Can Technology Enhance Healthy Lifestyles and Brain Fitness?

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Effects of Aging on Cognition

Performance declines with increasing age for Speed of Processing, Working Memory, and Long-Term Memory.

Performance is preserved over age for World Knowledge.

Park and Reuter-Lorenz, 2009
Model of cognitive decline in healthy and pathological aging

Sperling et al., 2011
Can we bend the curve with technology?
Is there evidence?

The New York Times

BUSINESS DAY | BUSINESS BRIEFING

Lumosity Game Developer Agrees to $2 Million Settlement

By THE ASSOCIATED PRESS JAN. 5, 2016
Cognitive Training Online

Many are loosely based on scientific research of the benefits of training in specific cognitive domains.

Scientists delve into research

Game Designers bring to life

What does the science say?
Online Cognitive Training

Using Lumosity vs. crossword puzzles

- Over 4000 participants, ages 18 – 80 were randomly assigned to training with Lumosity tasks or crossword puzzles
- Tests of cognitive abilities were evaluated before and after training with 5 sessions per week over 10 weeks
- Cognitive training showed small but significant benefits after 20 days over crossword puzzles that increased over time

Hardy et al., 2015
What have we learned from the ACTIVE trial so far?

• After following over 2800 participants over 10 years, all groups declined.

• Each type of training led to improvements in the trained ability that dissipated but persisted years later.

• Cognitive training effects on daily functions were small but sustained benefits were observed even 10 years later.

Willis et al., 2006; Rebok et al., 2014
Cognitive training increases brain plasticity in healthy older adults

- Research used MRI to test cognitive training over 12 weeks in 37 healthy older adults randomly assigned to training and control groups.

- Training effects on brain blood flow and connectivity assessed at baseline (T1), mid (T2), and post-training (T3).

- Cognitive training increased brain blood flow and connectivity, showing greater neuroplasticity, even though cognitive benefits were small.

Chapman et al., 2013
NeuroRacer: A technological advance?

Anguera et al., 2013
Animal Studies

May provide models that help us enhance brain training:
Cage enrichment is low-tech cognitive training

Enrichment led to new neurons in the hippocampus

Voss et al., 2013; Kempermann et al., 2010
Additive effects of exercise and enrichment in mice

Exercise plus cognitive challenges enhances neuron growth

Fabel et al., 2010; Kempermann et al., 2010
Why?

Wild rodents do not live in cages with a running wheel...
...and neither do humans
Exercise Increases Brain Volume in Areas Affected by Aging

Healthy older adults assigned to exercise for 6-months, 3 hrs/week

Pattern of brain atrophy from 20 to 84 years with frontal regions most affected

Can animal models help us create new technology-based interventions for humans?

Alexander et al., 2006; Bergfield et al., 2010

Colcombe et al., 2006
Translating Benefits to Humans

Indoor exercise in impoverished environments

How to enrich environments for humans?
Enhancing the Exercise Experience
Evidence in Humans

Mild cognitive stresses + exercise

Anderson-Hanley et al., 2012
Target specific cognitive domains and neural systems linked to brain aging and physical activity:

1) Executive functions
   • Inhibition & Shifting
   • Working memory

2) Long-term memory

3) Processing speed

4) Spatial navigation
Aerobic and Cognitive Training (ACT) System

- Tablet-based software used on exercise equipment
- Hand-held controllers to control turning and to respond to tasks
- Speed can be controlled by heart rate
Preliminary ACT Study Underway

Goal: Determine the benefits of simultaneous exercise and cognitive training

- Randomized controlled trial of healthy older adults, ages 60 – 74
- Training 3 times per week over 12 weeks
- Cognitive tests and ratings assessed at baseline, 6 weeks, and 12 weeks
- Evaluate change between groups on memory, executive function, processing speed & self-ratings
Early Results: Baseline vs. 6-week

Word-List Learning and Memory

*Group x time interaction, p < 0.035
Conclusions

- Cognitive training alone seems to show significant, but small, effects.

- Simultaneous exercise and cognitive training takes advantage of how we use our brain in natural world and may boost the benefits of cognitive training.

- Technology can help combine exercise and cognitive training to improve the aging brain.
Suggestions for Daily Life

• Stay informed on the research behind new technologies to support cognitive and brain health

• Before purchasing or trying out new technology, ask about the scientific evidence to support the claims

• Look for emerging technologies that challenge you to engage the world in new and interesting ways
Thank You Supporters!