Improvement of visual attention through a web-based training program

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Bay Area Neuroscience Gathering

January, 19, 2007, San Francisco, CA

Introduction

Though many studies have identified effective methods to improve cognitive abilities [1,2,3], most people do not have access to these methods.

We developed a web-based game-like program that makes cognitive training accessible to a larger audience. The program is composed of a set of exercises designed to improve attention, working memory, processing speed, and response inhibition among other executive processes.

Since cognitive training exercises can be tedious, our exercises are structured as engaging games to encourage long-term consistent use. Prior to this study, our novel approach to cognitive training had not yet been tested.

The goal of this pilot study is to explore the effectiveness of the visual attention component of the program.

Training Program Description

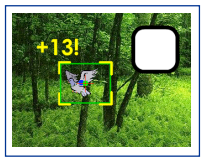
The training program consists of a set of exercises designed to train and improve attention, working memory, processing speed and executive function.

The program is composed of five discrete exercises. Each exercise was specifically developed to train one or more cognitive functions. Key components of the program are:

- Dynamic difficulty changes to consistently challenge each individual and enhance their progression
- Web-based platform ensures ease and ubiquity of access
- Game-like features and motivations (such as scoring, unlocking of levels, etc.) transform a tedious training task into an entertaining game, leading to better compliance and more effective training
- Simple self-instruction: No human trainer required

The Training Exercise Related to Visual Attention:

The *Birdwatching* game is designed to increase the spatial extent of visual information that can be processed in a short amount of time.



- Goal is to get high scores by accurately detecting the location of the brief stimulus (bird image)
- Difficulty adjustments made by decreasing stimulus duration (range: 30-200ms), increasing eccentricity of stimulus, and increasing non-relevant information

Methods

Single-arm design

Trained Participants: Pre-test (1 session) ◊ Training (daily for 5 weeks) ◊ Post-test (1 session)

Control Participants: Pre-test (1 session) ◊ no contact for duration of training ◊ Post-test (1 session)

Volunteers/Participants:

Trained: n = 14 (8 female), mean age = 57
Control: n = 8 (3 female), average age = 49
Recruited by email from various locations across US

Training

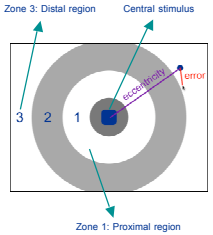
Each user trained alone without guidance using personal computer

Once daily for 5 weeks; Average number of sessions = 33, duration of each session = 5 min (embedded within 20 minute cognitive program), trials per session ~35.

Assessment

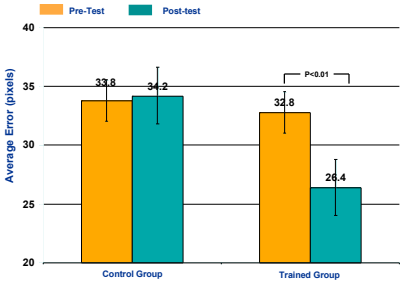
Pre- and Post-assessment is a web-based test of divided attention and processing speed.

User must simultaneously identify central stimulus and locate peripheral stimulus during 100ms presentation.



Results

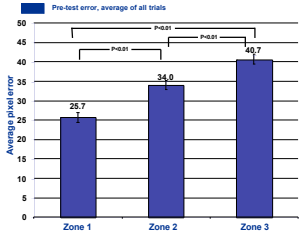
Trained subjects improved significantly



- Training reduced average error in localization of transient, non-central stimulus (p=.004, two-tailed t-Test)
- There was no significant change in average error in the control group

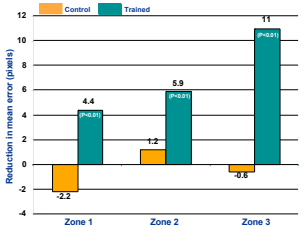
Trained participants performed better than controls in the untrained test of visual attention.

Mean error increases with eccentricity



- Distal zones have larger errors indicating that the test was effective as a measure of visual attention
- The average error in each zone was different than the average error in each of the other zones using the t-Test with Bonferroni correction

Improvement greatest on most difficult stimuli



- The trained group improved in all three zones (Bonferroni t-Test)
- No significant changes were observed in the control group
- Largest improvements after training were in the most distal stimuli

Discussion

- All participants were able to use the testing and training software from a personal computer without guidance.
- Compliance and qualitative feedback suggests that the game structure motivates frequent training (see poster: "Working memory improvement following web-based cognitive training")
- Trained subjects improved at the visual attention exercise (data not shown).
- Trained subjects also improved at the untrained visual attention test, suggesting that the program drives improvement that generalizes to other measures of visual attention and processing speed.

The results of this pilot study indicate that training and improving a fundamental cognitive ability such as visual attention is possible with a web-based application. The study also demonstrates the viability of conducting an entire study online, including intervention and assessment. We invite other researchers to consider or discuss potential applications to their own human behavior research.

References

1. Schaie, K., Willis, S., Hertzog, C., & Schulenberg, J. (1987). Effects of cognitive training on primary mental ability structure. *Psychology and Aging*, 2(3):233-242.
2. Ball, K., Berch, D., Helmers, K., et al., Effects of cognitive training interventions with older adults: A randomized controlled trial. *Journal of American Medical Association*, 288(18):2271-2281.
3. Green, S. & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, 423:534-537.

The Lumos Labs cognitive training program can be accessed at
http://www.lumoslabs.com/