COMPUTERIZED TRAINING OF WORKING MEMORY
– A new method for improving cognition in aging

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Background

Working memory (WM) involves holding and manipulating information for short periods of time. Anatomically, WM is associated with the prefrontal cortex, an area of the brain that exhibits pronounced decline in aging (Raz et al. 2004). Thus, age-related deficits are routinely observed in WM tasks (Wilde et al. 2004). Prior research demonstrates that WM can be improved by intense computerized training in children with attention deficit hyperactivity disorder (Klingberg et al. 2002, 2005), as well as in adults with or without acquired brain injury (Olesen et al. 2004; Westerberg et al. 2007).

Aim: To examine the effects of WM training in older and younger adults, with special focus on the generalizability and maintenance of intervention-related gains.

Methods

Participants

45 persons between 60 and 70 years of age (M = 63.7) were randomized to a intervention (*N* = 26) or a comparison (N = 19) condition. To examine potential age-related differences in plasticity of working memory, 55 persons between 20 and 30 years of age (*M* = 26.3) were included and randomized across conditions (intervention: *N* = 29; comparison: *N* = 26).

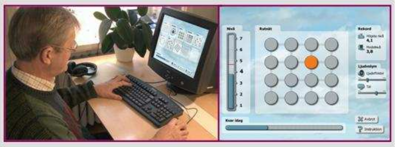

Figure 1. Tasks included in the training software tap visuo-spatial WM (remembering the position of objects) as well as verbal WM (remembering phonemes, letters, and digits). Responses to each trial are logged on to a file on the computer and automatically uploaded to a server, so that compliance could be verified. Feedback is given once a week via the internet by a psychologist. For details on the training software (ReMemo®), see www.cogmed.com

Intervention

The intervention involved intense and adaptive computerized training on various verbal and non-verbal WM tasks (Klingberg et al. 2002, 2005; Westerberg et al. 2007; Fig. 1). Participants trained at home on a personal computer. The computer program features 90 WM trials, which take approximately 30 minutes to complete. Training was performed five days per week during five weeks.

In order to optimize the cognitive demands, the difficulty level on each task is automatically adjusted close to the level of each individual's capacity.

The comparison condition involved training with the same software, but there was no adaptivity - the difficulty level remained constant across the intervention period.

Domain	Task
A. Criterion	
Similar tasks as in the training software	Span Board forward Digit Span backward
B. Near transfer	
Non-trained WM tasks	Span Board backward Digit Span forward
C. Far transfer	
Cognitive Non-trained task assessing other cognitive domains	PASAT (attention) Stroop (interference control) RAVLT (episodic memory) RAVEN (problem solving)
Subjective Self rating of memory and attention in daily living	Cognitive Failure Questionnaire (CFQ)

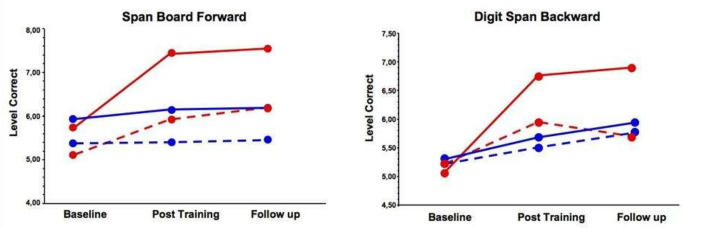

Figure 2A. Results on the criterion tasks

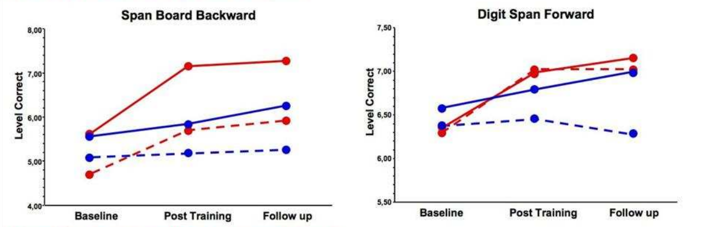

Figure 2B. Results on the near transfer tasks

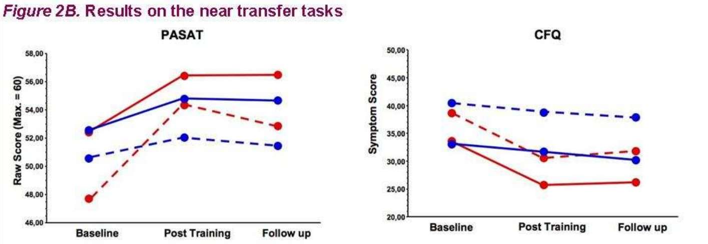

Figure 2C. Results on the far transfer tasks

Old Intervention — Old Comparison — Young Intervention — Young Comparison

Figure 2. Mean values from raw data on the neuropsychological tests and self-rating

Outlook

Ongoing work within the project involves delineating neural correlates of training-related gains using fMRI, as well as examining a wide variety of cognitively relevant polymorphisms (e.g., COMT, DAT, BDNF, KIBRA) regarding the size of gains from the intervention.

Outcome measures

To evaluate training effects, a neuropsychological test battery was administered before and after the training period, and at follow-up three months later. The tests were chosen to evaluate both *near* and *far* transfer of training (see table to the left).

Results

A. Criterion tasks

Trained older persons showed improved performance on the *criterion tasks* (Span Board forward and Digit Span backward), although gains in these tasks were larger for the young. (Fig. 2A).

B. Near-transfer tasks

On the *near transfer* tasks (Span Board backward and Digit Span forward), both age groups showed similar intervention-related gains (Fig. 2B).

C. Far-transfer tasks

We also found evidence for *far transfer* of training, both in terms of attentional performance (PASAT) and with regard to self-evaluation of cognitive problems in everyday life (CFQ) for both age groups (Fig. 2C).

By contrast, there were no training-related gains in Stroop, RAVLT, or Raven.

D. Maintenance testing

At follow-up, three months after the training period, the improvements in the criterion and transfer tasks were, in general, maintained.

References

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Conclusions

Although the young intervention group improved more than the old on the criterion tasks, the results indicate that systematic training of WM can improve older persons´ performance on laboratory measures of cognitive functions as well as affect self-perceptions of everyday cognitive functioning. The generalization to non-trained tasks exceeds what is commonly observed in intervention research on declarative memory.

Disclosure: Dr. Westerberg own stock in Cogmed AB

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