

**"New 2015 Study Added to 'Why Cogmed Matters for Traumatic Brain Injury – TBI.'**



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**Agenda**

- **Why Working Memory, attention and executive functioning (EF) matter for TBI.**
  - WM & TBI: Survival, community integration, Quality of life, reduced depression
  - WM Correlates with EF
  - EF & TBI: *Obtaining competitive employment, occupational outcomes, and social integration.*
- **Cogmed Specific Studies & Acquired Brain Injury/TBI.**
  - 2010, Lundqvist, et al., 2010 *sets stage for 2015, Hellgren et al.*
  - 2015, Hellgren, et al.
  - 2007, Westerberg, et al.
  - 2011, Johansson & Tornmalm
  - 2013, Åkerlund et al.
  - 2013, Bjorkdahl et al.
  - 2015, Weicker et al.
- **Going back to Work:**  
Adults with TBI and vocational outcomes.
- **Going back to School:**  
Children with TBI and the effects upon learning

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# What is Cogmed?

- ▶ Computerized Cognitive Training targeting Working memory
- ▶ DEMO?
  - Go to: <http://my.cogmed.com/>
- Choose Version:
  - Choose Language:
    - British English
    - US English
    - Français
    - Norsk (bokmål)
    - Nederlands
    - Svenska
    - Italiano
    - Português (Brasil)

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## TBI Long term effects & working memory (WM)

TBI can result in significant long-term negative effects on multiple aspects of life including employment.

- ▶ **Reduced working memory** along with age, injury, and lifestyle factors was **associated with reduced long-term survival** (Himanan, et al., 2011).
  - Age at injury and vocational outcome also correlated with reduced long-term survival (Himanan, et al., 2011).
  - Vocational outcome was associated with age, TBI severity, cognitive impairment, later TBI's, and alcohol abuse (Himanan, et al., 2011).
- ▶ **Better Working Memory predicted** "increased community integration, greater life satisfaction, and lower levels of depression."
  - General self-efficacy mediated the predictive value of working memory on life satisfaction and depression." (Wood & Rutterford 2006). This was more than 10 years post TBI. In this study injury severity predicted only decreased life satisfaction.
  - **Demographic and cognitive factors *may*** be more predictive of long-term outcomes than injury severity. ***These authors emphasize the importance of early social intervention post TBI.*** (Wood & Rutterford, 2006).

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## Adult TBI, WM and EF correlate with Quality of Life

(Dissertation, DaVanzo, 2009)

- ▶ 60 adult survivors of TBI.
- ▶ Administered **Quality of Life** after Brain Injury scale.
- ▶ "Results revealed moderate correlations between cognitive/linguistic impairment functions of short-term memory and **working memory/executive function** with **QOL**."
- ▶ A strong correlation between participation and QOL.



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## Focal lesions in adults with acute mild TBI & neurocognitive outcome

(Lee, et al., 2008)

- ▶ Mild adult TBI patients had significantly worse performance on working memory tasks than matched controls at acute (<2 weeks), at 1 month and 1 year post injury.
- ▶ Also, CT and 3TMR imaging findings didn't account for the cognitive impairment which may suggest that *new techniques such as "diffusion tensor imaging" may be needed to provide biomarkers for Neurocognitive and functional outcome in mTBI.*




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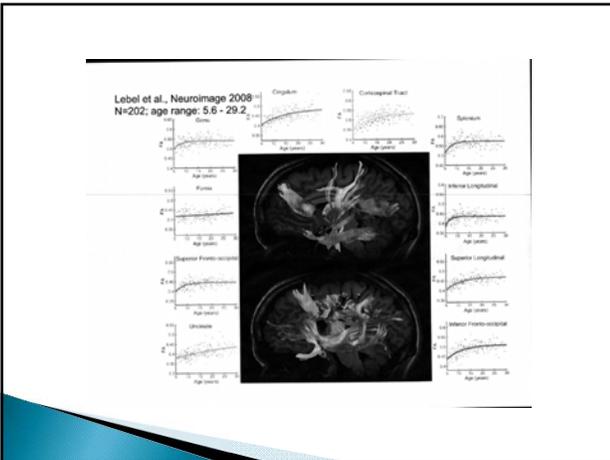
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## Meta-Analytic Review of Neurocognitive Effects of Pediatric TBI

(Babikian and Asarnow, 2009)

28 publications reviewed from 1988-2007. 3 distinct injury severity levels, 3 time intervals for 14 key neurocognitive domains.

### Time intervals:

Time 1: 0-5 months, Time 2: 6-23 months, Time 3: 24+ months.

Severity was based upon the Glasgow Coma Scale (GCS) score and often confirmed by clinical findings (such as loss of consciousness, posttraumatic amnesia, and/or positive neuroimaging findings).

Mild (GCS 13-15) Moderate (GCS 9-12) Severe (GCS 3-8)

We will only look at few items here.

**Highlights:** Intellectual deficits Pediatric TBI (Time 3=long-term > 24 + months)

- **Working Memory deficits** Pediatric TBI
  - ES (Effect size) Mild (.092), Moderate (.194), Severe (.453)
- **Attention deficits** Pediatric TBI (long-term 24 + months)
  - ES Mild (< .347), Moderate (.316), Severe (.710)
- **Processing speed deficits** Pediatric TBI
  - ES Mild (.336), Moderate (.731), Severe (.925)

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**Long term effects of Pediatric TBI with Intra Cranial Pressure (ICP) related to working memory, attention & executive functioning**  
(Stawik, et al., 2009)

▶ Study of Severe pediatric TBI patients:

- One group had ICP - intracranial pressure
- The other group did not.
- Both groups had normal IQ's.
- **ICP group only showed long-term deficits** on "various measures of attention and executive function such as working memory, decision-making, and impulsivity."
- This suggested ICP lead to "diffuse brain injury"
- Also, measures of attention and EF are sensitive to raised ICP.



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**TBI Severity & Impact on Working Memory (WM)**

**The more severe the injury the more severe the impact on WM.**  
(Levin, et al., 2002; Roncadin, et al., 2004; Ewing-Cobbs et al., 2004; Conklin, et al., 2008).

**TBI results in significantly lower VSWM & VWM** (Gorman et al., 2012).

Severity of TBI predicts difficulty in producing speech sounds **which is predicted by WM** and pragmatic inference. (Dennis, et al., 2000)



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**Executive Functioning & Long term effects of TBI**

▶ **For Adults: Executive Functioning (EF) is related to obtaining competitive employment, occupational outcomes, and social integration.** Biggest problem areas - shopping, managing money, and transportation - all correlate with EF. (Perna, et al., 2012; Ownsworth & McKenna, 2004)

▶ **For Children: TBI (moderate and severe) results in long-term EF deficits which related to child psychosocial outcomes, parent & family functioning** (Mangeot, et al., 2002). Also, **EF scores were consistently related to a test of working memory but not to other neuropsychological measures.**

- Subjects with severe TBI had the lowest EF scores (Mangeot, et al., 2002).
- Children in this study were injured between ages 6 to12 (Mangeot, et al., 2002).
- They were between 10-19 years old at the time of assessment (Mangeot, et al., 2002).
- 33 **severe**, 31 **moderate**, 34 with orthopedic injuries (Mangeot, et al., 2002).

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Other factors affecting TBI long term outcome

- **General Intellectual functioning/Global Cognitive functioning** post-injury relates to ability to return to work with less services – yet not receiving enough services might interfere with a successful transition for those that are more cognitively intact. (Ownsworth & McKenna, 2004; Perna, et al., 2012)
- ▶ **Injury Severity** of TBI has been found to be a strong predictor of early TBI recovery (Wood & Rutherford, 2006).
- ▶ **Pre-morbid functioning**



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Other Variables Affecting Pediatric Outcomes of TBI

- Age of injury, Severity of Injury, SES, Family environment, pre-morbid functioning.
- ▶ Ages 3-6: **severity of injury** and **family environment** have a big influence on *post-injury school readiness* (Taylor, et al, 2008: JINS)
  - ▶ Ages 2-6: Adaptive and behavioral outcomes associated with **injury severity and pre-morbid abilities**(Catroppa et al, 2008: J Ped Psych)
  - **Low-SES** associated with worse functional outcomes after pediatric TBI (Keenan et al, 2006: Pediatrics)



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Family factors affecting Pediatric outcomes of TBI

- Parent psychological distress, perceived family burden, and coping skills affect outcomes (Yeates et al, 2002: J Ped Psych).
- Injury has long-term effects on academic and behavior outcomes but is **moderated by family environment** (Taylor et al, 2002: Neuropsychology).
- **Parent acceptance of injury report lower stress than denial group, active coping increases when stressing the use of active coping decrease stress** (Wade et la, 2001: J Ped Psych).



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## Factors post TBI impacting return to work.

- **Social perception** abilities relate to interpersonal aspects of job functioning and social integration more generally.
  - May need to train on reading social cues and situations.
  - **Social outcomes associated with executive functioning**, pragmatic language skills and **social problem-solving** (Yeates et al., 2004; JINS).
  - **Some authors suggest an early focus upon social intervention post TBI** (Wood & Rutherford, 2006).

### Addressing attention, memory, working memory and executive deficits can improve workplace outcomes.

- ▶ A significant proportion of TBI patients, including those who are severely injured, are able to return to productive employment if sufficient and appropriate effort is invested (Shames, Treger, Ring, & Giaquinto, 2007).
- ▶ **Web-based family interventions after pediatric TBI have been found effective in helping families and improving outcomes** (Wade et al., 2008; J head Trauma Rehab).

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## Cognitive Effects of Concussions – Mild TBI: Memory Problems

• **Memory problems:** This area has the most research supporting it. Many of these effects would be short-term.

- **Working Memory** (Terry, et al., 2012; Levin et al., 2002; Roncadin, et al., 2004; Levin et al., 2004)
- **Episodic Memory** (Tremblay, et al., 2013; DeBeaumont, et al., 2009)
- **Delayed memory** (Killam, et al., 2005)
- **Visual/verbal memory** (Matser, et al., 2001; Covassin, et al., 2010)
- **Immediate memory performance** (Chapman, et al., 2006)
- **Memory** (Clark, 2010; Iverson, et al., 2004; Covassin et al., 2008)



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## Cognitive Effects of Concussions: Attention, Processing Speed Problems, Response Inhibition, etc.

- **Attention problems:** (Terry, et al., 2012; Clark, 2010; Killam, et al., 2005; Matser, et al., 2001)
- **Divided attention** (Wall, et al., 2006)
- **Self-reported attention** (Brooks, et al., 2013)
- **Processing Speed** (Iverson, et al., 2004; Killam, et al., 2005; Covassin, et al., 2009; Gardner, et al., 2010)
- **Visuomotor speed** (Shuttleworth-Edwards, et al., 2008)
- **Response Inhibition** (De Beaumont, et al., 2009; Wall, et al., 2006; Levin, et al., 2002)

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## Why Cogmed matters for Adult TBI & concussions (mild TBI)

For Adults with TBI reduced WM has been associated with reduced survival. WM has been associated with *community integration, better Quality of life & reduced depression.*

WM Correlates with EF. Cogmed improves WM.

Better Executive Functioning in survivors of TBI has been found to be associated with *obtaining competitive employment, better occupational outcomes, and social integration.*



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## Lundqvist, Grundstrom, Samuelsson & Ronnberg, (2010) study precursor to Hellgren, Samuelsson, Lundqvist & Borsbo (2015)

### ► Ethical Considerations of 2015 study relate to 2010 study.

Before the present intervention (used in the 2015 study) was introduced as a standard training program in the clinic, a randomized controlled study (approved by the local research ethics committee, Dnr 187-06) with a cross-over design was conducted [23].

The 2015 study was based on the same standard procedures, criteria & outcome instruments as in the 2010 controlled study.

All information has been collected from medical records and test forms summarized by the rehabilitation team.

**Included subjects were not subjected to any special measures beyond those included in clinical routines.**

**Authors of 2015 study only had access to anonymous data.**

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## Cogmed helps heterogeneous group of brain injured adults reduce cognitive failure (Lundqvist, Grundstrom, Samuelsson & Ronnberg, 2010)

Computerized training of working memory in a group of patients suffering from acquired brain injury

ANNA LUNDQVIST<sup>1,2</sup>, KERSTIN GRUNDSTRÖM<sup>1</sup>, KERSTI SAMUELSSON<sup>1,2</sup>, & JERKER RÖNNBERG<sup>3</sup>

<sup>1</sup>Rehabilitation Medicine, Department of Clinical and Experimental Medicine, Faculty of Health Sciences, Linköping University, Sweden, <sup>2</sup>Department of Clinical Rehabilitation Medicine, University Hospital, Linköping, Sweden, and <sup>3</sup>Swedish Institute for Disability Research, Linnæus Centre HEAD, Sweden

Structured and intense working memory training improves subjects' cognitive functioning, ratings of occupational performance and ratings of overall health. Randomized, waitlist controlled, test-retest design.

Lundqvist, A., Grundstrom, K., & Ronnberg, J. (2010). Computerized working memory training in a group of patients suffering from acquired brain injury. *Brain Injury*, 24(10), 1173-1183.

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**NEW COGMED 2015 STUDY: Cogmed with Acquired Brain Injury**  
**Differentiating time since Injury**  
(Hellgren, Samuelsson, Lundqvist, Borsbo, 2015)

Participants did not have any co-morbidity that could have any significant effect on working memory.

**Inclusion criteria:** Age 20 - 65 years.

**SUBJECTIVE WM IMPAIRMENT & OBJECTIVE WM IMPAIRMENT:** Significantly impaired WAIS WM index (**VERBAL WM INDEX**) compared with index of verbal comprehension measured and/or index of perceptual organization or a WAIS WM index < 80 as measured by the WAIS-III, and motivated for training.

**Exclusion criteria:** IQ ≤ 70 as measured with WAIS-III/WAIS-IV, depression according to DSM-IV, and perceptual or motor difficulties that make the computerized WM training impossible.

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**NEW COGMED 2015 STUDY: Cogmed with Acquired Brain Injury**  
**Differentiating time since Injury**  
(Hellgren, Samuelsson, Lundqvist, Borsbo, 2015)

**Training Intensity Varied:**

WM training performed on a computer (PC), and each session was 45 - 60 minutes of intense exercise including one break.

**KEY UNIQUE ASPECTS OF THIS STUDY IN USING COGMED:**

**INTENSITY VARIATION:** The exercise intensity varied between four and five days/week for five to seven weeks.

**TRAINING IN PAIRS OR GROUPS:** All subjects trained in pairs or in groups of three in a quiet, private room at the Department of Rehabilitation Medicine.

**COACHES PRESENT IN ROOM DURING TRAINING:** One of three certified coaches (OTs) was present in the room during every training session. Once a week, the coaches provided specific feedback. The patients also received continuous feedback from the computer program. Both individual performances and group performances were analyzed and presented at a 20-week follow-up session. Each individual was then encouraged to provide feedback about their experiences and asked whether they had noticed any long-term effects from the training.

*No other therapies were applied during the examination period.*

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**Cogmed with Acquired Brain Injury Differentiating time since Injury**  
(Hellgren, et al., 2015)

A neuropsychologist performed all neuropsychological tests, which were conducted before and 20 weeks after WM training.

**Assessments:**

**PASAT:** Paced Auditory Serial Attention Test, measures WM, info processing speed and ability to sustain and divide attention.

**Forward and backward block repetition.**

**Listening Span task.**

**Canadian Occupational Performance Measure (COPM)** – on WM-related activity *performance and satisfaction.*

**EQ-5D Index (European Quality of Life Instrument-Five Dimensions):** self-assessment on a person's perceived state of health on 5 dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression.

**EQ-5D VAS European Quality of Life Instrument-100 Points Health Scale.** Perceived health on a scale of 0 to 100.

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**NEW COGMED 2015 STUDY: Cogmed with Acquired Brain Injury  
Differentiating time since Injury  
(Hellgren, et al., 2015)**

Differences Related to Time since Injury: n=13 Injury >18 month ago, n=34 ≤18 months ago.

Both groups showed significant differences on WM index ( $p \leq 0.001$ ).

**However, the improvement in WM was greater with those injured less than 18 months ago at the ( $p < .05$ ) level.**

**Those with less than 18 months since injury fared better on COPM performance and satisfaction.**

There were no significant differences concerning age, gender or education between the 2 groups.

There were no significant differences on neuropsychological tests.

There were no significant differences on the quality of life measures.



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**NEW COGMED 2015 STUDY: Cogmed with Acquired Brain Injury  
Differentiating time since Injury  
(Hellgren, et al., 2015)**

**Limitations:** *No Control group.* However, previous research with the same design and method has shown that *spontaneous recovery during the study period seems to be negligible and that the test-retest effect cannot explain the improvement between test sessions (Lundqvist, et al., 2010).*

**Strengths:** A strength of our study is its large sample size: previous studies relied on fewer participants [23]-[30]. Another strength is that we evaluated the effects of WM training using several methods—e.g., reflecting both trained (WM index) and untrained (neuropsychological tests) WM tasks. The evaluation also included an investigation of the outcome in patients' everyday life, in terms of individually identified occupations of importance (COPM). The fact that data collection was done before and 20 weeks after training, rather than directly after training, can also be seen as strength. That is, the 20-week evaluation might produce more realistic accounts of daily activities than merely relying on patient evaluations conducted immediately after WM training, since the intensity of the WM training period, and the fact that it offered structure and attention could have affected the results from the data collection if data had been collected immediately after the training period.



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**NEW COGMED 2015 STUDY: Cogmed with Acquired Brain Injury  
Differentiating time since Injury  
(Hellgren, et al., 2015)**

**Clinical Implications:** "Computerized WM training is effective for patients with acquired brain injury. Despite the change in training intensity compared to other studies [23] [25] [29] [30], our study produces good results. *The change in training intensity makes the demanding training less so and therefore more patients might be able to cope with the training.*"

"This study shows that some patients whose injuries occur more than 18 months before WM training improve more; *however, this improvement may have been even greater if the training has occurred even earlier.*"

"As it may be valuable for patients to receive this training soon after their injury, rehabilitation teams should make an early assessment of need."

"At the same time, it is important to keep in mind that training can have an effect even a long time after injury, so WM training can be beneficial for a lot of patients with working memory dysfunction after a brain injury despite time since injury. However, the expectations associated with later stage training should be somewhat lower."



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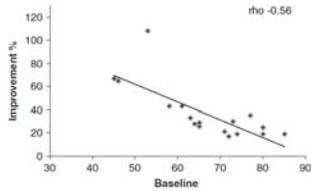




**WM training for patients with acquired brain injury:  
Effects in daily life**  
(Johansson & Tornmalm, 2011)

Population: N = 18 adults with ABI, ages 16-65 years (M=47.5 years), heterogeneous, 1-22 years post-event (M = 7 years)

Design: Test- retest, T1 = baseline, T2 = post-intervention, T3 = 6 month follow up  
Those with a lower baseline showed a greater percentage of improvement.  
*In other words, those more impaired improved the most.*



Baseline index  
correlates positively  
with percent  
improvement

Figure 2. Correlation between baseline index and improvement in percentage on training software QM.

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**WM training for patients with acquired brain injury:  
Effects in daily life**  
(Johansson & Tornmalm, 2011)

Results: Treatment group evidenced **improvements at T2 and T3** on:  
(T1 = baseline, T2 = post-intervention, T3 = 6 month follow up)

- 1) Cognitive Failures Questionnaire (CFO) – reduced cognitive problems
- 2) Canadian Occupational Performance Measure (COPM) (T2 data) – improved performance/satisfaction
- 3) Diary & Semi-structured interview – self awareness - // CQP & COPM

Take home: Heterogeneous group of brain injured adults self-report decreased cognitive failures and improved occupational performance and satisfaction. Interviews with and diary entries of participants support questionnaire outcomes. Users with poorest baseline showed most improvement.

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**Can computerized working memory training improve impaired  
WM, cognition and psychological health?**  
(Akerlund, Esbjornsson, Sunerhagen, Bjorkdahl, 2013)

Adults with acquired brain injury in the **sub-acute phase** after acquired brain injury average age= 47. 7 years, n = 47, range= 22-63.

3 stages of treatment for brain injury:

**Acute**—to stabilize the patient immediately after the injury;

**Sub-acute**—to rehabilitate and return the patient to the community; and

**Chronic**—to continue rehabilitation and treat the long-term impairments.

Design: Randomized included **all outpatients** at the **Department of Rehabilitation Medicine**, Sahlgrenska University Hospital, Goteborg, Sweden, during March 2008 to December 2010.

Patients **included if below normal range on digits forward, digits reversed** on WAIS-III; **digit span and/or blocks forward and/or blocks reversed** on the WAIS-III NI Span board. Exclusion criteria aphasia/non-Swedish communicable or if contra-indicated by MD (i.e. pronounced fatigue, pain or depression).

No significant differences were found between the Intervention group (IG) and Control Group (CG) regarding gender, age, time since injury, RLS (reaction level scale), educational level, diagnosis

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**Can computerized working memory training improve impaired WM, cognition and psychological health?**  
(Akerlund, et al., 2013)

Table III. Background data for the Intervention (IG) and Control (CG) groups.

	Gender, male/female	Age (years), M/dRange	Time since injury (weeks), M/dRange	RIS, M/dRange	Educational level, n, years of studies	Diagnosis frequency, % (n)
IG, n=25	13/12	51 22-63	32 12-135	1 1-6	3, 1-9 years 8, 9-12 years 14, 12+ years	68% stroke (17) 16% trauma (4) 16% other (4)
CG, n=20	10/10	53 22-62	22.5 16-500	1 1-5	2, 1-9 years 11, 9-12 years 7, 12+ years	75% stroke (15) 15% trauma (3) 10% other (2)

NOTE: For ethical reasons at the conclusion of the 18 weeks those in the CG who wanted to do Cogmed, did.  
For this purpose the CG was divided into C1 and C2.  
C1 were those that did Cogmed. (n=11)  
C2 were those that refused to do Cogmed. (n=10)

**Can computerized working memory training improve impaired WM, cognition and psychological health?**  
(Akerlund, et al., 2013)

**Measures:** The WAIS-III NI, Digit span, Arithmetic, Letter-Number Sequences, (*Working Memory sub-scale- aggregate of digit span, arithmetic & Letter-Number sequences*), Spatial span

Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS): This cognitive screening tool includes seven subscales: **speech & language, orientation, attention/concentration, visuospatial & visual problem-solving, memory, affect and self-awareness vs performance.**

**Self ratings** administered baseline and at follow-ups at 6 and 18 weeks.

Self-rating scales DEX: **Dysexecutive Questionnaire of problems in emotion, personality, motivation, behavior and cognition to assess problems in goal-directed behavior.**

Self-rating: HADS (Hospital Anxiety and Depression Scale): **Self-assessment of emotional and psychological health.**

Both groups underwent integrated rehabilitation.

The IG also trained with the computerized WM training program, Cogmed QM, which was offered to the CG and followed up after the study completion (C1).

**Can computerized working memory training improve impaired WM, cognition and psychological health?**  
(Akerlund, et al., 2013)

A1= baseline: intervention group (IG) n=25, control Group (CG), n=20  
A2 = 6 week post training IG=22, CG=18, (*Working Memory sub-scale- aggregate of digit span, arithmetic & Letter-Number sequences*)

A3 = 18 weeks post training IG=20, CG=18

A4 = after training week 24. BNIS= Barrow Neurological Inst. Screen for higher cerebral functions

A1-A2:	Digit Span:	IG: .003**			
	Digit Span rev:	IG: .004**			
	WM subs:	IG: .000***	CG: .003**	C1: .011*	
	BNIS:	IG: .006**			IG/CG: .044*
A2-A3:	No sig. diff.				
A1-A3:	Digit Span Rev	IG: .001***			IG/CG: .003**
	WM subs	IG: .003**			
	BNIS	IG: .006**			
	<b>HADS D</b>	IG: .005**			
A3-A4	Digit Span Rev			C1: .039*	
	WM subs			C1: .012*	
A1-A4	Digit Span			C1: .024*	
	Digit Span Rev			C1: .041*	
	WM subs			C1: .011*	
	BNIS			C1: .053	
	<b>HADS A</b>			C1: .027*	
	<b>HADS D</b>			C1: .024*	

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

**Can computerized working memory training improve impaired WM, cognition and psychological health?**  
(Akerlund, et al., 2013)

**Results:** Both groups improved after their WM training in Working Memory, BNIS and in Digit span, particularly the reversed section.

Both the BNIS and the Digit span differed significantly between the IG and CG due to the greater improvement in the IG after their WM training.

Psychological health improved as both groups reported less depressive symptoms and the CG also less anxiety, after the training.

**Conclusion:** Results indicated that computerized WM training can improve working memory, cognition and psychological health.



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**"A randomized study of computerized working memory training and effects on functioning in everyday life for patients with brain injury"**  
(Ejorckdahl, Akerlund, Svensson & Ebjornsson, 2013)

Adults with acquired brain injury in the **sub-acute phase** after acquired brain injury average age= 51 years, n = 38, Intervention Group (IG, n=20), control group (CG, n=18), range= 22-63. 16 men, 22 women.

**SAMPLE:** The median time since injury was 27 weeks (range=12-500 weeks). The cause of WM problems was stroke (n=28, 74%), traumatic brain injury (n=5, 13%) or other (n=5, 13%).

The majority, 63.8%, were fully conscious and 8.5 were unconscious at admittance to the emergency ward.

**Design:** *Outpatients with WM deficits* were randomized to an intervention group (IG) or control group (CG). Inclusion criteria of 5 digits/blocks forwards or 4 digits/blocks reversed in the WAIS-III Digit span and WAIS-III-NI Span board. 24 excluded due to communication problems (aphasia/not speak Swedish), or not being fit for testing. 50 declined participation. The remaining accepted. There were 7 dropouts for various reasons.



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**"A randomized study of computerized working memory training and effects on functioning in everyday life for patients with brain injury"**  
(Ejorckdahl, Akerlund, Svensson & Ebjornsson, 2013)

Assessed before Cogmed (A1), Baseline (A2) 5 weeks, (A3) 3 months after intervention. After follow up, CG was offered Cogmed (A4) n=8.

**Assessments:** WAIS-III Digit span reversed, *Fatigue Impact Scale (FIS)*, **Assessment of Motor and Process Skills (AMPS)**, Rivermead Behavioral memory Test-II (RBMT-II) and a WM questionnaire.

**Results:** IG improved on *Digit span & FIS*, (A1-A2) and significant more than the CG on the **WM questionnaire**, A1-A3. **Both groups improved on the AMPS motor skill** while the AMPS process skill trended toward significant improvement in the IG, A1-A3. Post training CG (C1) improved on digit span & Rivermead Behavioral Memory Test-II( RBMT-II) (A3-A4) and an improvement in everyday memory (RMBT-II) and a "subjective perception of fewer problems in WM demanding situations."

*"The need to assimilate the gain in WM may explain that improvements in occupational performance not were presented until later."*

**Conclusion:** Cogmed had a generalized effect on functional activity and reduced fatigue.



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and University of Leipzig  
Angelika Thöne-Otto  
University of Leipzig

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## Can WM Be improved by Training? A Meta-Analysis With a Special Focus on Brain Injured Patients

Weicker, Villringer & Thöne-Otto

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### Can WM Be improved by Training?

**Objective:** Deficits in working memory (WM) are commonly observed after brain injuries and cause severe impairments in patients' everyday life. It is still under debate if training can enhance or rehabilitate WM in case of malfunction. The current meta-analysis investigates this issue from a clinical point of view. It addresses under which conditions and for which target group WM training may be justifiable.

- **Method:** Relevant WM training studies were identified by searching electronic literature databases with a comprehensive search term. In total, 103 studies, which added up to 112 independent group comparisons
  - (N 6,113 participants), were included in the analysis. **Results:** Overall, WM training caused a moderate and long-lasting improvement in untrained WM tasks. Moreover, improvement of WM functioning led to sustainable better evaluation of everyday life functioning, however, effect sizes were small. Concerning transfer effects on other cognitive domains, long-lasting improvements with small effect sizes were observed in cognitive control and reasoning/intelligence. In contrast, small immediate,
  - but no long-term effects were found for attention and long-term memory. Studies with brain injured patients demonstrated long-lasting improvements in WM functions with moderate to large effect sizes.
  - A main moderator variable of intervention efficacy is the number of training sessions applied. **Conclusion:**
  - WM training produces long-lasting beneficial effects which are strongly pronounced in patients with acquired brain injuries. This finding supports the application of WM training in clinical settings. To determine optimal training conditions, future studies must systematically investigate the characteristics of interventions as they are at present inevitably confounded.
  - **Keywords:** working memory training, rehabilitation, meta-analysis, brain injury, cognitive plasticity
- Supplemental materials: <http://dx.doi.org/10.1037/neu0000227>

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**Conclusion:**  
WM training produces long-lasting beneficial effects which are strongly pronounced in patients with acquired brain injuries. This finding supports the application of WM training in clinical settings.  
To determine optimal training conditions, future studies must systematically investigate the characteristics of interventions as they are at present inevitably confounded.  
*Keywords: working memory training, rehabilitation, meta-analysis, brain injury, cognitive plasticity*

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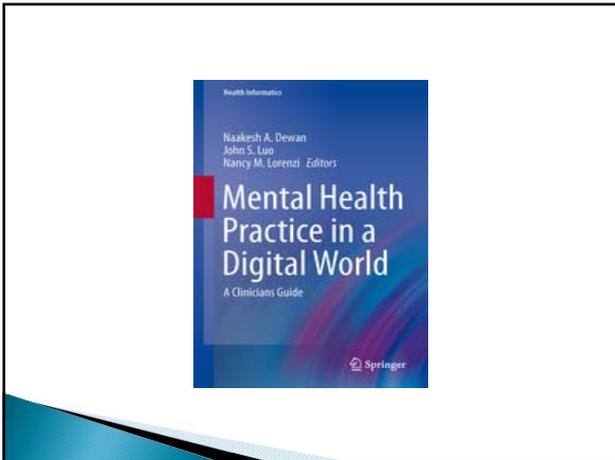
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**Returning to Work after Moderate to Severe TBI**

•Only 29.9% working full-time at time of interview compared to 64% pre-injury (Colantonio, Ratcliff, Chase et al., 2004).  
Longitudinal study 7 -24 years post TBI.

•Return to competitive employment after severe brain injury is related to intellectual functioning both on initial exam (inpatient) and post-acute exam (discharged).

•Return to work:  
•Avg. VIQ (initial) 95 -108 (discharge)  
•PIQ (initial) 87-103 (discharge)

Not Return to work:  
•Avg. VIQ (initial) 78-88 (discharge)  
•PIQ initial 68-83 (discharge)

•Significant relationship between activity limits & Residual cognitive impairment at follow up.



•Biggest problem areas – shopping, managing money, and transportation – all correlate with EF.

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### Going Back to School: Pediatric TBI's Impact upon Learning

Children with TBI were disproportionately compromised in **selective learning (SL) efficiency** in contrast to memory span when compared to normally developing children.

Also, the **effect of TBI on performance was demonstrated to take place at the time of encoding**, rather than at retrieval(SL to learn items selected from among others)(Hanten, et al., 2002).

**Encoding** is know to be the time of skill acquisition and to place a larger load upon working memory (Huang-Pollock & Karalunas, 2010)

Language comprehension tasks with **high working memory demands** generally posed the most difficulty for adolescents with traumatic brain injury. (Moran & Gillon, 2004)

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### Pediatric TBI Impact upon Learning

Post TBI adolescents placed in **High WM demand conditions** performed **poorly on understanding inferences**, but not when WM demands were low. (Moran & Gillon, 2005).

Moderate to severe TBI resulted in **deficits in phonological loop (PL) and central executive tasks** vs. controls in school-aged children. On new learning tasks the TBI group consistently **produced fewer words**.

Results **revealed impaired Phonological Loop function related to poor encoding and acquisition on a new verbal learning task** in the TBI group. (Mandalis, et al., 2007)



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### Pediatric TBI's Impact upon Learning

Emerging evidence suggests that a traumatic brain injury (TBI) in childhood **may disrupt the ability to abstract the central meaning or gist-based memory from connected language** (Chapman, et al., 2006).

TBI groups showed **decreased performance on a summary production task as well as retrieval of specific content from a long narrative** (Chapman, et al., 2006).

**WM on n-back tasks was impaired in children with severe TBI**, whereas immediate memory performance for recall of a simple word list in both TBI groups was comparable to controls (Chapman, et al., 2006).

Interestingly, **working memory**, but not simple immediate memory for a word list, **was significantly correlated with summarization ability and ability to recall discourse content**. (Chapman, et al., 2006)

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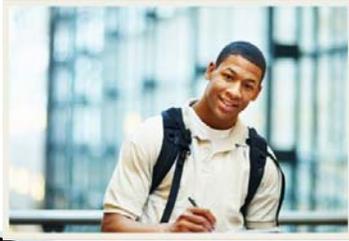
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### TBI Impact upon Learning

Adolescents with TBI differed from their non-injured peers in **their understanding of proverbs**. In addition, *working memory capacity influenced performance for all participants*. (Moran, et al., 2006) (5,499 in CA system).




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### Working Memory Components Most Highly Related to Types of Academic Learning

(Dehn, 2008) (Table 5.2 p. 95)

Reading Decoding	Reading Comprehension	Written Language	Math
Phonological STM	<b>Executive WM</b>	<b>Executive WM</b>	Visuospatial WM
Verbal WM	Verbal WM	Verbal WM	<b>Executive WM</b>
<b>Executive WM</b>		Phonological STM	
NOTE:	STM= Short-Term Memory	WM= Working Memory	

ALWAYS LEARNING

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### variable Protocol may benefit TBI Patients by FURTHER “titrating” training.

- ▶ The Variable Protocol was originally developed to help children in schools complete Cogmed in a more manageable time frame during a school day.
- ▶ The Variable Protocol has NOT yet been used in a study of TBI patients.
- ▶ Instead of the traditional 45–50 minute training session training sessions were reduced to: 25 or 35 minutes
- ▶ Sessions can be done 3, 4 or 5 times a week.
- ▶ See next slide for examples.

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## Cogmed Plus: Pediatric & Teen EF Interventions

- ▶ A colleague of mine suggested some Executive Functioning training programs.
- ▶ Peg Dawson & Richard Guare: Amazon:
  - One is book called **Smart but not Scattered**, by Peg Dawson and Richard Guare. There is a child and teen version on Amazon.
  - **Executive Skills in Children and Adolescents, Second Edition: A Practical Guide to Assessment and Intervention**, Peg Dawson and Richard Guare. Also, **Coaching Students with Executive Skills Deficits**.
- ▶ Another such program/book is: **Late, Lost, and Unprepared: A Parents' Guide to Helping Children with Executive Functioning**. By Joyce Cooper-Kahn & Laurie Dietzel. On Amazon.
- ▶ Finally, there is a book by George McCloskey: **Assessment and Intervention for Executive Function Difficulties (School-Based Practice in Action)**
- ▶ I have not used any of these programs, but both George McCloskey and Peg Dawson/Richard Guare were suggested by my colleague

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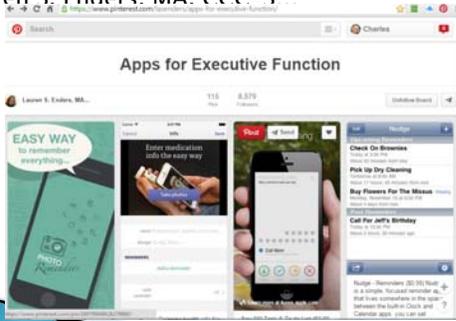
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## Apps for Executive Function

- ▶ <https://www.pinterest.com/lasenders/apps-for-executive-function/>
- ▶ Lauren S. Enders, MA, CCC-S...




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## Cogmed Plus: Adult EF Interventions

- Cognitive-Behavioral Therapy for Adult ADHD: Targeting Executive Dysfunction Hardcover** - March 7, 2011 by [Mary V. Solanto](#) (Author) Amazon.
- "It describes effective cognitive-behavioral strategies for helping clients improve key time-management, organizational, and planning abilities that are typically impaired in ADHD. Each of the 12 group sessions—which can also be adapted for individual therapy—is reviewed in step-by-step detail. Handy features include quick-reference Leader Notes for therapists, engaging in-session exercises, and reproducible take-home notes and homework assignments. The book also provides essential guidance for conducting clinical evaluations and overcoming treatment roadblocks. The treatment program presented in this book received the Innovative Program of the Year Award from CHADD (Children and Adults with ADHD)."
- Mastering Your Adult ADHD: A Cognitive-Behavioral Treatment Program Therapist Guide (Treatments That Work)**, by [Steven A. Safren](#) (Author), [Carol A. Perlman](#) (Author), [Susan Sprich](#) (Author), [Michael W. Otto](#) Used in conjunction with the corresponding client workbook, this therapist guide offers effective treatment strategies that follow an empirically-supported treatment approach. It provides clinicians with effective means of teaching clients skills that have been scientifically tested and shown to help adults cope with ADHD. The step-by-step, session-by-session descriptions are a practical resource for therapists who deliver the treatment to clients with ADHD. Together, the therapist guide and client workbook contain all of the information and materials necessary to delivery this treatment in the context of individual outpatient cognitive behavioral therapy.

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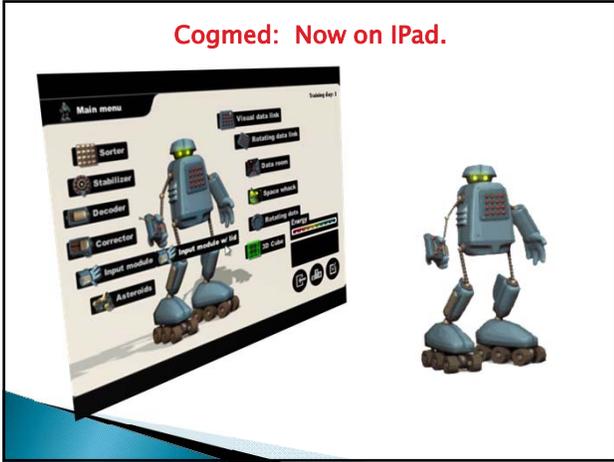
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**Cogmed: Now on iPad.**



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