19	23
Banuelos Elementary	6 (100%)	4.4	23.7	5 (83.3%)	6 (100%)	6	6
Baytown Junior	-	-	-	-	-	0	33
Bonnie P. Hopper Prim...	-	-	-	-	-	0	1
Bowie Elementary	5 (62.5%)	1.9	23.1	3 (37.5%)	8 (100%)	8	9
Carver Elementary	13 (81.3%)	9.1	18.2	11 (68.8%)	16 (100%)	16	21
Cedar Bayou Junior	-	-	-	-	-	-	-
Crockett Elementary-1	3 (30%)	11.4	13.2	9 (90%)	10 (100%)	10	13
Crockett Elementary-2	-	-	-	-	-	-	-



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COGMED



NEXT >

Class Level Data on Trends Report

SHOW LATEST:

1 Month

3 Months

6 Months

Custom

Goose Creek School ... > **Horace Mann Junior**

Horace Mann Junior	10 (83.3%)	3.0	20.4	9 (75%)	11 (91.7%)	12	23
Coach	Compliant	Blocks behind	Average trained blocks	Motivated	Valid	Total Started	Total Created
[REDACTED]	10 (83.3%)	3.0	20.4	9 (75%)	11 (91.7%)	12	23



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Student Level Data on Trends Report

Training	Compliant	Blocks behind	Trained blocks	Motivated	Valid	Status
gc03-88295	✓	1.4	22	✓	✓	Ongoing
gc03-91095	✓	1.4	22	✓	✓	Ongoing
gc03-3001747	✗	11.4	12	✓	✓	Ongoing
gc03-86697	✓	0.4	23	✓	✓	Ongoing
gc03-3009123	✓	0.4	23	✓	✓	Ongoing
gc03-91528	✓	0.4	23	✗	✓	Ongoing
gc03-91768	✓	2.4	21	✓	✓	Ongoing
gc03-84692	✓	0.4	23	✓	✓	Ongoing
gc03-87055	✓	2.4	21	✓	✓	Ongoing
gc03-615948	✗	9.4	14	✗	✗	Ongoing
gc03-90617	✓	3.4	20	✗	✓	Ongoing



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Validity Measures on Trends Report

Compliant

Trainee seems to be training according to the plan in terms of time/block and blocks/week.

Motivated

A large portion of the training is performed below the estimated capacity which may impact the effectiveness of the training. Check motivational status and remind them that training at their limits is what will strengthen their working memory!

Valid

Trainee is progressing as expected on the exercises in terms of index improvement.

[View Details Training Info](#)

[Close](#)

Student Level: 3 Cogmed Progress Indicator (CPI) Measures of Generalization: WM, Following Instructions & Math Fluency



Help



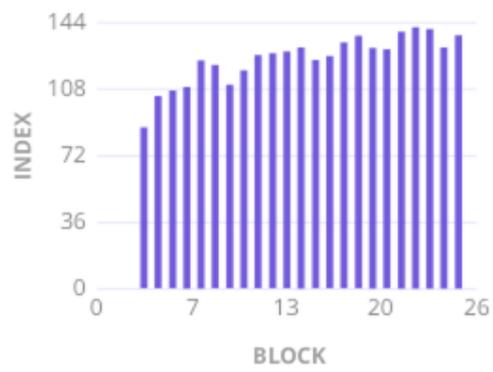
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INDEX

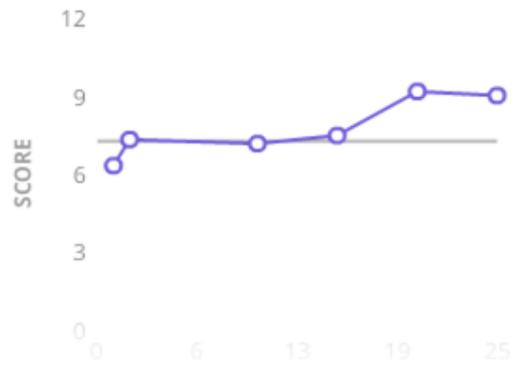


TRAINING TIME

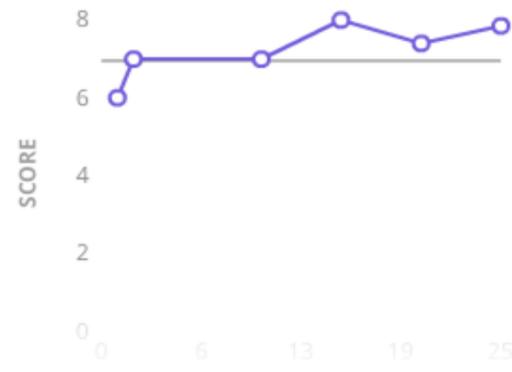


LISTEN UP IMPROV.	14%
ADD UP IMPROV.	6%
BLOCKS BEFORE NEXT CPI	0
MIN/BLOCK	50
BLOCKS/WEEK	5
PROGRAM	Cogmed RM
STATUS	Completed

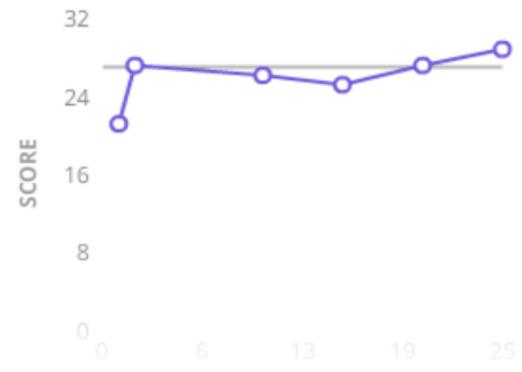
CPI - SHAPE UP



CPI - LISTEN UP



CPI - ADD UP



Student Cogmed Progress Report

At the end of the training staff are able to print out PDF progress reports for each student which summarizes the student's training progress, CPI improvements and self reports.

Progress Report - User ID: u131015

Training Details:
Start Index: 87 **Age:** 41
Max Index: 143 **Age at training:** 40
Index Improv.: 56 **Trained Days:** 25/25

Index / Day

Elapsed Training Time / Day

Cogmed Progress Indicator (CPI):
Working memory: 25%
Following instructions: 14%
Math challenge: 6%

Working memory

Following instructions

Math challenge

Motivation
 User u131015 has self-reported **average** levels of motivation and satisfaction with the training experience.

Low Average High

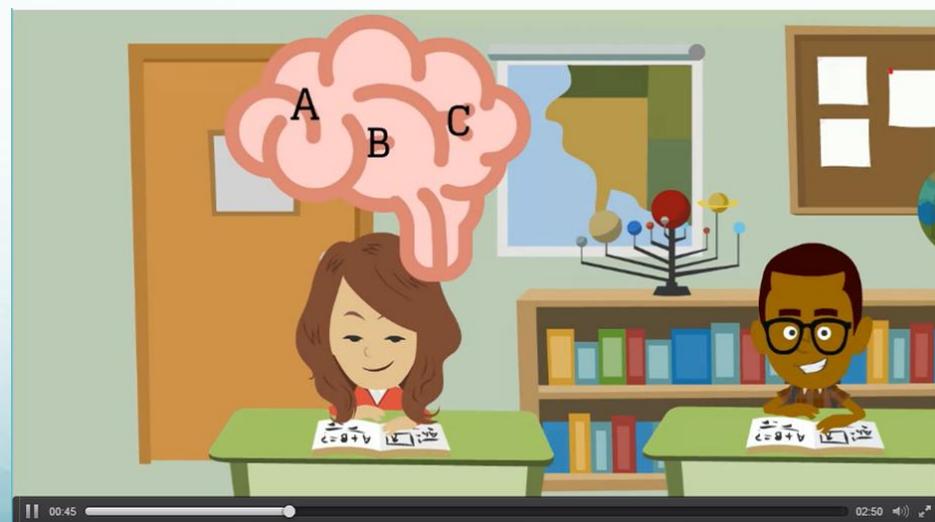
	Checkpoint 1	Checkpoint 2	Checkpoint 3
Confidence for performance	High	High	High
Effort	High	Low	High
Confidence for completing training	High	High	High

	strongly disagree	disagree	somewhat disagree	neither agree or disagree	somewhat agree	agree	strongly agree
I think the training will help me.						←	→
I think I'll be pretty good at doing the training.			←				→
I plan on putting a lot of energy into the training.						→	
I think the training will be very challenging.							→
I think that the training will be fun.		←					
It is important to me to do well on the training.						→	
I believe that I will be able to complete the training.							→

Start-up Session Challenge Made Easy

Videos to help you out with presenting Cogmed

- Start Up Session is now fully automated making less work for the teachers.
- These videos educate the students about Cogmed, its effects on users, and how to complete the program in a fun and engaging way. These videos create an understanding and excitement around Cogmed.



Time to do Cogmed? Tough for schools. 40-50 minutes a day, 5 days a week, 5 weeks.

- RM-school-aged version & QM adolescent/adult version would take between 40-50 minutes a day. Just too long for school.
- JM the preschool version was already very short at only 15 or 20 minutes per training session. So there was not a concern for shortening it.
- A Beta Release of Cogmed was proposed with 25 or 35 minute sessions for 3, 4, or 5 sessions a week.

Basis for Variable Protocols:

Analysis of 3,629 protocols of Beta Data

- Pilot results with 70 children training on the shorter versions were promising.
- **Beta released:** 25 minutes per training block and one of approximately 35 minutes.
- Data from 3,629 completed Cogmed trainings (**UK, USA, AU, NL**) of RM and QM were used.
- The data was analyzed to investigate the effects of the new training protocols.

Results of Variable Protocols: Analysis of 3,629 protocols of Beta Data

- No significant differences on the CPI tasks between groups (WM Odd one out, following instructions and math fluency). Measures of generalization.
- Improvements did not vary based upon number of training blocks per week.
- Self-rated improvements in everyday attention were equal across protocols.

CONCLUSION: Shorter training protocols can be recommended with confidence to users.

What do the Variable Protocols Look Like?

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 13 weeks	3 days per week for 10 weeks	3 days per week for 9 weeks

* Indicates total training time including breaks

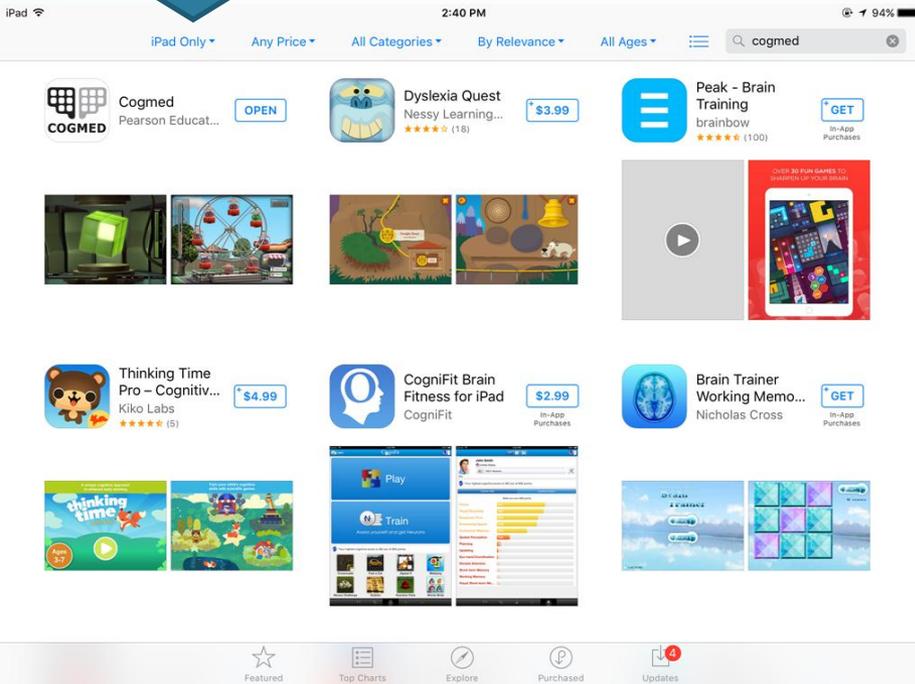
** Yellow, Standard protocol supported by published peer-reviewed research

Schedule for coach calls

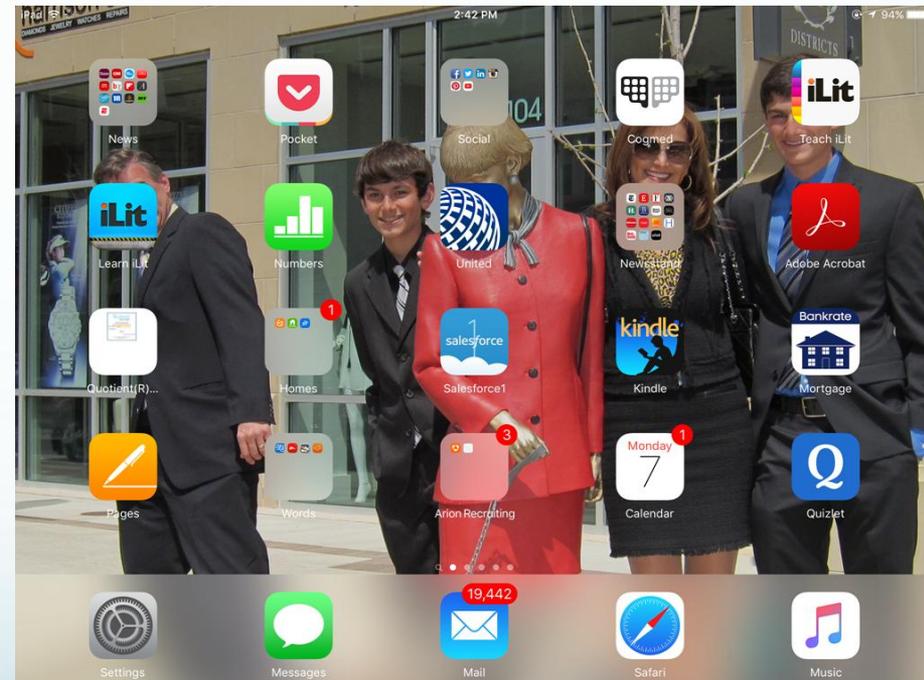
	25 min	35 min	50 min
CPI Session	Training Day		
CPI baseline 1	1	1	1
CPI baseline 2	2	2	2
	5 Coach Call 1	5 Coach Call 1	5 Coach Call 1
CPI Day 3	10 Coach Call 2	10 Coach Call 2	10 Coach Call 2
CPI Day 4	20 Coach Call 3	17 Coach Call 3	15 Coach Call 3
CPI Day 5	30 Coach Call 4	23 Coach Call 4	20 Coach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

DILEMMA OF DIFFERENT DEVICES: iPad Version of Cogmed Downloadable from both the Apple App Store and on Android App on Google Play.

Cogmed on Apple App Store:



Cogmed on Ipad:



Major pragmatic obstacles previously thwarting 'whole-class' Cogmed are now addressed.

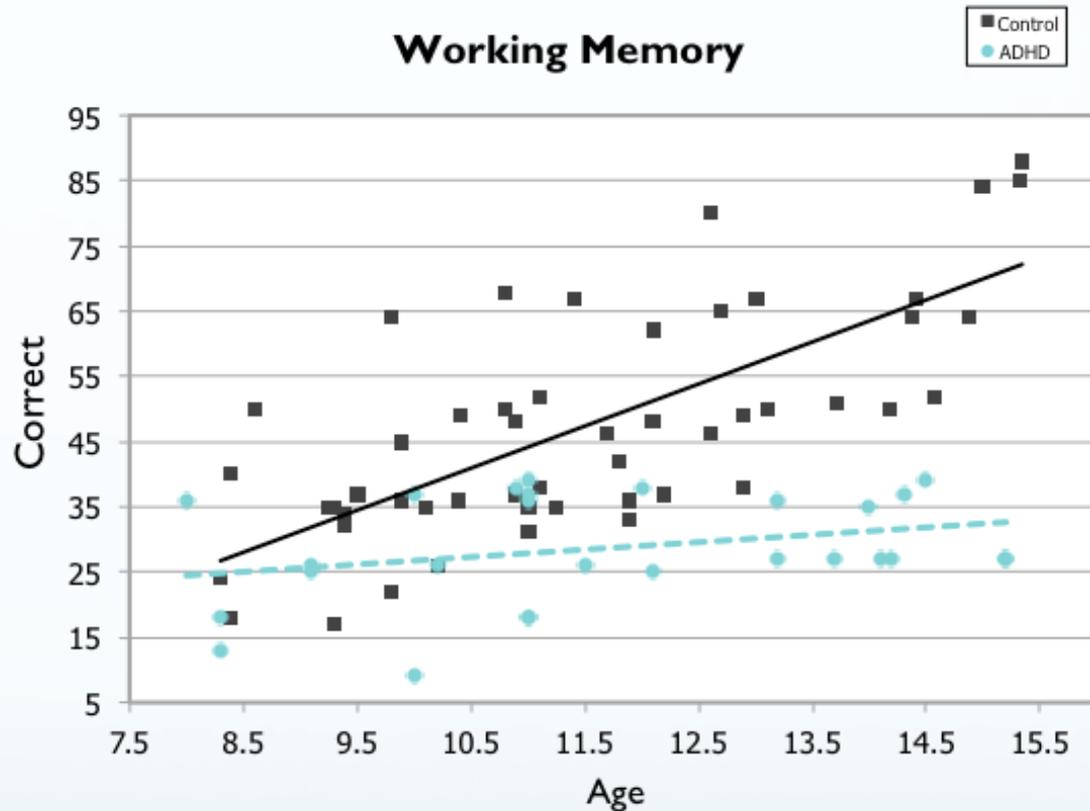
1. Whole-class Cogmed obstacles addressed

- | | |
|-------------------------------|-----------------------------|
| 1. Tracking several students: | Trends Reporting. |
| 2. Initial session challenge. | Videos of Initial sessions. |
| 3. Time to do Cogmed. | Variable protocols |
| 4. Device Dillema. | Online & tablet forms. |

Conceptual rationale of WM deficits?

Rationale for TD children?

The WM deficit Rationale for Cogmed. Implication for those without such deficits?



Westerberg et al. (2004), Visuo-spatial working memory:
a sensitive measurement of cognitive deficits in ADHD.
Child Neuropsychology 10 (3) 155-61.

First one must understand Working Memory's Critical role in learning generally.

A system for temporary storage and manipulation of information, necessary for a wide range of cognitive tasks

To keep information in your mind for a **short period of time (seconds)** & use in your thinking

Processes all stimuli we encounter - updating

Delegates to different parts of our brain to take action - shifting

Allows us to **block** out unnecessary information—
inhibition

Keeps us updated on what's happening –
& **focused** on what matters

Particularly important in the first stage of Learning: encoding.

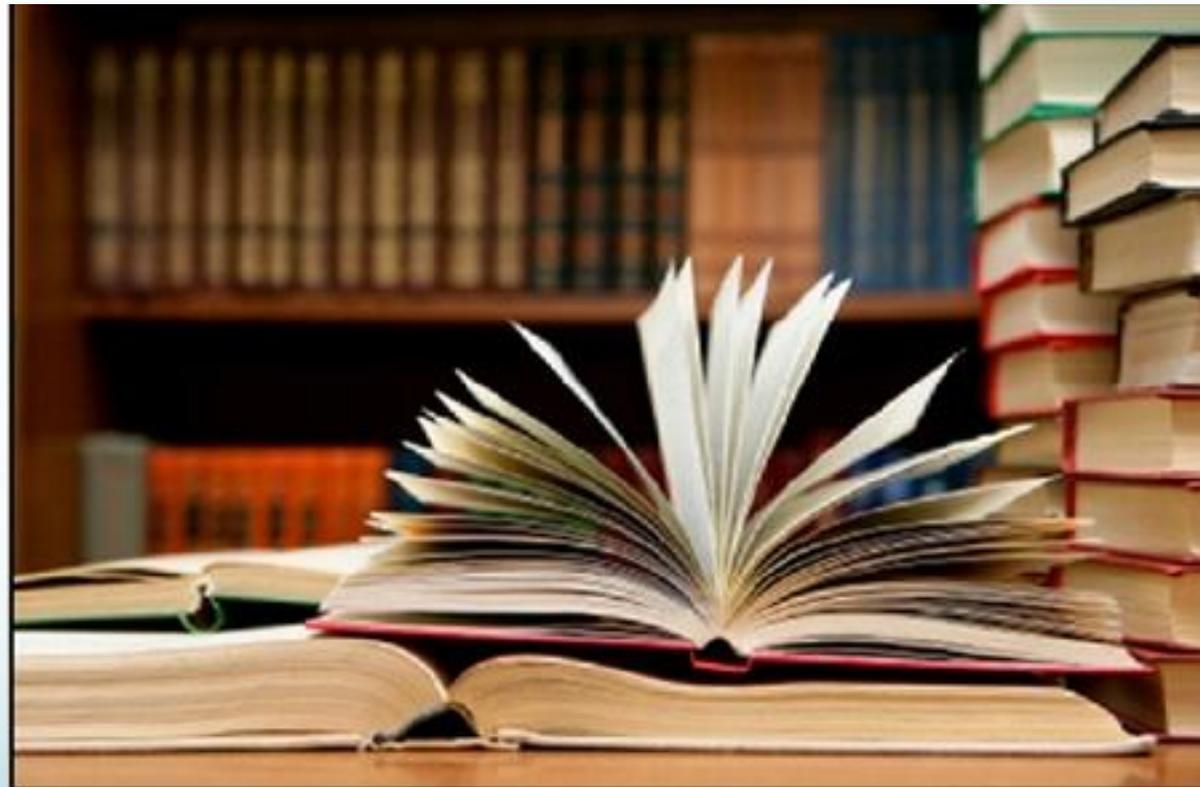


Understanding how ADHD affects learning. More errors, slower learning, no automaticity.

(Huang-Pollock & Karalunas, 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.

Is Better Working Memory Better for most kids?
Do any of the problems for WM deficit children parallel issues for TD children?



Rationale for TD children: WM & Cognitive Inhibition relevant for **word recognition** for Dyslexics & Typically developing (TD)

(Schwenck, et al., 2015)

- 3rd & 4th graders from Taiwan TD & Dyslexics.
- Compared on WM, cognitive and behavioral inhibition & word recognition.
- Two groups did not differ significantly in behavioral inhibition.
- Dyslexics showed lower levels of cognitive inhibition
- Both groups WM & cognitive inhibition contributed to word recognition.
- Also contribution of WM & cognitive inhibition greater than only cognitive inhibition alone (to word recognition).
- BOTH TD & dyslexics WM showed greater contribution to word recognition than cognitive inhibition.

WM, Inhibition, phonological awareness & naming speed related to **early math performance** in TD children

(Navarro, et al., 2011)

- 424 TD middle class children between ages 4 to 7 in Spain.
- The results demonstrated that children performing worst on central executive, phonological processing, and inhibitory processes showed lower results in early mathematical tasks
- **Far Transfer:** Multiple factors relate to early math achievement, not only WM, but phonological processing & inhibitory processes too.

Phonological awareness Linked to **Reading problems**, Memory & Attention Linked to **Math Problems**.

(Schwenck, et al., 2015)

- 6 Groups of 2nd grade children in the U. S. (Usually 7 to 8 years old)
 - Reading Disabled (24 children), Math disabled (22), Combined (35), Low achieving (29), Overachieving (28), Typically developing (28)
- ““Overall, reading problems were linked to deficits in **phonological awareness**, while **mathematics problems were linked to memory and attention deficits**.”
- Furthermore, those with combined problems in reading and math had what were considered “**additive deficits in phonological awareness and attention**.”
- This also applied for low achieving children who were also depicted as being low socioeconomic status.
- Conversely good phonological awareness was a protective factor for overachieving children.
- Even more importantly data suggested a firming of lines of division between groups at the end of elementary school than in grade 2 in which the cognitive variables and group membership was more pronounced then.

WM & verbal reasoning predict **reading** and **writing** for TD 2nd & 3rd graders

(Niedo, et al, et al., 2014)

- Evidence-based conceptual framework for predicting individual differences in reading and writing achievement for TD readers and writers in early childhood (2nd and 3rd grade) for 5th grade.
- Reading: oral real word and pseudoword accuracy and rate, reading comprehension
- Writing: handwriting, spelling, composing skills
- Verbal reasoning & WM
- Verbal reasoning & WM accounted for more variance than Verbal Reasoning alone, except for handwriting for which WM alone were better predictors.

Non-Cogmed adaptive WM intervention & Transfer Effects: Near: Clear. Far: Complex.

(Henry et al., 2014)

- 6 wk, 5 to 8 year old TD children. Active or control. 18 sessions of 10 minute training 3 days a week.
- Assessed WM, word reading, and math. 6-mo & 12-mo follow ups.
- **Near Transfer:** At post-test, trained group *significantly larger gains* than the control group on the two trained executive-loaded working memory tasks (Listening Recall and Odd One Out Span) and on two untrained working memory tasks (Word Recall and Counting Recall). These ‘near transfer’ effects were still apparent at 6-month follow-up.
- **‘Far transfer’ effects were less evident:** there was no difference between the groups in their gains on single word reading and mathematics over 12 months, and spelling skills did not differ at 12-month follow-up. “
 - “However, **the trained group showed significantly higher reading comprehension scores than the control group at 12-month follow-up.** Thus, improving the ability to divide attention between processing and storage may have had specific benefits for reading comprehension.

Could TD poor WM broaden the lens and bring into focus other problems? Anxiety? Depression?

(Owens et al., 2012)

- TD ages 12 to 13 from UK schools.
- Investigated reduced academic performance among young people with anxiety and depression – not diagnosed disorders.
- Relationship between negative affect, worry, WM, and academic performance using self-report questionnaires, school administered academic test data and a battery of computerized WM tests.
- **“Higher levels of anxiety and depression were associated with lower academic performance. “**
- **“There was support for a mediation hypothesis, where worry and central executive processes mediated the link between negative affect and academic performance.”**
- **“Further studies should test these hypotheses in larger longitudinal samples.”**

Could TD poor WM broaden the lens and bring into focus other problems? Social Functioning?

(McQuade, et al., 2013)

- N=116 TD 4th and 5th grade children.
- Is WM associated with multiple measures of concurrent social functioning in TD children?
 - Peer rejection
 - Overall social competence
 - Relational aggression
 - Physical aggression and conflict resolution skills
- **Poor central executive WM was associated with both broad social impairments** (peer rejection and poor overall social competence) and **specific social impairments** (physical aggression, relational aggression, and impaired conflict resolution skills);
- Poor verbal storage was associated only with greater peer rejection, and spatial storage was not associated with any measures of social impairment.
- **Other Moderators:**
 - Aggressive behavior and conflict resolution skills mediated the association between central executive and broad measures of social functioning.
 - Greater physical aggression and impaired conflict resolution skills were both significant mediators; relational aggression was not.

Does Cogmed generalize to improved attention in children?

(Shinaver & Entwistle, 2014)

Study	Study design	Sample	Measures
Klingberg et al., 2005	RCT – double blinded	ADHD Children	DSM-IV Parent Rating, Conner’s Parent Rating Scale
Green et al., 2012	RCT – double blinded	ADHD Children	Restricted Academic Situations Task (RAST)
Beck et al., 2010	Randomized, waitlist control	ADHD Children	Conner’s Parent Rating Scale, BRIEF Parent & Teacher Form
Mezzacappa & Buckner, 2010	Pilot	ADHD Children	Teacher ADHD-RS-IV
Gibson et al., 2011	RCT - Randomized, active control	ADHD Children	DuPaul ADHD Scale – Teacher and Parent
Holmes et al., 2009	Active Control	Poor WM children	Following Instructions Task
Thorell et al., 2009	RCT - Randomized, active control, double-blinded	Typical Pre-schoolers	Auditory CPT
Grunewaldt et al., 2013	“Stepped Wedge”, waitlist control	Typical Pre-schoolers	Auditory CPT

Studies which have found significant differences on a variety of measures of attention.

Note: This does not include studies from 2013-2014.

Cogmed:

Near: Clear. Far: Complex.

Skill/behavior
'Far Transfer'

**Reading
comprehension**

Math skills

Language
development

**On-task
behavior**

WM may be necessary but not sufficient:

**May need domain specific skills, may need improved domain general executive functioning skills.
Remediation and other interventions may be necessary.**

Generalized
Effects
'Near
Transfer'

Rate of learning

**Reduced
Cognitive
Failure**

**Following
Instructions**

**Attention/
Concentration**

Executive
functions

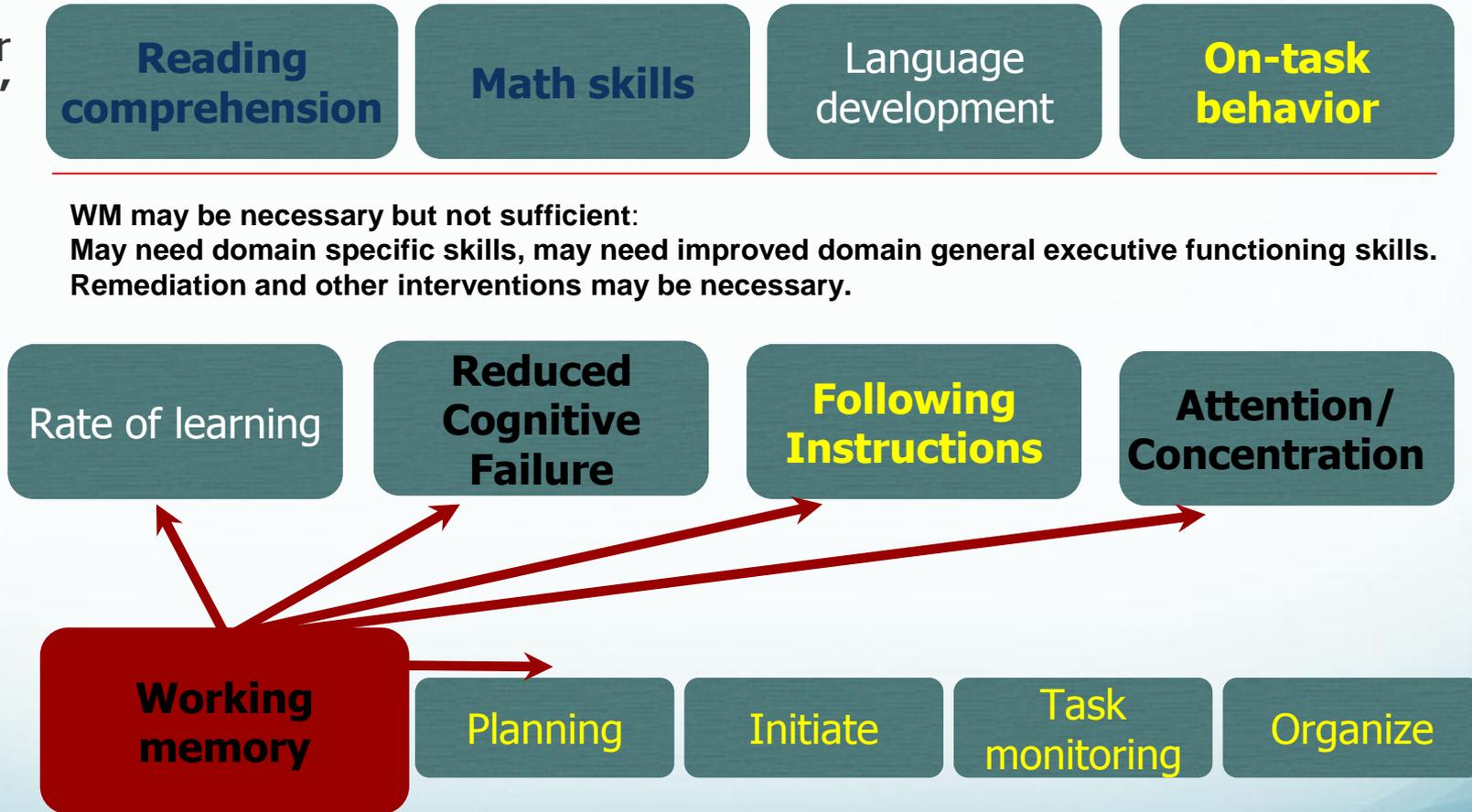
**Working
memory**

Planning

Initiate

**Task
monitoring**

Organize



Support for “whole-class” Cogmed (22 studies, 12 of adults) Many since 2013.

Population

**Typical
Adults (12
studies),
children/Adol. (6)
Preschoolers (3)**

Klingberg et al., 2002 (exp. 2)
Olesen et al., 2004
Westerberg & Klingberg, 2007
McNab et al., 2009
Brehmer et al., 2009; 2011; * 2012
Bellander et al., 2011
* Gibson et al., 2012, 2013
Söderqvist et al., 2013
* Dunning & Holmes, 2014
• Metzler-Baddeley, et al., 2015

• Holmes & Gathercole, 2013 (Trial 1)
* Astle, et al., 2015
Söderqvist et al., 2014
* Dunning & Holmes, 2014
* Gibson et al., 2014
• Soderqvist & Nutley, 2015
• Faith, et al., 2015

Thorell et al., 2009
* Bergman-Nutley et al., 2011
Söderqvist et al., 2012

**Brain
Injury/Stroke (6)**
Westerberg et al., 2007
* Lundqvist et al., 2010
* Johansson & Tornmalm, 2011
* Åkerlund et al., 2013
* Björkdahl et al., 2013
* Hellgren et al., 2015

NOTE: Untapped potential in several typically developing groups (21 studies; e.g. “Aging” with adults, “enrichment” or “prevention” for children and preschoolers, supports argument for “whole class Cogmed”, etc.).

NOTE: 6 studies on the topic of classroom behaviour, low WM students, underachieving students, low language ability students all since 2013.

**Classroom Behavior
Low WM, Low
Academic
Achievement, Low
Language Ability.
SEBD (8)**

• Holmes et al., 2009
• * Roughan & Hadwin, 2011
* Holmes & Gathercole, **2013** (Trial 2)
* Dunning et al., **2013**
* Bergman Nutley & Klingberg, **2014**
* Holmes et al., **2015** (Low Language)
* Yin, et al., **2015**
Partanen, et al. **2015

Underlined:
discussed today.
Red font= studies
used as basis for
claim that Cogmed
improves attention.

Adults

Children/ Adolescents

Preschoolers

22 on ADHD

ADHD/ Special needs

*Gropper et al., 2014
*Mawjee et al., 2014, *2015
**Liu, et al., 2015

* Klingberg et al., 2002,2005
* Holmes et al., 2010
* Gibson et al., 2011, 2013
* 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
** Hovik et al.,2013
**Steeger, et al., 2015
**Van der Donk, et al., 2015
*Stevens et al., 2015

** van Dongen-Boomsma et al., 2014

(*randomized, placebo controlled, *independent investigators)

Red font= used for claim of improved attention.

Adults

Children/ Adolescents

Preschoolers

Cogmed was done with children with low working memory in groups of 6 to 12 students at a time.

(Dunning, et al, 2013)

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
Dunning, et al., 2013	100%	NR	NR	NR	NR	NR	NR

- 810 children ages 7-9 given Automated Working Memory Assessment (AWMA), **verbal WM** (backward digit recall) and **VS WM** test Mr. X involving recalling a series of locations, interspersed with mental rotation decisions.
- n=94 children at or **below the 15th percentile on both** WM tests with English as their first language (47 boys, mean age=8 yr, 5 m),
- **3 groups**: Adaptive training, **non-adaptive training**, no intervention.
- 6 weeks of training. Then follow-up assessments.
- Follow up at 12 months: 15 schools in adaptive, 19 in non-adaptive groups.
- Schools randomly assigned to adaptive or non-adaptive training.
- Classroom-based tasks administered: following instructions, rhyme recall, sentence counting (processing), sentence counting (storage).

Group Delivery in a randomized, controlled trial (RCT) (2)

(Dunning et. al., 2013)

- **Training: Conducted within school in GROUPS of 6-12 under a researcher's supervision.** Children received small rewards like stationery items for every 5 training sessions completed. *Not all motivational features were equated across the two programs.*
- **Total time spent on task:** was recorded in the Cogmed log and was comparable across groups 80% adaptive 82% non-adaptive. This was a response to criticism of previous research.



Adaptive vs. non-adaptive Cogmed training

Rationale: Repeated recital of WM trials when difficulty level is not adapted typically leads to faster reaction times but not an increase in WM capacity - no generalization

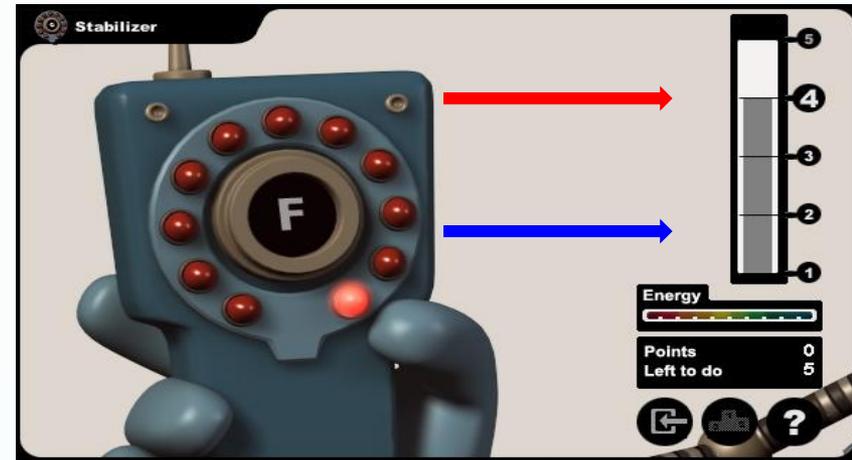
“Non-adaptive training”

(placebo – but perhaps it is **Actually ‘mini-Cogmed’**. The problem is that it sets a rather high bar and **Reduces differentiating EF**):

- 2-3 items per span
- same number of items per trial
- not challenging WM capacity

Adaptive training:

- maintain multiple stimuli simultaneously
- short delays while stimuli held in WM
- unique sequencing order each trial
- difficulty level adapts as function performance
- correct trial: sub-level increase, more difficult span arrangement, more items per span
- incorrect trial: almost right – small decrease, not even close – large decrease



RCT (3) Impact upon WM

(Dunning, et al, 2013)

	Adp. Vs non adpt.		Adp. vs no int.		Non-ad vs no int.	
WM	t	d	t	d	t	d
AWMA						
VSTM	1.32	.14	.43	.28	1.72	.44
VS-STM	1.50*	.87	2.73**	.57	.187	.36
VWM	3.66***	.99	6.43***	1.63	2.83**	.59
VSWM	2.38*	.67	3.89***	.77	1.38	.14

*p< .05, **p<.01, ***p<.001.

RCT (4) Impact upon Class-based tasks (Dunning, et al, 2013)

	Adp.	Vs non	Adp	Vs no int.	Non-ad	Vs no int.
Class	t	d	t	d	t	d
FI	2.59*	.71	1.21	.12	1.16	.98
Rhyme recall	.28	.11	1.50	.26	.59	.14
Sentence counting	.59	.32	1.85	.54	1.22	.31
<i>Sentencing counting (processing)</i>	.93	.70	2.37***	1.10	1.44*	.61
<i>Basic Reading</i>	1.52	.36	2.26*	.62	3.62***	.85
Written Exp.	1.99*	.69	1.42	.57	.4	.23
<i>Attention Omissions</i>	.47	.19	2.53*	.32	1.98*	.24

*p< .05, **p<.01, ***p<.001.

RCT (5)

(Dunning, et al, 2013)

- Cogmed significantly boosted performance on untrained WM tasks in children with low WM.
- **This enhancement was substantial in magnitude and was partially sustained for 12 months.**
- **Adaptively trained children made significantly greater improvements in tests of VS STM & Verbal and Visual Spatial WM** than non-adaptively trained or those that received no intervention.
- 1st double-blinded RTC study on this key group of poor learners that meets stringent criteria for intervention research. Results reinforce earlier outcomes with low WM kids (Holmes, et al., 2009).

RCT (6)

(Dunning, et al, 2013)

- Classroom behaviors did not show sustained improvement at one year.
- At follow up accuracy in sentence counting (processing) correctly the number of words in a sentence did improve.
- Suggested that scaffolding may be required for training to generalize and be effective in new situations (Wilson, 2008).
- **The greatest improvements in WM following training were observed in complex span** measures strongly associated with children's academic achievements in literacy and mathematics (Swanson & Siegel, 2001; Alloway, Gathercole, Willis & Adams, 2004). Response to research.
- It is possible that outcome measures lacked sufficient subtlety to detect changes that more process-oriented measures may find.
- **PRIORITY:** Establish whether other training activities can be developed to promote the “application of these enhanced WM skills to less predictable memory-demanding situations in the classroom.”

Teacher-led “whole class” Cogmed.
 Delivery to the entire class of mixed ability students
 (Holmes & Gathercole, 2013) Trial 1

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
Holmes & Gathercole, 2013 (trial 1) mixed ability	NR	NR	NR	NR	NR	NR	NR

Trial 1: n=22, 8-9 year old children.

- **1st Question: Can teachers do Cogmed with an entire class?**
- **2nd Question: Will a class of mixed ability students benefit as a whole by doing Cogmed?**
- Yes & Yes.
- The class as a whole significantly improved on both trained and untrained WM tasks with effect sizes comparable to reported studies. Year-4 in school South of England.
Trained in a single group of 22 at the beginning of the school day. Supervised by teacher and class assist.

Teacher-led “whole class” Cogmed.
Delivery to the entire class of mixed ability students
(Holmes & Gathercole, 2013) Trial 1

- 4 Aspects of WM made significant gains:

TRIAL 1 Cohen’s d effect sizes:

- Verbal Short Term (VST) = .43
- Visuo-spatial Short Term Memory (VS-STM)= 1.12
- Verbal Working Memory (VWM)=.75
- Visuo-spatial working memory (VSWM)= .94

- Training gains were most substantial for children with low baseline WM on VSWM and VWM. Both of these are strongly associated with learning.

Teacher-led “whole class” Cogmed.
 Delivery to the entire class of mixed ability students
 (Holmes & Gathercole, 2013) Trial 1

subtests	Pre		Post		t	p	d
	m	SD	M	SD			
Digit recall	100.35	16.73	106.25	17.62	1.91	.07	.34
Word recall*	100.75	17.00	106.85	15.56	2.12	.05	.37
Dot matrix*	102.90	20.65	122.30	18.18	4.24	.00	1.00
Block recall*	103.30	16.87	116.20	13.64	2.77	.01	.85
Backward digit recall*	100.50	10.34	116.30	13.24	4.40	.00	1.34
<i>Counting recall</i>	104.85	13.90	104.15	12.76	.19	.85	.05
<i>Mr. X*</i>	109.65	14.08	122.90	19.99	2.82	.01	.78
<i>Spatial recall*</i>	108.40	13.77	120.70	11.44	2.93	.01	.98

Teacher-led “whole class” Cogmed
 Delivered in groups of 12, 13 & 25
 (4) Trial 2:
 (Holmes & Gathercole, 2013)

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
Holmes & Gathercole, 2013 (trial 2)	NR	NR	NR	NR	NR	100% (Low aca. Perf.)	NR

- n=50 children ages 9 -11 **-low academic performance** from a cohort of 256 Year 5 and 6 children attending middle school in South East England.
- **Selections based on raw scores in English and math from teacher assessments administered at the end of the previous year.**
- English assessed reading, writing, speaking and listening skills.
- Math assessed the ability to use and apply math, complete tests of number and algebra, shape space and measures and handling data.
- N=25 from Year 5 (age 9 years, 5 months, 16 boys) and 25 from year 6 (age 10 years, 6 months, 13 boys).
- **These children had the lowest teacher assessment scores of their cohorts.** They were **matched with 50 children based upon age, gender and performance** on the teacher assessments from the previous cohorts of children in year 5 and 6.

Teacher-led “whole class” Cogmed
Delivered in groups of 12, 13 & 25
(4) Trial 2:
(Holmes & Gathercole, 2013)

- Data are presented separately because year 5 and year 6 have distinct status in the UK state education system. SAT’s are required in year 6 and optional in year 5.
- The year 5 group was trained as one group of 25 supervised by the head teacher and a classroom assistant. (Whole class)
- Year 6 was trained in two smaller groups (n-13, n-12) supervised by the same staff at the end of the school day.

Teacher-led “whole class” Cogmed
 Delivered in groups of 12, 13 & 25
 (4) Trial 2:
 (Holmes & Gathercole, 2013)

	Year 5			Year 6		
	Trained Group	Comp. group	d	Trained Group	Comp. group	d
English	1.48 (1.56)	2.36 (1.58)	.56	2.00 (1.44)	1.12 (1.20)	.67
Math	1.36 (1.29)	-1.04 (2.88)	1.15	2.12 (1.13)	1.32 (1.55)	.60
	(standard deviation)					

Class of typically Developing 4th grade Students did Cogmed in their Curriculum.
In 6th grade they were significantly higher than peers in reading.
(Soderqvist & Bergman Nutley, 2015)

- Gain in **Reading** two years after Cogmed : $d=.66$ ($p<.05$)
- Secondly gains in **math** showed a similar pattern with an effect size (Cohen's $d=0.58$) **which trended toward significance** at ($p=.091$).
- **The gains correlated with the degree of improvement during training.**
- Control group received education as usual.
- 1st Cogmed study of long-term effects beyond 1 year on academic performance.
- Both groups at baseline were normal/high performing according to national standards.
- $n=20$ in the Cogmed class, $n=22$ in the control group.
- Measures were the Swedish National Standardized Tests administered in Spring of third grade.
- T=0
 - Reading comprehension subtest
 - Mental arithmetic subtest
 - Age appropriate tests were given at year 4 and 6.
- T=1 & 2:
 - Dimensions of reading rate, reading comprehension and spelling from Diagnostic Reading and Writing Test.
 - Math: Adler Mathematical Screening test.

Cogmed Training with Typically Developing Children in groups of 8 with I pads and headphones delivered by the teacher.

(Falth, et al., 2015)

- n=32, 16 intervention group, 16 control group. 1st grade students.
- This study of working memory training investigates the impact of intervention with memory training on students' school performance.
- Before and after the intervention, all the participants were tested on word decoding skills, reading comprehension, and automated mental arithmetic. The results showed that both groups had improved on all tests after the intervention, **but that the intervention group performed significantly better on the word decoding test than the control group**. However, this study demonstrated no differences due to memory training with regard to mental arithmetic between the intervention group and the control group.
- A possible interpretation of the result is that structured memory training is beneficial for students' reading development.

Is there any scientific evidence that the brain actually changes as a result of doing Cogmed?

Cogmed's Impact upon the Brain Neurophysiology in *Children (Typically Developing)*

(Astle, et al., 2015)

This study considered the Neural Basis for Cogmed Training Effects in a systematic, controlled manner in children.

Typically developing children.

n=33, 6 did not finish training leaving n=27.

Children between 8 to 11 years old.

13 adaptive group (3 boys), 14 in placebo group (7 boys)

Average age adaptive=119.2 months. (9.93 years)

Average age non-adaptive=118.8 months (9.9 years)

Groups were not significantly different based upon gender or age.

Exclusion Criteria: Developmental Disorder Diagnosis or an acquired neurological condition.

Design: Double Blind, Randomized, Placebo-Controlled Trial
(non-adaptive Cogmed). RCT.

Treatment group did Cogmed RM.

Control did non-adaptive Cogmed.



Cogmed's Impact upon the Brain Neurophysiology in *Children (Typically Developing)* (Astle, et al., 2015)

- **Cognitive Assessments:** Pre/Post Training: AWMA Automated Working Memory Assessment: Verbal Short Term memory (VSTM), Spatial Short Term Memory (SSTM), Verbal Working Memory (VWM), Visual Spatial Working Memory (VSWM). No pre-training differences.
- **MEG: Magnetoencephalograph (MEG):** Pre/Post Training. Data acquisition and basic preprocessing is outlined in detail in the study. Same process used pre/post. A high-density whole-head Vector View MEG system (Elekta-Neuromag) containing a magnetometer and two orthogonal planar gradiometers at 102 positions (306 sensors in total). See article for other details.
- **Training:** Cogmed training at home. Progress monitored remotely by research team. Children completed a minimum of 20 sessions of training with an upper limit of 25 training sessions.
- **Adaptive training:** Treatment group.
- **Non-Adaptive training:** Control group.

Cogmed's Impact upon the Brain Neurophysiology in *Children (Typically Developing)* (Astle, et al., 2015)

Post Cogmed Training: Among typically developing children connectivity between frontoparietal networks and both lateral occipital complex and inferior temporal cortex was altered in a way that mirrored improvements in WM capacity. ***In other words the increase of connectivity correlated with the magnitude of improvement in WM capacity. This change was greater in those that completed adaptive Cogmed than non-adaptive.***

This was based upon using a relatively new technique: **MEG** – Magnetoencephalography.

How new?

My neuro-radiologist/wife saw it and said:

“What is that? I’ve never seen that before.”



Advantages of MEG:

- “MEG is **faster** than fMRI and PET, as it measures brains’ electromagnetic activity, rather than their fuel consumption.”
- “MEG is **more precise** than EEG, as the signals MEG detects are less distorted (as a result of superconductivity and tunneling) by passing through the brain and skull tissue that gets in the way. The magnetic changes are a more direct measure of brain activity. MEG is **more accurate**.”

<https://www.youtube.com/watch?v=FR7SP9eNd0k>



Key Aspects of Magnetoencephalograph - MEG

- For our purposes the key issues with MEG are:
 - The method involves measuring the electromagnetic activity of the brain. This is considered a more direct, accurate and precise measure of neuronal activity than EEG.
 - It is a way to measure brain activity *at rest*.

- Effects seen while at rest cannot be attributed to strategy.

There is no strategy engagement while resting.

- Effects seen while at rest cannot be attributed to motivation.

There is no need to be motivated while resting.

Improvement in WM Capacity on the **Group level** of Adaptive vs. “Placebo”.

(Astle, et al., 2015)

6280 • J. Neurosci., April 22, 2015 • 35(16):6277–6283

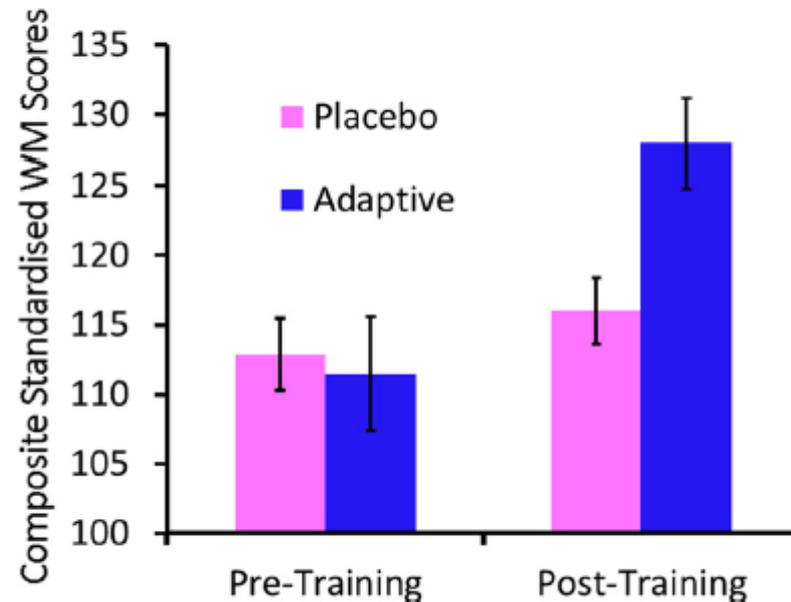


Figure 2. Performance on the standardized working memory assessments in both groups, before and after training. Error bars indicate the SEM.

Critical Finding

Cogmed's Impact upon the Brain Neurophysiology in Children (Astle, et al., 2015)

- **Critical Finding:** “Improvements in WM (on untrained tasks) after training were associated with **increased strength of neural connectivity at rest, with the magnitude of these specific neurophysiological changes being mirrored by individual gains in untrained WM performance.**”
- **Noteworthy:** There was **considerable individual variation** of magnitude of change in WM before and after Cogmed. Individuals varied in the amount of change in WM, but **increased WM capacity correlated with the degree of increased neural connectivity.**



Figure 3: Functional Interaction between group/time (A - Green) & Changes in Connectivity for **Groups** (B) & **WM/Connectivity for Individuals** (C).

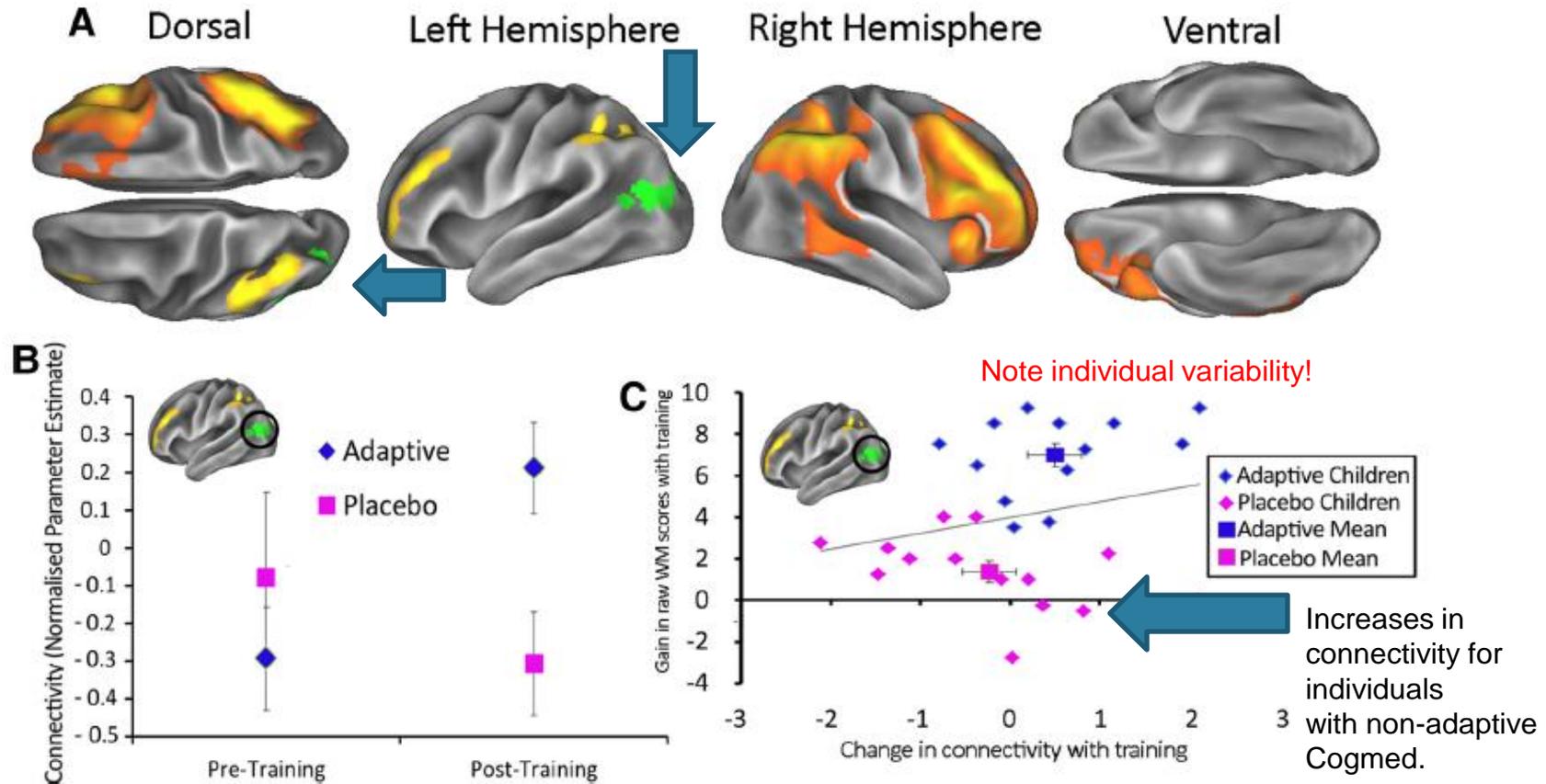


Figure 3. **A**, Red-orange areas correspond to a right hemisphere frontoparietal seed network (Smith et al., 2012). The green area highlights an area of functional interaction with this network that demonstrates a significant interaction between group (Adaptive vs Placebo) and time (pretraining versus posttraining) in the first GLM analysis, corrected for multiple comparisons across voxels, seed networks, and frequencies. **B**, Connectivity values for left LOC for each intervention group before and after training. **C**, Changes in connectivity values for individual subjects across both intervention conditions plotted against changes in working memory capacity after training. In all cases, the error bars correspond to the SEM. All of the measures of connectivity show normalized parameter estimates from the GLM.

Astle, et al., (2015) Deepens the Evidence that Cogmed Results in a Change in WM Capacity

- *Due to the measurable difference in brain activity while at rest post **training the gains from Cogmed cannot be attributed to motivation or strategy since one is not engaging in any activity while at rest.***
 - *Response to critics alleging improved strategy use and varying motivation explain improvement performance while claiming that there is no “actual increase in WM capacity” from training.*
- This biophysical indicator of increased neuronal connectivity consistent with and correlated to the behavioral change of increased WM capacity deepens the evidence indicating a brain-behavior basis of change.



Individual Variability Implications of Astle, et al., (2015)

1. Individual Differences Implications:

Subject variables may help us to better understand individual variation in gains.

- 1. Closer scrutiny of individual differences among subjects may help us to better account for variation in gains independent of coaching (e.g. mindsets (Dweck), etc.)*
- 2. This suggests the pragmatic likelihood that training may work better for some individuals than others. Understanding this has implications for training which may include 'dosing' issues or the amount of training overall.*

2. Coaching Implications:

Better understanding how to facilitate these “optimal gains” suggests a closer scrutiny of components of coaching effectiveness and individual differences.

- 1. Coaching components may be essential for optimizing gains.*
- 2. It also suggests that certain types of coaches or coaching with certain components is more effective with certain trainees.*

Why does resting state functional connectivity matter? (Barnes, Woolrich, Baker, Colclough & Aistle, 2015)

- ...”**the strength of connectivity** between a fronto-parietal network and lower-level processing areas in inferior temporal cortex **was associated with spatial working memory capacity**, as measured outside the scanner with educationally relevant standardized assessments. “
- *“This study represents the first exploration of the electrophysiological mechanisms underpinning resting state functional connectivity in source space in childhood, and the extent to which the strength of particular connections is associated with cognitive ability.”*
- ***In short, behavioral changes were registered in brain changes.***

Why does resting state functional connectivity matter? (Barnes, Woolrich, Baker, Colclough & Astle, 2015)

IMPLICATIONS:

- Effects of Cogmed in Astle, et al., (2015) ***cannot be explained away as an expectancy effect.***
 - ***The change found is not simply the subjective view of subjects, coaches, parents or teachers.***
- Since changes were found at rest suggests it cannot be explained by greater strategy use, but an actual increase in capacity is a more reasonable explanation.
 - Greater WM capacity was associated with greater connectivity in Barnes, et al., 2015.
 - In the Cogmed-specific study, Astle, et al., 2015, greater gains in WM capacity and greater connectivity AFTER COGMED was found.
 - Hence the conclusion is that this is very strong data to suggest that:
 - Cogmed leads to gains in WM capacity reflected in changes in neuronal functioning.

Summary

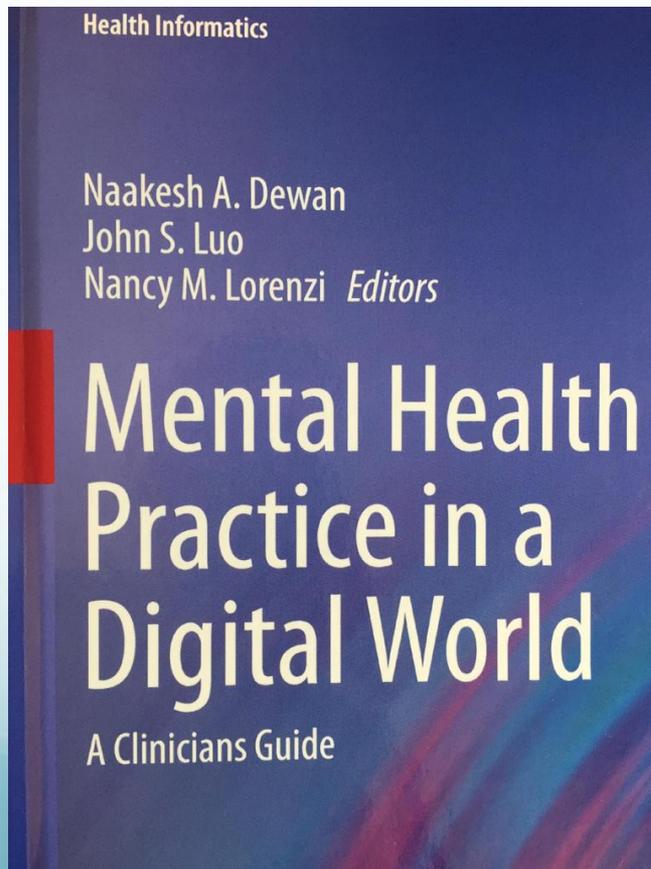
- Most practical obstacles of delivering Cogmed to entire classes have been overcome.
- 10 studies of typically developing children (3 preschoolers) have found significant benefits. Another 12 studies of typically developing adults have made similar conclusions. That equals the most researched group of Cogmed clients – those with ADHD.
- Cogmed has been successfully delivered in groups of 8, 6-12, 12, 13, 22 & 25 students at once.
- The learning of typically developing children similarly hinges upon WM capacity as those with deficits.
- Typically developing children post-Cogmed have shown improved WM, improved word decoding, improved reading.
- Astle, et al., 2015 findings showed that improved WM capacity correlated with increased brain connectivity at rest. There was notable individual differences in both gains in WM and increases in connectivity.
 - Individual variability is consistent with the arguments of Shinaver & Entwistle that severity of disorder and comorbidity are quite likely moderators of gains in Cogmed.
 - The argument is plausible for typically developing populations.
 - Ignoring individual variation in all Cogmed studies may be a reasonable explanation for a lack of findings or limited findings in some studies. Same is true for severity and comorbidity.
 - ‘Dosing’ the amount of training could be key to reaching those with more severe disorders and/or comorbidity.

Book Chapter published by Charles & Peter in
"Mental Health Practice in a Digital World"

Our chapter: *"Computerized Cognitive Training Based upon Neuroplasticity."*

Please [Click Here](#) or go to this URL:

<http://www.springer.com/us/book/9783319141084#>



This chapter puts into the larger perspective computerized cognitive training in the areas in which it has been most applied clinically: Schizophrenia, Traumatic Brain Injury & ADHD.

It is in this chapter where the “severity of disorder” argument is made.

Our Other Publications since 2013

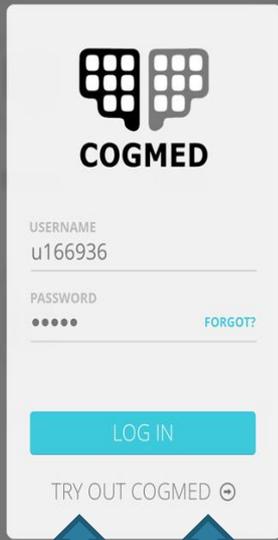
Shinaver, C. S., III, Entwistle, P. C., Soderqvist, S. (2014). **Cogmed Working Memory Training: Reviewing the Reviews**. *Applied Neuropsychology: Child*.

Entwistle, P.C & Shinaver, C. S. III (2013). **Working Memory Training & Cogmed**. In S. Goldstein, & J. Naglieri (Eds.), *Handbook of Executive Functioning*. New York, NY: Springer.

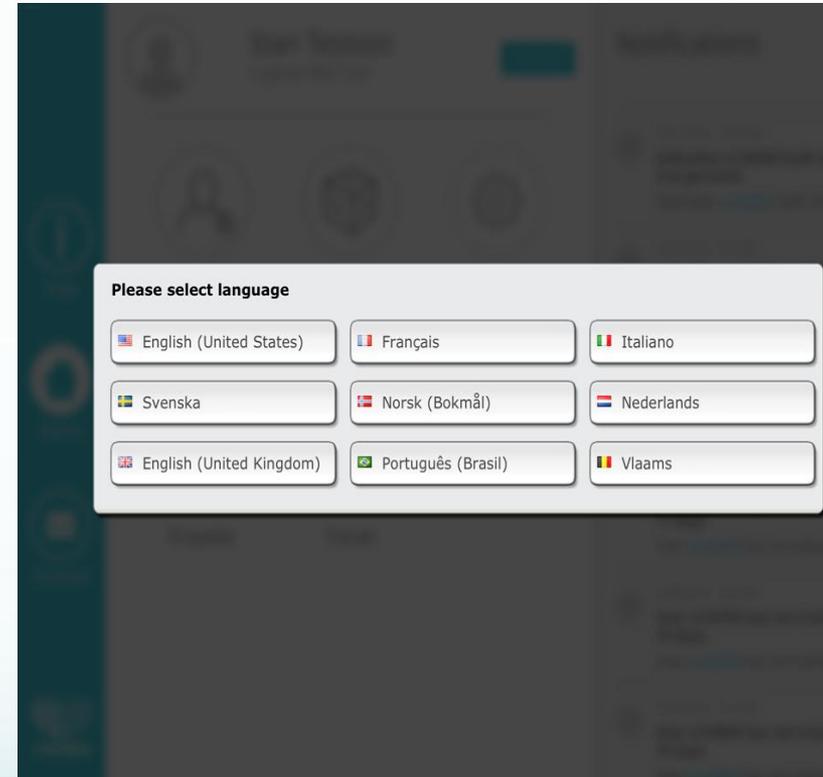
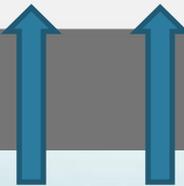
Cogmed on my.cogmed.com: Demo without password.

Demo at login by clicking on: “Try Out Cogmed”
No password required.
New Login URL: my.cogmed.com

Demo Languages:



The image shows a login form for Cogmed. At the top is the Cogmed logo, which consists of two speech bubbles with a grid pattern inside, and the word "COGMED" below it. Below the logo are two input fields: "USERNAME" with the value "u166936" and "PASSWORD" with a masked password "•••••". To the right of the password field is a link that says "FORGOT?". Below the input fields is a blue "LOG IN" button. At the bottom of the form is a link that says "TRY OUT COGMED" with a right-pointing arrow icon.



The image shows a language selection dialog box titled "Please select language". It contains nine buttons arranged in a 3x3 grid, each with a small flag icon and the language name. The languages are: English (United States), Français, Italiano, Svenska, Norsk (Bokmål), Nederlands, English (United Kingdom), Português (Brasil), and Vlaams.

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Thank you!

