A computer-based cognitive training based on NeuroNation

A Study Conducted by the Division of Experimental Psychology and Neuropsychology, FU Berlin (Under direction of Professor Michael Niedeggen, PhD)

Background

Working Memory (WM) is responsible for perceiving, memorizing (for a short period of time) and updating information, amongst other things [1]. WM explains a significant part of fluid intelligence [2]. Studies showed that by specifically training WM fluid intelligence can be improved [3]. The efficacy of commercially available brain training, however, needs further empirical evidence.

Research questions:

1) Can a computer-based WM-training improve performance in similar WM-tasks?
2) Can a computer-based WM-training improve performance in tasks, which are associated with WM (e.g. mental flexibility)?
3) Can WM-training improve performance in tasks, which are only indirectly associated with WM (memory; selective and divided attention; processing speed)?
4) Can WM-training positively influence subjective wellbeing and the estimation of one‘s own cognitive capacities?

Method

During a 4 week training plan participants trained their WM for 25 minutes daily using 9 computer-based tasks, developed by NeuroNation (5 Updating; 2 Span; 2 Perception). The efficacy of the WM-training in the experimental group (EG) was compared with an active control group (CG).

Sample

Experimental Group:
N = 13 (8 Women, 5 Men). 55-80 years
Control Group:
N = 11 (8 Women, 3 Men). 55-78 years

The CG received a memory-strategy-training and computer-based tasks developed by NeuroNation, unrelated to WM (i.e. focus-tasks). All computer-based tasks were adaptive. A pre- and posttest, consisting of psychometric tests, assessed the training-related changes. Separate group meetings took place once a week, in which training concepts and training goals were presented to participants. In addition transfer effects of the tasks on participants' daily lives were discussed in these meetings.

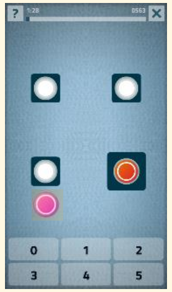
Neuropsychological Tests (All Tests in German)
SKT (Pretest; Brief Assessment of Memory and Attention disorders)
Rivermead Behavioural Memory Test (Subtest: 1 to 4)
LGT 3, subtest: company logos (Learning and Memory test)
VLMT (Verbal Learning and Memory test)
TAP, subtest: divided attention (Attention Assessment)
Trail Making Test A-B (Mental Flexibility)
Geriatrische Depressionsskala (Geriatric Depression Scale)
Nürnberger Altersinventar; subtest: Self Evaluation Scale (Geriatric Inventory)
Visuospatial n-back task

Examples of the computer-based tasks

Control Group

Task: Finding the digits in ascending order

Experimental Group - Updating



Task: Counting the number of balls in each bin

Experimental Group - Span

Task: Memorizing the order, the dots were presented in

Results

Effect on other WM-tasks (direct transfer)

In the non-trained visuospatial WM-task (n-back) [4] both groups showed an improvement in their reaction time. The improvement was significantly stronger in the EG than in CG (Figure 1).

Effect on cognitive performance, associated with WM (indirect transfer)

Both groups showed improvement in a task, assessing mental flexibility (TMT A-B). Again, the improvement was significantly stronger in the EG than in CG (Figure 2).

Generalized transfer effect (far transfer)

Neither the EG nor the CG showed a generalized transfer effect (memory; selective and divided attention; processing speed).

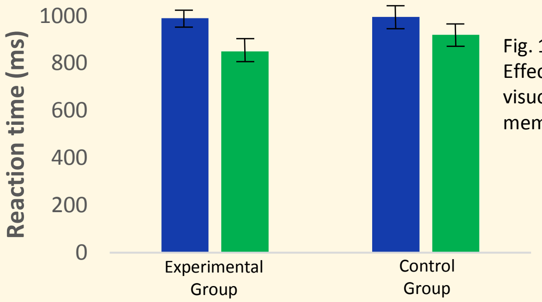


Fig. 1: Effect on visuospatial memory

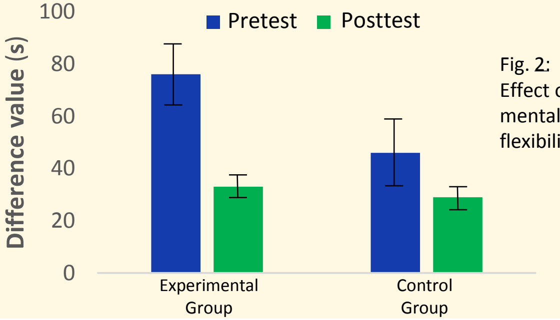


Fig. 2: Effect on mental flexibility

Effect on subjective wellbeing and belief on one‘s cognitive capacities (far transfer)

Neither the EG nor the CG showed a change in subjective wellbeing or the estimation of one‘s own cognitive capacities.

Summary

1) WM-training showed, compared to memory-strategy-training, a transfer to other – non-trained – WM-tasks. The training was not only sensitive to one mode(picture/words) but showed improvement in other processing modes as well (visuospatial).

2) In addition, WM-training showed, compared to memory-strategy-training, a transfer effect to other cognitive domains, which are closely related to WM. To be precise, mental flexibility improved.

3) Neither WM-training nor memory-strategy-training improved cognitive abilities, which are only indirectly linked to WM (memory; selective and divided attention; processing speed).

4) Neither WM-training nor memory-strategy-training positively affected subjective wellbeing or the estimation of one‘s own cognitive capacities.

References

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