The Working Memory and Plasticity Lab

The Quest for Transfer

SCHOOL OF EDUCATION
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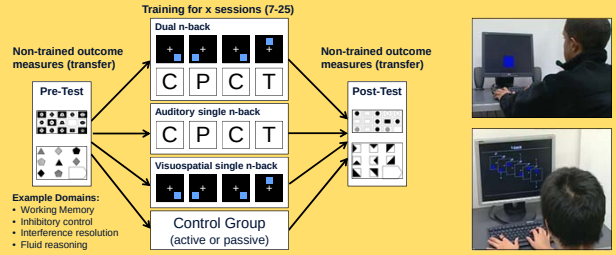
Model: In order to yield **transfer** effects, a training paradigm should:

- require the use of **working memory** skills
- require the use of multiple **processes**
- match the participants' **capacity** in terms of difficulty
- **discourage** the generation of task-specific **strategies**

Training Young Adults

General Procedure (Basic Design):



Specific Training Effects:

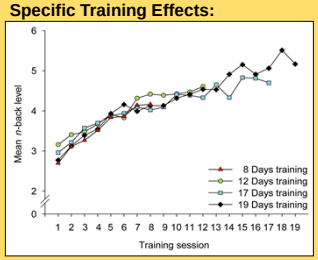


Figure 1. Performance increase in the trained task shown separately for 4 training groups. For each session (x-axis), the average level of *n* achieved by the participants is presented (y-axis) (Jaeggi et al., 2008).

Transfer Effects (WM & Gf):

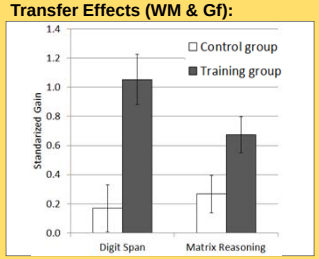


Figure 2. Standardized improvements (pre vs. post) for the control and the trained groups in working memory and fluid reasoning (Jaeggi et al., 2008).

Dose-Response Curve:

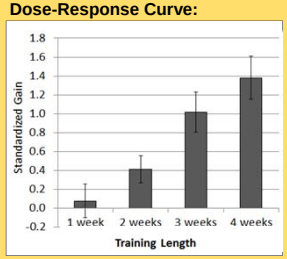


Figure 3. Gain on fluid intelligence as a function of training time following dual n-back training. The longer the training duration, the larger the gain (Jaeggi et al., 2008).

Transfer to Gf (Composite Measures):

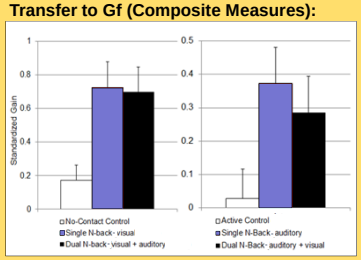


Figure 4. Standardized improvements in various fluid intelligence measures (composite) for the control and two trained groups (Left: Jaeggi et al., 2010; Right: Jaeggi et al., 2014).

Conclusion:

Our results provide evidence of transfer from training on a demanding working memory task to various nont-trained outcome (=transfer) measures. This transfer resulted even though the trained task was entirely different from the outcome measure itself (e.g. transfer to visuospatial reasoning after verbal training). Furthermore, the amount of gain in intelligence critically depended on the amount of training: more training resulted in more improvement in fluid intelligence. That is, the training effect was dosage-dependent. Finally, transfer to spatial skills occurs as a function of either single visuospatial, verbal, or dual n-back training, thus, it is domain-general.

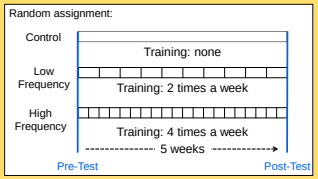
Training Older Adults

Old-old Adult Training Study

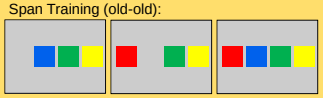
- Mean age: 80.1 years (SD = 3.6)
- 12 weeks of training, twice a week (in groups)
- 2 interventions: cognitive vs physical exercise

Young-old Adult Training Study

- Mean age: 68.1 years (SD = 2.6)



Span Training (old-old):



N-back Training (young-old):

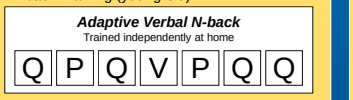


Figure 5. Training tasks (visuospatial/verbal).

Transfer Measures Gf (from WAIS):

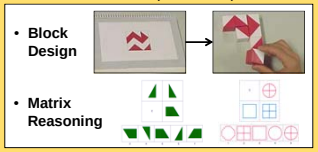


Figure 6. Training and transfer tasks.

Transfer Effects (old-old):

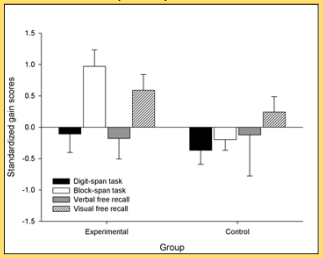


Figure 7. The gain scores for the transfer effects visualized in units of standard deviations (Buschkuehl et al., 2008).

Transfer Effects (young-old):

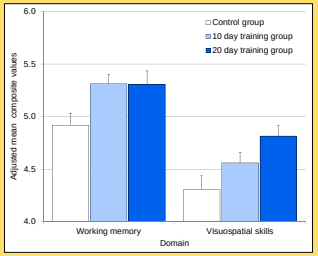


Figure 8. Standardized gain scores for the transfer effects visualized in units of standard deviations (Stepankova et al., 2013).

Conclusion:

Our results with older adults demonstrate that it is possible to improve memory and fluid intelligence in in this population using an intervention targeting working memory, indicating that induced plasticity is possible even in advanced age. Further, we replicated the dose-response effect observed in young adults, as well as the domain-independent effects of n-back training.

References

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Training Typically Developing Children

N-back Training

- Mean age: 9.0 years (SD = 1.5)
- 4 week training (20 sessions)

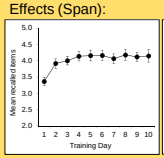
Span Training

- Study 1: Mean age: 9.5 years (SD = 0.5)
- Study 2: Mean age: 5.5 years (SD = 0.5)
- 2 week training (10 sessions)

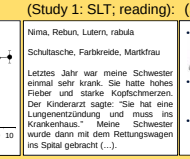
Alternative Interventions:

- (1) 'Knowledge builder' Contains general knowledge, vocabulary, and some trivia questions (control intervention)
- (2) Linear number game (~'chutes and ladders')
- Both control games are equally well-liked and motivating as the WM games.

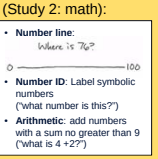
Specific Training Effects (Span):



Transfer Measures (Study 1: SLT; reading):



Transfer Measures (Study 2: math):



Specific Training Effects (N-back):

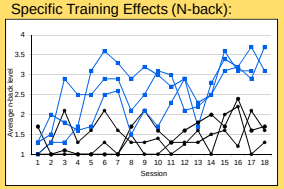


Figure 9. Training performance – six prototypical participants showing different learning trajectories.

Transfer Effects (Span) – Reading & Math:

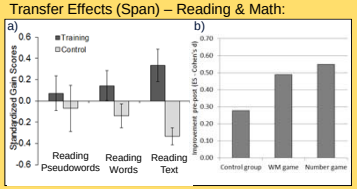


Figure 10. a) Gain scores for the various reading measures as a function of span training (Loosli et al., 2012). b) Gain scores for math outcome measures (3 tasks) after span training (Daubert et al., 2015).

Transfer Effects (N-back):

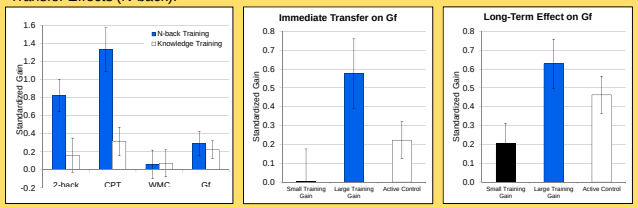


Figure 11. The panel on the left shows transfer to the various outcome measures. The panel in the middle illustrates performance gain in Gf as a function of training improvement (small vs large training gain vs active control). The right panel shows the long-term effects approximately 3 months after training completion (Jaeggi et al., 2011).

Conclusion:

Children who trained on working memory showed transfer in measures of reading and math (span training), or executive control and fluid intelligence (n-back training). Importantly, only children who trained well showed transfer, thus, demonstrating that the training quality is critical for transfer. The effects remained after a period of three months without training (longitudinal effects).