Game-Based Cognitive Training Effects in Young Adults

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Introduction

- Targeted, computerized working memory (WM) training involves the use of interventions designed to improve WM capacity.
- The primary question regarding such training is whether improvement on one task (i.e., the trained task) will affect performance on another, untrained task. That is, are there *transfer effects* in cognitive training studies?
- In studies involving WM training, *near transfer effects* are said to be found when training improves performance on an untrained task intended to directly measure WM capacity.
- In contrast, *far transfer effects* are found when WM training improves an untrained task intended to measure abilities that have been found to be related to WM capacity (e.g., general fluid intelligence).
- A number of recent studies have examined the effectiveness of targeted working memory (WM) training in young adults. In many of these studies, participants' WM was trained using a traditional version of the *n*-back task.
- The results of such studies have been mixed, both in terms of near and far transfer effects. For example, some have found positive WM training effects (Au et al, 2015), while others have found no training effects (e.g., Redick et al., 2013).

Present Studies

- The purpose of the present studies was twofold:
  1. The present studies examined the effectiveness of working memory training using an iPad-based, videogame version of the *n*-back task.
  2. Examine the effectiveness of targeted, computerized WM training in young adults who possess relatively low WM capacity.
- These questions were examined across two experiments.

Experiment 1

Method

Pre-Test

- Participants were college students recruited from California State University, San Bernardino
- Tasks were administered to each participant individually across one ninety minute session.

WM Capacity tasks

- OSPAN: hold a set of letters in memory while simultaneously performing math problems
- SSPAN: hold a set of spatial locations in memory while simultaneously deciding if presented images are symmetrical or not
- Verbal Working Memory (VWM-WRAML): hold in memory and reorder verbally presented sets of animal and non-animal items

- Participants were invited to participate in either cognitive training or to return for an additional testing session (No Contact)

Training

- Participants were randomly assigned to play one of two cognitive training tasks.

Recall the Game (N=16)

- Recall is an adaptive gamified version of the N-Back task
- Players navigate a spaceship and collect energy pods based on a specific pattern (1-back, 2-back, etc.) of their characteristics (e.g., color, shape, or sound)
- All players begin at 1-back and progress based on individual performance
- Game play began at 25 minutes per session and slowly increased to 40 minutes for the final two sessions

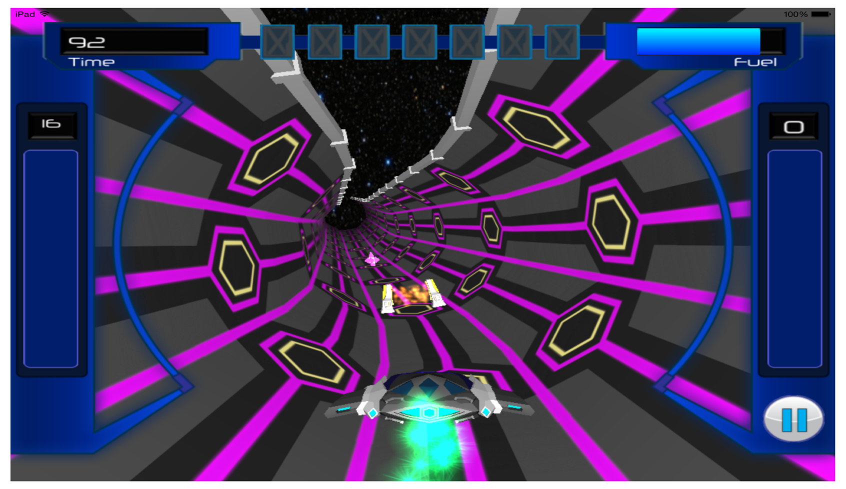

Figure 1: Image from Recall the Game

Ultimeyes (N=14)

- Ultimeyes is an adaptive game designed to train cognitive skills such as visual attention
- Players use a stylus to tap on "gabors" that appear against a gray background
- Players adjust the visibility of the "gabors" that become progressively harder to see
- Game play lasted 25 minutes each session

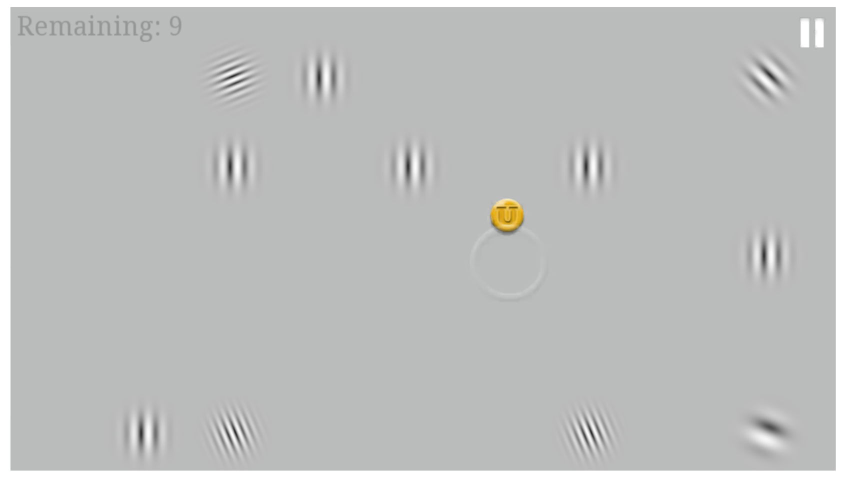

Figure 2: Image from Ultimeyes

- Participants were trained for approximately 11 hours over a period of 4 weeks. Progress was monitored for Recall the game

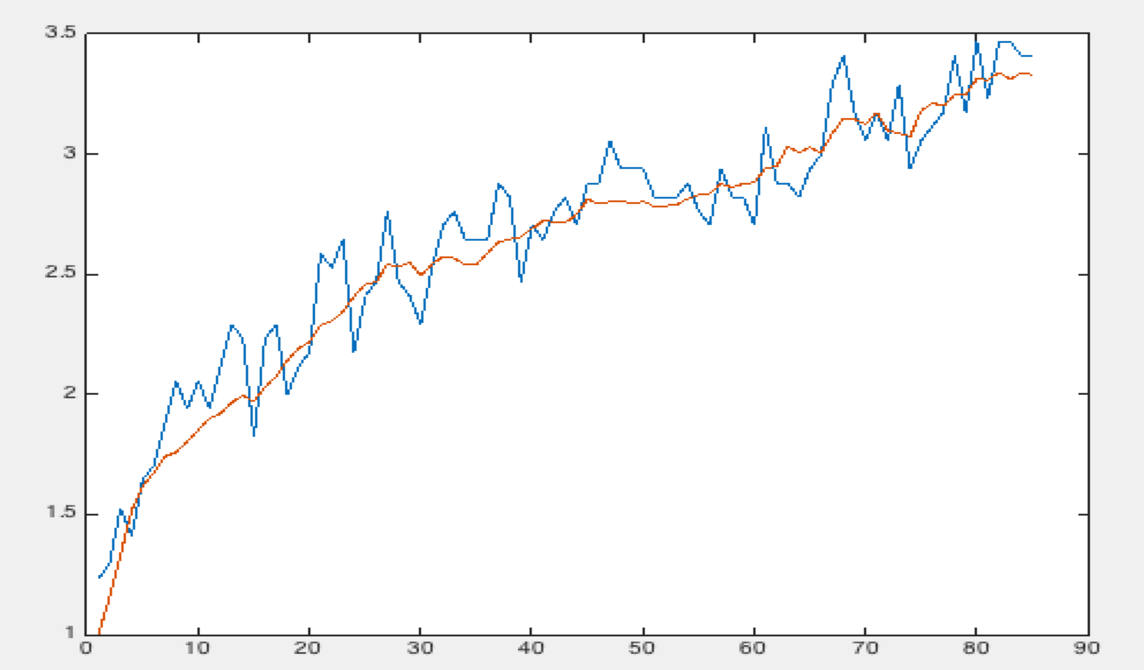

Figure 3: Example of a high progress trainee

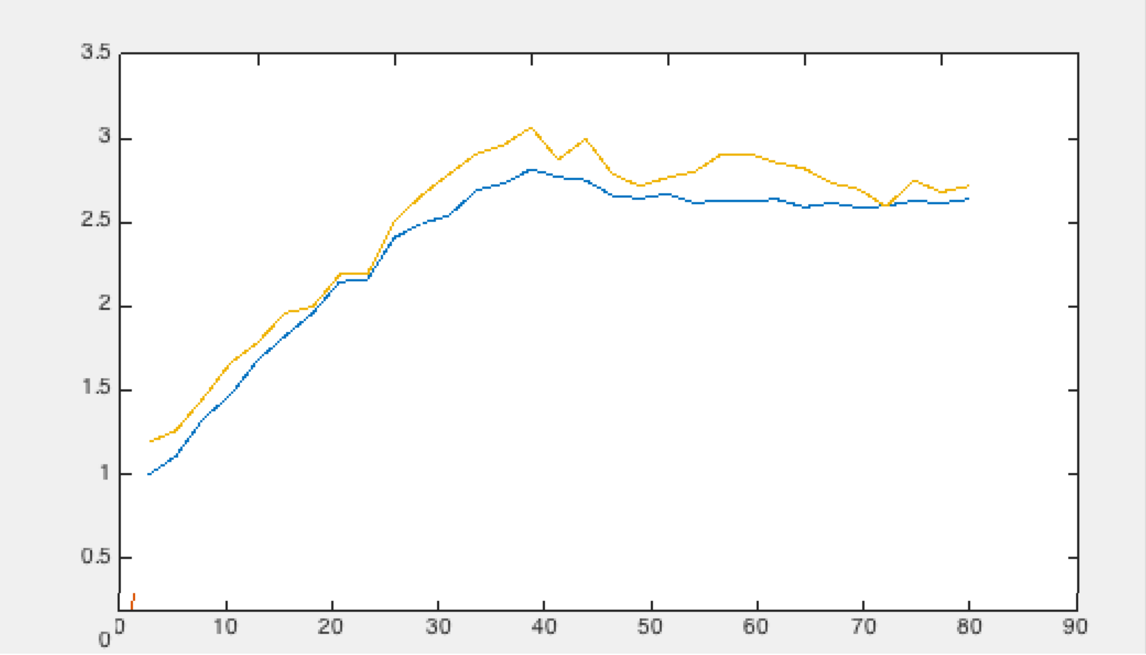

Figure 4: Example of a low progress trainee

Post-Test

- Average amount of time between completing training and post-testing was 7 days
- Control condition participants did not complete any training and returned for post testing 4 weeks after they completed their pre-test
- The tasks used at the post-test phase were the same tasks that were administered during the pre-test phase

Results

- *t*-tests were used to compare pre- and post-test scores on WM capacity tasks

Control (No contact)

- No significant improvements were found with any of the WM tasks

Recall the Game

- Marginal improvement was found in the OSPAN task, $t(15) = -1.852$, $p = .08$
- Trainees split based on progress made during training (see Figures 3 and 4)
  - **High progress trainees (N=8)**
    - Significant improvement in the OSPAN task, $t(7) = -3.362$, $p < .05$
    - Significant improvements found in the OSPAN/SSPAN Composite scores, $t(7) = -2.588$, $p < .05$
  - **Low progress trainees (N=8)**
    - No significant or marginal improvements seen in WM tasks

Ultimeyes

- Marginal improvement in the WRAML VWM task, $t(13) = -2.045$, $p = .06$
- Significant Improvement in the OSPAN task, $t(13) = -2.823$, $p < .05$
- Significant Improvement in the OSPAN/SSPAN composite scores, $t(12) = -3.120$, $p < .05$

Experiment 2

Method

Pre-Test

- Participants were college students recruited from California State University, San Bernardino
- The same WM capacity tasks were used as in Experiment 1
- Tasks were administered individually across two sessions: one 20 minute session and one 90 minute session
- VWM-WRAML scores were evaluated and participants with standard scores of 7 or below were invited to participate in cognitive training

Training

- The same training tasks were used as in Experiment 1
- Trained for approximately 11 hours over a period of 4 weeks

Post-Test

- The same tasks were administered in the pre-test as the post test over one 90 minute session

Results

- *t*-tests were used to compare pre- and post-test scores on WM capacity tasks

Recall the Game (N=12)

- Significant improvement in the WRAML VWM task, $t(11) = -2.959$, $p < .05$
- Marginal improvement in the OSPAN task, $t(11) = -1.992$, $p = .07$
- Significant improvement in the SPAN task, $t(11) = -4.177$, $p < .05$
- Significant improvement in the OSPAN/SSPAN Composite scores, $t(11) = -3.061$, $p < .05$

Ultimeyes (N=13)

- Significant improvement in the WRAML VWM task, $t(12) = -4.033$, $p < .05$

Summary and Conclusions

1. Our data suggests that targeted WM training using a gamified version of the *n*-back task can increase WM capacity.
2. Our data provides some evidence of far transfer effects in from WM training. Specifically, our visual attention training task (Ultimeyes) improved performance on the WRAML VWM task.
3. WM training appears to be the most effective if one of two important criteria are met: (1) The trainee is actively engaged throughout the training, and shows improvement on the training task, (2) The trainee has relatively low WM capacity.

References

- Available upon request.