ABSTRACT

Recently, Klingberg and colleagues (2005) found that intensive training on a battery of verbal and visual-spatial working memory tasks significantly improved symptoms in a sample of Swedish children (ages 7-12 years) diagnosed with ADHD relative to a placebo control group. The present study replicated the findings obtained by Klingberg et al. (2005) using a sample of adolescents obtained from the United States. The sample consisted of twelve students (ages 12-14 years; 7 males) recruited from a public middle school in a medium-sized, Midwestern city. All participants had been previously diagnosed with ADHD, and were being treated with stimulant medication prior to and during the study. The RoboMemo working memory training intervention (Cogmed Cognitive Medical Systems AB) was administered to the participants in a school computer laboratory. The intervention consisted of 11 verbal and visual-spatial working memory exercises. Each participant completed 25, 1-hour training sessions over the course of 6 weeks. Training was conducted in the mornings before the school day began. Participants were assessed before and after the working memory intervention using the following four measures: Digit Span—standardized test of verbal working memory; Span Board—standardized test of spatial working memory; Raven's Progressive Matrices —standardized test of abstract non-verbal reasoning; and the Vanderbilt Diagnostic Rating Scale—ADHD checklist for parents and teachers. Results indicated significant improvement in all three of the cognitive measures. In addition, there were significant decreases in inattentive and hyperactive-impulsive symptoms as rated by parents, and a significant decrease in inattentive symptoms as rated by teachers. The present findings provide corroborating evidence that working memory training can significantly improve inattentive (as rated by both parents and teachers) and hyperactive (as rated by parents) symptoms associated with ADHD in a medicated sample of U.S. adolescents. From a broader perspective, the present findings suggest that cognitive training techniques may be a useful means of accelerating the developmental trajectory of executive functioning.

Working Memory Training for Early Adolescents with Attention-Deficit Hyperactivity Disorder

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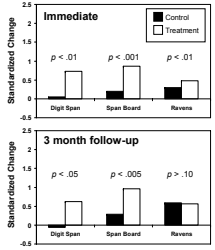
RoboMemo: A Working Memory Intervention

Klingberg et al. (2005) Study

- Randomized control design with RoboMemo (Cogmed Cognitive Medical Systems AB)
- 53 unmedicated children (7-12 years) with ADHD from Sweden
- N = 27 Treatment; N = 26 Control.

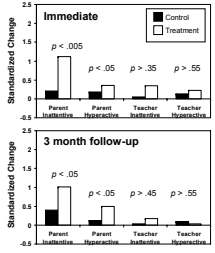
RoboMemo Can Improve Working Memory



Standardized change scores depicted in each of the three cognitive outcome measures for Klingberg et al.'s (2005) control condition and Klingberg et al.'s (2005) treatment condition.

Note: Standardized change = $\left(\frac{T_2 - T_1}{SD_1}\right)$, where *T1* refers to pre-training and *T2* refers to post-training.

RoboMemo Can Improve ADHD Symptoms



Standardized change scores depicted in each of the three cognitive outcome measures for Klingberg et al.'s (2005) control condition and Klingberg et al.'s (2005) treatment condition.

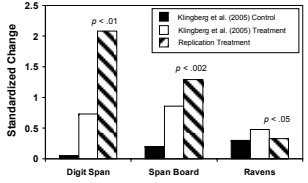
Note: Standardized change = $\left(\frac{T_2 - T_1}{SD_1}\right)$, where *T1* refers to pre-training and *T2* refers to post-training.

Notre Dame Replication Study

Can these effects be replicated?

- Compared effects of RoboMemo in a new sample to Klingberg et al. (2005)
- 12 medicated adolescents (12-14 years) from midwestern U.S. (7=ADHD-PI; 5=ADHD-C)

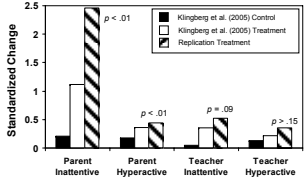
Working Memory was Improved



Standardized change scores depicted in each of the three cognitive outcome measures for Klingberg et al.'s (2005) control condition, Klingberg et al.'s (2005) treatment condition, and the present replication treatment condition.

Note: Standardized change = $\left(\frac{T_2 - T_1}{SD_1}\right)$, where *T1* refers to pre-training and *T2* refers to post-training.

ADHD Symptoms were Improved



Standardized change scores depicted in each of the four ADHD symptom rating conditions for Klingberg et al.'s (2005) control condition, Klingberg et al.'s (2005) treatment condition, and the present replication treatment condition.

Note: Standardized change = $\left(\frac{T_2 - T_1}{SD_1}\right)$, where T_1 refers to pre-training and T_2 refers to post-training.

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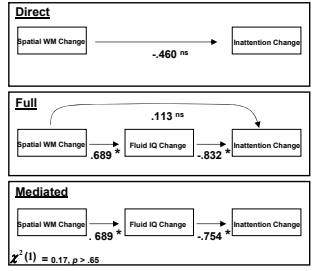
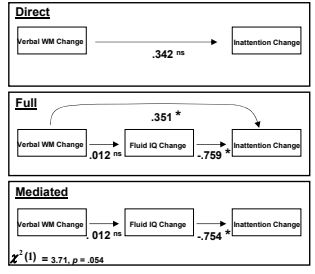
Fluid IQ Mediates Relation Between Spatial WM and Inattention



Enhanced spatial WM reduces ADHD symptoms indirectly via enhanced fluid IQ.

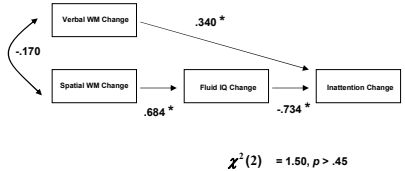
Fluid IQ Does Not Mediate Relation Between Verbal WM and Inattention



Enhanced verbal WM increases ADHD symptoms directly.

Notre Dame Replication Study

Combined Model



Enhanced spatial WM reduces ADHD symptoms indirectly via enhanced fluid IQ.

Enhanced verbal WM increases ADHD symptoms directly.

Conclusions

- The present findings provide evidence that working memory training can significantly improve inattentive and hyperactive symptoms associated with ADHD in a medicated sample of U.S. adolescents.
- Enhanced spatial WM reduces ADHD symptoms indirectly via enhanced fluid IQ.
- Enhanced verbal WM increases ADHD symptoms directly.

References

Klingberg, T, Fernell, E., Olesen, P.J., Johnson, M., Gustafsson, P. Dahlstrom, K., Gillberg, C., Forssberg, H., Westerberg, H. (2005). Computerized training of working memory in children with ADHD—A randomized, controlled trial. *Journal of the American Academy of Child and Adolescent Psychiatry*, *44*, 177-186.