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

Westerberg H, Brehmer Y, D' Hondt N, Söderlund D, Bäckman L.

Aging Research Center, Karolinska Institutet, Stockholm, Sweden

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 an 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).

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.

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.

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.

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.

References