

# **MPC Corporation**

## **Annual Progress Report: 2007 Formula Grant**

### **Reporting Period**

July 1, 2009 – June 30, 2010

### **Formula Grant Overview**

The MPC Corporation received \$136,227 in formula funds for the grant award period January 1, 2008, through June 30, 2011. Accomplishments for the reporting period are described below.

### **Research Project 1: Project Title and Purpose**

*Brain Pathways to Cardiovascular Health* - The purpose of this project is to use noninvasive brain imaging methods to determine the human brain systems that mediate individual differences in blood pressure reactions to mental stress. Research suggests that individuals who show large-magnitude increases in blood pressure during mental stress are at increased risk for developing coronary heart disease (CHD). From a public health perspective, the importance of this project is that it will help to determine the brain pathways by which mental stress may influence CHD risk. It may also reveal markers of stress-related brain activity that could be objectively measured and possibly targeted for modification in people at risk for CHD.

### **Anticipated Duration of Project**

1/1/2008 - 6/30/2011

### **Project Overview**

Coronary heart disease (CHD) is the leading cause of premature disability and death in the United States. CHD progresses slowly over the lifespan, with clinical symptoms (e.g., angina) and events (e.g., myocardial infarction) often occurring late in life. From the perspectives of prevention and intervention, it is important to identify early risk factors for CHD. There are several known and interacting genetic, behavioral, and psychosocial risk factors for CHD. Cumulative evidence shows that increased CHD risk is associated with a person's tendency to exhibit large cardiovascular reactions (e.g., large rises in blood pressure) to acute mental challenges or stressors. When expressed recurrently over the lifespan, such cardiovascular reactions may increase risk for CHD. The objective of this project is to explicate the human brain pathways by which mental stress may lead to cardiovascular reactions associated with CHD risk. This study will assess (1) mental challenge-induced blood pressure changes, (2) functional brain activity assessed noninvasively by functional magnetic resonance imaging, and (3) known behavioral and psychosocial CHD risk factors in 20 men and 20 women (aged 20-40 years) who do not have a cardiovascular disease. Aim 1 tests the prediction that larger-magnitude blood pressure reactions to the stressors will be associated with greater brain activation (as revealed by

greater functional magnetic resonance imaging [fMRI] blood oxygen level-dependent [BOLD] responses) in the cingulate cortex, the anterior insula, and the amygdala. Aim 2 tests the prediction that greater activation in these brain areas to the stressors will be associated with a specific psychosocial CHD risk factor, self-reported symptoms of depression. This project is designed to specify the brain pathways that may link mental stress to exaggerated blood pressure reactions and CHD risk. The information provided by this project may identify patterns of stress-related brain activity that could be targeted for intervention in people at risk for CHD.

### **Principal Investigator**

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### **Other Participating Researchers**

Howard J. Aizenstein, MD, PhD, Lei K. Sheu, PhD, Allison M. Remo, MSc, Megan Nable, BS - employed by University of Pittsburgh

### **Expected Research Outcomes and Benefits**

This project is expected to lead to a greater understanding of how the human brain links stressful experiences with the risk for developing coronary heart disease (CHD). CHD is known to result from a number of interacting genetic, behavioral, dietary, and social influences. It has also long been suspected that the experience of mental stress among some individuals may lead to changes in cardiovascular activity (e.g., rises in blood pressure) that could contribute to risk for CHD over the lifespan. But exactly how the brain links mental stress with bodily changes that could cause cardiovascular problems has been studied mostly in animals. This brain imaging project in humans is expected to demonstrate that blood pressure rises excessively during stress, which has been associated with early hypertension and atherosclerosis, and will relate to patterns of activity in brain areas that control the body's stress-response systems. As a result, the benefits of this project would be a better understanding of the brain-body pathways that underlie a person's vulnerability for CHD. In the distant future, and with continued study, it is feasible that people's health status could be improved through interventions designed to reduce CHD risk by modifying or altering specific patterns of brain activity associated with mental stress and related cardiovascular changes among some individuals prone to CHD.

### **Summary of Research Completed**

The current project began recruitment and testing in January 2008. Since then, we have used the funds toward covering the costs of MRI scanning time, employing research associates, and purchasing computer equipment. In the next year, we will continue with data entry, reduction, and analysis procedures. These are to be overseen by the principal investigator (Peter J.

Gianaros) and the project statistician (Lei K. Sheu). The individuals tested in the current neuroimaging study provide measures of cardiovascular (e.g., heart rate and blood pressure) reactivity to mental stress tasks that they complete inside the MRI scanner; responses to questionnaires about personality traits, health habits, and demographics; and brain imaging data.

All participants who consented to participate thus far were seen by Sara Snyder for the MRI scanning session. At this session, Ms. Snyder conducted a brief medical and health behavior interview, explained the study protocol, and conducted the neuroimaging protocol with an MR technician. She then debriefed the participants and collated data for electronic entry and analysis.

Brain imaging data have been transferred from the MRI center to Dr. Gianaros' laboratory at the University of Pittsburgh, and have been stored and archived. Paper and pencil measures are in the process of being entered by Ms. Snyder. These data will enable us to examine levels of brain activation and cardiovascular responses to the stress tasks and to quantify the relationship between behavioral and biological risk factors for CVD with brain imaging and questionnaire data. These measures will permit an examination of how stress influences neural activity, possibly providing a better understanding of the neurobiological pathways for the increased susceptibility to cardiovascular disease.

To validate the efficacy of the stress tasks that are completed in the MRI scanner, all participants have completed rating scales to assess their level of positive versus negative emotion, arousal level, and sense of control. We have also assessed performance in the "stressful" and "non-stressful" conditions of the mental stress tasks, termed the Stoop and MSIT tasks. These data have been entered in a database, and an initial examination of the data for the subjects who have been completed the MRI scanning protocol shows that participants reported feeling more unpleasantness, less control, and more arousal as their performance declined from the non-stress (C) to stressful (IC) task periods. This observation provides initial support for the efficacy of the tasks.

We have also published one paper based on the findings of this study in 2009. The reference for this paper is Gianaros PJ, Sheu LK, Remo AM, Christie IC, Crtichley HD, Wang J. (2009). Heightened resting neural activity predicts exaggerated stressor-evoked blood pressure reactivity. *Hypertension*, 53(5), 819-25.

Given the initial evidence that the task is effective at influencing stress levels, we believe it is critical to continue analyzing the neuroimaging and cardiovascular data through the remaining period of the study. Once all data are collected, we will spend the remaining time reducing and analyzing data and examining the cardiovascular findings to determine the relationship between psychological stress and neural activation patterns involved in the cardiovascular stress response.

## **Research Project 2: Project Title and Purpose**

*Justifying Underlying Motivation in Adolescents* - This project focuses on investigating the relationship among regulatory processes—obesity, sleep, and emotion—in a sample of adolescents, with a long-term goal of better understanding the interrelationships and pivotal aspects to broad-based interventions to treat obesity. The project includes an innovative strategy

for measuring regulatory processes in adolescents that integrates psychological (mood), behavioral (eating, physical activity, sleep), and biological (endocrine, inflammation) pathways to optimize long-term wellness. This goal will be achieved by using state-of-the-art ecological momentary assessment (EMA), namely answer-only cellular phones and BodyMedia SenseWear Weight Management Solution™, to capture data in “real time” within the adolescent’s environment.

### **Anticipated Duration of Project**

7/1/2008 - 6/30/2011

### **Project Overview**

This project will evaluate an innovative ecological momentary assessment (EMA) strategy for collecting data, using answer-only cellular phones and BodyMedia SenseWear Weight Management Solution™. Self-regulation skills, encompassing both behavioral (eating, physical activity, sleep) and psychological (mood) disturbances, will be targeted, as well as biological pathways (e.g., insulin, glucose, ghrelin, leptin, IL-6, C-reactive protein [CRP]). The primary aim of this project is to use EMA in natural environments to assure feasibility and compliance, as well as to document eating, physical activity, sleep, and mood in obese adolescents during an optimal developmental window. The project focuses on methods that bridge objective laboratory measures of mood and behavior and more ecologically valid measures within the environment. These data will be collected as part of an ongoing clinical trial of manualized cognitive behavioral therapy in adolescents from the outpatient Weight Management and Wellness Center at the University of Pittsburgh Medical Center. The specific aims of this project are to: (1) evaluate the feasibility of using SenseWear Weight Management Solution™ in overweight children participating in an empirically validated weight management intervention; (2) examine the efficacy of adding a technology-based device to an existent, empirically validated weight management intervention for severely overweight children/adolescents compared to the standard of care in an outpatient pediatric weight management center; and (3) examine the relationship between EMA and self-report measures with regard to weight, body mass index (BMI), and metabolic profile—collected at the Pediatric Clinical and Translational Research Center (PCTRC)—at baseline, session four, and session nine. This modified behavioral intervention provides a paradigm shift in the existing methodology used to treat behavioral, psychological, and biological disturbances in adolescents with obesity and various co-occurring psychological and/or medical conditions.

### **Principal Investigator**

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## Expected Research Outcomes and Benefits

The specific research outcomes of this project are related to developing more efficacious treatments for overweight children so that they lose weight and achieve better health. To achieve this goal, overweight adolescents will use ecological momentary assessment (EMA) technology, i.e., the SenseWear Weight Management Solution™ and answer-only cellular phones, to record “real-time” data on eating, physical activity, sleep, and mood, while they participate in a cognitive behavioral weight management intervention. Another research goal will be to determine the ease of using this technology in daily life and the ways in which the technology can be improved to help with weight management. Finally, the project will explore whether the data from this technological approach differ from the children’s self-reports with regard to weight, BMI, and metabolic measures at three time points as the children progress through the intervention program. The benefits of this project relate to cost-effective, practical, and motivational ways to improve weight loss for children and adolescents. For example, if adolescents are more likely to use the EMA technology, this tool could help them improve both their physical and mental health. Researchers and clinicians will gain a better understanding of the mechanisms of change and will be better equipped to provide more efficacious interventions when treating adolescents. The data from this project will provide the groundwork for developing an intervention strategy that adolescents will find more appealing and be more likely to use, which will promote better long-term health.

## Summary of Research Completed

Hypothesis 2: We have examined the efficacy of adding a technology-based device to existent, empirically-validated intervention for severely overweight adolescents. As we proposed, we matched each child on age, race, and BMI at baseline to our standard of care group. Adolescents in our cognitive behavioral therapy/motivational interviewing and SenseWear group lost a mean of  $-1.0 \pm 3.1$  kilograms. The adolescents receiving the standard of care (clinical comparisons) gained significantly more weight from baseline to Session 12 follow-up  $27 \pm 5$ ,  $t(64) = -8.3$ ,  $p < .01$ . It should be noted that there was a significant difference in the amount of time elapsed from Session 1 to Session 12 (treatment group = 3 months, standard of care = 2 years [range .5 year – 4.6 years]). Therefore, we also looked at the standard of care group compared to the intervention plus technology group at the 90-day timepoint. The standard of care group gained  $.5 \pm 3.2$  kg while the treatment plus technology group lost  $-1.0 \pm 3.1$ ,  $p = .4$ . We have obtained a summer fellowship for an undergraduate student who is attending a clinical PhD program in the fall to further investigate these differences. We also submitted a grant application to the Research Advisory Committee at the University of Pittsburgh to secure funding to run parallel groups with and without the technology to better control for differences.

Hypothesis 3: We have begun to analyze two other facets of the current investigation that relate to Hypothesis 3—(1) the relationship among mood, weight, and physical activity and (2) the

relationship among metabolism, hormones, and mood. First, we have evaluated the efficacy of incorporating the Ecological Momentary Assessment (EMA) to better understand the temporal relationships among weight, mood, and sleep in adolescents. Thirty-two obese female girls with major depressive disorder (MDD) and 31 control, non-depressed girls (mean age=14, BMI=30, 81% Caucasian) reported on physical activity and positive affect in their natural environment. EMA consisted of 14 phone calls from Thursday to Monday evening as well as data from a wearable actigraph. Despite being clinically diagnosed with MDD, no differences were found on positive affect for the MDD/obese group versus the non-MDD group ( $t=.29$ ,  $p=ns$ ). While overall BMI differences were found between groups, there was no main effect of BMI on positive affect for either group. MDD, obese girls reported more positive affect after engaging in physical activity relative to control girls, ( $F_{(1,112)} = 6.17$ ;  $p < .05$ ). These findings suggest that adolescent girls who are obese and depressed do not differ significantly in mood from control, non-depressed adolescent girls. Physical activity may have a protective effect for obese, depressed youth as it significantly affects positive mood.

Our second investigation addressing Hypothesis 3 examined a possible psychological correlate to obesity with a subgroup of adolescents diagnosed with polycystic ovary syndrome (PCOS). There are two current hypotheses about pathophysiologically-driven psychopathology in this sample: (1) hyperandrogenemia or (2) insulin resistance. The aim of the current investigation is to examine the impact of hormonal (free testosterone, androstenedione) and metabolic (insulin sensitivity) parameters on depressive symptomatology at baseline in 40 obese, 10–20 year-old females with PCOS (mean age = 16 years, BMI = 38 kg/m<sup>2</sup>, 53% Caucasian). Laboratory values were collected as part of a larger investigation to examine the impact of insulin sensitizers versus oral contraceptive pills in adolescents with PCOS. Fasting testosterone and androstenedione were collected and homeostatic model assessment (HOMA-IR) was used as an index of insulin resistance. Despite higher rates of overall depression in adolescents with PCOS compared to BMI-matched controls, there was no relationship between depressive symptoms and free testosterone,  $\rho=-.02$ ,  $p=.46$ , insulin resistance,  $\rho=-.06$ ,  $p=.37$ , or androstenedione,  $\rho=.26$ ,  $p=.21$ . Further studies are needed to compare adolescent girls with PCOS to BMI-matched, non-PCOS controls to assess the relationships among BMI, hyperandrogenism, and depression. These results may have implications for identification, prevention, and intervention to reduce both obesity and depression in adolescents diagnosed with obesogenic syndromes.

This research has enabled us to obtain data to apply for support to extend the current line of investigation. On a related note, Dr. Rofey was granted a Mentored Patient-Oriented K-23 Career Development Award on 9/21/2010 and has, therefore, transferred off of the Building Interdisciplinary Research in Women's Health K-12 grant. This state grant not only provided Dr. Rofey with a mechanism to collect pilot data but also continues to allow her to expand her investigation into the added efficacy of actigraphy to clinical interventions.

Publication:

Rofey DL, Hull EE, Phillips J, Vogt K, Silk JS, Dahl RE. Utilizing Ecological Momentary Assessment in pediatric obesity to quantify behavior, emotion, and sleep. (2010) Jun;18(6):1270-2. *Obesity (Silver Spring)*.

### **Research Project 3: Project Title and Purpose**

*Familial Pathways to Early-Onset Suicide Attempts* - There are very few empirically validated treatments for suicidal behavior, and none exist in adolescents, who are at highest risk for incident attempt. The major goal of this project is to evaluate potential clinical and biologic intermediate phenotypes that bridge the gap among genes, childhood adversity, and the clinical risk factors for suicidal behavior in order to move from a descriptive to an explanatory model. The results of this study should help to identify the temporal and likely causal sequence and interactions that result in the onset of suicidal behavior and, thus, help to establish a framework for treatment and prevention of suicidal behavior in high-risk individuals.

#### **Duration of Project**

1/1/2008 – 3/31/2008

#### **Summary of Research Completed**

This project ended during a prior state fiscal year. For additional information, please refer to the Commonwealth Universal Research Enhancement Annual C.U.R.E. Reports on the Department's Tobacco Settlement/Act 77 web page at <http://www.health.state.pa.us/cure>.

### **Research Project 4: Project Title and Purpose**

*Genetic Vulnerabilities to Stress-Elicited Risk for Upper Respiratory Infectious Illness* - We are all exposed to common upper respiratory viruses most days of our lives. However, we don't always get sick, and some people are more likely to get sick than others. In 25 years of studying common colds, we have found that people experiencing higher levels of psychological stress are more likely to develop a symptomatic illness when exposed to common cold viruses than those reporting less stress. Even so, not everyone who is stressed develops a cold. The purpose of this project is to study the interaction of psychological stress and gene polymorphisms that regulate the production and/or action of inflammatory chemicals (cytokines) and of a stress hormone (cortisol) in regulating illness during infection with a common cold virus. We predict that such interactions may account for why some people are less affected by stress than others in terms of their susceptibility to upper respiratory illness.

#### **Anticipated Duration of Project**

7/1/2008 - 6/30/2011

#### **Project Overview**

The major purpose of the project is to determine whether specific genetic factors associated with expression of disease modify psychological stress associated with increased risk for symptomatic illness among persons exposed to a cold virus. Approximately equal numbers of healthy, adult male and female subjects between the ages of 18 and 55 years will be recruited and enrolled. At baseline (before exposure to the virus), we will collect demographics, psychological, autonomic,

endocrine, immune, genetic (buccal scraping), and health practice measures. Then, the enrolled subjects will be quarantined for a 6 day period (1 day pre and 5 day post virus exposure) and exposed to a low infectious dose of a common cold virus (rhinovirus strain 39) administered as nasal drops. Throughout, subjects will be monitored for the development of infection and illness (about 1/3<sup>rd</sup> develop symptomatic illness). Specifically, all subjects will complete a standard respiratory sign-symptom protocol (e.g., congestion, runny nose, sneezing, cough) wherein each symptom is rated on a scale ranging from none (0) to very severe (4). Volunteers will be tested daily for nasal clearance function (objective measure of congestion) and mucus weights (nasal secretions collected in tissues are weighed). The scores for the day before challenge are used as the baseline measures and total post-challenge scores are calculated as the sum of the scores over the 5 days after challenge. Other procedures performed once on each day include nasal washes for assessment of viral shedding and local cytokine production, general physical examinations, and ENT examinations. During the morning, afternoon and evening, blood pressure, heart rate and temperature will be recorded. 28 days after challenge the volunteers will report to the hospital for a blood draw to assess specific antibodies to the challenge virus. All investigators and personnel are blinded to all baseline measures.

*Indicators of illness:* The major outcomes of the project are clinical illness and disease severity. Severity will be assessed using the measures of signs and symptoms of illness described above. The presence of a clinical cold (symptomatic illness) will be defined as the combination of verified infection (viral isolation or 4X increase in viral-specific antibody) and an illness score based on objective markers -- total mucus weight of  $\geq 10$  grams and/or average nasal clearance time of  $\geq 7$  minutes after adjustment for baseline.

*Analysis:* We will test whether genotypes for IL-6 and glucocorticoid receptors interact with psychological stress burden to predict illness.

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### **Other Participating Researchers**

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### **Expected Research Outcomes and Benefits**

We will add the collection of specific genetic information to an NIH funded study of the role of psychological stress and other psychosocial factors in susceptibility to symptomatic illness among persons exposed to a common cold virus. The addition of genetic information to this

project will have two potential benefits. First, it will provide information on whether the specific genotypes we are assaying (pro-inflammatory cytokine and cortisol receptor genotypes) will themselves predict resistance to the common cold. Preliminary evidence from our laboratory suggests that those with polymorphisms that are associated with greater cytokine production may in fact be more susceptible. Second, both sets of genotypes may help us identify persons who are at greater risk for disease when under stress. Both of these findings would allow clinicians to predetermine the risk levels of individuals to identify those most likely to benefit from preventive interventions.

## **Summary of Research Completed**

### *Research Methods Used*

*Cortisol.* For the corticosteroid gene polymorphisms, we focused on the three SNPs in genes encoding corticosteroid proteins, including (1) gamma-aminobutyric acid (GABA) A receptor alpha 6 (GABRA6): rs3219151 (1519 T > C, 3'-UTR), (2) adrenergic alpha 2A receptor (ADRA2A): rs1800544 (-1291 G > C, 5'-UTR), and (3) corticotropin releasing hormone receptor 1 (CRHR1): rs110402 (intron1). Genotyping was performed using TaqMan Genotyping Master mix (Applied Biosystems), and the 7300 System SDS software (version 1.4; Applied Biosystems) was used for instrument control, automated data collection, and genotype assignment.

*Release of free cortisol.* One of the foci of this project is whether the release of free cortisol is associated with cortisol receptor genotypes. Saliva samples for the assessment of cortisol will be collected 6 times a day starting at wakeup and running through bedtime. This will be done on three separate days during the baseline period. The sample will be assayed using a time-resolved immunoassay with fluorometric end point-detection. The area under the curve (AUC) will be calculated for each of the three days (controlling for the participant's wake-up time) and an AUC across the three days calculated for use in the analyses to indicate total free-cortisol release.

### *Milestones Accomplished*

We collected buccal samples and conducted the cytokine genotype assays and data analysis where we ask whether cytokine polymorphisms predict illness and whether cortisol polymorphisms predict diurnal cortisol response. Stress-by-gene interaction analyses are still in progress.

### *Data Analysis*

*Cortisol receptor genotypes.* In our initial analyses, we are interested in whether the cortisol receptor genotypes are associated with the production of free cortisol. We conducted a separate analysis of covariance for each of the three cortisol genes (GABRA6, CRHR1, and ADRA2A). In each analysis, the covariates included sex, age, and race and the independent variables were the three genotypes (CC, CT/TC, TT).

### *Results*

*Cortisol receptor genotypes.* These preliminary analyses indicated that there was only a difference for the GABRA6 gene ( $p < .01$ ), with the area under curve for 3-day diurnal cortisol levels being lower for the TT genotype.

Genotype	N	mean	CC	21	5648
CT/TC	48	5621	TT	25	5366

Publication: Doyle WJ, Casselbrant ML, Li-Korotky H, Cullen Doyle AP, Lo C, Cohen, S. The IL-6 (-174, C/C) genotype predicts greater rhinovirus illness. *The Journal of Infectious Disease*, 201, 199-206. 2010.

### **Research Project 5: Project Title and Purpose**

*Financial Incentives to Improve Health Among Elderly Populations* - The objective of this study is to determine the effectiveness of four varied monetary incentive systems to motivate healthy behaviors and improve health outcomes in elderly populations. Improving our understanding of the use of monetary incentive systems to promote healthy behaviors is becoming increasingly important as use of these types of incentives has increased rapidly in wellness programs intended to increase preventive health activity and decrease long run health costs.

### **Anticipated Duration of Project**

1/1/2008 – 8/31/2010

### **Project Overview**

This project will determine the impact of various monetary incentive systems on individuals' motivation to engage in healthy behaviors and on health outcomes. Specifically, this between-subject randomized controlled trial (RCT) will examine the impact of four types of monetary incentive systems on senior citizens' use of a software program designed to improve mental functioning and enhance memory and on those individuals' mental functioning outcomes. The four incentive systems include: 1) Atomistic - Each individual is rewarded for his or her individual participation; 2) Altruistic - Participants will be paired and will be rewarded according to the other individual's participation; 3) Cooperative - Individuals will be paired and both members of the pair will be rewarded according to average participation; 4) Competitive - Individuals will be paired and will be rewarded according to relative participation. Pairs will be matched on gender, and there will be an effort to also roughly match on age and education. However, once matched, pairs will be randomly assigned to conditions. In addition, the study will also include a control group receiving the same software training and access to the computers with the software but with no financial incentives to use the software.

Participation will be measured as a combination of the time per day spent actively using the computer program and the number of activities successfully completed per session. Rewards will be monetary and will range to a maximum of \$5 per day.

Three outcomes will be measured: 1) time spent using the software, 2) number of activities completed using the software (both accurate and inaccurate responses will be tracked), 3) changes in cognitive function and memory. These three outcome measures will allow us to

effectively capture the impact of the incentive systems on motivation, performance, and health outcomes.

Participants will be residents of retirement communities in and around Pittsburgh, Pennsylvania. The duration of the study will be one month for each pair of participants (though all participants will take approximately one year to run).

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### **Expected Research Outcomes and Benefits**

77 million baby boomers in the United States will soon be reaching retirement and many will begin facing declining mental functioning and ill health. Improving our ability to delay or lessen these declines is essential for maintaining population health. Further, rapidly increasing health care costs make the health of this large cohort particularly relevant to governments which will bear the burden of financing much of the care that these individuals receive. However, because this cohort is on the leading edge of the health decline, much can still be done to prevent ill health and decrease future medical costs. As such, generating effective motivational tools to encourage these individuals to take preventive health measures and accurately assessing the relative effectiveness of the various strategies is a critical step toward improving health and decreasing costs.

There is evidence that computer training programs can be used to enhance a variety of aspects of cognitive functioning including, but not limited to, memory, information processing speed, and learning. Further, many of these gains can be sustained over time. However, because mental declines often happen slowly, preventive actions to forestall these declines can be time consuming and mentally challenging, and computers can be daunting to the elderly who are often less technologically savvy. Therefore, many individuals may not take the necessary preventive actions. While these barriers to action exist, they may potentially be overcome with the right incentives to engage in preventive health behaviors before health conditions become severe. We propose to design and test monetary incentive systems intended to motivate individuals to engage in healthy behaviors such as mental health exercises. Consequently, we expect to observe

an increase in behaviors promoting mental health and direct health benefits in the form of improved cognitive functioning.

### **Summary of Research Completed**

In the first half of this reporting period, the study focus was on making changes to the study materials and design based on the results of the pilot study as detailed in the last report. These changes included increasing the sample size, narrowing the age range of participants, and decreasing the incentive amount earned per game. These changes entailed alterations to the study's screening and enrollment procedures, training and recruiting materials, and technical operations of the website in which the study's games are embedded and incentives are calculated.

The project began actively enrolling participants in the second half of the reporting period. Participants were recruited from classes for senior citizens at local universities and online bulletin boards. Prior to enrollment, all participants are screened for pre-existing cognitive decline, depression, and appropriate computer access and knowledge. To date, 51 participants have been enrolled.