# 3-D VR TRAINING MODULATES N2PC AND CDA ERP COMPONENTS IN VISUAL SELECTIVE ATTENTION AND WORKING MEMORY TASKS

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## Abstract

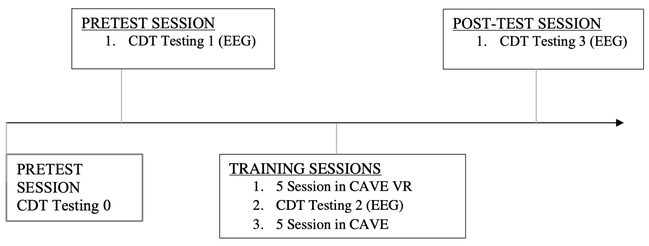
We measured the effects of virtual reality (VR) training on the N2 posterior contralateral (N2pc) and contralateral delay activity (CDA), event-related potential (ERP) components associated with visual selective attention and working memory. Thirty participants engaged in a 3-D VR environment developed for game-like training. The training (10 sessions) was designed to improve visual working memory by enhancing the ability to filter relevant from irrelevant visual stimuli. After five and 10 trainings, each participant in the VR group completed a change detection task (CDT) using a 2-D computer screen. Fifteen control group participants performed CDT only, without training between the CDT tests. In both groups, the CDT stimulus set size was two or four target objects with zero or two distractors. The N2pc and CDA differences related to the CDT load were visually analyzed and formally tested with repeated measures of analysis of variance. The relation of the neurophysiological results with the behavioral results, including accuracy and reaction times, was also analyzed.

## Background

- Selective attention is the ability to select and manipulate specific information while suppressing irrelevant distractors [1]
- Visual working memory capacity is the process of maintaining the information for a short time [2]
- To measure the visual selective attention and VWM capacity a change detection test (CDT) is used, and neural responses are represented by the N2pc (N2 posterior-contralateral) and contralateral delay activity (CDA) wave.
- The effect of training in a 3-D immersive virtual environment on visual attention and VWM capacity is still an open research question.

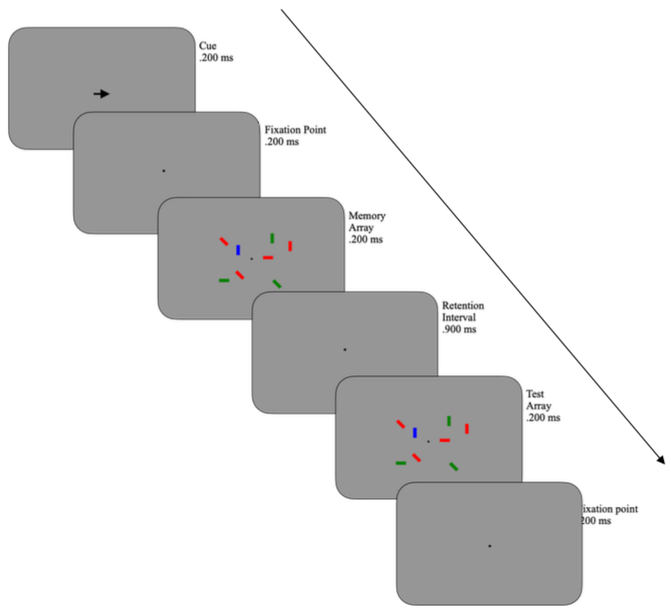
## Experimental Design

- 15 subjects with 10 CAVE training sessions
  15 subjects with no training (control group)




- CAVE VR (Tower Defense VR game, [3])

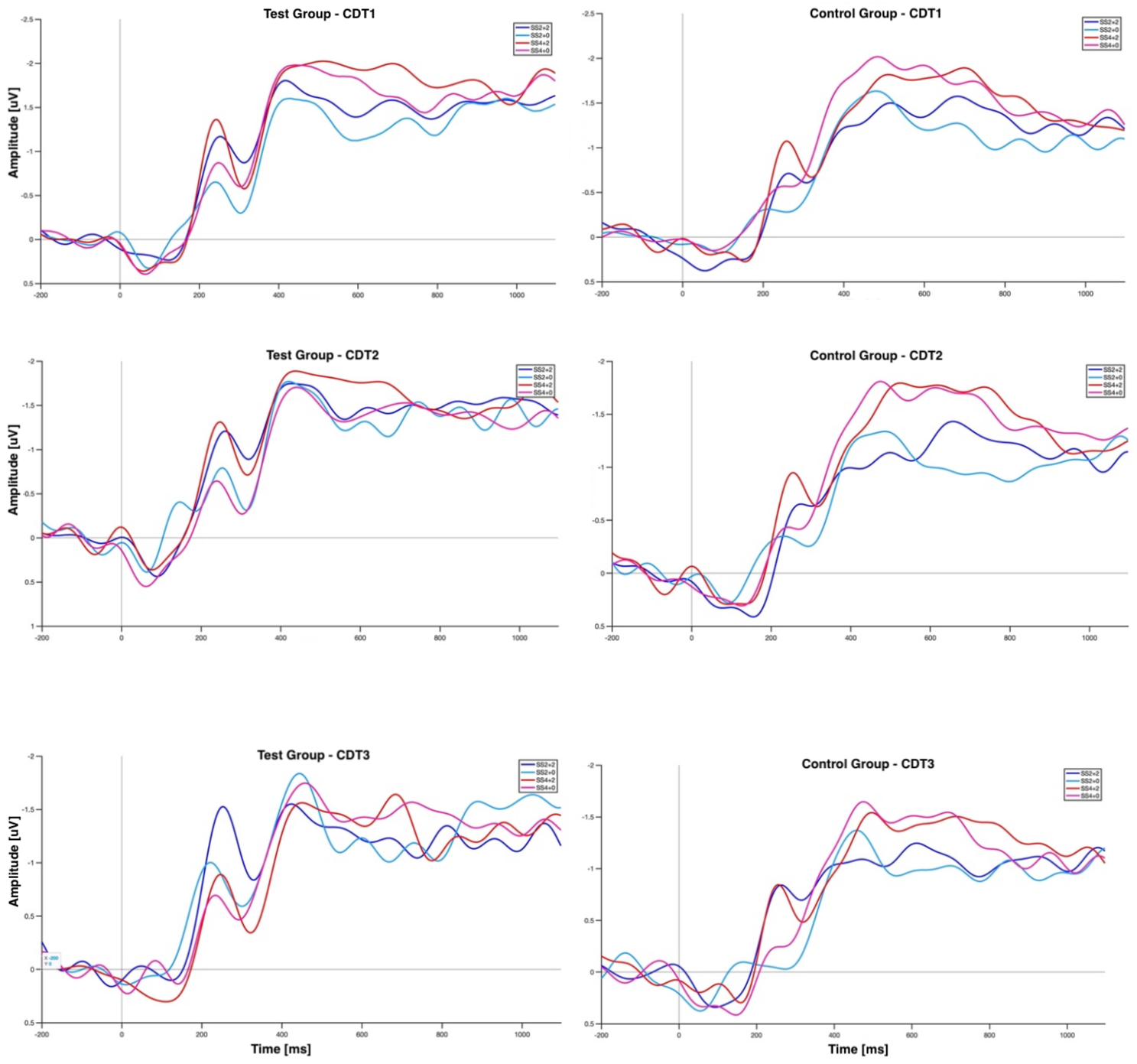
- CDT test (designed by PDT, PsychoPy, [4]),
  SS2+0, SS2+2, SS4+0, SS4+2
  40 blocks per SS, with 2 hemifield and 2 change conditions, 640 trials in total.



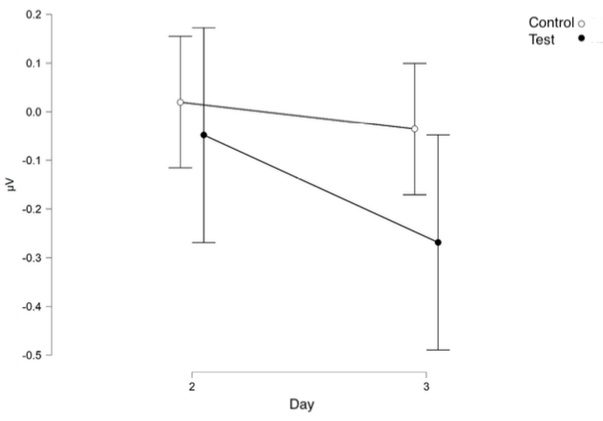

- EEG, electrodes: PO7-PO8, P3-P4, O1-O2, P7-P8

## Results

- Group ERP averages (contra - ipsi difference wave) shown for each CDT testing day and each set size.




- Mixed Model Repeated Measures (MMRM implemented by PROC MIXED, SAS) was applied on adjusted CDT2 and CDT3 endpoints with CDT1 serving as a baseline. Endpoints Tgt4: SS4+2 - SS4+0, and Tgt2: SS2+2 - SS2+0 were considerd. The main factors are Day (two levels: CDT2, CDT3), Set Size (two levels: Tgt2, Tgt4), Group (two levels, Test, Control), and their interaction were considered.
- CDA (370 ms - 850 ms): no significant main effects found, Least Square Mean Estimates show a significant decrease of Tgt4 CDA endpoint (p=0.035, -0.27 $\mu$V) in the test group on CDT3 (after 10 training sessions).




- N2pc (260 ms - 330 ms) and Pd (distractor positivity, 340 ms - 370 ms): no significant effects observed, further analysis is ongoing
- RT (reaction time) & Accuracy: no significant effects observed

## Conclusions

Although formal statistical testing did not find a significant difference between the trained and control groups, when analyzing least mean square estimates, a considerable effect indicating improved filtering was observed. A significant non-zero difference at the level of several tenths of $\mu$V was observed when comparing a CDA difference between trials with and without distractors after ten days of training versus the before-training difference. In the control group, there were no significant LSM differences.

## References

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