Cognitive Domain-specific Computer Game Training Effects in Healthy Older Adults: Comparison of Auditory & Visual Adaptive Games

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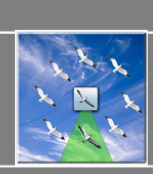
INTRODUCTION

- Cognitive declines with age (Hedden & Gabrieli, 2004; Nilsson, 2003) have motivated development of cognitive training methods that might delay or reverse these changes (Ball et al., 2002).
- There is a growing body of evidence that computer-game based cognitive training can be effective in older adults (Zelinski & Reyes, 2009), and computer game play in older adults has been shown to reduce reports of depression and increase well-being in older adults (Allaire et al., 2013), but some studies have failed to find cognitive transfer effects beyond improvements in actual game play (Owen et al., 2010).
- A recent meta-analytic study (Toril, Reales, & Ballesteros, 2014) confirmed computer game training effects across a range cognitive domains in older adults, but more study regarding specific cognitive functions that are enhanced and the characteristics of games is needed.
- The present study compared two sets of computer games designed to reverse age-related cognitive decline due to reductions in visual (Insight) and auditory (Brain Fitness) perception (Posit Science, 2005, 2008). The games are adaptive in that they adjust difficulty level to the recent performance of the player.
- The present study concentrated on far transfer of training to broad domains of cognitive function based on multiple cognitive tests.
- A combined visual-auditory game training group was included to document any synergistic effects of training, and there was a delayed third assessment to document the durability of training.

Hypotheses

- Visual and auditory training will yield domain-specific training effects (i.e., visual processing & verbal memory).
- Combined training will synergize yielding training effects for both verbal and visual cognitive indices.

Design & Procedure

Group		Training (8-10 weeks)			
Control (*N*=37)	Test 1	none	Test 2	none	Test 3
Insight (*N*=41)		visual games 		none	
Brain Fitness (*N*=38)		auditory games 		none	
Both Types (*N*=38)		visual & auditory 		none	
		8-10 weeks		8-10 weeks	

Participants

Measure	Training (*N* = 117)	Control (*N* = 37)
Demographics		
Age, *M*±*SD*	69.9±5.7	69.8±6.3
Education (yrs), *M*±*SD*	16.4±2.6	16.2±2.8
Gender (% F)	57.3%	56.8%
Cognitive		
MMSE (range 0-30), *M*±*SD*	28.0±1.6	27.9±1.5
GDS (range 0-15), *M*±*SD*	0.7±1.2	0.9±1.5

MEASURES

- **Primary** (RBANS, Randolph, 1998)
  - **RBANS Verbal** (based on Duff et al., 2006): List Learning, List Recognition, List Recall, Story Memory, Story Recall
  - **RBANS Visual** (based on Duff et al., 2006): Figure Copy, Figure Recall, Line Orientation, Coding
  - **RBANS Total**
- **Secondary**
  - **Working Memory:** RBANS Digits, WAIS-IV Letter-Number
  - **Processing Speed:** WAIS-IV Coding & Cancellation
  - **Verbal Memory 2:** HVLT Total & Delayed

RESULTS

- **Training Effects** (see Table 1)**: Mean improvement Test 1 to 2, each training group vs. non-training group.**
  - Significant ***Visual Training***: RBANS Total & Visual, Working Memory
  - Significant ***Auditory Training***: Working Memory
  - ***NO*** Significant Training Effects for Both Group
- **Training Interactions** (see Figure 1)**: Significant Crossover Interactions.**
  - RBANS Total & Visual, Working Memory
  - No evidence of synergy of training across game groups
- **Durable Training Effects** (see Table 2)**: Mean improvement, each training group vs. non-training group from test 1 to 3 for significant effects from Table 1.**
  - Significant ***Visual Training***: RBANS Visual
  - Significant ***Auditory Training***: RBANS Visual

DISCUSSION

- Visual training games yielded training effects that transferred to a visual processing index, that was durable to testing session 3. Whereas the auditory training failed to replicated previous finding of a verbal memory training effect with a similar set of games (Zalinski & Reyes, 2009). Moreover, no training effects were found for the secondary verbal memory index. **This is modest support for cognitive specificity of training, but suggests that visual cognition is more sensitive to computer game training.**
- Both visual and auditory groups yielded working memory training effects that failed to reach significance at the final test. However, there were not training effects for processing speed. This may be due to non-durable training of working memory control processes common to the visual processing domain (see Basak et al., 2008, for a similar finding).
- **The combined training group** (alternating visual & auditory training of same overall amount as the other training groups) **failed to yield any training effects in comparison to the non-training group.** This may have been due to a sensitivity to training amount for each set of games, or a training interference effect opposing training synergy.

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Table 1: Training Effects (No Training vs Training) Test 1 to 2

Measure	Visual Games (*N* = 41)			Auditory Games (*N* = 38)		
	Mn Δ	*p*	ES (d)	Mn Δ	*p*	ES (d)
Primary						
RBANS Total	4.3	.019	.43	2.1	.152	.22
RBANS Verbal Memory	1.5	.254	.14	-1.0	.673	-.10
RBANS Visual Processing	2.9	.027	.38	1.2	.206	.16
Secondary						
Working Memory	5.0	.013	.45	3.9	.043	.35
Processing Speed	-1.8	.800	-.17	-0.6	.618	-.06
Verbal Memory 2	-1.8	.753	-.17	2.5	.186	.22

Figure 1: Significant Training Interactions

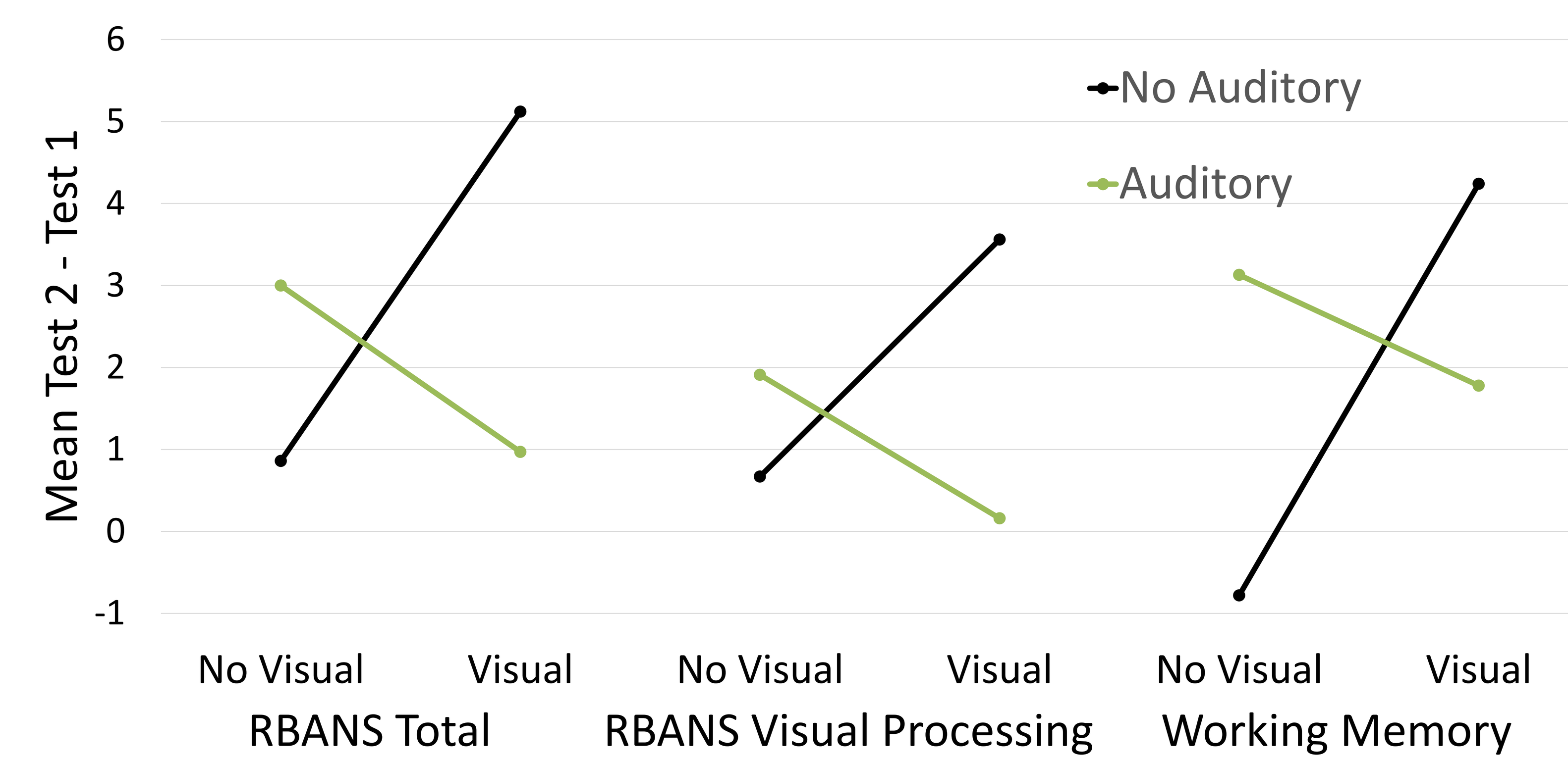

Table 2: Training Effects (No Training vs. Training) Test 1 to 3

Measure	Visual Games (*N* = 41)			Auditory Games (*N* = 37)		
	Mn Δ	*p*	ES (d)	Mn Δ	*p*	ES (d)
Primary						
RBANS Total	1.4	.269	.15	2.1	.172	.24
RBANS Visual Processing	3.3	.026	.46	3.2	.031	.45
Secondary						
Working Memory	3.3	.069	.31	3.7	.052	.35

Acknowledgments

This research was supported by NIH AREA Grant 1R15AG038879-01A1. We would like to thank Sarah Daniels, Savannah R. Erwin, Meg DiDonato, and our testing and scoring teams.

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