

Using the Web for Behavioral Research and Intervention: Evidence from Cognitive Training

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Introduction

The internet may be a powerful tool for expediting human research and behavioral intervention. Among the benefits of using the web instead of traditional in-lab methods are:

- Automation: fewer experimenter resources are needed, leading to faster and cheaper research
- Subject diversity: not limited to college students [1]
- Large number of subjects possible: could reveal subtle effects

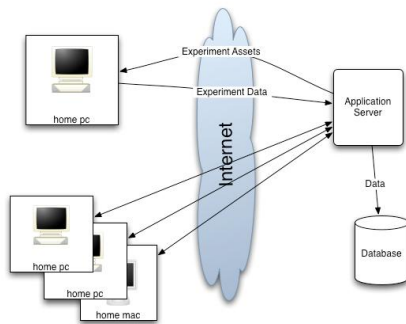
However, a number of challenges arise with web-based intervention:

- Enforcing and monitoring subject compliance [2]
- Environment and system variability between subjects
- Ensuring accurate data collection
- Communicating instructions in text is problematic [2]

We developed a web-based research and intervention platform, and conducted a proof-of-principle study to show that the internet can be an effective medium for conducting research. Here we attempt to address each of the above challenges.

Is it feasible and efficient to conduct assessment, intervention, and data collection entirely online?

Methods



Presentation: Experimental assets (including tests, training games, and instructions) are presented on any common web browser on each subject's home computer.

Administration: The Application Server is controlled by the experimenter and sends the appropriate materials to each subject's home computer.

Data: Following completion of each activity, data is sent from the subject's computer to the Database. Usage and progress can be monitored throughout the experiment. An example:

Subject ID	Game ID	User Level	Difficulty	Game Score	#Correct	#Trials	Error(pixels)	Timestamp
1023	Birdwatching	4	4	2712	18	27	22.8	8/1/2007 20:00

Experiments and Results

Study 1: Training cognitive abilities in adults

Goal of research

Can web-based exercises improve cognitive function in healthy adults?

Research led by Michael Scanlon of Lumos Labs.

Reasons to use web

- Intervention intended for web distribution
- Increased efficiency of research
- Accessibility for older subjects

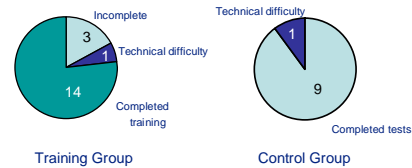
Experimental design

Intervention: Lumosity cognitive exercises. 20 minutes/day, 29.2 days.

Assessment: Web based cognitive tests.

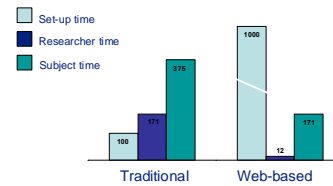
Subjects: 28 volunteers (mean age=54), recruited by email, trained using personal computer.

Compliance



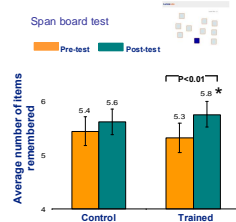
- 82% of subjects completed all stages of the study
- Game structure and accessibility may encourage compliance

Efficiency (estimated hours)

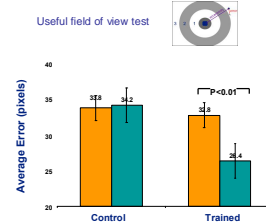


- 159 hours save by experimenter and 204 by subjects
- Substantial set up time for web application

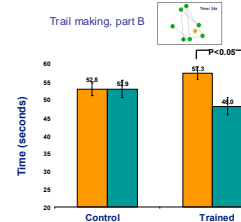
Spatial working memory



Visual attention



Executive processing



Study 2: Chemobrain rehabilitation in children (in progress)

Goal of research

Can computer exercises remediate cognitive deficits in children who have undergone chemotherapy?

Research led by Dr. Shelli Kesler at Stanford.

Reasons to use web

- Duration of intervention
- Subjects can drive
- Need to monitor compliance
- Finding appropriate subjects
- Number of subjects

Experimental design

Intervention: Memory and reasoning exercises from Lumosity for 20 minutes/day, 60 days.

Assessment: neuropsychological test battery in person.

Subjects: 180 recent chemo patients (10 currently enrolled, age 9-16).

Study 3: Training under-performing students in India (in progress)

Goal of research

Can computer-based cognitive exercises help under-performing students perform better?

Research led by Dr. Anjan Basu at the Step One Foundation, Kolkata, India.

Reasons to use web

- Cost effective
- Subjects are far away (India)
- Duration of intervention
- Small research facility

Experimental Design

Intervention: Lumosity guided trainer for 30 minutes/day, 30 days.

Assessment: neuropsychological test battery in online application.

Subjects: 45 middle school students.

Discussion

This research demonstrates the viability of running a cognitive intervention and assessment experiment on the internet. We have begun to address some of our main concerns with this approach:

Usability: Participants were able to complete the testing and training from a personal computer without guidance.

Compliance: 78% of the training group completed all stages of the experiment; compliance may increase with email reminders.

Data collection: Training and testing data was captured by the server-side database, allowing us to monitor subject compliance.

Effective intervention: Participants in the training program improved non-trained measures of spatial working memory, visual attention, and executive function.

We identified important considerations for web-based research:

Environmental variability: All comparisons are within-subject paired t-Tests.

Instructions: User interface and text must be clear and simple.

Could this platform be useful in your research?

While the development of an online software application is impractical for most labs, we are making our application more widely available. We are currently expanding this online platform to make it easier for other researchers to design and conduct their own experiments.

The application is most useful for certain types of studies:

- Large number of human subjects
- Studies requiring more than one session for each subject, such as an intervention study or longitudinal study
- Testing or intervention must be adaptable to a computer

References

- Robert A. Peterson (2001). On the Use of College Students in Social Science Research: Insights from a Second-Order Meta-analysis. *Journal of Consumer Research*, volume 28: 450-461.
- Lenert, L. Munoz, R., Stoddard, J., Delucchi, K., Bansod, A., Skoczen, S., & Perez-Stable, E. (2003). Design and pilot evaluation of an internet smoking cessation program. *J Am Med Inform Assoc.*, 10: 16-20.

The Lumosity cognitive training program can be accessed via <http://www.lumosity.com/>

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