RESEARCH PROPOSAL

Effect of Brain Training through Lumosity™ on Flexibility in College Students

PROJECT BACKGROUND AND RATIONALE

With the growth in personal technology, there has been an increased effort in using technology to improve both physical and mental health, and to maximize learning. In fact, the Centers for Medicare and Medicaid services have recently started seeking proposals to reimburse costs of certain cognitive trainings (Parker-Pope, 2014). There are many brain-training programs on the market that claim to increase cognitive function, one the most popular of these being Lumosity.com™, with 50 million subscribers in 180 countries (Parker-Pope, 2014). Promotional material for Lumosity.com™ makes strong claims for its effectiveness across the lifespan:

> "Any brain can get better. And Lumosity.com can help. It's like a personal trainer for your brain, improving your performance through the science of neuroplasticity. But in a way, it just feels like games. Start training with Lumosity.com right now and discover what your brain can do."

However, limited scientific evidence exists to support the advertised claim that cognitive training can have widespread and transferable benefits. Groups have assessed the ability of Lumosity™ to improve deficits in survivors of severe traumatic brain injury (Zickefoose, 2013) or epilepsy (Koorenhof, 2011). They found that while participants did show significant improvements in the trainings, these skills had limited generalization on tests outside of the games. Research that shows the positive effects of Lumosity™ training in middle aged adults comes from employees of Lumosity™'s research division Lumos Labs, and thus must be evaluated for bias (Hardy, 2011; Sternberg 2013).

If Lumosity's™ trainings can in fact produce the claimed effects, it is important to determine which aspects of the program are contributing to this. When signing up for Lumosity™, the program provides a series of options outlining skills that can be targeted for improvement. These include "Memory", "Attention", "Speed", "Problem solving" and "Flexibility." During a Fall 2013 special topics course in Molecular Neurobiology, the students in Dr. Kaur's class were challenged to identify two of these five factors, based on the Lumosity™ definitions. They identified "Flexibility," also known as cognitive shifting, as one of the two skills central to success in the classroom and the study described below was based on their consensus.

Current research supports the idea that flexibility is closely related to learning, at least in young school children (Bull & Scerif, 2001; Cartwright, 2002; Yeniad et al., 2013; Kieffer et al., 2013). In studies looking at groups affected by various psychological disorders, flexibility has also been shown to be an important factor in emotional health (Johnco et al., 2014; Brockmeyer et al., 2013; Wykes et al., 2002; Go€k"cen et al., 2014). Very few studies have looked at explicitly training flexibility, especially in the general population, but the limited research seems to indicate that flexibility is a skill that can be enhanced (Brockmeyer et al., 2013; Glass et al., 2013; Masley et al., 2009; Wkyes et al., 2002). However, there is little evidence to suggest that the relevant training would result in widespread improvements in cognition and in fact, flexibility may not be correlated with general intelligence at all (Friedman et al., 2006).

Thus, there is a clear need for unbiased third party run studies that probe the effectiveness of Lumosity™ training, compared to other cognitively challenging tasks, in building transferrable skills. We aim to undertake this project to assess whether Lumosity™ can build transferable cognitive skills in college students aged 18-24.

PROJECT DESCRIPTION

Our study proposes to examine the ability of training with Lumosity™ to increase flexibility in tasks outside of the Lumosity™ website for college students at UNC Asheville. Our proposed experiments are designed to isolate specific training tasks within Lumosity™ that are geared towards flexibility and compare pre and post test scores on non-Lumosity™ based assessments that evaluate global changes in flexibility and fluid intelligence in participants.

All participants will be undergraduate students at UNC Asheville, ages 18-24, of both sexes and will not have used Lumosity™ for more than a continuous week prior to joining the experiment. After signing informed consent forms and answering a survey to establish participant characteristics, students will be randomly distributed into one of four groups – No Contact control, Alternate Task control, Crystallized Intelligence Task and 3-5 per Week test group. The experiment will begin with all participants completing a pre-test. Training will last for 6 weeks, after which participants will complete a post-test. The level to which skills built within the Lumosity™ format are transferred to other flexibility and fluid intelligence tests will be assessed. The data will be statistically analyzed to observe any training based skill transference and to account for differences in background and any role it might play in skill transference. This set up will allow us to test whether other cognitively challenging tasks (our case, Sudoku puzzles or crystallized intelligence tasks) are lacking compared to Lumosity™'s specifically designed brain-training games. Our data will be submitted to a peer reviewed journal to show from an unbiased third party experiment whether Lumosity ™ training does more than just increase your ability to play those particular games more effectively. Additionally, it provides an opportunity to comment on the use of brain training games and similar programs in pedagogy at the college level. This project should provide insight on the mechanisms that underlie cognitive flexibility, and how it is integrated into the overall behavioral output system.

We will present our findings at the fall undergraduate research symposium as well as the Synapse neuroscience conference held at UNCA in March.

MATERIALS/EQUIPMENT

1. Computers to run Lumosity™ training*
2. Memberships to Lumosity™ for student participants
3. Sudoku puzzles for control participants*
4. Pre/Post tests to assess transference of skills*
5. Participants (aim to recruit at least 100 students)*
6. Office supplies*

*Funding not requested for these expenses, should have materials on hand for this.

RATIONALE FOR PRE AND POST TESTS

The pre and posttest batteries will consist of the Stroop Task, Raven's Advanced Progressive Matrices (RAPM), and the Paper Folding Task. In the studies, on which this current study bases most of its methodological and theoretical foundations, these tasks have all been used to measure the same cognitive factors we are targeting (Jaeggi et al., 2008; Redick et al. 2013).

The Stroop Task is one of the most prolific tasks in psychological study with more than 700 related articles relating to attention, conflict, decision making, and automaticity since J.R. Stroop's original dissertation (MacLeod, 1991). In this study, the scores on the Stroop task are meant to index the level of cognitive flexibility in participants. The classic Stroop task and/or variations of it have been used to measure flexibility in many studies before, either independently or as a component of a battery of tasks (Glass et al., 2013; Johnco et al., 2013; Sato et al., 2013).

Fluid intelligence will be measured with two tasks: the RAPM, and the paper folding task. Due to a positive inter-correlation between them, both tasks have been successfully used together in batteries to

measure general or fluid intelligence (Johnson et al., 2004; Johnson et al., 2008). The RAPM has been widely used in measuring general intelligence (Raven, 2003). Paper folding is used to assess an individual's spatial reasoning abilities which have been linked to general cognitive factors (Boonen et al, 2014; Ekstrom et al., 1976; Tosto et al., 2014; Turner et al., 2007).

DETAILED BUDGET WITH NARRATIVE JUSTIFICATION

Lumosity™ is a highly popular and well-advertised brain-training system that is easily accessible on computers and hand-held devices, making it a great choice for a platform to test claims of widespread transfer from cognitive training. In order to appropriately track the training habits of participants as well as their progress over the training period we would like to provide a fully paid membership to Lumosity™ for each participant in the test group. A full access membership to Lumosity™ includes the ability to personalize training regimes, so we can focus on flexibility building tasks, training reminders, access to the full inventory of brain training games and a large reserve of training data. With a full membership, Lumosity™ will keep a detailed history of training, allow us to compare collected data for each participant against other Lumosity™ users, gain access to additional assessment tools, and run the study multiples times over the next year with different cohorts of participants.

1. Lumosity™ memberships for participants
   "Yearly Family Access" allows 5 participants a full membership for a fee of **$129.99** for a year (allowing the reuse of a membership to run the test multiple times with new participants).

   We are requesting 4 family memberships to account for our 20 participants in the everyday Lumosity test group. This would total to a cost of **$519.96**.

The Lumosity accounts will be purchased either by Dr. Foo or through the undergraduate research office. At the end of each semester, passwords will be changed by Dr. Foo or another faculty member in the psychology department so that the accounts will not be accessible outside of the department.

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