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ADHD, Cogmed & College

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October, 2016

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Agenda

- ADHD cracks the Foundation of Learning straining development.
- How does ADHD affect Adult functioning?
- Data for traditional treatment of Adult ADHD is limited.

This clinical challenge is far from solved.

- Overview of Cogmed-Specific Studies ADHD.
- **Cogmed research with ADHD adults is in its preliminary stages with a few studies.**
- We will review presently existing Cogmed specific studies with Adults with ADHD

Why Working Memory is the Target of Cogmed.

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

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Visual Spatial Working Memory in ADHD. Deficits exacerbate functioning over time.

Deficits persist.

Capacity gap increases over time.

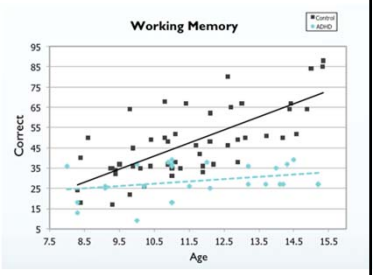
Domain specific knowledge & skills suffer.

Deficits feed upon each other.

Negative momentum: Further and further behind.

Confidence?

Self-efficacy?



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

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ADHD Cracks the Foundation of Learning...& Functioning.

(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***.

Consider the result of these struggles in adulthood:
A distinct trajectory of poorer academic achievement.

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"Normal Children": Working Memory Increases 4 to 15 years

(Gathercole, et al, 2004)

- From 6 years onward, a model consisting of **3** distinct but correlated **factors** corresponding to the working memory model (**phonological working memory, visual spatial working memory, central executive working memory**) provided a good fit to the data.
- The results indicate that the **basic modular structure of working memory is present from 6 years of age and possibly earlier**, with each component ***undergoing sizable expansion in functional capacity throughout the early and middle school years to adolescence.***

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Critical Distinction between "Normal Children" & ADHD: Normal = WM Continues to Develop until Young Adulthood.

(Huizinga, et al, 2006).

4 age groups (**7, 11, 15, and 21 year olds**) carried out nine basic experimental tasks (three tasks for each EF), the **WCST** (Wisconsin Card sort Task), and the **ToL** (tower of London).

Analyses of (co)variance revealed a continuation of EF development into adolescence. Confirmatory factor analysis yielded **two common factors:**

Working Memory and Shifting.

Variables assumed to tap Inhibition proved unrelated to EF.

Shifting was seen to continue to develop into adolescence, while Working Memory continued to develop into young-adulthood.

Regression analyses revealed that **Working Memory contributed most strongly to WCST performance in all age groups**.

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Working Memory deficits correlate with Reading Comprehension Problems: Meta-analysis.

(Carretti, et. al., 2009)

Good comprehenders vs poor comprehenders:

"...memory tasks that are demanding in terms of **attentional control and that require verbal information processing** are best at distinguishing between" between these two groups.

"...**suggesting that both domain-specific factors as well as general factors of working memory contribute to reading comprehension performance."**

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Visual Spatial WM (VSWM) & VS ST memory *PREDICT* Math achievement.

(Bull et al, 2008)

For 4 year old children WM & ST memory along with EF (executive functioning) **predicted 1st grade and 3rd grade achievement.**

BETTER DIGIT SPAN (verbal working memory) & EF skills provided an **immediate head start** in **math and reading** that was maintained through the **first 3 years of school**.

Visual spatial working memory and **visual spatial short term memory predicted math achievement** at each time point.
EF (executive functioning) skills **predicted learning in general.**

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Growth in WM predicts better math problem solving

(Swanson, et. al., 2008)

n=353 at risk elementary school children 1st-3rd grades.
Assessed children at risk for serious math problems.
Is growth in working memory an important predictor of children's problem solving in math? YES.
Growth in WM is an important predictor of children's problem solving beyond the contribution of reading, calculation skills, and individual differences in phonological processing, inhibition, and processing speed.

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The Far transfer challenge.
Consider Multiple Factors: Limiting, Moderating & Facilitating?

INDIVIDUAL LIMITING FACTORS:

1. "Mindsets": Growth-oriented vs. static mindset.
2. Motivation.
3. Behavior issues: Impulsivity, hyperactivity, defiance, etc.

DOMAIN LIMITING FACTORS?
Domain Specific knowledge (vocabulary? Phoneme knowledge, etc.)

FAR TRANSFER?
Reading comprehension?
Math?
Language acquisition?

Facilitating Factors?

Executive Functions (EF)?

Domain general skills (processing speed?)

Near Transfer:

Improved working memory, Sustained Attention, Following Instructions.

Teaching or training to address far transfer areas of interest is likely necessary.

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

Cogmed improves working memory. How with that improved capacity be used?

ADULTS: More remediation is likely necessary given expected missed foundational learning.

Working memory

College Students with ADHD Struggle.

(Weyandt, et al., 2013)

Statistically significant group differences on many variables in college students with ADHD vs. those without.

With ADHD were significantly worse:

- Executive functions
- Study/organizational skills
- Attention
- Academic performance

- Internalizing/externalizing disorders
- Emotional expression
- Social adjustment.

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Trajectory of Adults with ADHD. ... Not reaching potential.

"Adverse Trajectory":

- Willcutt, et al., (2012) meta-analysis of 546 studies of ADHD patients captures the typically expected adverse trajectory:
  - Those with ADHD had "***significant and persistent impairment in social, academic, occupational and adaptive functioning*** *when intelligence, demographic factors and concurrent psychopathology are controlled*" (Willcutt, et al., 2012).

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How do the deficits of ADHD Affect Adult functioning? Consider ***Work***…

Clinic referred sample of adults with ADHD:

- ***ONLY 22.2% worked as their source of income*** (Bjervan, et al., 2012).

General population:

- ***Whereas 72% of general population work for income*** (Bjervan, et al., 2012).
- *Higher inattentive ratings were found to be associated with a lower level of employment* (Bjervan, et al., 2012).

NOTE: ***Cogmed results in improved attention***.

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Does ADHD present differently in adulthood?
Yes. More Inattention Less Hyperactivity.

(Larrson, et al., 2011)

Often, Inattention persists and may worsen while hyperactivity/impulsivity may decline.

Larsson, et al., (2011) 1,450 twin pairs in a longitudinal study.
Parent ratings administered at ages **8-9, 13-14 and 16-17** (Larsson, et al., 2011).

2 Trajectories:

Hyperactivity-impulsivity (HI):	Low or ***high and over time decreasing***.
Inattention:	Low inattention or ***high and increasing inattention.***

Adult ADHD is more likely to include inattention.

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Extreme Outcome of Adult ADHD: Over-representation of ADHD in *Prison. Early identification and treatment are critical.*

Meta-analysis: Prevalence of ADHD in incarcerated populations ***across countries using 42 studies*** compared those in prison with ADHD vs. general population (Young et al., 2015):

"***there is a fivefold increase in prevalence of ADHD in youth prison populations (30.1%) and a 10-fold increase in adult prison populations (26.2%).***"

Significant country differences were found.

Indicates substantial societal cost ADHD in the world.

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ADHD Adults & Prison:
One way to reduce its likelihood: Rx.

(Lichtenstein, et al., 2012)

(n=25,656) Population Study in Sweden.

"…among patients with ADHD who were taking medication there was a significant 32% reduction in the criminality rate for men and a 41% reduction in women."

Crime reduction notable even when:
- Different drugs used &
- Different crimes tracked (violent vs. non-violent).

Reduction ranged from 17%-46%.

Can Cogmed may play a role?

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ADHD Adults in Prison:

Very likely not diagnosed as children.

•Ginsberg, et al., (2010) found: "The estimated prevalence of adult ADHD among longer-term inmates was 40%. Only 2 out of 30 prison inmates confirmed with ADHD had received a diagnosis of ADHD during childhood."

•6.7% prison inmates confirmed diagnosed with ADHD in childhood
•40% in prison estimated to have ADHD as adults.

Can better diagnosis and treatment prevent this trajectory?

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ADHD Adults in Prison:

More Severe Executive Functioning Deficits than others with ADHD.
(Ginsberg, et al, 2010)

Clinical outpatient sample of Adults with ADHD vs.
Adult Prison inmates with ADHD.

Both significantly worse Executive Functioning (EF) vs. healthy controls after controlling for IQ.

BUT, Prisoners with ADHD significantly worse than the outpatient clinic adult ADHD males on EF.

Intervention to improve EF with ADHD adults is critical.

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While Rx may help Adults with ADHD in some ways there is much it doesn't address. Consider MTA

(Molina et al., 2009)

Multi-Modal Treatment of ADHD (MTA study) largest study of childhood ADHD treatment ever conducted ***showed the limits of traditional approaches***. 4 treatment groups Indistinguishable at 6 and 8 years.

6 and 8 years post 14 month intensive treatment program ADHD children fared worse than a comparison group on 91% of the variables considered (Molina, et al., 2009). Including grades earned in school, arrests and other clinically relevant outcomes.

Original 4 distinct treatment groups:

Best medication regimen developed to date
Extensive behavioral management
Combination of both
Typical psychiatric community care.

Investigators called for "innovative treatment approaches targeting specific areas of adolescent impairment."

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Traditional Treatment of Adult ADHD Limited Data.

"As recently as 1997, the empirical database guiding the selection of psychosocial treatments for adults with attention-deficit/hyperactivity disorder (ADHD) could be summarized as "entirely anecdotal" (AACAP, 1997, p. 107S).

2/4/2016 Search of the APA database using terms: "Adult Attention Deficit Hyperactivity Disorder" or "ADHD" and "treatment": 5 relevant publications.

2/4/2016 Search of the APA database using terms: "Adult Attention Deficit Hyperactivity Disorder" or "ADHD" and "medication" returned 2 relevant articles.

- Detecting 'feigned ADHD in college students'
- 'Stimulant medication use in college students" Comparison of appropriate users, misusers, and nonusers'.

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Rx abuse by college students complicates matters for young adults who do have ADHD.

Hartung, et al., 2013: little is known about the efficacy of stimulant medications for college students with ADHD.

Yet "A focus has emerged, however, on illicit stimulant use among undergraduates, with studies suggesting such behavior is not uncommon (e.g., Arria et al., 2013)." (Hartung, et al., 2013)

"Both types of misusers (i.e., students who abused their prescriptions and those who obtained stimulants illegally) reported concerning patterns of other and combined substance use, as well as higher prevalence of debilitating side effects such as insomnia and restlessness." (Hartung, et al., 2013)

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Many Adults with ADHD remain undiagnosed and untreated. (Manos, 2010)

Many adults with ADHD have comorbid disorders.

The combination of these disorders contribute to "severe functional impairment in multiple domains…

These problems are found to be closely associated with low levels of quality of life.

Currently there is a growing recognition that treatment of adult ADHD should extend beyond its core symptoms, and include overall quality of life." (Giervan & Nordahl, 2010).

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Gap in Research on effective Adult ADHD Treatment?

Psychotherapy has to adapt to Adult ADHD to be more effective.

(Russell & Rotain, 2005)

"Requests for the assessment and treatment of attention-deficit/hyperactivity disorder (ADHD) among adult patients are on the rise."(Russell & Rotain, 2005).

"…the ***same core symptoms of inattention, impulsivity, and hyperactivity that create functional problems in patients' lives also interfere with the effectiveness of psychotherapy***. "(Russell & Rotain, 2005).

Medications alone are often considered to be insufficient treatment.

1 study found that combined treatment with both Rx and psychotherapy was associated with improvements on all clinical measures. (Rostain & Ramsay, 2006).

…partial solution with minimal empirical support. Any other options? Cogmed?

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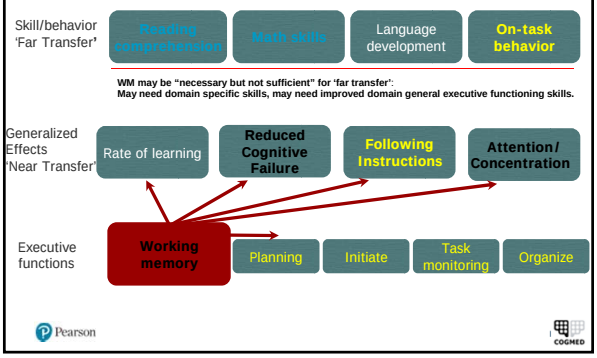
Why Train Working Memory? Facilitates Learning at the initial encoding.



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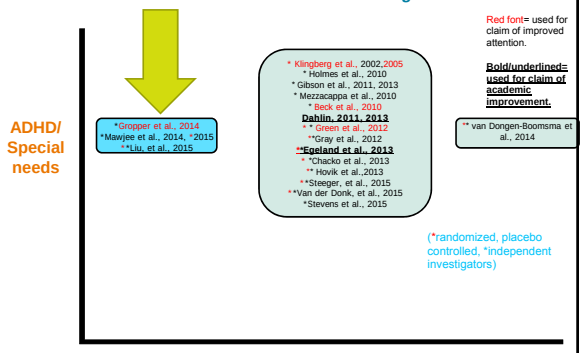
Over 75 total published Cogmed Studies
22 on ADHD- ***Adult ADHD is a new area of investigation since 2014.***



Cogmed Claims Regarding ADHD are *not specific to adults* though one adult study is cited (Red):

DOWNLOAD Here: http://www.cogmed.com/research V3, online in May, 2015.

CLAIM: In clinical trials, CWMT has been shown to improve attentional problems in many with ADHD (3, 11, 25, 47)

a) as evident in rating scales (3, 11, 47)

b) or measured with objective measures (25)

NOTE: The claims were not specific to adults with ADHD. Only one study included adults (Gropper, et al., 2014)

References cited above:
3) Klingberg, T. et al., 2005)
11) Beck et al., (2010)
25) Green, et al., (2012)
47) Gropper, et al., (2014)

Severity Differences between ADHD Combined type (ADHD-C) & ADHD Inattentive type (ADHD-I) based upon Co-Morbidity.
(Willcutt et al., 2012)

Meta-Analysis of Co-Morbidity in ADHD-C vs ADHD-I (Willcutt et al., 2012)

	ODD	CD	GAD	SAD	MDD	BIPOLAR	LD	Speech/ language	Tics
ADHD-C	51.8%	21.6%	11.3%	13.5%	9.8%	6.9%	24.2%	14.8%	15.8%
ADHD-I	24.9%	7.1%	10.4%	8.7%	9.5%	3.2%	**29.1%**	**17.8%**	12.1%

ODD= Oppositional Defiant Disorder, CD=Conduct Disorder, GAD=generalized anxiety disorder, SAD= seasonal affective disorder, MDD= Major depressive disorder, LD=Learning disorder. Data is from Willcutt et al., (2012).

This meta analysis found substantial difference between comorbidity of ADHD-C vs. ADHD-I. This suggests the possibility that ADHD-C may be a more severe form of the disorder. Additionally, most clinicians would agree that trainees with more comorbidity are more difficult to treat, often require multiple treatments of greater intensity and duration.

Severity Continuum for Adult ADHD studies with Cogmed. (Yellow highlights)

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
1. Dahlin, 2010	NR	33% diag. 60% rated inatt.	NR	NR	NR	9.5%***	0%
2. Dahlin, 2013 (not randomized)	-	33% diag. 60% rated inatt.	22%	NR	NR	22%	0%
3. Klingberg, et al. 2002	-	NR	100%?	NR	43%	NR	NR
4. 2005 Klingberg, et al. 2005	-	25%	75%	0%	0%	NR	0%
5. ****Hovik, et al., 2013	-	0%	100%	0%	**69.6%**	NR	NA/0%
6. Green, et al., 2012	-	42%	42%	17%	**67%**	0%	NR
7. Van Dongen-Boomsma, et al., 2014	-	7.7 %	**80.8%**	**11.5%**	**0%**	NR	3.8%/0%
8. Beck et al., 2010	NA	71%	29%	NR	61%	NR	46%
9. Chacko, et al., 2013	-	34%	66%	0%	**27%**	NR	50%/9%
Gropper, et al., 2014	-	**51%***	**NR**	**NR**	26%	57%	NR
MawJee et al., 2014	NA	NR	NR	NR	60.5%	28.9%	NR
MawJee et al., 2015	About 20% poor VWM, 13.5% poor VSWM	?	?	?	51.5%	22.7%	NR
Liu, et al., 2015	?	?	?	?	55%, 45%, 47%	30% stand/22% brief, 9% control	
10. Gray et al., 2012	-	NR	**100%**	**NR**	98%	100% Severe	100%/0%

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*Gropper et al., 2014 did not report whether the subjects in their study were ADHD-C or ADHD-I.
HIGHLIGHTED: STUDIES OF ADULTS WITH ADHD WHO HAVE DONE COGMED.

Cogmed & Adult ADHD

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Cogmed with College Students with ADHD/LD

(Gropper, 2014)

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
Gropper, et al., 2014	-	**51%*****	**NR**	**NR**	26%	57%	NR

DESIGN: Wait list control. Not blinded (Cannot claim causality.)
n=62, college students, ages 19-54.

Registered with student services with a confirmed diagnosed of ADHD & LD

BESD Binomial Effect Size Display (BESD) calculation was used to compare changes in effect size of WM capacity.

CFQ: Cognitive Failure Questionnaire was used at a measure of generalization but is also considered a measure of "ecological effects".

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Cogmed with College Students with ADHD/LD

(Gropper, 2014)

ADHD in College: ADHD/LD in college are unique.
•Doing comparatively well in College.
•Yet, missed substantial skill development.
• Should we expect academic achievement to improve post Cogmed?

Expectations:
•Cogmed could 'open window' to better encoding to remediate missing skills.
•Target Executive functions **post Cogmed**.
•Target academic skill remediation **post Cogmed**.

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Cogmed with College Students with ADHD/LD

(Gropper, 2014)

RESULTS:
Cogmed group: Significantly improved VWM (WAIS),VSWM -(CONTAB). Maintained at 2 month follow up.

Fewer self-reported ADHD symptoms (ADHD Self Report Scale).
Fewer cognitive failures – maintained at 2 months.

Using Binomial Effect size display (BESD) 47% difference between groups, BESD 28% reduction of symptoms, cognitive failure questionnaire 25% reductions.

BETTER EFFORT = BETTER RESULTS
Index scores predicted WM improvement on CONTAB, ASRS, CFQ. In other words students cannot just go through the motions.

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ADHD/LD College Students Self-reported changes post Cogmed suggest ecological improvements.

(Gropper, 2014)

THE STUDENTS CONCLUSIONS (Ecological effects):
• Majority noticed an improvement in **recalling verbal information** (e.g. phone numbers, appointments, names).

• Improvement in verbal memory allowed students to learn and retain information from lectures and books **without re-reading over and over again**.

• Several students reported that they could **better sustain attention and feel alert for longer periods of time.**

• Some reported that they did NOT improve in time management or organizational skills, but there were not substantial changes in these areas. Scaffolding makes sense.

• Overall the feedback was positive.

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).

(MawJee, et al., 2014)

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
MawJee, et al., 2014	NA	NR	NR	NR	60.5%	28.9%	NR

DESIGN: Wait list control. Not blinded (Cannot claim causality.)

SUBJECTS: n=38, post-secondary students (college students in Canada from several Colleges and Universities in Canada), ages 18-35. mean age=23.39, SD=4.02. 52.6% Male.

Registered with student services in Canada with a confirmed diagnosis of ADHD. Subtype not clear.

28.9% also had an LD.

Rx: 60.5% were on medication. Of the 23 (60.5%) participants who were being treated with medication for their ADHD symptoms, 2 received non-stimulant medication (atomoxetine), while the majority (*n = 21) received* psychostimulants.

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).

(MawJee, et al., 2014)

ADHD type or presentation unclear. However, it was ***somewhat likely that this was a group of combined type ADHD*** due to the requirement of an elevated ASRS 18 item scale which has hyp./impulsivity items.

Medication status was not controlled in this study, but participants advised to maintain their current pharmacological treatment during study.

Medication status and dose were recorded at each visit: 3 of the 23 (13%) participants, one in each of the three groups reported taking a higher dose of medication at the post-test assessment than at the pre-test assessment.

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

Rx: 1/3 doses of Adderall, Concerta or Ritalin are not "placebo controls". They are not sugar pills.

Psychotherapy: 1/3 dose of psychotherapy not considered a "placebo" control for a full number of psychotherapy sessions?

Mawjee et al., 2015 solution of "Brief Cogmed" is an atypical notion of "placebo control" as noted* above. It *can be reasonably challenged as not a true "placebo control".

The attempt by Mawjee, et al., 2014 to provide "adequate control for non-specific effects of training, such as the participant's level of arousal, engagement, motivation and expectancy for change" though well-intended creates problems with the interpretation of the results.

It arguably becomes a study of 'dosing' of Cogmed.

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Investigating "dose effects" not Cogmed efficaciousness.

Mawjee et al., (2014) state that Klingberg (2010) asserts that to be effective "training must not only be adaptive but also intensive for there to be improvement".

"Intensive" was not defined by Klingberg (2010) as only the standard protocol (5 sessions/wk X 5 weeks for 40-50 minutes). It was not defined.

Variable Protocol: A couple years ago the Cogmed development team did a 'beta' version of cogmed which was only 25 to 35 minutes long and this was found to be similarly effective. (To be reviewed later).

Dismissing Cogmed efficaciousness if the brief version is effective is illogical.

Mawjee et al., 2014 and 2015 data add useful data for dosing considerations.

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Further complicating element was that the majority in all groups did not have verbal working memory deficits!

(MawJee, et al., 2014)

Dilemma: Majority 74% did not have a verbal WM deficit.

	Standard		Short		Waitlist		Total	
As Randomized	M	SD	M	SD	M	SD	M	SD
WAIS Digit Span	9.5	2.23	9.00	2.69	9.82	3.19	9.47	2.59
As Analyzed	9.25	1.83	9.43	2.93	9.00	2.47	9.21	2.4

As noted by the investigators ***"only 26% having poor auditory-verbal WM****, as indicated by scaled scores below the 16th percentile."*

No group as a whole shows a WM deficit.

This suggests other possible bottlenecks for difficulties with learning – not working memory – especially for the 29% with LD. As such, it would be somewhat unlikely to find far transfer to improved learning with such a group.

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Additional unique element was that the majority in all groups did not have verbal working memory deficits!

(MawJee, et al., 2014)

One would expect this to limit the far transfer to academic effects as one expects these groups to have other factors to negatively affecting their learning (e.g. processing deficits, poor processing speed, etc).

Six (15.8%) participants scored at or below the 7th percentile (standardized score ≤ 78) on the Math Fluency Subtest from the WCJ-III, indicating ongoing academic difficulties in basic mathematical skills.

WM may be "necessary" for improved functioning in math but not "sufficient" as some math specific skills may be lacking independent of WM.

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).
(MawJee, et al., 2014)

Criterion measures:

(a) Digit Span Forwards (DSF),
(b) Digit Span Backwards (DSB), and
(c) Digit Span Sequencing (DSS) from the Wechsler Adult Intelligence Scale–Fourth Edition (WAIS-IV) were used to assess auditory-verbal working and short-term memory (Wechsler, 2008)
(d) Spatial Span Forwards (SSF)
(e) Spatial Span Backwards (SSB) from The Cambridge Neuropsychological Testing Automated Battery (CANTAB) was used to assess visual-spatial short-term and WM (Fray, Robbins, & Sahakian, 1996);
(f) Finger Windows Forwards (FWF)
(g) Finger Windows Backwards (FWB) subtest from The Wide Range Assessment of Memory and Learning–Second Edition (WRAMLII) was used as another measure of visual-spatial short-term and WM (Sheslow & Adams, 2003).

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).
(MawJee, et al., 2014)

Near-transfer measures.

(a) The CANTAB Spatial WM task was used to assess strategy skills and visual-spatial WM (Fray et al., 1996),

(b) The CANTAB Pattern Recognition Memory task assessed visual short-term memory (Fray et al., 1996),

(c) an adapted version of Kahneman's WM task was used to assess visual WM.

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).
(MawJee, et al., 2014)

Far-transfer measures.

*(a) The 18-item **Adult ASRS*** (ASRS v1.1) a self-rated ADHD rating scale was used to evaluate current manifestation of ADHD symptoms.
(b) The Cognitive Failures Questionnaire (CFQ) was used to assess self-reported errors in memory, perception, and motor function when completing everyday tasks.
(c) The **Barkley Deficits in Executive Functioning Scale–Short Form** (BDEFS-SF) was used to evaluate executive functioning deficits in everyday life activities (Barkley, 2011).

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).
(MawJee, et al., 2014)

***Criterion WM measures**: Standard training group significantly improved on the **WAIS-IV DSB (VWM)** F(1,24)=7.45, p=.004.* Post hoc tests showed that standard group did significantly better than waitlist controls (p=.001), **but there was no significant difference between standard and shortened training, or wait list control and shortened group**.

CANTAB SSB (VSWM) was significant F(1,24)=4.60, p=.023. Standard length group did significantly better than both the shortened training group and wait list group. While the latter two groups did not significantly differ.

No significant differences on WAIS-IV DSF and Sequencing or CONTAB SSF. Finger Windows Forwards and backwards were not significant.

Near-transfer & far-transfer WM measures: No differences found beyond CONTAB SSB noted above.

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).
(MawJee, et al., 2014)

POWER ANALYSIS PROBLEM, AGAIN NOTED: They found that for a medium effect size to be detected at an 80% chance with an alpha set at .05 a sample of **25 participants in each group would be required to detect CANTAB differences and a sample of 19 in each group to detect differences in ASRS**.

These samples only contained: n=18 Standard training n=8 in shortened training and n=12 waitlist control.

These sample sizes were not large enough to detect differences with inferential statistics.

Investigators said that such inferences were not their focus on this pilot study.

Sample sizes dictated that this would not be appropriate.

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).
(MawJee, et al., 2014)

Results: No significant difference in completion rate or training index in standard vs. shortened-length groups. Both groups showed improvement and put forth good effort during training.

Their Conclusion: Preliminary findings suggest that shorter training sessions may induce similar levels of engagement, motivation, and expectancy of improvement in participants. (Head Scratcher?) It's the same program, just shorter.

They conclude: Larger scale RCT with shortened training as an "active control" group is warranted, but will modify the study protocol.

The "MINI-COGMED" problem. Shortened adaptive Cogmed is still Cogmed. Pearson now offers the "**variable protocol**" - a shortened version of Cogmed which is a 25 or 35 minute version of the program.

This 15 minute version of Cogmed is not really a "**control**" or a "**placebo**". It is "**mini-Cogmed**". ***A low dose of Ritalin is still Ritalin.***

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WM Training in ADHD: Controlling for Engagement, Motivation, and Expectancy of Improvement (Pilot Study).

(MawJee, et al., 2014)

Compliance Measures Problem: Attrition of standard Cogmed group. Elevated Paranoia, lack of ambition and grit for standard group.

The attrition rate for this study was high, with 14 of the 38 participants (36.8%) not completing their assigned treatment condition.

In the standard-length group, 44.4% (*n = 8) of* participants completed the training in 5.63 weeks (*SD* = 0.74, range = 5-7 weeks).

In the shortened-length group, 75% (*n = 6)* completed the training in 6.29 weeks (*SD = 1.38, range = 5-9* weeks).

GRIT SCORE DIFFERENCES BETWEEN COMPLETERS AND NON-COMPLETERS: Post hoc analysis (*t tests) differences* between completers and non-completers revealed significant differences. Non-completers had higher scores on Paranoia of the SA-45, *t(34, 1) = 2.24, p = .03,* and lower scores on the GRIT subscales, specifically Ambition, *t(x) = 2.06, p = .05, and Perseverance of Effort, t(x) = 2.23, p = .03.*

Pearson

Compelled by shortened Cogmed as effective Pearson did a Beta and found delivering shortened Cogmed has similar benefits.

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

WM Training in Post-Secondary Students with ADHD: A Randomized Controlled Trial (Follow-up to 2014 study)

(MawJee, et al., 2015)

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
MawJee et al., 2014	NA	?	?	?	51.5%	22.7%	NR

DESIGN: RCT: Randomized controlled trial. Claim: "Controlled for motivation, engagement, and expectancy of change".

n=97, post-secondary students, 59.8% female (unusual).

College students in Canada from 'several Colleges and Universities in Canada, ages 18-35. mean age=23.9, SD=3.41.

N=32 'standard-length Cogmed', n=33 "brief Cogmed", n=32, waitlist controlled group, **BUT waitlist NOT included in follow up comparisons.**

Registered with student services in Canada with a confirmed diagnosis of ADHD.

22.7% self-reported an LD.

Rx: 51.5% were on medication. Of the participants who were being treated with medication for their ADHD symptoms, 17 Concerta, 11 Vyvanse, 9 Adderall, 6 Ritalin, 3 Dexadrine, 3 Strattera 1 another unnamed medication. **Not controlled Rx status**.

Pearson

Like the pilot study the majority in all groups did not have a working memory deficit - fewer than even in the pilot study.

(MawJee, et al., 2015)

Dilemma: Majority 80% to 86.5% did not have a WM deficit.

As noted by the investigators in this follow up study ***"approximately 20% having poor auditory-verbal WM and 13.5% having poor visuospatial working memory"*** (Mawjee, et al., 2015, p. 12)

Again, as in the pilot study, no group characterized by a deficit in WM suggesting other possible bottlenecks for learning.

One would expect limited the far transfer to academic effects as other factors at play may be negatively affecting their learning not WM.

Six (15.8%) participants scored at or below the 7th percentile (standardized score ≤ 78) on the Math Fluency Subtest from the WJC-III, indicating ongoing academic difficulties in basic mathematical skills. Also, not truly math Deficit.

WM may be "necessary" for improved functioning in math but not "sufficient" as some math specific skills may be lacking

Pearson

WM Training in Post-Secondary Students with ADHD: A Randomized Controlled Trial

(MawJee, et al., 2015)

Measures: WAIS-IV Digit Span (auditory-verbal WM), CANTAB: SPATIAL SPAN (visual spatial WM), WRAML Finger Windows (VSWM)

Transfer of training: Short-term memory, Cognitive speed, Math fluency, Reading fluency, Complex reasoning, ADHD symptoms.

Results: ***On 5 of 7 measures shortened training conferred as much benefit on WM performance as did standard length training, with both CWMT groups improving more than the waitlist-control group.***

Only 2 findings remained after correcting for multiple comparisons.

Follow up analyses showed that post-training improvements on WM performance were maintained for at least 3 months. There was no evidence of any transfer effects but the standard-length group showed improvement in task-specific strategy use.

Their conclusion: This study failed to find robust evidence of benefits of standard-length CWMT for improving WM in college students with ADHD and the overall pattern of findings raise questions about the specificity of training effects.

Pearson

Dosing issue?

WM Training in Post-Secondary Students with ADHD: A Randomized Controlled Trial

(MawJee, et al., 2015)

7 measures both groups were significantly different than waitlist control:

WAIS-IV: Digits Forwards, Digits Backwards, Digit Sequencing
CANTAB Spatial forwards & Backward
WRAML Finger Windows Forwards & Backwards

After Bonferroni correction only 2 remained: CANTAB Spatial forward & WRAML Finger Windows Forwards

On 2 measures standard training was significantly greater than shortened described as "high intensity threshold".
WAIS-IV: Digit Span Sequencing.
WRAML Finger Windows backwards.

No significant differences were found for near or far transfer.

However, waitlist controls were dropped for follow up. So no conclusions can be made regarding whether gains would have emerged later.

Pearson

WM Training in Post-Secondary Students with ADHD: A Randomized Controlled Trial
(MawJee, et al., 2015)

3 months follow up:

Standard training effect maintained in the following areas when comparing standard versus shortened Cogmed:

WAIS-IV: Digit Sequencing
WRAML Finger Windows Forwards

Another difference between the groups:

61% of the short-training group reported rewarding themselves after completing a training session. Only 37% of the those in the standard-length training group did.

Most frequently-used: a preferred activity, such as playing sports or a videogame (61% of the responses), or food or drinks (39% of responses).

Pearson

EEG alpha power during maintenance of information in WM in adults with ADHD and its plasticity due to working memory training: A randomized controlled trial.
(Liu, et al., 2015)

Study	WM deficit	ADHD-I Attention problems	ADHD-C	ADHD-HI	Rx%	LD	ODD/CD
Liu, et al., 2015	NA	NR	NR	NR	Trial 1: 52.2% with 97.2% on stimulants. Trial 2: 55.9%, 45.2%, 47.1%	Trial 2: 30% , 22% 9%	NR

DESIGN: 2 trials, 1st Trial to determine EEG differences (posterior alpha activity) between normal vs. ADHD during visual delayed match-to sample tasks, but the measures of the VSWM task were "not yet reported".
2nd trial: All ADHD subjects randomized into Standard Cogmed, 15 minute Cogmed, waitlist controls.

•1st trial compared adults with ADHD to health peers and measured posterior alpha activity during a visual delayed match-to-sample task using EEG. Study 1: n= 136 college students with ADHD and n=41 health peers (aged 18-35).
•2nd trial compared standard Cogmed, n=, brief Cogmed, n= , waitlist control, n=, NOT BLINDED "due to nature of treatment arms". ***however medication was not an experimental manipulation***

Pearson

EEG alpha power during maintenance of information in WM in adults with ADHD and its plasticity due to working memory training.
(Liu, et al., 2015)

Medication status was not controlled in this study, but participants were advised to maintain their current pharmacological treatment throughout the study. Medication status and dose were recorded at each visit: 3 of the 23 (13%) participants, one in each of the three groups, reported taking a higher dose of medication at the post-test assessment than at the pre-test assessment.

Treatment:
"Standard Cogmed": 25 training sessions in 5-6 weeks for 45 min./day
"Brief Cogmed": 15 minutes/day.
Waitlist: no training.

Pearson

EEG alpha power during maintenance of information in WM in adults with ADHD and its plasticity due to working memory training.
(Liu, et al., 2015)

Results: The ADHD group tended to be less accurate than the peers. Similarly, the ADHD group exhibited lower posterior alpha power at a trend level compared to their healthy peers. ***There were no training effects on participants' performance*** and only marginal increases in posterior alpha power in training groups compared to the waitlist group.

Conclusions: ***Considering that the training effects were small*** and there was no load and dose effect, we conclude that the current study provides no convincing evidence for specific effects of Cogmed.

Alternate hypotheses:

1. EEG may not be a sufficiently sensitive measure to find differences in brain activity.
2. The MEG (Magneto-Encephalography) is more sensitive and Astle, et al, (2015) did find differences post Cogmed for children who completed the program.
3. The explanation for a lack of behavioral differences with adults is unclear given that 3 other studies of adults with ADHD found differences. It is possible a lack of sufficient variety of behavioral measures contributed.

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Summary

AHDH is a lifelong disorder and society pays a high price in terms of the cost of incarceration, lost revenue, reduced economic opportunity. ADHD is a persistent impairment: Inattention, impulsivity and hyperactivity are also seen in adults with inattention more commonly persisting into adulthood. Both society and individuals with ADHD are paying a price for a lack of effective treatment for this disorder.

•Many inmates in prison are undiagnosed ADHD and untreated.

•Many college students with ADHD have challenges in achievement. College students may benefit from Cogmed.

•Even short forms of Cogmed have been found to be efficacious.

•Near and far transfer continue to be a concern with this population. One of these four studies found transfer.

•Lack of clarity about he mechanism of change for near and far transfer for adults continues to be a concern.

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Cogmed is presently offered in 12 Languages

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Thank you!

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