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**Effects of Internet Based Training on Cognition in Older Adults**

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**PSY625: Biological Bases of Behavior**

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Effects of Internet Based Training on Cognition in Older Adults

**Specific Aims**

The idea that maintaining high levels of cognitive activity protects the brain from neurodegeneration is not new, and much evidence has accumulated that people with high levels of cognitive ability and activity tend to maintain cognitive function well as they age (Hertzog et al. 2009). Beyond the idea of maintaining cognitive function in healthy aging, studies such as Verghese et al. (2003) found that higher levels of cognitive activity were associated with lower rates of dementia in a 21- year longitudinal study. While much of the data indicating higher levels of cognitive activity leads to better long-term function is necessarily correlational, a number of studies have begun to systematically assess the effect of cognitive interventions on cognitive function. The largest of these, the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE; Jobe et al. 2001) has found long lasting effects (5 years; Willis et al. 2006) of relatively short cognitive training activities (10 hours).

The specific aim of this proposal is to assess the effectiveness of A Fictitious Brain Training Program on research participants followed longitudinally who may be experiencing the very earliest signs of cognitive decline. Recent research tracking the trajectory of age related cognitive decline (e.g., Mungas et al. 2010) has suggested that it may be possible to identify cognitively healthy individuals at risk for significant imminent cognitive decline by examining baseline cognitive assessments or recent change, even though test scores do not reach the abnormal range.

**Background**

Techniques for maintaining and enhancing cognitive function in an increasingly aging population are of great potential benefit to those who might suffer from Alzheimer’s disease and related disorders and also to society as a whole. Higher cognitive function leads to better maintenance of activities of daily life, less need for chronic care, and direct improvements in quality of life. Research examining effective methods for cognitive enhancement is becoming increasingly prevalent and has led to a number of recent review studies, e.g., Hertzog et al. (2009), Lustig et al. (2009), Green & Bavalier (2008). These studies review evidence from both longitudinal studies of increased levels of mental activity on maintenance of cognitive function and intervention studies aimed at directly improving cognition with targeted cognitive training. For these cognitive interventions to provide widespread benefit, it is critical to identify who will gain from cognitive intervention studies and to assess methods of administering effective cognitive training.

In a large scale cognitive intervention study (ACTIVE), Ball et al. (2002) found that training increased cognitive function with as little as 10 hours of task-specific training and these gains were still evident 5 years later (Willis et al. 2006). However, none of the three types of training used in that study were found to generalize to the other types of cognitive function. Participants were trained on either verbal episodic memory, reasoning (pattern identification), or speed-of-processing (visual search skills). Gains were observed in the domain of training, but not on the other two domains. As noted by Salthouse (2006), this result is inconsistent with the strongest form of the “use it or lose it” hypothesis. However, it does hold promise for cognitive training interventions that train broadly across a wide variety of domains. The hypotheses implied by the “use it or lose it” hypothesis is that cognitive training is protective broadly against the cognitive decline associated with aging. The more commonly observed specific areas of training improvement suggest an analogy to physical fitness training: the brain should not be thought of as a single “muscle” to be strengthened but as a collection of individual abilities that could each be improved through “exercise.” In addition, the analogy could be extended to the idea that cognitive training “exercise” should be thought of as an activity to be engaged in on a regular basis, not as a single intervention.

The cognitive training that will be used in the proposed project is based on an internet delivered set of activities designed by the company BrainExercise. The training is based on practice across a wide range of cognitive abilities, and by being highly available via the internet, is also available for regular follow-up re-training to maintain benefits. With this type of intervention, even if a cognitive intervention training does not provide a global benefit and delay decline across all types of cognition, training can be used across many areas to increase overall function. The ability to deliver cognitive training via the internet becomes important logistically since the benefit of training may depend on regular access to a broad array of cognitive activities. In the successful ACTIVE study, training was administered in face-to-face sessions requiring significant personnel and logistical support.

The issue of identifying tasks suitable for cognitive training with memory-impaired patients is an important one. In a follow-up reanalysis of the ACTIVE study data, Unverzagt et al. (2007) found that patients scoring >1.5 standard deviations low on memory tests did not benefit from the verbal episodic memory training in ACTIVE. In addition to seeing cognitive training as a method for delaying or reducing the onset of memory disorders such as MCI or AD (as in Verghese et al. 2003), suitable interventions to try to rehabilitate memory function or train compensatory strategies may provide an important benefit to MCI and AD patients.

Numerous studies have suggested that elderly who are currently cognitively within the normal range, but on the lower end of the range are at risk for subsequent cognitive decline, including the development of Alzheimer’s Disease (Rubin et al, 1998; Sliwinski, Lipton, Buschke, & Stewart, 1996).

Older participants who score within normal cognitive ranges but who exhibit personal cognitive decline within that normal range are also at higher risk for the later development of Alzheimer’s Disease (Villemagne et al, 2008; Collie et al, 2001). The most at-risk group of currently healthy elderly may be those who have shown some cognitive decline and are now at the bottom of the healthy range. Since this proposal is to investigate at the effectiveness of cognitive training in patients at risk for Alzheimer’s Disease, the ideal comparison groups are healthy older adults who are at increased risk relative to their age group (cognitively normal, but lower scoring) and those who are cognitively normal and exhibiting no current evidence of memory impairment.

**Significance**

The proposed research will use an online-based software company to administer a structured intervention of cognitive skill training to patients experiencing some memory decline. Prior intervention studies have typically provided cognitive training in individual or small-group environments with the patients physically present with a trainer. If interventions based on training via the internet are shown to have similar benefits, many more people can gain these benefits since the labor involved in administering this type of training is much lower. In addition, improvements in the type of training administered can be made centrally and more quickly positively impact many more patients. For the pilot intervention study proposed here, we will be working with the Brain Science division at A Fictitious Company. The Fictitious program is a home-based, computerized, cognitive training program in which a customized training plan is developed for each participant based on an initial baseline cognitive assessment and ongoing training progress. The training plan is based on 21 different tasks that each focus on one or two of 14 different specific cognitive abilities. To collaborate on examining the effectiveness of their training plan, they are making available licenses for all study participants to access the training program without cost. In addition, all performance data on all compliance, cognitive assessments and performance on training components will be available for collaborative analysis to assess efficacy of specific training elements in our study population.

The ability to deliver cognitive training via the internet holds tremendous promise for making training benefits available widely. Concerns about the task-specificity of benefits and the need for consistent training to maintain cognitive function can be met by making training easily available at home. The proposed research will work with the cognitive science research group of the A Fictitious company to assess the effectiveness of their targeted, individually customized cognitive training methods to improve cognitive functions in patients engaged in long-term outcome research at the Brain Center at an Important University.

**Proposed Study**

**Participants:**

Forty cognitively normal participants will be recruited, including 20 participants scoring 1 SD below age and IQ-adjusted norms on neuropsychological tests of memory (Rentz et al. 2004), and 20 participants scoring no worse than .5 SD below adjusted norms. Participants will be recruited from A University. The patients will be randomly assigned to two groups: intervention and waitlist (baseline) control. The intervention group will receive cognitive training via Fictitious Brain Training Program over a two month period. The waitlist control will not initially receive training. However, since we expect that the training will provide benefits to the patients, participants in the waitlist control group will be given access to the Fictitious Brain Training Program software at the end of the protocol following the “post-training” assessment. This ensures fair and ethical treatment of groups as well as providing additional data about the effectiveness of the Fictitious Brain Training Program.

There are no major risks to patients who participate in the research. The training program is designed to be self-paced so that patients can manage fatigue or frustration. Patients may elect to stop participating in the study at any time. The potential benefits of the proposed research are considerable. The study protocol may provide a treatment to slow or reverse the cognitive decline associated with MCI (and Alzheimer’s Disease) using the internet, making this treatment broadly and inexpensively accessible.

**Procedures:**

Once identified as a candidate for enrollment, patients will be met with in person at their residence. Patients will have the training protocol described and provide informed consent if they wish to enroll. Availability of necessary internet access will be assessed. Once enrolled, patients will be provided with a license to access The Brain Training Program and a research assistant will guide them through the initial setup process. The intervention will follow the standard Brain Training Program practice: initial assessment on a range of cognitive functions followed by 24 20-minute training sessions over approximately 8 weeks. The rate of training sessions recommended is 3 sessions per week but is ultimately chosen by the patient.

These sessions are followed by a re-assessment within the Brain Training Program of performance on their identified group of 14 cognitive functions.

Participants’ self-rating of quality of life will be assessed with a Quality of Life-Alzheimer’s disease (QoL-AD) scale described by Logson et al. (2002). While the current participants do not require an assessment of quality of life appropriate for cognitively impaired individuals, all cognitive training improvement in these participants will also be compared with a group of patients who have a diagnosis of MCI and who are currently involved on an ongoing assessment of A Fictitious Brain Training Program. The same set of performance improvement instruments will be used in both studies to provide maximum comparability across all groups.

**Hypotheses & Analysis:**

The intervention group is expected to exhibit reliably higher scores on all post-training assessments than the waitlist control group. Scores on the Fictitious Brain Training Program cognitive assessments are very likely to improve reflecting the training invested in those specific cognitive tasks. Improvements on specific cognitive assessments will be compared to estimates of improved domain-specific performance available via the Brain Training Program.

For the current population of cognitively normal participants who might be showing the first signs of memory impairment, changes in self-rating of their quality of life (via the QoL-AD) will be examined carefully. While improvements in activities of daily life may not be significantly improved as these patients are not generally impaired, increases in general cognitive function may lead to better overall quality of life by improving problem solving, language comprehension and general attention skills. Improvements on this measure would be a key indicator of the potential of cognitive training to provide significant benefits to older adults.

Assessment of improvement will be made for only participants who complete the training course of 24 sessions. Performance of patients who do not complete the training will not indicate whether the training is effective at improving cognitive function. However, the drop-out rate is a key element to assess for evaluating the overall effectiveness of internet-delivered cognitive training. High rates of drop-out (e.g., >25%) may indicate that the cognitive training needs to be adjusted in difficulty to meet the needs of older adults or that additional support (e.g., more patient contact) is needed to guide the patients through the training. An important element of the current project is the assessment of difficulty of completing the training and obtaining feedback from participants about their experiences with the online cognitive training.

**Budget Justification**

Funding is requested for a half-time graduate research assistant to be responsible for all aspects of subject recruitment, training and data collection. Addition funding of 10% is requested for the principal investigator who will oversee the study and conduct data analysis and publication of results.

Travel funding is requested for the PI to attend one national meeting to present the preliminary results of the study. Additional travel expenses are requested to pay for costs of transportation by the research assistant to each subject’s home.

Subject payment of $50 for each subject (40 total) is requested to reimburse subjects for their participation time.

Funding is requested for an Apple Laptop computer (15” with retina display, 2.8 GHz processor, 1 TB hard drive) that will be used for data collection and analysis. Additional funding will be used to purchase the Quality of Life Scale and office supplies.

See Appendix A: Budget for detailed budget figures.

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**Appendix A: Budget**

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| **SUMMARY PROPOSAL BUDGET**  | **FOR INSTITUTION USE ONLY** |
| ORGANIZATION      | PROPOSAL NO. | DURATION (MONTHS) |
| PRINCIPAL INVESTIGATOR (PI)/PROJECT DIRECTORInstructor B. Jones, PhD | AWARD NO. |  |
| A. PERSONNEL: PI/PD, Co-PIs, Faculty, Graduate Assistants, etc.  | Funds |
|  List each separately with name and title.  | Requested By |
|  | Proposer |
|  1. Instructor B. Jones, PhD ($90,000/year) - 10% effort for 12 months |  $9,000 |
|  2. Research Assistant (RA) - 50% effort for 12 months |  $25,000 |
| TOTAL SALARIES |  |  $34,000 |
| B. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) |  |
| None |  |
|       |  |
|       |  |
|  TOTAL EQUIPMENT | $0 |
| C. TRAVEL | 1. DOMESTIC - PI attendance at national meeting | $1,500 |
|  | 2. OTHER - Travel for RA to participants home | $1,000 |
| TOTALTRAVEL |  | $2,500 |
| D. PARTICIPANT SUPPORT | $2,000 |
|  1. STIPENDS | $ | 50  |  |  |
|  2. TRAVEL |  |  |  |  |
|  3. SUBSISTENCE |  |       |  |  |
|  4. OTHER |  |       |  |  |
|  TOTAL NUMBER OF PARTICIPANTS (40) TOTAL PARTICIPANT COSTS | $2000 |
| E. OTHER DIRECT COSTS |  |
|  1. MATERIALS AND SUPPLIES- Computer for patient training, data collection and analysis | $3200 |
|  2. OTHER Quality of Life scale | $1200 |
|  3 OTHER Office supplies | $736 |
|  4. OTHER       |       |
|  TOTAL OTHER DIRECT COSTS | $5,136 |
| F. TOTAL DIRECT COSTS (A THROUGH E) | $43,636 |
| G. TOTAL INDIRECT COSTS (F&A) (Rate = 37.5%) | $16,364 |
| **H. TOTAL DIRECT AND INDIRECT COSTS (F + G)** | **$60,000** |