

MPC Corporation

Annual Progress Report: 2007 Formula Grant

Reporting Period

July 1, 2010 – June 30, 2011

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.

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.

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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 current funds towards covering the costs of MRI scanning time and toward employing research associates and purchasing computer equipment. We also completed data entry, reduction, and analysis procedures. These were overseen by the PI (Peter J. Gianaros) and the project statistician (Lei K. Sheu). The individuals tested in the current neuroimaging study provided measures of cardiovascular (e.g., heart rate and blood pressure) reactivity to mental stress tasks that they completed inside of the MRI scanner, responses to questionnaires about personality traits, health habits, and demographics, and brain imaging data.

All participants who consented to participate 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 subjects 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 were stored and archived. Paper and pencil measures were coordinated 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.

In order 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 vs. 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. This data has been entered in a database, and an initial examination of the data for the subjects who have completed the MRI scanning protocol shows that participants report feeling more unpleasantness, less control, and more arousal as their performance declined from the non-stress to stressful task periods. This provides initial support for the efficacy of the tasks.

We have also published the following papers based on the findings of this study.

Gianaros PJ, Onyewuenyi I, Christie IC, Critchley H. (in press). Brain systems for baroreflex suppression during stress in humans. *Human Brain Mapping*.

Ryan JP, Sheu LK, Gianaros PJ (2011). Resting state functional connectivity within the cingulate cortex jointly predicts agreeableness and stressor-evoked cardiovascular reactivity. *NeuroImage*, 55, 363-370.

Given the initial evidence that the task is effective at impacting levels of stress, we believe it is critical to continue analyzing the neuroimaging and cardiovascular data through the remaining period of the study. Once all data is 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.

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.

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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

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.

The primary aim of this project is to use EMA, specifically the SenseWear WMS, 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 are 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 eight. 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.

Over the course of this funding, we recruited 50 child-parent dyads (children = 71% female, 76% Caucasian, mean age = 13, mean BMI percentile = 96). All five treatment groups have been completed and each of the participants wore the SenseWear WMS throughout the duration of the group. Weight loss from baseline to Session 12, mean = 1.0 ±3.1 kilograms. Additionally, adolescents participating in an empirically validated intervention are being continuously recruited and enrolled in the treatment, and EMA data are being collected from these participants. We have begun to examine all three of the proposed hypotheses.

Hypothesis 1: We have evaluated the feasibility of using SenseWear WMS in overweight adolescents participating in an empirically validated intervention. These data examined the feasibility of using Ecological Momentary Assessment (EMA) to examine important domains relevant to interregulatory health processes in overweight adolescent females in their natural environments. Participants were 20 overweight adolescent females engaged in a cognitive-behavioral and motivational interviewing intervention aimed at weight loss and improving mood. During this EMA protocol, participants were asked to report their physical activity (PA), nutrition, mood, and sleep over three extended weekends (Thursday to Monday). Simultaneously, participants wore the SenseWear WMS that provided instantaneous PA feedback (steps taken and kilocalories) and sleep parameters (duration and efficiency). EMA compliance rates for the armband was 74.7% ± 0.3.

Hypothesis 3: We are in the process of examining the relationship among interregulatory processes. A positive association existed between baseline depression and armband compliance (Rho = 0.50, p=0.03). No relation was found between sleep problems and armband compliance; however, a positive association existed between baseline measures of breathing regularity during sleep and armband compliance (Rho = 0.44, p=.052). No associations existed between baseline BMI and armband compliance (p=0.99).

Recently, we completed a follow-up to these analyses to include a depressed, non-obese group. Emerging evidence suggests that child and adolescent depression is associated with deficits in regulating emotion. Although depression is a common comorbid condition in obese youth, it is not known if the underlying disturbances in mood are similar to non-obese youth with depression. The current investigation utilized Ecological Momentary Assessment (EMA) to explore whether there are differences in affect in the real-world environment of obese adolescents with MDD (MDD + Obesity), normal weight adolescents with MDD (MDD only), and non-depressed, normal weight adolescents (Control). EMA is an innovative method that provides more ecologically valid measures in the environment, providing more accurate data on daily shifts in positive and negative affect as they are occurring under natural conditions. The primary aim of the current investigation was to compare positive affect (PA) and negative affect (NA) across the three groups of adolescents.

Thirty-five MDD + Obesity adolescents (mean age=15; BMI=38.), 20 MDD only adolescents (mean age=14, BMI=24), and 54 Control youth (mean age=13, BMI=22) reported on affect in their natural environment. EMA consisted of 14 phone calls over an extended weekend from Thursday to Monday evening. At each call, participants were asked to rate their current affect on a subset of 5-point scales from the Positive and Negative Affect Schedule for Children (PANAS-C).

Data on momentary emotion were analyzed using repeated measures linear mixed effects models to account for the nesting of assessments within participants and within days. Main effects for diagnostic group emerged in predicting global PA ($F = 16.17, p < .001$). Least Significant Difference (LSD) tests of marginal means indicated that PA was lower for the MDD only group ($M = 2.5, SE = .07$) compared to the MDD + Obesity group ($M = 2.89, SE = .07$) and the Control group ($M = 2.91, SE = .04$). Main effects for diagnostic group emerged in predicting global NA ($F = 74.04, p < .001$). Least Significant Difference (LSD) tests of marginal means indicated that all three groups differed from each other on NA, with the MDD only group reporting the highest NA ($M = 1.70$ [range =1.0-4.2], $SE = .03$), followed by the MDD + Obesity group (M [range] = 1.35 [1.0-3.2], $SE = .03$) and the Control group (M [range] = 1.28 [1.0=2.8, $SE = .02$]).

These results indicate that the dysregulation in emotion associated with Major Depressive Disorder may be different for non-obese and obese adolescents with depression, given that MDD only youth reported lower PA. While MDD only reported the highest NA, MDD + Obesity youth also differed significantly from controls. Future research may explore unique treatment strategies for youth with MDD + Obesity versus youth with MDD only, as there may be important underlying differences in etiology and manifestation of the depressed mood.

Our second investigation addressing Hypothesis 3 investigated 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. Despite high rates of overall depression in adolescents with PCOS (45%) 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.

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.

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 1/3rd 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 ≥ 10 grams and/or average nasal clearance time of ≥ 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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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

One focus of our project has been to assess the role of genes that produce pro-inflammatory cytokines and adrenergic and glucocorticoid receptors in cold susceptibility (see data reported in previous annual reports and publication). Another focus of this project has been to identify genes that modulate the effects of stress on biomarkers that are critical in linking stress to disease risk. The subjects were 114 healthy white participants in a common cold viral-challenge trial. Psychological stress was assessed using the Perceived Stress Scale. Resting blood pressure was based on the average of 6 measures collected over 3 months, and we estimated cortisol release during the day by collecting 7 saliva samples distributed from waking until late evening (90 participants had complete cortisol data). Blood was drawn for use in genotyping (see procedures described in previous reports). We also collected detailed demographics and assessments of other psychosocial factors. We have just completed data entry and verification and the analyses of these data will continue. Here we report the evidence from the gene for the α -2A adrenergic receptor (*ADRA2A*).

The gene for the α -2A adrenergic receptor (*ADRA2A*) is expressed ubiquitously in cells throughout the body, and is involved in the regulation of numerous physiologic functions. Examples include modulation of systolic (SBP) and diastolic (DBP) blood pressure via effects on vascular smooth muscle, as well as metabolic functions such as insulin secretion and lipolysis. The C-1291G polymorphism in the promoter region of *ADRA2A* has been explored as a possible determinant of the effects of *ADRA2A* on several of these physiologic functions. McCaffery and colleagues, for example, explored the C-1291G polymorphism as a potential determinant of the modulating effects of *ADRA2A* on blood pressure, and found that those homozygous for the C allele displayed higher, albeit nonsignificantly so, resting SBP relative to G allele homozygotes and CG heterozygotes. This finding corroborates a similar marginal association of C allele homozygosity with higher SBP that was reported in an earlier study.

In the current study, we attempted to replicate this earlier work, but our main focus was on whether the C-1291 polymorphism would modify the influence of psychological stress in blood pressure. Frequencies of each of the three C-1291G polymorphism allele pairings are as follows: for whites ($n=114$), CC = 51.8%, CG = 43.9%, GG = 4.4%; for blacks ($n=43$), CC = 11.6%, CG = 37.2%, GG = 51.2%. These race-specific distributions of the allele pairings are comparable to what previously has been reported. Given the difference in frequency of CC homozygotes between races, we conducted our analyses among whites only. We found no main effect association of *ADRA2A* genotype with blood pressure. However, we did find that genotype moderated the association of perceived stress with resting SBP and DBP such that high levels of perceived stress were associated with higher SBP and DBP among CC homozygotes relative to GG homozygotes and CG heterozygotes (see Figures 1 and 2). Because of our interest in genotype influences on activities of the hypothalamic-pituitary adrenal axis, we also examined diurnal cortisol concentration (area under the curve [AUC]) as the dependent variable. Results paralleled those for resting blood pressure. Specifically, although *ADRA2A* genotype showed no main effect association with cortisol AUC, it moderated the association of perceived stress with cortisol such that high stress was associated with higher cortisol concentrations among CC homozygotes relative to those carrying a G allele (see Figure 3).

Figure 1. Systolic Blood Pressure (SBP; $n = 114$; $p < .001$ for interaction)

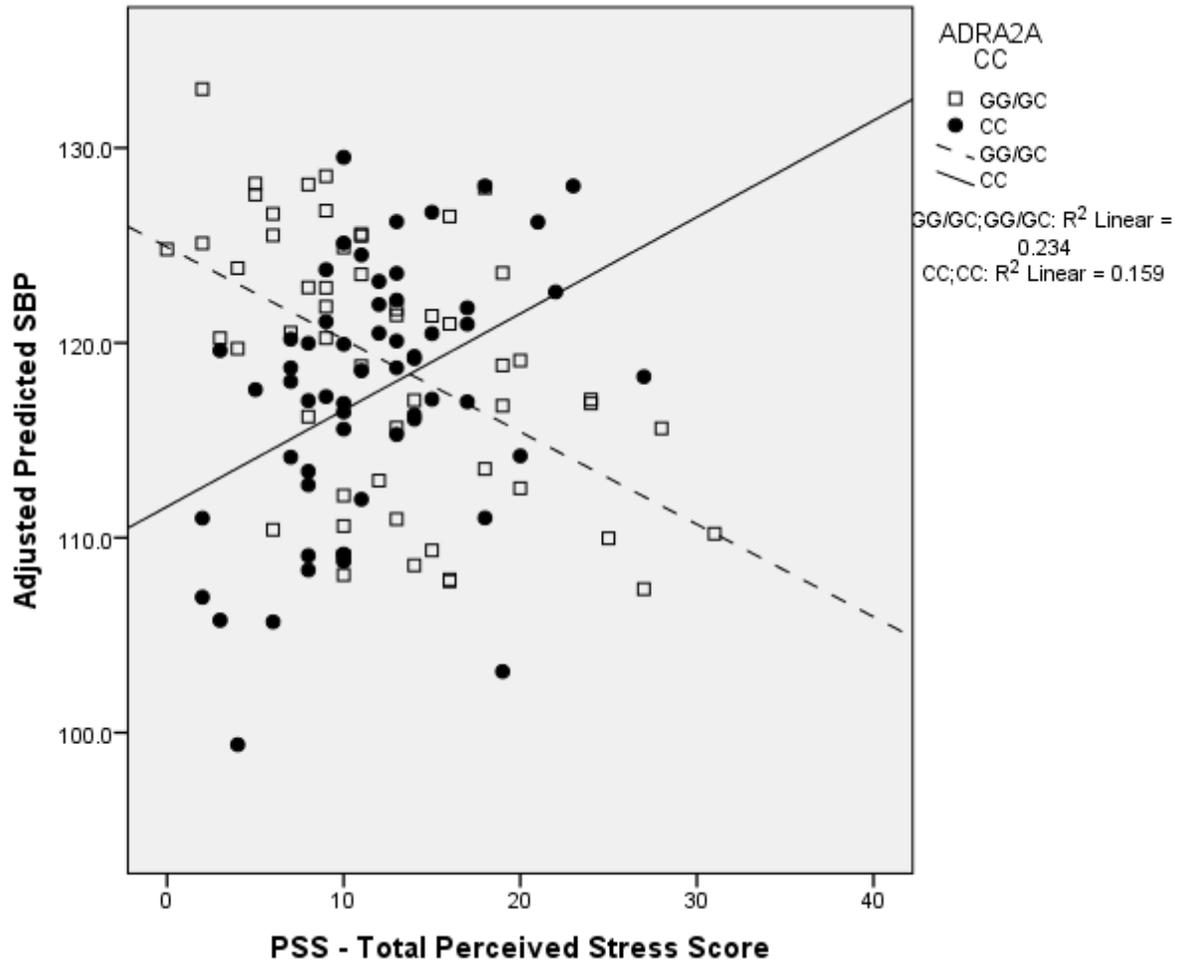


Figure 2. Diastolic blood pressure (DBP; $n = 114$; $p < .001$ for interaction)

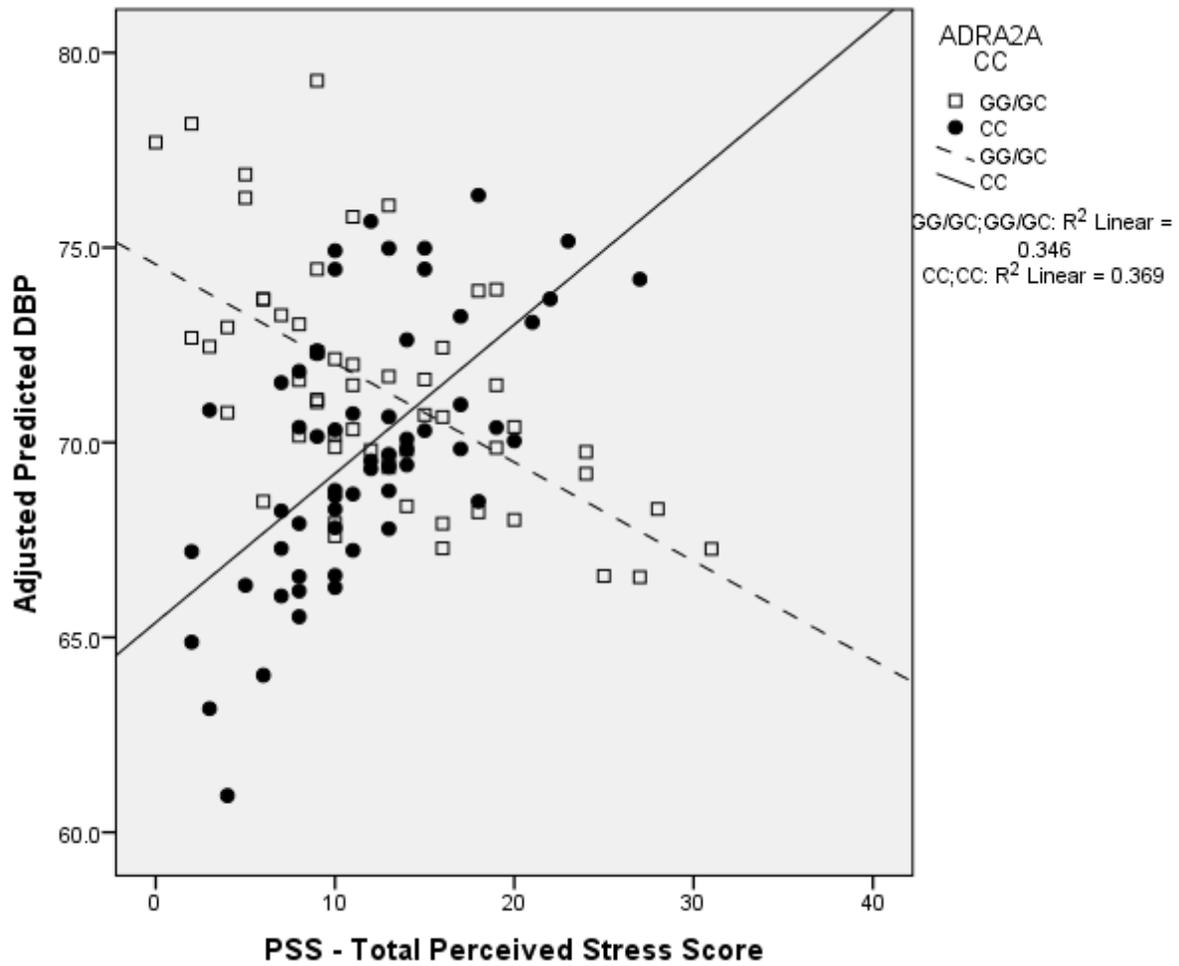
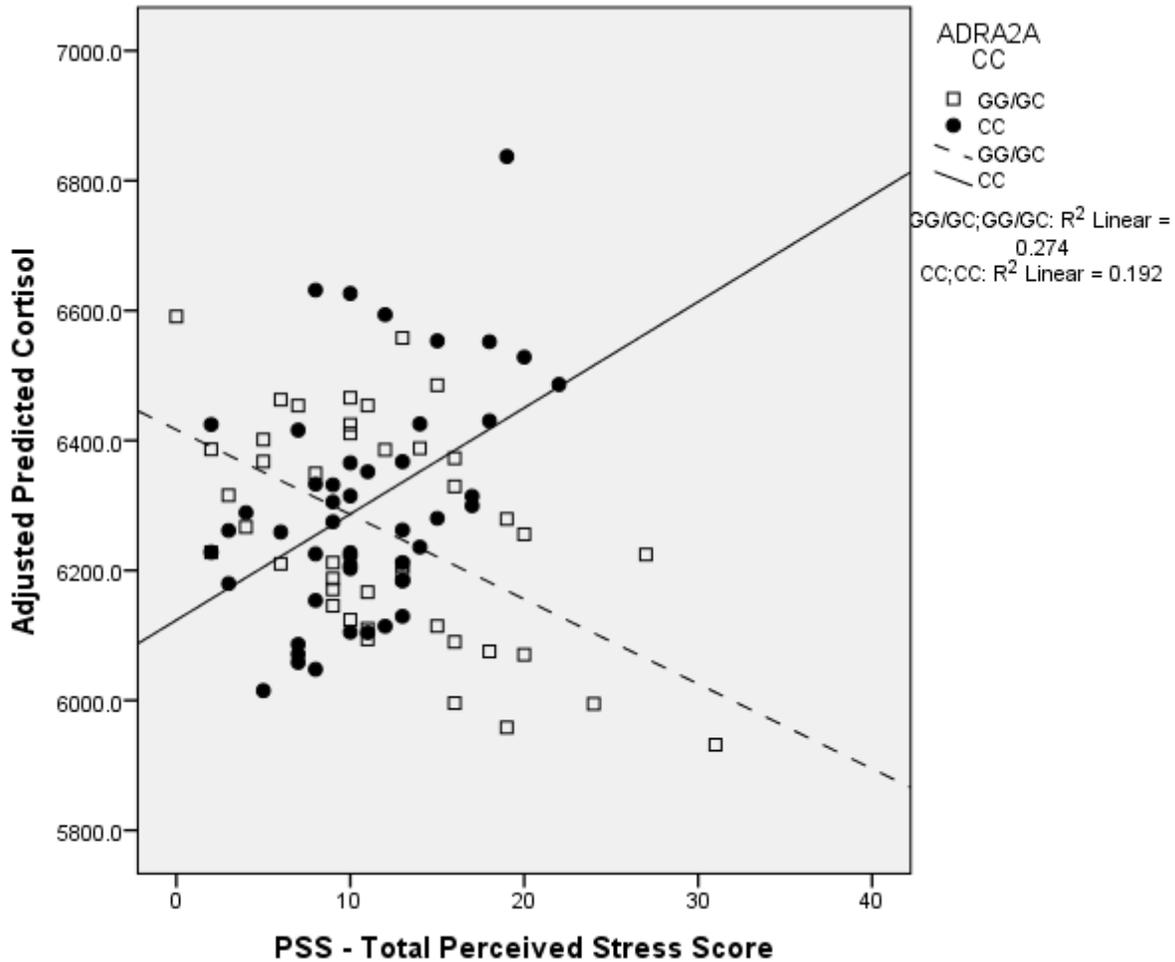


Figure 3. Cortisol AUC ($n = 90$; $p = .02$ for interaction)



The sample here is small for genetic analysis, so (even though these associations are statistically reliable) we consider this work only suggestive, and are pursuing following it up with similar analyses in a data set based on a larger Pittsburgh based community study (the Adult Health and Behavior Study). However, these results indicate the possibility that feelings of stress may translate into less or more biological-stress response depending on genotype. We will continue further analyses of the role of other genotypes in moderating the effects of psychological stress on stress biomarkers in this data set as well.

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.

Duration of Project

1/1/2008 – 6/30/2011

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

Recruitment and data collection were completed during this reporting period. Table 1 presents a break-down of outcomes for those who contacted the study.

The age of the targeted population coupled with the nature of the study presented special challenges to recruitment. As the study involves the use of computer games, there are technological requirements for participation, including ownership of a home computer, high speed Internet access at home, and regular use of an e-mail address. Use of such technology among this age group is not as widespread among those younger than age 55. Transportation also presented difficulties. Three visits to the CMU campus are required. Some of those who contacted the study no longer drove, were too afraid to drive to the campus's urban location, or did not have access to public transportation. Finally, health issues came into play. All participants are required to be cognitively normal. The screening for cognitive health includes screening out subjects with a diagnosis of any physical conditions known to affect cognitive function, screening out subject taking any cognitive enhancing medications/medications to treat cognitive decline, administering the Geriatric Depression Screen, and administering the Telephone Interview for Cognitive Status (TICS). Some potential participants did not pass this screening. Given all of the above factors, recruitment fell slightly short of the original goal of 400 participants.

Table 2 shows a breakdown of outcomes for those who enrolled in the study. The majority of those who withdrew from the study did so because of health reasons ranging from carpal tunnel syndrome to cancer. Those who were removed from the study were typically removed because they were not coming in for required visits and were not responding to contact from the study. Participants were given at least three months for a visit and at least five contact attempts were made before they were removed from the study.

Table 1: Recruitment

Total Contacted Study	788
Ineligible	183
No Response to Contact	162
Not Interested	72
Enrolled	371

Table 2: Enrollment

Total Enrolled	371
Completed Study	310
Completed Exercises Only	2
Removed	25
Withdrew	34