Memory Self-Efficacy Predicts Responsiveness to Inductive Reasoning Training in Older Adults

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Rationale

Aging is associated with monotonic declines in fluid and executive cognitive abilities. Yet, there is potential for cognitive enrichment with advancing age [2], with studies finding evidence for plasticity among older adults in response to a wide variety of interventions [6]. Component specific cognitive training interventions involve the direct training of isolated cognitive components such as speed, memory, and reasoning [1]. While these training regimens produce clear improvement in trained abilities [1,2], there are substantial individual differences in the effectiveness of training. The goal of the current study is to examine whether individual differences in self-efficacy beliefs about memory capacity are associated with responsiveness to the targeted training of inductive reasoning.

Methods

Participants

- 105 community-dwelling older adults.
  - Age: 60-94 (M = 72.9; SD = 7.7).
  - Education: 15.5 years (SD = 2.7).
  - Randomly assigned to inductive reasoning training program (N = 47) or a waitlist control group (N = 58).

Training Program

- 16-week program.
- Logic puzzles and games interleaved with an IR training program [5], adapted from the ACTIVE trials [1].
  - Basic Series and "Everyday" Serial Problems.

Retention

- 80.1% retention in training. Of the 9 who dropped, 4 returned for post-test.
- 91.4% of control participants returned for post-test.
- No evidence for significant differences between drops and retained on any of the key variables.

Measures

Inductive Reasoning (α = .90)
Letter sets
Number sets
Letter Series
Word Series
Everyday Problem Solving

- **Memory self-efficacy:** Memory capacity beliefs subscale (α = .86) from Metamemory in Adulthood Scale.
- **Daily log** of the amount of time (in half-hour increments) participants spent on the training materials.

Analysis

- **Intent-to-treat analyses** [3]: participants who dropped from the program were invited back.
- **Second Order Latent Change Score Models (LCSM):** Multiple measures of IR were used to define two latent factors.
  1. Latent Intercept: initial individual differences in IR at the first occasion of measurement.
  2. Latent Slope: amount of individual change in IR from pretest to posttest.
     - Constrained for strict measurement invariance.
     - Latent MSE factor specified using parcels, built with item-to-construct technique [4].
- **Hierarchical Linear Models (HLM):** Additional analyses on the number of weeks participants allocated to the training. Number of weeks was nested within subjects. Individual growth model was fit, with random intercepts and random effects for time.

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Results

Effects of Training on Change in Inductive Reasoning

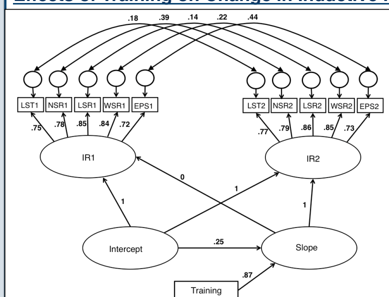

Figure 1. LCSM of Effects of Training on Changes in Inductive Reasoning [$\chi^2(48) = 69.48$, CFI = .97; RMSEA = .06]

- Group membership was a significant predictor of change in IR (sMLE = .87, $z = 2.73$, $p < .01$; $d = .44$).

- *Control Slope*: (MLE = 1.03, *SE* = .47, $z = 2.15$, $p < .05$).
- *Intervention Slope*: (MLE = .33, *SE* = .31, $z = 1.07$, $p > .10$).

- Training effects were localized to IR.

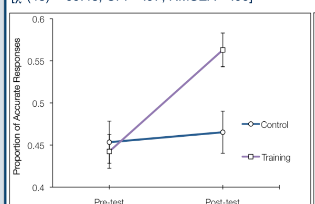

Figure 2. % Accuracy in IR Tasks

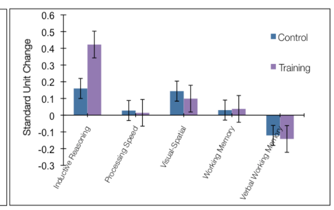

Figure 3. Standard Unit Change in Cognition

Search for an Underlying Mechanism

- Test for independent and joint effects of MSE and Week on amount of time allocated to training materials.

Level 1 - $Y_{ij} = B_{0j} + B_{1j}[Week]_{ij} + R_{ij}$
Level 2 - $B_{0j} = \gamma_{00} + \gamma_{01}[MSE]_{0j} + U_{0j}$
$B_{1j} = \gamma_{10} + \gamma_{11}[MSE]_{0j} + U_{1j}$

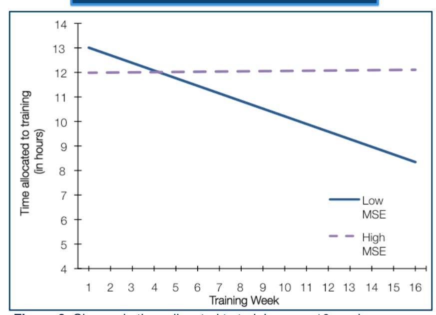

Figure 6. Change in time allocated to training over 16 weeks as a function of MSE

- However, change in time allocated to the training did not mediate the relationship between MSE and change in IR. (Bootstrapped Sobel; $B = .002$; $z = -.66$).

Effects of MSE and Age on Change in Inductive Reasoning

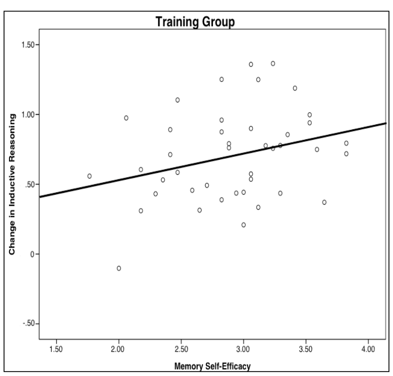

Figure 4. Standard Unit Change in IR as a Function of MSE

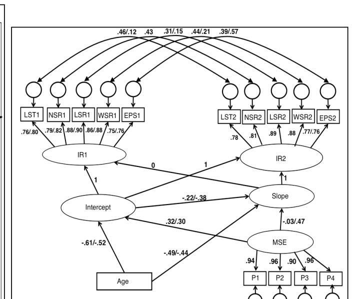

Figure 5. LCSM of Effects of Age and MSE on Change in IR

Control: [$\chi^2(298) = 139.79$, CFI = .93, RMSEA = .05]
Training: [$\chi^2(298) = 131.60$, CFI = .94, RMSEA = .08]

- Age was negatively related to initial IR ($sMLE_{Control} = -.61$, $z_C = -3.53$, $p_C < .001$; $sMLE_{Training} = -.52$, $z_T = -2.96$, $p_T < .01$) and change in IR ($sMLE_C = -.49$, $z_C = -2.34$, $p_C < .05$; $sMLE_T = -.44$, $z_T = -2.16$, $p_T < .05$).

- **MSE significantly predicted gains in IR within the training group (sMLE = .47, $z = 2.27$, $p < .05$) but not control (sMLE = –.03, $z = -.14$, $p > .10$).**

Conclusions

- Self-efficacy beliefs are associated with the degree to which individuals can gain from the targeted training of a specific fluid ability.

- Findings are consistent with recent research showing positive relationships between older adults' MSE beliefs and performance in goal-based situations [5,6,7,8,9].

- Extends prior findings by showing that MSE beliefs predict change in performance in a non-memory domain. Thus, the relationship between MSE and change in cognition may not be limited to memory but may rather be reflective of change in fluid abilities more globally.

References

[1] Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., Marsiske, M., . . . Willis, S. L. (2002). Effects of cognitive training interventions with older adults: A randomized controlled trial. *Journal of the American Medical Association, 288,* 2271–2281.
[2] Hertzog, C., Kramer, A. F., Wilson, R. S., & Lindenberger, U. (2008). Enrichment effects on adult cognitive development: Can the functional capacity of older adults be preserved and enhanced? *Psychological Science in the Public Interest, 9,* 1–65.
[3] Lachin, J. M. (2000). Statistical considerations in the intent-to-treat principle. *Controlled Clinical Trials, 21,* 167–189.
[4] Little, T. D., Cunningham, W. A., Shahar, G., & Widaman, K. F. (2002). To parcel or not to parcel: Exploring the question, weighing the merits. *Structural Equation Modeling, 9,* 151–173.
[5] Margrett, J. A., & Willis, S. L. (2006). In-home cognitive training with older married couples: Individual versus collaborative learning. *Aging, Neuropsychology and Cognition, 13,* 173–195.
[6] Stine-Morrow, E. A. L., & Basak, C. (2011). Cognitive interventions. In K. W. Schaie & S. L. Willis (Eds.), *Handbook of the Psychology of Aging* (7th ed.). New York: Elsevier.
[7] Stine-Morrow, E. A. L., Miller, L. M. S., & Hertzog, C. (2006). Aging and self-regulated language processing. *Psychological Bulletin, 132,* 582–606.
[8] West, R. L., & Yassuda, M. S. (2004). Aging and memory control beliefs: Performance in relation to goal setting and memory self-evaluation. *The Journals of Gerontology: Psychological Sciences, 59*, 56–65.
[9] West, R. L., Bagwell, D. K., & Dark-Freudeman, A. (2008). Self-efficacy and memory aging: The impact of a memory intervention based on self-efficacy. *Aging, Neuropsychology, and Cognition, 15,* 302–329.
[10] For more information, see Payne, B. R., Jackson, J. J., Hill, P. L., Gao, X., Roberts, B. W., & Stine-Morrow, E. A. L. (2011). Memory self-efficacy predicts responsiveness to inductive reasoning training in older adults. *The Journals of Gerontology: Psychological Sciences*, 10.1093/geronb/gbr073 .