Transfer of working memory training observed in contralateral delay activity

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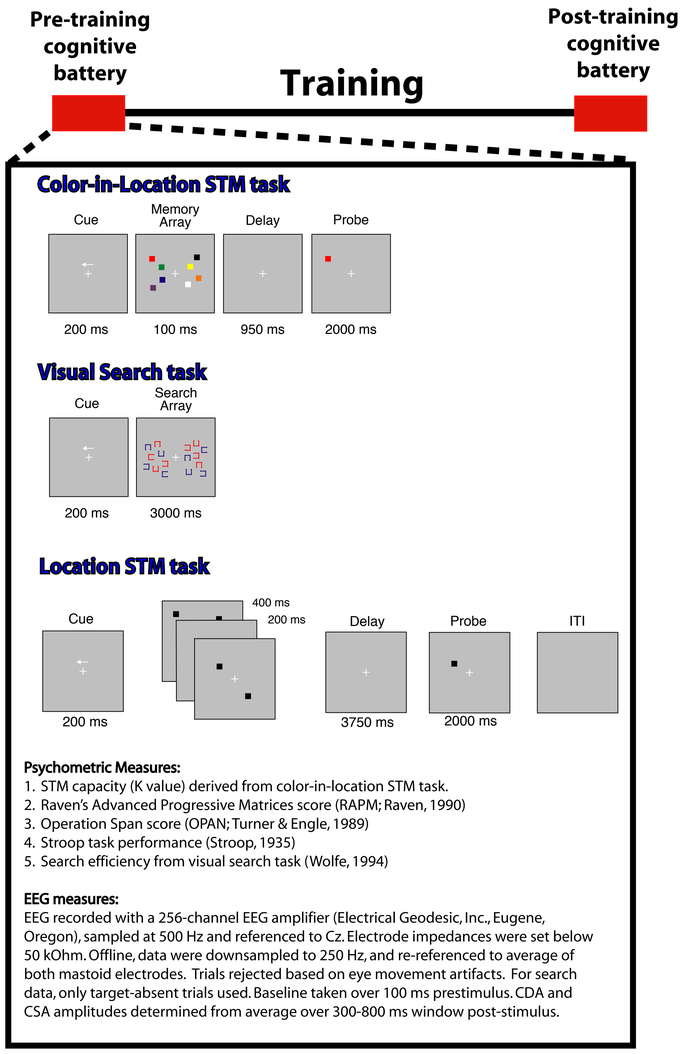
Introduction

Training on working memory tasks improves performance on the task itself and results in changes in fMRI and DTI-based measures, whose effects localize to fronto-parietal brain regions - implicated in working memory and short-term memory (STM) performance (Olesen *et al.*, 2004; Dahlin *et al.*, 2008; Takeuchi *et al.*, 2010).

Does intensive training on a working memory task transfer to behavioral and neural markers of STM capacity?

Experimental design

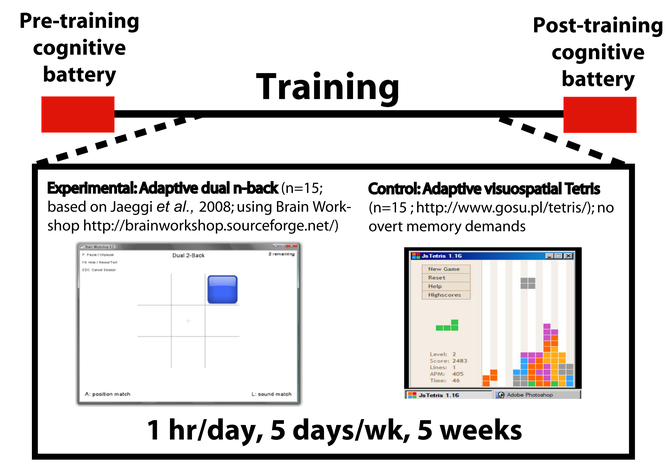


Psychometric Measures:

1. STM capacity (K value) derived from color-in-location STM task.
2. Raven's Advanced Progressive Matrices score (RAPM; Raven, 1990)
3. Operation Span score (OPAN; Turner & Engle, 1989)
4. Stroop task performance (Stroop, 1935)
5. Search efficiency from visual search task (Wolfe, 1994)

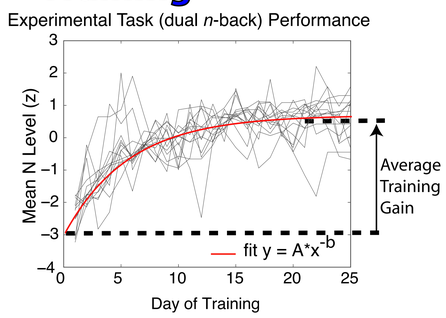
EEG measures:

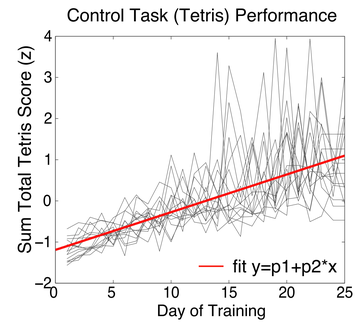
EEG recorded with a 256-channel EEG amplifier (Electrical Geodesic, Inc., Eugene, Oregon), sampled at 500 Hz and referenced to Cz. Electrode impedances were set below 50 kOhm. Offline, data were downsampled to 250 Hz, and re-referenced to average of both mastoid electrodes. Trials rejected based on eye movement artifacts. For search data, only target-absent trials used. Baseline taken over 100 ms prestimulus. CDA and CSA amplitudes determined from average over 300-800 ms window post-stimulus.



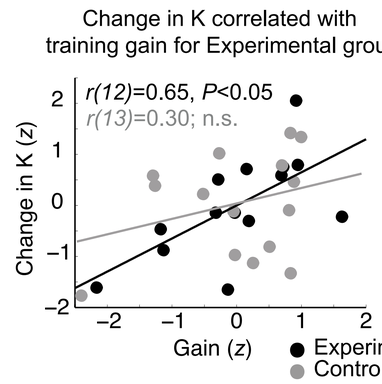
Results

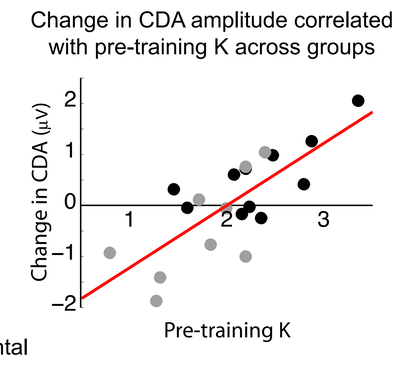
Training





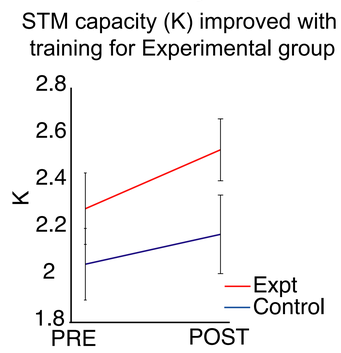
Both groups improved with training. Learning on *n*-back task well fit by power law (mean adj R^2=0.81). Control group performance did not fit well to power function (mean adj R^2=0.49), and thus was fit to a linear function (mean adj R^2=0.75).

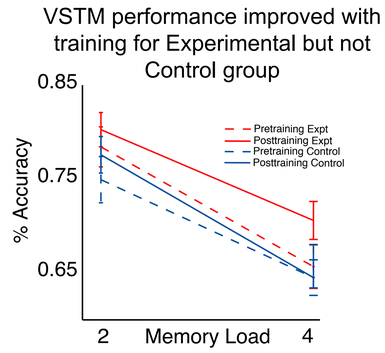




Working memory training transferred to STM. No significant training transfer to complex span (OSPAN), fluid intelligence (RAPM), interference control (Stroop task), or behavioral search efficiency (derived from visual search task).

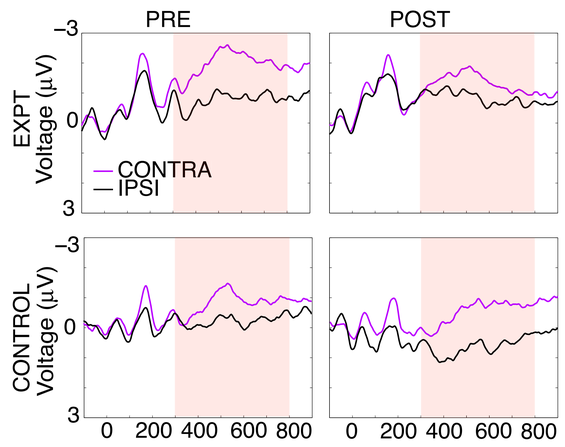
Pre-Post Psychometric Measures

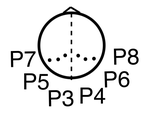




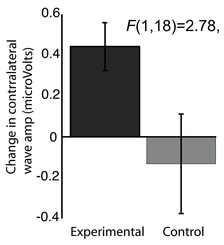
Pre-Post Event-Related Potential Measures

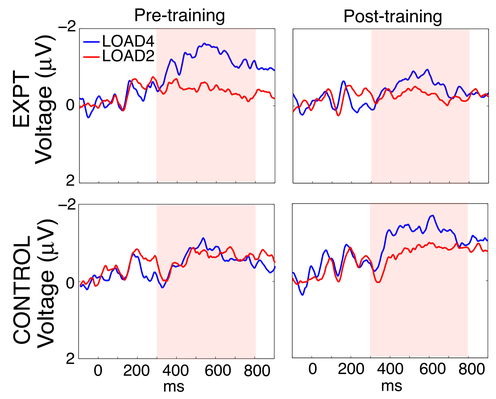
Contralateral Delay Activity (CDA) for Load 4





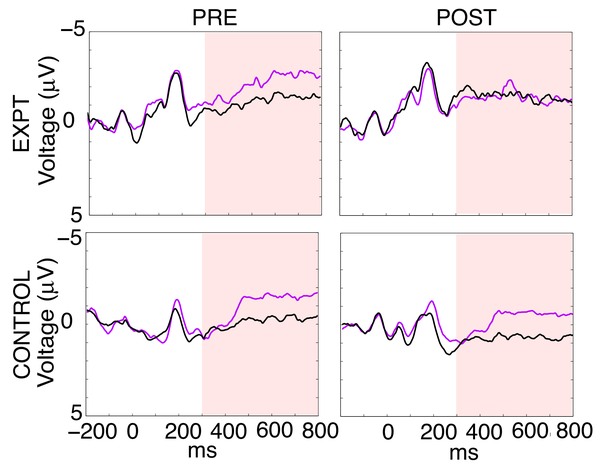
WM training reduced contralateral difference waveform amplitude (Load 4 versus 2) for Experimental, not Control group

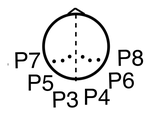


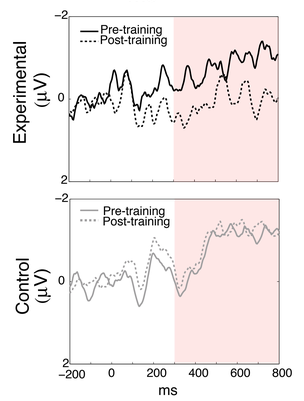


Neural marker of STM capacity (the CDA; Vogel and Machizawa, 2004), derived from color-in-location STM task, decreased with training *F*(1,18)=6.92, *P*<0.05.

Contralateral Search Activity (CSA) for Target-Absent Trials

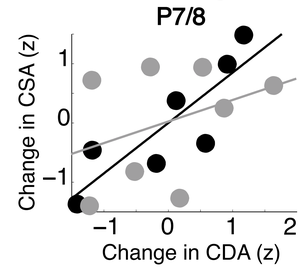






Parallel far transfer of training to the CSA (derived from visual search, with no overt memory component) *F*(1,12)=4.84, *P*<0.05.

Working memory training-related change in CDA correlated with training-related change in CSA



These findings suggest that transfer of working memory training effects may be strongest for tasks that engage the same underlying neural networks.