Training and transfer effects of executive functions in preschool children

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Introduction

Working memory (WM) and inhibitory functions (IF) are cognitive functions related to ADHD (Attention Deficit Hyperactivity Disorder). Previous studies have shown that it is possible to improve WM capacity through computerized training in children, adolescents and adults (Klingberg et al., 2002; 2005; Olesen et al. 2004; Westerberg et al., 2008). This has not yet been shown for inhibitory functions.

Objectives

The purpose of this study was to investigate whether it is possible to improve WM capacity or inhibitory control in preschool children through computerized training programs targeting WM or IF (Fig. 1). An additional aim was to determine the extent to which any training effects generalize to other executive functions.

Intervention

- 5 weeks of computerized training in preschools
- 5 days/week
- 15 min/session
- Adaptive difficulty algorithm

Methods

64 children aged 4-5 (mean=4y, 4m), semi-randomly divided into 4 groups, participated in the study. The intervention groups (WM, n=17 and IF, n=18) were compared with two control groups, one active (AC, n=13) (playing a commercially available computer game) and one passive (PC, n=16) (participating only in pre- and post-testing). The computerized training programs used in the study were developed by the authors in collaboration with the company Cogmed systems (Stockholm, Sweden)

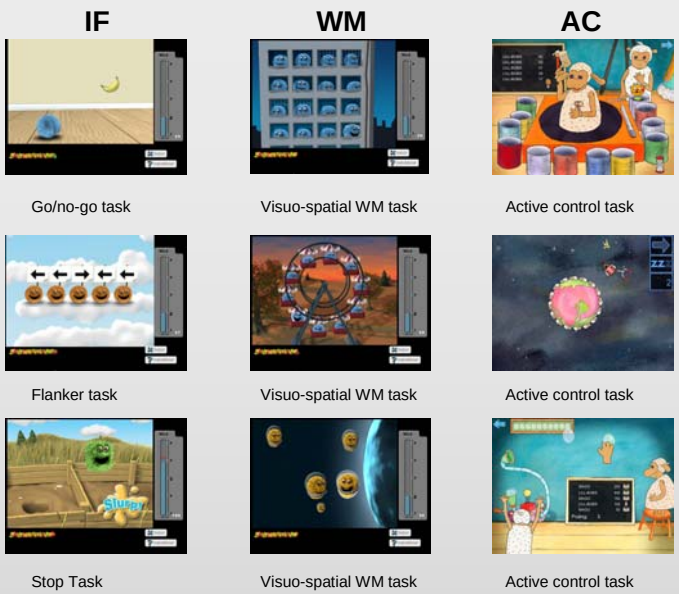

Fig. 1. Examples of the IF, the WM and the AC intervention, from left to right.

Results

Analysis of the training tasks revealed an improvement from the average of the highest level reached during days 2-4 compared to the last 3 days, for all WM tasks, *ts* >1.96, $p < .05$.

For the inhibition training, the children improved significantly on the go/no go tasks, $t > 3.70$, $p < .01$, and the flanker task, $t > 2.92$, $p < .05$, but not on the stop signal tasks, $t > 1.13$, *ns.*

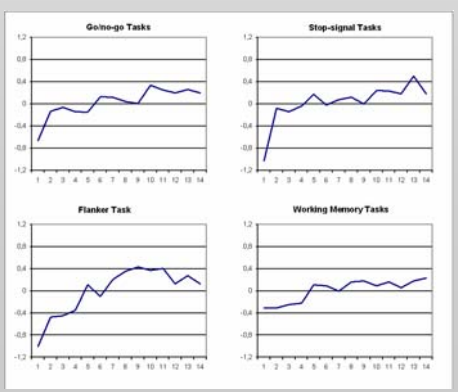

Fig. 2. Standardized training curves for the 3 types of IF and the combined WM training tasks.

Table 1. Results of ANCOVA and post hoc t-tests.

Tests +p<.10, *p<0.05, **p<0.01	Post-Pre training effects F-value	 Contrasts
WM		
Span board (Spatial WM)	5.98 **	WM>C*
Word span (Verbal WM)	4.14*	WM>C**
Inhibition		
Stroop-like task (errors)	0.83, *ns*	
Go/no-go (commissions)	0.13, *ns*	
Attention		
CPT (continuous performance task)	2.7+	WM>C*
Go/no-go (omissons)	3.30*	WM>C*

An overall analysis of covariance (ANCOVA) was conducted to identify group related differences and, when found, planned comparisons revealed which group accounted for the effect (Table 1).

Effects of WM training on WM tasks were large even in the non-trained verbal domain (Cohen's effect sizes 0.91-1.15). Significant effects were also seen on the attention tasks for the WM group compared to controls.

Conclusions

Results show that WM training can be successful even in children as young as 4 years, and improves both WM and attention. Training IF did not lead to significant improvements on any of the tests compared to controls.

References

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