PREDICTING TREATMENT ADHERENCE FROM ELECTROPHYSIOLOGICAL BIOMARKERS AND INDIVIDUAL DIFFERENCES IN BEHAVORIAL ACTIVATION (BAS) AND BEHAVIORAL INHIBITION (BIS) SYSTEMS

by

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Obstructive sleep apnea (OSA) is a common chronic sleep disorder with a demanding and complex treatment regimen. Even though continuous positive airway pressure (CPAP) is a highly effective treatment for OSA, approximately 25% of those prescribed CPAP do not adhere. In accordance with a recent call for a biopsychosocial approach to address CPAP nonadherence, two studies were designed to investigate patient-centered factors of nonadherence. Study One was a laboratory-based experimental study with the aim to identify predictive variables of behavioral intentions to adhere to advantage- and disadvantage-framed health messages, which simulated receiving an OSA diagnosis and subsequent CPAP treatment recommendations. Multiple regression models indicated that higher behavioral intentions after viewing the advantage-framed message were expected from undergraduate participants endorsing higher positive emotional responses from the message and lower use of humor as a coping strategy. Higher behavioral intentions after viewing the disadvantage-framed health message were expected from undergraduate participants endorsing higher feelings of control, greater relative right hemisphere baseline cortical activity, higher levels of behavioral inhibition, and lower use of humor as a coping strategy. Study Two was a community-based study that aimed to identify

predictive variables of CPAP adherence in a clinical sample of adult patients with OSA. Logistic regression analyses were employed in accordance with current adherence criteria at seven, thirty, sixty, and ninety day time-points. Age significantly predicted nonadherence at sixty days, while age and subjective severity rating predicted nonadherence at ninety days. Multiple regression analyses were used to predict total hours of CPAP use at the same time-points, and were able to identify additional predictors with clinical utility. Age, race, and reward responsiveness trait were significant predictors of total hours of CPAP use at sixty days, while age and race were significant predictors at ninety days. Important clinical implications are discussed in light of findings for enhancing likelihood of CPAP adherence.

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Doctor of Philosophy in Clinical Health Psychology

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CHAPTER I: INTRODUCTION

While advances in healthcare are responsible for increases in life expectancy and overall quality of life, subpar adherence rates to such treatments have perplexed researchers for decades. On average, 25% of patients who are recommended complex treatment interventions do not adhere, which translates into significant health complications and approximately $300 billion (US) per year (DiMatteo, 2004). Patients who suffer from obstructive sleep apnea (OSA) are at even higher risk of nonadherence, with nonadherence rates to continuous positive airway pressure (CPAP) treatment ranging from 29% to 83% (Collard, Pieters, Aubert, Delguste, & Rodenstein, 1997; Grote, Hedner, Grunstein, & Kraiczi, 2000; Popescu, Latham, Allgar, & Elliott, 2001; Rauscher, Popp, Wanke, & Zwick, 1991; Weaver & Grunstein, 2008; Weaver et al., 1997; Wolkove, Baltzan, Kamel, Dahrusin, & Palayew, 2008). CPAP nonadherence research is shifting from investigation of biomedical variables that have alone shown little predictive power, to exploring psychosocial variables that are more promising at varying degrees across identified constructs (Engleman & Wild, 2003; Weaver & Chasens, 2007; Weaver & Grunstein, 2008).

This movement towards inclusion of psychosocial variables in the study of CPAP adherence is reflective of the healthcare system's general acknowledgement of the need for a holistic approach to patient care, especially for implementing complex and demanding interventions such as CPAP. In fact, it was not until very recently (Crawford, Espie, Bartlett, & Grunstein, 2014) that a formal call for a biopsychosocial approach to addressing CPAP adherence was made to the sleep medicine community and the healthcare system at large. Such an approach to patient care of those who suffer from OSA would reflect the movement from providers thinking in terms of "compliance" (e.g., the extent to which a person's behavior aligns with health advice) to "adherence" (e.g., the extent to which a person's behavior corresponds

with agreed upon recommendations from a provider) (Sabate, 2001). Thinking in terms of "compliance" creates an environment where the patient is more likely to take a passive consumer role when gathering important health information. This also equates to a "doctor-centered" model, where the active mechanisms of change are assumed to be a physician's instructions only, with little regard for a patient's unique perspective or more complex person-centered factors (Crawford et al., 2014).

In consideration of a biopsychosocial model of CPAP use, Crawford and colleagues (2014) were careful to consider the multidimensional nature of "nonadherence," as defined by the World Health Organization (WHO) in 2001. The WHO determined that nonadherence is a result of four main factors, namely the healthcare system, condition-related factors, therapy-related factors, and patient-related factors (Sabate, 2001), which grossly map onto the three major domains comprising the biopsychosocial framework (condition- and therapy-related factors mostly subsumed under biomedical, patient-related factors subsumed under psychological, and healthcare system subsumed under sociocultural categories); however, all factors are thought to be fluidly related across domains at some level. Many researchers have begun delineating such variables through psychosocial health behavior models (e.g., Health Belief Model, Theory of Planned Behavior, and the Protection Motivation Theory). However, without careful consideration of the influences of biomedical factors on adherence through these frameworks, findings from these lines of research can pose similar threats to taking a completely holistic, patient-centered approach. A safeguard against such threats includes considering individual differences in predisposing traits and associated physiology in each domain of the biopsychosocial framework. Taking such an approach can provide clinicians and researchers

alike a patient-centered lens through which to consider biomedical, psychological, and social factors influencing behavioral intentions and adherence behavior.

In summary, a historically simple idea of "compliance" has proven to be a much more complex and important phenomenon that is best approached using a biopsychosocial framework. With countless variables influencing a patient's ability to adhere to treatment recommendations, addressing treatment adherence concerns can be a daunting task for healthcare providers and researchers. Given the variability of the treatment adherence literature and the importance of treatment adherence for increased quality of life and survival, considering the mechanisms of perceiving health information at the neurophysiological and individual differences levels could help to inform existing theories used to explain nonadherence, and subsequently inform alterations in treatment and intervention protocols. Other implications include early identification of patients at risk of nonadherence, and provision of a feasible approach to delivering novel health information tailored to meet the needs of patients based on individual differences.

The proposed study aimed to investigate individual differences related to the phenomenological experience of receiving health information. This has been explained using a biopsychosocial framework of CPAP adherence (Crawford et al., 2014) that incorporates relevant facets of Reinforcement Sensitivity Theory (RST) and considers the person/individual-centered factors of leading motivational health behavior change models.

Specific aims included the following:

1. Investigate predictive factors of CPAP adherence.
2. Explore risk factors for nonadherence at important moments in the general sequence of receiving a diagnosis and treatment recommendations.

3. Investigate potential message tailoring approach for enhancing behavioral intentions and adherence behavior.

CHAPTER II: ADHERENCE LITERATURE REVIEW

In 2002, the World Health Organization reported that chronic diseases were responsible for 88% of all deaths in the United States. Chronic diseases require long-term ongoing treatment adherence for patients to experience increased quality of life or even survival. As previously mentioned, about 25% of patients who are recommended complex treatment interventions do not adhere, which results in significant health and financial costs (DiMatteo, 2004). As a result of ongoing complications resulting from nonadherence, researchers have focused their efforts on delineating predictive risk factors. Research on medication adherence alone has uncovered over 200 variables influencing patients' adherence behaviors (Fenerty, West, Davis, Kaplan, & Feldman, 2012).

Researchers have begun organizing predictive factors into constructs, including patient factors (e.g., substance use, health literacy), environmental or contextual factors (e.g., social support, socioeconomic status), patient-clinician relationship factors (e.g., clear communication, time spent explaining disease and treatment), disease factors (chronicity, severity, response to treatment), health care delivery factors (e.g., wait for appointments, convenience of clinic and pharmacy), and treatment regimen factors (e.g., pill burden, complexity, side effects) (Ingersoll & Cohen, 2008). Type of disease was also found to be associated with varying rates of nonadherence to treatment, with the highest adherence rates in patients with human immunodeficiency virus (HIV), arthritis, gastrointestinal disorders, and cancer, and the lowest adherence rates in patients with pulmonary disease, diabetes, and sleep disorders (DiMatteo, 2004). Disease course was also related to nonadherence behavior, as patients with acute conditions generally demonstrate higher rates of adherence to treatment than patients with chronic diseases (DiMatteo, 1994; van Dulmen et al., 2007).

The Health Belief Model, Theory of Planned Behavior, and Protection Motivation Theory were natural developments after consistent observations that psychosocial variables were significantly influencing adherence. Their development was timely, as major threats to life and health were shifting from infectious diseases to those of lifestyle and behavior. Today, psychosocial models are increasingly utilized to describe and explain high risk behaviors such as nonadherence associated with current leading causes of morbidity and mortality, including heart disease, atherosclerosis, obesity, cancers, and HIV infection (Bogart & Delahanty, 2004).

While investigation of all high risk behaviors is imperative, adherence to a prescribed treatment regimen is especially important as these patients have already received or are at high risk for acquiring a diagnosis of a chronic or acute condition. Therefore, this review will focus on the ways in which the major psychosocial models have been used to describe and explain nonadherence to a prescribed treatment regimen for a diagnosed condition, also known as "treatment" or "secondary" nonadherence (Fenerty et al., 2012). As the present study does not explicitly test specific constructs of these major models, the purposes of this review are constrained to highlighting the ways in which researchers have already begun delineating predictive constructs of adherence behavior, and to exploring important underlying mechanisms pertaining to the influence of individual differences on these predictive constructs.

Health Belief Model

The Health Belief Model (HBM) was originally proposed in the late 1960s as a means to explain the decision-making process individuals experience about whether to adopt health behaviors (Rosenstock, 1966). It was the first of its kind to emphasize the importance of subjective perceptions of incoming health information and related benefits, barriers, and cues to action to making a behavioral change (Baban & Craciun, 2007).

According to the HBM, individuals undergo a decision-making process by which they consider several factors related to a specific health behavior, including their perceptions about susceptibility to an illness, severity of the illness consequences, benefits of engaging in the health behavior, and barriers and costs of engaging in the health behavior. These subjective cognitive conclusions culminate into subjective beliefs about personal health threat as well as the effectiveness of a health behavior if adopted. Cues to action can also trigger adoption of a health behavior if belief conditions are optimal for internal or external triggers to be attended. The three main constructs of the HBM are health threat, effectiveness of a health behavior, and cues to action. The adoption of the health behavior is a function of these constructs, and this relationship is thought to be mediated by behavioral intentions (Baban & Craciun, 2007).

While the HBM has been used to predict a wide range of health behaviors including regular exercise, general dietary behaviors, condom use, and smoking (see Bogart & Delahanty, 2004, for a review), relevant to this study is how the HBM has been used to predict adherence to a prescribed treatment regimen. Much of the research done in the area of treatment adherence has indirectly used the HBM to compare differences between those who do and do not adhere to treatment.

Some of the major findings in the literature to date include testing specific facets of the HBM. For example, patients who adhere to medication regimens are more likely to perceive a broad multitude of benefits to receiving the treatment than those who do not adhere, while those who do not adhere to medication regimens are more likely to perceive more costs of medication than those who adhere (Adams & Howe, 1993; Chan, 1984; Hogan, Awad, & Eastwood, 1983; Pool & Elder, 1986). Another major finding in the literature is that patients who do not adhere to

medication regimens commonly report low perceived susceptibility to the illness as well as high costs to receiving the medication (Howanitz & Freedman, 1992; Pool & Elder, 1986).

HIV and acquired immune deficiency syndrome (AIDS) are serious conditions that can be managed successfully with levels of at least 95% adherence to highly active antiretroviral therapy (HAART) (Barclay et al., 2007; Begley, McLaws, Ross, & Gold, 2008). These incredibly high adherence rates could mean the difference between sustained viral suppression and progression to AIDS for a patient with HIV, or life and death for a patient with AIDS. Therefore, it is imperative that researchers systematically investigate barriers to successful HAART adherence from the perspectives of patients suffering with one of these conditions.

Malcolm, Ng, Rosen, & Stone (2003) qualitatively examined the beliefs about HIV/AIDS of patients with excellent adherence to HAART and compared them to the beliefs of patients with suboptimal levels of HAART. Among major findings, patients with excellent adherence to HAART believed that their adherence rates needed to be 90-100% to be effective, which speaks to the HBM construct of perceived effectiveness of a health behavior. On the other hand, patients with suboptimal adherence levels did not believe that the adherence rates needed to be that high, and were less likely to trust their healthcare providers.

Similar findings emerged from a prospective, cross-sectional study of the HBM and additional factors such as neurocognitive status, self-efficacy, and age in patients with HIV (Barclay et al., 2007). Relevant to the HBM was the finding that lack of perceived treatment utility (i.e., perceived effectiveness of a health behavior) was a main predictor of poor adherence rates in younger patients over a one-month period using electronic monitoring technology. Another important finding regarding younger patients was that low self-efficacy was also a

predictor of poor adherence rates. Interestingly, the sole predictor of poor adherence in older patients was decreased levels of neurocognitive functioning.

Begley, McLaws, Ross, & Gold (2008) conducted a study assessing a reformulated health belief model that included the main constructs of the original HBM along with self-efficacy and several other psychosocial variables. Three significant predictors of protease inhibitor nonadherence emerged from analyses. Nonadherence was found to be associated with low adherence self-efficacy and seriousness of nonadherence consequences related to HIV, lack of perceived threat of consequences related to HIV illness, and multiple recreational drugs usage.

Baloush-Kleinman and colleagues (2011) sought to examine the utility of the HBM in predicting adherence to antipsychotic medication in patients with schizophrenia using a naturalistic, longitudinal design focusing on the early stages of illness when nonadherence is most likely. Results from structural equation modeling indicated that the main predictors of adherence were symptom severity, being in the earlier stage of illness, and attitudes towards antipsychotic medication. More specifically, there were several predictors of positive attitudes towards antipsychotic medication, including negative symptoms of schizophrenia, possessing an awareness of medication needs and the social consequences of illness, and with patient perception of trust in the physician. Additionally, Budd, Hughes, and Smith's (1996) found the constructs perceived susceptibility, perceived severity, and perceived benefits of adherence to antipsychotic medications to be main predictors of adherence in a group of highly adherent patients compared to those patients demonstrating low adherence. Given the high rates of nonadherence to antipsychotic medication in this population (approximately 74% within 18 months of the CATIE clinical trial; Lieberman et al., 2005) and the negative consequences

thereof, these findings offer great insight for health care providers into the importance of considering perceptions of patients when delivering antipsychotic medication regimens.

Diabetes mellitus is another condition in which adherence rates to treatment regimens are crucial to overall health and life expectancy. Diabetes mellitus is a metabolic disease precipitated by defects in insulin secretion and/or insulin action, resulting in hyperglycemia. This can cause problems in the eyes, nerves, kidneys, heart, and blood vessels, and can reduce life expectancy by 20 years (Gillibrand & Stevenson, 2006). The diabetic treatment regimen consists of careful monitoring of diet and glycemic blood levels, as well as the adoption of many new health behaviors including but not limited to daily insulin injections, urine testing, dietary modifications, and exercise routines (Janz & Becker, 1984). Given the complexity of the diabetic regimen entailing the adoption of a high number of new health behaviors along with the chronic nature of diabetes mellitus, it is not surprising that adherence rates are rather low.

The HBM has been used to investigate nonadherence to diabetic regimen in both children and adults. Brownlee-Duffeck and colleagues (1987) found that the perceived costs of adhering to the diabetic regimen, such as difficulty of injections or embarrassment of adhering to regimen in the company of friends, was the only significant predictor on self-reported adherence among patients aged 13 to 26 years old. They also found that perceived susceptibility and severity were significant predictors of glycated hemoglobin levels, which is an average measure of plasma glucose concentration over time.

Bond, Aiken, & Somerville (1992) conducted a similar study on 56 adolescent outpatients with insulin-dependent diabetes mellitus to test the predictive utility of the HBM. Low perceived threat and high perceived benefits compared to costs were associated with the highest adherence rates. High threat and cues to seek treatment were associated with poor

metabolic control, but poor metabolic control was not associated with nonadherence. Age was inversely related to adherence to the exercise, insulin injection, and frequency of engagement in the diabetic regimen. In this study, willingness and ability to act on cues was most closely associated with adherence.

Seeking to improve the predictive utility of the HBM, Aalto, Uutela, and Aro (1997) conducted a study on 423 adults with Type I diabetes mellitus assessing the original constructs of the HBM and several additional variables and their associations with adherence to the diet and blood glucose self-monitoring components of the diabetic regimen. These additional variables included locus of control, self-efficacy, health value, and social support. Consistent with HBM, physiological cues to action were predictive of adherence to blood glucose self-monitoring. Diabetes-related social support was predictive of diet adherence. Consistent with the extended HBM, perceptions of benefits of adherence to the diabetic regimen were influenced by internal locus of control and self-efficacy for carrying out tasks required of the regimen (Aalto & Uutela, 1997).

Gillibrand and Stevenson (2006) sought to apply the extended HBM to young people (ages 16-25 years old) with Type I diabetes mellitus. High levels of family support predicted adherence to the self-care component of the diabetes regimen. However, high levels of family support in conjunction with low locus of control to manage their diabetes seemed to influence perception of severity and vulnerability to illness in an adverse way. High internal locus of control and high self-efficacy was associated with perceiving more benefits than costs of adhering to the self-care component of the diabetic regimen (Gillibrand & Stevenson, 2006).

In summary, the HBM has been successfully utilized and extended to include other constructs to predict and study underlying mechanisms involving adherence to complex

treatment regimens, such as diabetes and HIV treatments. In particular, self-efficacy and perceived threat influenced adherence to both treatment regimens. Perceived effectiveness of a health behavior influenced adherence to HIV regimen, while perceived costs and benefits of adherence, perceived susceptibility and severity of illness, and willingness to act on cues to action influenced adherence to diabetes regimen. Interestingly, a high internal locus of control and high self-efficacy was associated with perceiving relatively more benefits than costs of adherence to diabetes regimen. The HBM has also been used to study barriers associated with antipsychotic medication adherence. Perceived susceptibility, perceived severity, and perceived benefits of adherence were constructs that were found to influence adherence behaviors. One of the main considerations of each of the studies highlighted has been on person-centered variables, including a patient's unique perceptions about the disease and about their abilities to follow through with treatment recommendations.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) was created as an expansion of the earlier Theory of Reasoned Action in an effort to broaden its applicability (Baban & Craciun, 2007). Thus, these theories overlap substantially in constructs, with the exception of the addition of perceived behavioral control to the TPB (Ajzen & Fishbein, 1980). Like the HBM, the TPB also stresses the role of perceptions in motivating actions toward adopting health behaviors. According to the TPB, intentionality is the most proximal cause of behavior. Furthermore, intentions are influenced by attitudes towards adopting a behavior, social norms, and perceived behavioral control. Attitudes are a cognitive summation of the perceived likelihood of acquiring an outcome by adopting a health behavior and the evaluation of that outcome. The more desirable the outcome is perceived by the individual, the more positive is the attitude towards adopting the

health behavior. Social norms refer to the perception that other people whose opinion is highly valued want the individual to adopt the health behavior. Thus, an individual who is motivated to adhere to the desires of significant others will also be more likely to adopt the health behavior through the social norms construct of the TPB. Finally, perceived behavioral control is the individual's subjective rating of difficulty level of adopting the health behavior, given the individual's perceived resources and barriers to do so (Baban & Craciun, 2007).

A meta-analytic review of 185 studies was conducted in an effort to test the utility of the TPB and its individual constructs (Armitage & Conner, 2001). Overall, the TPB was found to be a good predictor of both behavior and intention. Specifically, the TPB explained 27% of the variance in individuals' actual behavior, and 39% of the variance in their intentions. All constructs except for subjective norms were found to be good predictors of intentions or behaviors. The weakness of the subjective norms construct points to poor measurement of this construct in past research and the need to provide a better definition or its expansion within the TPB (Armitage & Conner, 2001).

Generally, the TPB has been successful at predicting a wide-range of health behaviors, including healthy dietary changes (Astrom & Rise, 2001; Conner, Norman, & Bell, 2002; Payne, Jones, & Harris, 2004; Povey, Conner, Sparks, James, & Shepherd, 2000), exercise (Godin & Kok, 1996), adolescent smoking (Higgins & Conner, 2003), and student alcohol and tobacco use (McMillan & Conner, 2003). The TPB has also been used to predict health screening behaviors (Bowie, Curbow, LaVeist, Fitgerald, & Zabora, 2012; Conner & Sparks, 1996; O'Neill et al., 2008) and AIDS preventive behavior (Terry, Gallois, & McCamish, 1993).

Dietary and physical activity are common elements of treatment regimens for patients suffering from chronic illnesses or recovering from procedures used to treat chronic diseases,

such as cardiac disease, diabetes, obesity, and weight loss surgery. In addition to the general findings indicating that the TPB is a useful predictor of dietary behavior, the TPB has been used to investigate low-fat food consumption (Armitage & Conner, 1999; Paisley & Sparks, 1998), eating foods that are high in saturated fats (de Brujin, Kroeze, Oenema, & Brug, 2008), and healthy eating among participants at risk for diabetes (Blue, 2007). Recently, the TPB has been used to explain adherence to healthy eating regimens prescribed for different health conditions, including Type 2 diabetes and cardiovascular disease (White, Terry, Troup, Rempel, & Norman, 2010). In a one-month study, a group of researchers utilized the TPB to determine predictive factors of such a dietary regimen for patients with Type 2 diabetes, cardiovascular disease, or with both conditions. Results indicated that attitude and subjective norms were predictive of intentions to adhere to the dietary regimen. Furthermore, intentions and perceived behavioral control were associated with behavioral adherence via self-report. Interestingly, an additional variable, planning, was assessed and found to directly predict treatment adherence (White et al., 2010).

The TPB has also successfully predicted exercise behavior in a general sample of participants (Godin & Kok, 1996), as well as in a cardiac rehabilitation sample (Godin, Valois, Jobin, & Ross, 1991), and among college undergraduates and cancer survivors (Rhodes & Courneya, 2003). Other research has indicated that perceived behavioral control was a significant predictor of undergraduate women's intentions to exercise (Gatch & Kendziershi, 1990), and was the only variable that directly influenced exercise behavior in college students (Bryan & Rocheleau, 2002).

Blanchard, Courneya, Rodgers, Daub, and Knapic (2002) conducted a study utilizing the TPB to better understand motivation to exercise in participants undergoing Phase 2 of cardiac

rehabilitation, which suffers poor adherence rates despite potential significant quality of life increases. Eighty-one patients enrolled in a Phase 2 cardiac rehabilitation program completed questionnaires assessing each TPB construct before and after the program. They found that attitude, subjective norm, and perceived behavioral control successfully predicted exercise intentions (38% of the variance), which in turn predicted exercise adherence (23% of the variance) during Phase 2 cardiac rehabilitation program. TPB constructs explained more of the variance in exercise intentions at follow-up (51%), but exercise intentions still only explained 23% of the variance in exercise adherence (Blanchard et al., 2002).

In summary, the TPB is similar in many aspects to the HBM as it maintains that a patient's perceptions influence a decision of adherence. The TPB maintains that the most proximal cause of adherence behavior is one's behavioral intentions to adhere. These intentions are influenced by attitudes towards adopting adherence behavior, social norms about adherence to a treatment regimen, and perceived behavioral control. In the studies reviewed above, the TPB demonstrated good predictive utility for both behavioral intentions and adherence behavior. Main constructs that were especially useful throughout the reviewed studies included attitude, subjective norms, perceived behavioral control, which predicted behavioral intentions and in turn predicted adherence behavior.

Protection Motivation Theory

Protection Motivation Theory (PMT) is another psychosocial model that places people's subjective appraisals of incoming information at the forefront of explaining resulting behaviors (Rogers, 1975). A unique addition to the decision-making process that has been described across models thus far is the idea that emotion, specifically fear, elicits cognitive responses that result in target health behavior adoption (Baban & Craciun, 2007). Another unique component of the

PMT is the inclusion of personality variables and prior experiences as intrapersonal sources of information that are assumed to affect the cognitive mediating processes in the overall model (Floyd, Prentice-Dunn, & Rogers, 2000). Protection motivation is the impetus for a set of adaptive responses that result from both threat appraisal and coping appraisal. Similar to the HBM, increased perceived vulnerability to illness and perceived severity of the illness are thought to positively influence the probability of adopting the health behavior, but the motivation in the PMT is to protect oneself from the negative consequences of not adopting the health behavior. Fear arousal is thought to enhance protection motivation by increasing the perceived severity and vulnerability constructs. These constructs make up the threat appraisal process, while the coping appraisal process is an evaluation of response efficacy (i.e., adopting health behavior will result in threat removal) and self-efficacy (Baban & Craciun, 2007; Floyd, Prentice-Dunn, & Rogers, 2000).

Floyd, Prentice-Dunn, and Rogers (2000) conducted a meta-analysis of the PMT, and found that the effect sizes for all model variables were statistically significant and in the hypothesized directions, indicating a sound model for predicting health behavior adoption. Within this meta-analysis were studies on specific health problems and the adoption of protective health behaviors, such as AIDS prevention, cancer prevention, smoking cessation, medication adherence, and healthy diet and exercise. Overall, coping beliefs were important in participants' decisions to adopt a protective health behavior in all of the previously mentioned health problems, but were especially important in medication adherence and AIDS prevention (Floyd, Prentice-Dunn, & Rogers, 2000). Additionally, the PMT has been used as a good predictor of adopting protective health behaviors in fetal alcohol spectrum disorders prevention (Cismaru, Deshpande, Thurmeier, Lavack, & Agrey, 2010) sport injury rehabilitation adherence (Brewer et

al., 2003), adherence to asthma treatment regimens (Bennett, Rowe, & Katz, 2012; Schaffer & Tian, 2004), and adherence to diabetes treatment regimens (Palardy, Greening, Ott, Holderby, & Atchison, 1998).

As previously mentioned, physical activity is often incorporated into a treatment regimen for chronic diseases such as cardiovascular disease and diabetes. Plotnikoff and Higginbotham (2002) investigated the PMT's utility in predicting adherence to physical activity regimens in two community samples characteristic of high rates of coronary heart disease. Consistent with general findings, coping beliefs were strongly and positively correlated with exercise outcome measures than PMT's threat appraisal constructs.

Tulloch and colleagues (2009) also investigated PMT's utility in predicting exercise regimen adherence in patients with coronary artery disease. They assessed patients' coping and threat appraisals according to PMT at time of hospital discharge, and again at two and six months post discharge. They also assessed patients' exercise behavior at time of hospital discharge, and again at six and twelve months post discharge. Self-efficacy, response self-efficacy, and perceived severity successfully predicted intentions of exercise regimen adherence, and these intentions predicted exercise behavior, except at twelve months post discharge.

Plotnikoff, Lippke, Trinh, Courneya, Birkett, & Sigal (2010) also investigated the usefulness of the PMT for predicting exercise regimen adherence in patients with type 1 and type 2 diabetes. Overall, the PMT was effective in predicting adherence intentions and behavior in both groups. Specifically, self-efficacy was a stronger predictor than response efficacy of exercise adherence intentions. Self-efficacy and intention were significantly related with adherence behavior (Plotnikoff et al., 2010).

In summary, the PMT makes uniquely valuable contributions to the motivational health behavior change literature by incorporating affective processes and personality variables as potential mediating processes that lead patients to decide to adhere. It also incorporates a "protection motivation" construct, which serves as a catalyst for an individual to engage in coping responses that are congruent with their predisposing traits and affective tendencies. Like the HBM, perceived illness severity has predicted behavioral intentions to engage in an exercise regimen, and like the TPB, these intentions subsequently predicted adherence behaviors. Similarly, self-efficacy was also associated with adherence intentions and behaviors in the studies previously reviewed. In accordance with the PMT, coping beliefs were also predictive of adherence.

Measuring Adherence

While there is currently no gold standard of measuring treatment adherence behaviors, both objective and subjective methods have been employed in adherence research (Brown & Bussell, 2011; Fenerty et al., 2012). Objective methods include counting pills, referencing pharmacy refill records, using electronic medication event monitoring systems, or taking biochemical measurements of an added nontoxic marker to medication in blood or urine samples. Subjective methods include interviewing patients, caregivers, family members, and physicians about medication use or by employing one of several theoretically-driven self-report inventories about medication adherence attitudes (Brown & Bussell, 2011). An additional benefit to using a theoretically-driven self-report inventory in conjunction with other forms of adherence measurement methods is that these inventories can provide insight into patients' subjective beliefs and intentions surrounding treatment adherence and thus can inform subsequent effective intervention practices.

Several self-report inventories have been validated for use of measuring antipsychotic medication adherence attitudes, including the Drug Attitude Inventory (Sajatovic et al., 2010), Medication Adherence Rating Scale (Fialko et al., 2008; Thompson, Kulkami, & Sergejew, 2000), and Brief Adherence Rating Scale (Byerly, Nakonezny, & Rush, 2008). Only a few inventories have been developed for the purpose of predicting adherence attitudes outside of the realm of antipsychotic medication adherence. The Adherence Attitude Inventory was developed to assess four factors empirically associated with treatment adherence, namely cognitive functioning, patient-provider communication, self-efficacy, and commitment to adherence (Lewis & Abell, 2002). It has demonstrated preliminary evidence for use measuring adherence attitudes to HAART in HIV/AIDS patients (Lewis & Abell, 2002), as well as measuring adherence attitudes to antidepressant medication in older adults (50 years of age or older) with major depressive disorder (Sun et al., 2011).

Summary and Implications

The HBM, TPB, and PMT are all motivational models of health behavior change, which work on the assumption that drive or motivation is enough for health behavior adoption (Armitage & Conner, 2000). They have been utilized to predict health behavior adoption and to elucidate underlying mechanisms to inform interventions aimed at increasing adherence rates to treatment regimens (Baban & Craciun, 2007). While each model posits different constructs and underlying mechanisms of health behavior, a major similarity among the HBM, TPB, and PMT is the importance placed on subjective perceptions of incoming health information, and the subsequent cognitive decision-making process that ultimately provides the impetus for successful health behavior adoption. In short, each model emphasizes the individual's subjective cognitive process of forming behavioral intentions about a proposed health behavior, and its objective

behavioral result. As each of these models have been validated for use in health behavior prediction, it is highly likely that these common factors are indeed worth measuring clinically as a means to inform interventions.

Even with this good amount of evidence, few self-report inventories have been created to assess treatment adherence attitudes outside the realm of antipsychotic medication adherence studies. An additional challenge in treatment adherence research is the lack of a gold standard for measuring patient adherence behaviors, as subjective assessments are considerably unreliable and objective assessments are typically expensive and unrealistic for use outside of research studies (Brown & Bussell, 2011). Nevertheless, after decades of adherence research, it is clear that patient's subjective cognitions about a health condition and the adoption of a treatment regimen are important predictors of adherence despite these barriers to consistent measurement (Martin, Williams, Haskard, & DiMatteo, 2005).

While continued research is warranted for further delineation of such variables contributing to the complexities of treatment adherence, researchers should also consider in more detail the impact of individual differences on patient perception of novel health information. Most effective interventions for treatment adherence target one or more of the aforementioned nonadherence factors; however, an investigation of individual differences in the perception of health information, particularly when a patient receives a new diagnosis with treatment recommendations, may uncover invaluable knowledge regarding mechanisms to adherence that fundamentally affect patient decision-making. As such, a review of the individual differences literature follows.

CHAPTER III: INDIVIDUAL DIFFERENCES LITERATURE REVIEW

In general, broad facets of life are universally similar. There are many physical, developmental, cognitive, affective, and behavioral similarities that come with the experience of being human. This idea is reflected in the commonalities found among major health behavior change models used to predict and explain underlying mechanisms of treatment adherence. As subjective perceptions of incoming health information are at the core of each of the aforementioned motivational models, an investigation of individual differences is warranted. This phenomenological approach to studying adherence behavior, cognitive appraisals, and emotional experiences puts particular emphasis on that which makes each person unique. Studying individual differences can provide insight into the complexities of adherence, thus allowing for better understanding and prediction of adherence intentions and resulting behaviors (Hamann & Canli, 2004).

Personality and Health Behaviors

Research investigating the relationship between personality and health typically addresses one of three issues. The first issue is the potential causal effect personality has on the development and course of disease through physiological effects of stress. The second issue addresses how personality is related to engaging in specific healthy or risky behaviors, which in turn affect the risk of developing a new illness or exacerbation of current illness. The third issue relates to the moderating influence personality may have on the impact of acute medical stressors and the demands of chronic medical illness on the body to make physiological, psychological, and social adjustments (Smith & Williams, 1992).

Past research in this area has addressed the first of these issues, that is, the degree to which personality traits are causally related to physical illness. For example, an important line of

research investigating the relationship between Type A behavior and coronary heart disease was a driving force in the re-instigation of personality and health investigations. Type A behavior consists of hostility, competitiveness, and achievement striving, with hostility being a major contributor to heart disease (Dembroski, MacDougall, Costa, & Grandits, 1989). An expert panel of the American Heart Association concluded that Type A personality was a significant risk factor for heart disease, as people with Type A pattern were two times as likely to develop heart disease as people with a Type B pattern of easygoing, patient, and soft-spoken personality traits (Cooper, Detre, & Weiss, 1981).

Another example of research addressing the causal relationship between personality and physical illness is the more recent line of research on optimism. Optimism refers to a person's stable expectation of good outcomes (Carver & Scheier, 1982). According to Carver and Scheier (1982), higher levels of optimism result in the tendency to actively cope with stressors, thus alleviating physiological stress responses by lessening the effects of emotional adjustment. This hypothesis was supported in optimistic cardiac surgery patients who showed better postoperative recoveries and less likelihood of intra-operative myocardial infarction compared to less optimistic patients (Scheier et al., 1989).

While much research has addressed the first issue of personality's causal relationship with health, research utilizing the Five-Factor Model has addressed the second issue related to the prediction of engaging in health behaviors (Costa & McRae, 1985; Goldberg, 1990). The Five-Factor Model evolved from decades of personality research beginning with the works of Allport and Odbert in 1936, who scoured the English language for terms describing personality traits. Catell later (1943) used Allport and Odbert's list of 18,000 terms to ultimately create sets of bipolar trait scales that were eventually trimmed down to five factors (Goldberg, 1990).

Through adequate factor analyses, these five factors have evolved into the following constructs: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness (McCrae & Costa, 1985).

The Five-Factor Model has endured considerable criticism since its inception, including its major assumption that spoken language could systematically explain and reasonably reflect a concept as dynamic and complex as personality (McAdams, 1992). Nevertheless, the Five-Factor Model and its individual constructs continue to be used as a framework for investigating individual differences in adherence rates and health behaviors. For example, Extraversion, which is the tendency to be outgoing and experience positive emotions, was found to be associated with engaging in preventive health behaviors (Blumenthal, Sanders, Wallace, Williams, & Needles, 1982). Neuroticism, the tendency to experience emotional distress, was found to be associated with risky health behaviors and lack of healthy behaviors (Brook, Whiteman, Gordon, & Cohen, 1986, 1986; Mechanic & Cleary, 1980; Spielberger & Jacobs, 1982). Conscientiousness, the tendency to be methodical, reliable, and goal-oriented, and Agreeableness, the tendency to be tolerant and accepting, were found to be associated with healthy behaviors in a sample of Navy and Marine recruits (Booth-Kewley & Vickers, 1994).

In an effort to more specifically address the second main issue of personality and health, studies connecting the relationship between personality traits and adherence to prescribed health regimens have been conducted. Christensen and Smith (1995) used the Five-Factor Model of personality traits and the HBM to examine medical regimen adherence in 72 renal dialysis patients. The only significant personality factor associated with medication adherence was Conscientiousness. Conscientiousness, however, was not significantly correlated with adherence to the dietary component of the prescribed regimen. In a similar study with 70 hemodialysis

patients, Wiebe & Christensen (1997) found that an interaction between Conscientiousness and health beliefs (mostly perceived severity) significantly predicted individual differences in serum phosphorus levels, which is a measure of regimen adherence. Furthermore, they found that high Conscientiousness in combination with high perceived severity was associated with lower adherence rates. Researchers speculated that this pattern could be resulting from ineffective coping strategies such as avoidant coping associated with high levels of anxiety (Wiebe & Christensen, 1997).

Individual Differences and Health Behaviors

While past research on personality and health has utilized the HBM in conjunction with the Five-Factor model, other researchers have used the PMT with its uncertainty orientation construct as an individual difference variable in health behavior adherence. As previously explained, PMT posits that whether a person adopts a health behavior after receiving a health message (e.g., a diagnosis, instructions for treatment, etc.) depends on several conditions, including the severity of the health threat, perceived vulnerability to the threat, how efficacious the health behavior is perceived to be at alleviating the threat (response-efficacy), and perceived self-efficacy for carrying out the health behavior. When someone encounters a health message, two cognitive processes are activated that influence the cognitive factors previously described: threat appraisal and coping appraisal. Protection motivation is the integration of these two processes, which serves as a mediator to engaging in the health behavior as a means to protect the self from harm (Brouwers & Sorrentino, 1993).

Another factor consistent with the PMT that has been hypothesized to contribute to the likelihood of an individual adopting a health behavior is uncertainty motivation. Uncertainty motivation is the extent to which individuals are motivated to deal with uncertainty about the

self. Brouwers and Sorrentino (1993) hypothesized that uncertainty motivation, perceived efficacy (coping appraisal), and perceived threat (threat appraisal) would interact to predict health-related information seeking behaviors. One hundred fifty-five participants read one of several versions of an educational essay on a health condition and its corresponding treatment, which varied upon levels of threat and efficacy. In agreement with hypotheses, participants who were high on uncertainty orientation sought more health-related information as threat and efficacy increased, while those who were higher on certainty orientation sought more health-related information as either threat or efficacy increased.

While the PMT is a sound framework for prediction and explanation of health behavior adoption, there are still aspects of receiving health information left to be determined, such as the valence of the health message and the corresponding psychophysiology effects of receiving such information. Another framework for studying such phenomena exists, namely Reinforcement Sensitivity Theory (RST), and includes comprehensive measures of individual differences that can be used in conjunction with motivational models of health behavior to further elucidate adherence to prescribed treatment regimens.

Reinforcement Sensitivity Theory

A common approach to studying individual differences is to use dimensions of RST. This theory has been described as a neuropsychology of affective, motivational, and cognitive factors (Smillie et al., 2006). The premise of RST is that motivation and emotion may consist of the central physiological processes underlying personality (Depue & Collins, 1999). However, RST was not created or originally conceptualized as a way to describe personality, but instead as a theory of neurobiological systems suggested to relate to personality (Carver & White, 1994).

RST has evolved drastically since its formation in the 1970s by Jeffrey Gray from basic animal learning research (Smillie et al., 2006). RST was then used as a way to better understand anxiety and impulsivity. It was observed that rodents involved in basic animal learning research shared common biological systems related to anxiety and impulsive behaviors in the context of reinforcements. These behaviors varied among individual rodents in a stable and heritable way, comparable to dispositional attributes of humans, commonly referred to as personality traits. According to Gray (1990), cognition and emotion are two distinct variables that should be thought of as a function of adaptive, reinforcement behaviors, which shape personality. The notion that personality could be accounted for using physiological, motivational, and emotional concepts revolutionized the way that personality research was conducted thereafter (Leue & Beauducel, 2008; Smillie et al., 2006).

Traditionally, RST consisted of three systems, namely the Behavioral Activation System (BAS), the Behavioral Inhibition System (BIS), and the Fight/Flight System (FFS). These systems were thought to have distinct neural pathways, and are now typically examined via self-report scales (Carver & White, 1994). The BAS was considered to be the reward system, while the BIS was considered the punishment system. The FFS was conceptualized as a threat-response system.

The BAS has been associated with experiencing positive emotions, like happiness, commonly connected with approach behavior, resulting from mesolimbic dopaminergic reward system pathways (Demaree, Robinson, Everhart, & Youngstrom, 2005). The BIS on the other hand has been associated with experiencing negative affect, like fear, commonly associated with inhibition. The BIS has also been associated with anxiety, and is thought to be sensitive to signals of punishment, nonreward, and novelty (Carver & White, 1994). Neurophysiologically,

the BIS is modulated by adrenergic and serotonergic pathways (Demaree et al., 2005). The BIS was traditionally the central focus of RST, while the FFS was considered to be a mediator of responses to unconditioned aversive stimuli. Activation of the FFS resulted in rapid escape or defensive aggression. Activation of these systems was thought to lead to affective dimensions of positive and negative mood. Individual differences in this activation and reactivity of the BIS and BAS were believed to correspond to stable differences in emotionality and resulting behavioral tendencies as they were reinforced over time (Smillie et al., 2006).

The current conceptualization of RST is very similar to traditional RST. There are still three systems, namely the BIS, BAS, and a newly revised Fight/Flight/Freezing System (FFFS), and activation of each results in grossly similar kinds of behaviors outlined previously. The revised RST has some important modifications (Gray & McNaughton, 2000). The BAS is now more broadly conceptualized as being a mediator of responses to all appetitive stimuli, not just stimuli that have been conditioned as was previously posited. The FFFS is also a broader concept in that it is thought to be a mediator of responses to all aversive stimuli, not just unconditioned stimuli. The BIS is still the central focus of RST, and is still believed to be associated with anxiety. The main revision of the BIS is that it is activated by sources of conflict instead of being responsive to aversive stimuli. A source of conflict is defined as any experience that simultaneously activates the BAS and FFFS. Importantly, the BIS is no longer considered as a punishment system, but instead a conflict detection and resolution mechanism (Smillie et al., 2006).

Psychophysiology and RST. Since RST implies the importance of neurophysiology, much research has included the use of psychophysiological measures such as electroencephalography (EEG) and event-related potential (ERP). EEG is recorded from the

scalp and measures electrical activity generated by the brain, especially the cortex (Coles & Rugg, 1995). Generally, EEG is a noninvasive measure of spontaneous voltages created by currents that flow when many pyramidal neurons experience synaptic excitation of their dendrites in synchrony (Bear, Connors, & Paradiso, 2007). Researchers investigating RST and individual differences in resting EEG have found differences across levels of BIS and BAS with relative baseline asymmetry. For example, BAS has been associated with greater relative left frontal asymmetry, while BIS is associated with greater relative right frontal asymmetry (Sutton & Davidson, 1997). Some research has also indicated that BAS is associated with at least one negative emotion, namely anger, with observed greater left frontal activity due to its approach motivation tendencies (Harmon-Jones & Harmon-Jones, 2010). Resting baseline asymmetry is typically recorded at different time points in an experiment for blocks of time in minutes. During this time, the participant is exposed to minimal sensory stimuli and is asked to relax and remain still so as to not include sensory, cognitive, or motor artifact in the EEG.

While resting baseline asymmetry offers insight into individual differences associated with cortical arousal and correlated enduring traits, one way to gain insight into cognitive and emotional events that occur at the subsecond level is to examine event-related potentials, or ERPs. ERPs are voltage changes that occur as a result of the brain's response to a presented stimulus, and are thought to represent summated post-synaptic changes in neurons (Coles & Rugg, 1995). ERPs are recorded from a participant via electrodes evenly distributed across the scalp while the participant engages in an experimental task. Positive and negative deflections of voltage (e.g., N1, P1, N2, P2, etc.) are of particular interest in cognitive neuroscience research, as are the latencies in milliseconds, ordinal sequence in deflection order, amplitudes in microvolts of these deflections, and placement of electrodes that provides the pattern of a component's

voltage gradient over the scalp, which is believed to indicate underlying neuroanatomical activity (Friedman, Cycowicz, & Gaeta, 2001). The P300 is a special ERP response to novel stimuli presentations, and is thought to reflect dopaminergic modulatory effects of the locus coeruleus-norepinephrine system in decision-making (Coles & Rugg, 1995; Nieuwenhuis, Aston-Jones, & Cohen, 2005). The P300 is a positive displacement that usually occurs between 250ms and 500ms after stimulus presentation, and can be elicited using an oddball paradigm task, where participants are presented with frequently occurring stimuli and infrequently occurring deviant stimuli. In active oddball paradigm, participants are asked to respond to the infrequently occurring stimuli by either silently counting them as they are presented or by reaction time responses using a response device. The P300 occurs in response to the "oddball" or infrequently occurring stimuli presentations (Friedman, Cycowicz, & Gaeta, 2001).

For example, De Pascalis, Strippoli, Ricardi, & Vergari (2004) conducted an emotional-word recognition task using a visual oddball paradigm to test individual differences in anxiety and impulsivity according to Gray's RST at the electrophysiological level. Higher P300 peaks were observed over parietal and occipital electrode sites during target word presentations while in the emotionally incongruent conditions. P300 amplitudes varied across individual differences in anxiety at frontal and temporal electrode sites, as P300 amplitudes were larger in high-anxiety participants for unpleasant words compared to low-anxiety participants. Smaller P300 peaks were observed in high-impulsivity participants for negatively valenced targets over parietal and occipital electrode sites and longer P300 latencies over all electrode sites. These findings support the idea that individuals who are high in trait anxiety are more sensitive to negative information, but findings did not support the hypothesis that individuals who are high in impulsivity are more

sensitive to positive information. Instead, results support the "joint subsystems" hypothesis that predicts high impulsivity to be associated with attenuated sensitivity to punishment (Corr, 2002).

Similar emotional arousal effects have been demonstrated in both passive and active oddball paradigms (Delplanque, Silvert, Hot, & Sequeira, 2005; Keil et al., 2002; Mini, Palomba, Angrilli, & Bravi, 1996; Schupp et al., 2000), with the largest P300 responses over parietal electrodes (Olofsson, Nordin, Sequeira, & Polich, 2008; Sabatinelli, Lang, Keil, & Bradley, 2007). Arousal levels were found to be the primary determinant of P300 orienting responses over valence in a visual oddball paradigm utilizing the International Affective Pictures System (IAPS; Lang, Bradley, & Cuthburt, 2001) (Rozenkrants & Polich, 2008).

In an effort to elucidate underlying mechanisms of risky sexual practices, Lust and Bartholow (2009) used a visual oddball task in which pictures of condoms and alcoholic beverages from the IAPS were infrequently occurring stimuli among neutral, positive, and negative context images. They also assessed participants' evaluations of condoms via self-report measures. Self-reported condom evaluations were overall positive among participants, but P300 responses indicating novelty were smallest to pictures of condoms during the negative context condition, indicating that participants may be overriding their initial negative perceptions of condoms to report positive evaluations due to social norms that stress the benefits of condom use (Lust & Bartholow, 2009).

RST and Health Behaviors. Recent attention has been given to the observation that men seek psychological help significantly less often than women (Deane & Todd, 1996). In order to investigate this disparity, Tsan, Day, Schwartz, and Kimbrel (2011) assessed the relationship between restrictive emotionality, BIS, BAS, and psychological help-seeking behavior in 285 male college students. Results indicated that restrictive emotionality predicted both BIS and

attitudes towards psychotherapy. Furthermore, BAS Drive also predicted attitudes towards psychotherapy.

As health messages are typically received in an effort to persuade individuals to adopt a new behavior, a line of recent research has begun investigating the ways that persuasive messages influence decision making. People typically have cognitive responses to health messages that are considered as supporting thoughts, counter thoughts, or neutral thoughts (Shen & Dilard, 2007). This cognitive response is thought to mediate the relationship between message and attitude, which then leads to behavior adoption in many motivational health behavior models (Shen & Dillard, 2007). Specifically, individual differences in chronic activation of BIS and BAS predispose people to the tendency to feel a certain way when exposed to different health messages. Indeed, self-reported BIS and BAS were directly correlated with negative and positive emotional responses to messages, respectively, in a previous study (Dillard & Peck, 2001). Furthermore, individual differences in BIS and BAS are thought to reflect a tendency for avoidance- and approach-related behaviors, respectively.

In order to further elucidate the effects of individual differences on health behaviors, Dillard & Anderson (2004) investigated the ways that fear persuaded 361 participants to obtain a free influenza vaccination after reading a health message describing the dangers of influenza. Researchers assessed participants' fear arousal levels before and after presenting the fear-arousing message, and after presenting a message describing the way to obtain an influenza vaccination. Main results indicated that BIS was significantly and positively associated with fear arousal before and after presentation of the fear-arousing message, and also with peak fear intensity. BAS scores were not associated with fear measures, as predicted. Increases in fear and fear intensity positively influenced persuasion of participants to express their intent to obtain an

influenza vaccination. This study highlights the importance of individual differences in perception of negatively valenced health information, as higher BIS scores were associated with differences in perception of fear across time of reading the health message components (Dillard & Anderson, 2004).

Lauriola, Russo, Lucidi, Violani, & Levin (2005) investigated the role of personality in positively and negatively framed risky health decisions, including the BIS and BAS elements of RST, in order to fill the gap between behavioral decision models and message framing. Messages were framed according to attribute-framing (evaluation of a given attribute differs based on describing it in positive or negative terms), goal-framing (persuasive message's appeal differs based on describing benefits of attaining or consequences of not attaining a goal), and risky choice-framing (choice made differs based on risk level) procedures as a repeated factor, with half of the participants receiving a prevention vignette and the other half receiving the promotion vignette. Overall results indicated that individual differences in personality and health-related tendencies explained 22% of message appeal variance in the prevention focus condition, but only 6% in the promotion focus condition. Specific findings related to RST included that BAS subscales (especially BAS-Fun Seeking) were positive predictors of risk-taking in negative frame conditions (Lauriola et al., 2005).

Shen and Dillard (2007) also investigated the influence of RST elements and message framing on the processing of persuasive health messages, with a specific focus on advantage framing effects where messages differed on goal congruence. Framing effects were observed, as advantage framing resulted in stronger positive emotions, while disadvantage framing resulted in stronger negative emotions. An interaction was observed between BIS/BAS and framing on

cognitive response. BIS correlated positively with cognition in the disadvantage frame condition while BAS correlated positively with cognition in the advantage frame (Shen & Dillard, 2007).

Summary and Implications

In summary, considering health behavior through a perspective consistent with individual differences research has already uncovered many avenues for further exploration regarding adherence. Particularly useful are frameworks that allow for concurrent delineation of underlying neural mechanisms that influence immediate orientation to affective and novel stimuli, subsequent cognitive appraisals of the stimuli, and ultimate formations of behavioral intentions, which have been found to be predictive of adherence behaviors across motivation health behavior models. RST provides such a framework, and its facets have been shown to predict neurophysiological, cognitive, and behavioral responses that have useful applications for predicting adherence behaviors and devising practical, tailored approaches for adherence enhancement. Especially relevant to the current study were findings indicating from Shen and Dillard (2007) that message framing can evoke varying levels of affect, which can be tailored to appeal to individual differences in BIS or BAS, perhaps to an extent that would increase behavioral intentions and subsequent adherence behaviors. As the present study seeks to explore how these factors relate to a patient's experience of receiving a specific health diagnosis of OSA and CPAP treatment recommendations, the next chapter will focus on available research on OSA and CPAP adherence.

CHAPTER IV: NONADHERENCE FACTORS OF OBSTRUCTIVE SLEEP APNEA TREATMENTS

Obstructive Sleep Apnea (OSA) is a common sleep disorder characterized by at least five respiratory events caused by obstructions of the upper airway during sleep, due to collapse of the dilator muscles and soft tissues of the pharyngeal wall (ICSD-2, 2005; Olsen, Smith, & Oei, 2008). The respiratory events and the arousals from sleep needed to reinstate breathing result in two main clinical concerns, which are hypoxia of the brain and heart and sleep fragmentation (Aloia et al., 2003; Gale & Hopkins, 2004). One of the chief concerns reported by patients is inability to gain restorative sleep due to disruptions in the sleep cycle architecture. Concurrent OSA symptoms include daytime sleepiness, snoring, and choking arousals from sleep. Having OSA increases risk of hypertension (Coughlin, Mawdsley, Mugarza, Wilding, & Calverley, 2007; ICSD-2, 2005), Type II diabetes, and stroke (Malhotra & White, 2002), and is associated with cognitive impairments (Aloia et al., 2003; Malhotra & White, 2002; Watson, Loveless, Highsmith, Lehockey, & Everhart, 2013) and comorbid anxiety and depression (ICSD-2, 2005; Parish & Lying, 2003; Patel, White, Lamhotra, Stanchina, & Ayas, 2003; Veale, Poussin, Benes, Pepin, & Levy, 2002). It also places patients at risk of early mortality (Marshal, Wong, Liu, Cullen, Knuiman, and Grunstein, 2008; Punjabi et al., 2009; Young et al., 2008).

OSA sleep disruptions are either apneas (cessations in breathing lasting at least 10 seconds) or hypopneas (at least a 50% reduction in airflow for at least 10 seconds, associated with 3% oxygen desaturation from baseline, or at least a 30% reduction in airflow for at least 10 seconds associated with a 4% oxygen desaturation from baseline) (Lee, Nagubadi, Kryger, & Mokhlesi, 2008; Mbata & Chukwukw, 2012). The severity of OSA is determined from the number of these events per hour of sleep, and is called the apnea-hypopnea index (AHI). A

patient with an AHI between 5-14 is considered to suffer from mild OSA, while moderate OSA is defined as an AHI between 15-30, and severe OSA indicated by an AHI greater than 30 (Lee et al., 2008).

Approximately 20% of adults suffer from mild OSA, and 1 in 15 adults are estimated to suffer from moderate to severe OSA. Prevalence rates increase with age until they plateau around 65 years (Young, Skatrud, & Peppard, 2004). Men were found to be more likely to suffer from OSA than women, but women were more likely to have poorer outcomes. Excess body weight was also found to be associated with increased risk of OSA (Lee et al., 2008). In addition to OSA being a risk factor of other health conditions, often people who are diagnosed with OSA already have co-occurring chronic health conditions, especially cardiovascular and metabolic concerns (Becker et al., 2003; Einhorn et al., 2007; Foster et al., 2009; Gami et al., 2004 Logan et al., 2001; Oldenburg et al., 2007; Sjöström et al., 2002).

Patients who suffer from OSA are typically prescribed one of the following apparatuses: CPAP (continuous positive airway pressure), BiPAP (Bilevel Positive Airway Pressure), or APAP (Automatic Positive Airway Pressure). CPAP utilizes continuous and direct air pressure to keep the airway unobstructed, delivered from the air compressor-like CPAP machine through a mask placed over the nose and/or mouth. BiPAP provides two levels of pressure and three different modes within the patient's control of adjustment. APAP continuously monitors the patient's breathing using pressure sensors, and adjusts the pressure to accommodate the patient's breathing (e.g., increases the pressure when the patient is unable to breathe) (Moran, Highsmith, Lehockey, & Everhart, 2012). These treatments reduce the risk of adverse outcomes by preventing the collapse of the upper airway during sleep. CPAP has been shown to decrease daytime sleepiness, improve neurocognitive functioning, decrease hypertension, and improve

quality of life (Budhiraja et al., 2007; Kryger et al., 2000). Notably, adherence to CPAP has been shown to significantly reduce mortality risk for individuals with heart failure (Kaneko et al., 2003; Kasai et al., 2008), and to improve insulin sensitivity and blood glucose control (Babu, Herdegen, Fogelfeld, Shott, & Mazzone, 2005; Harsch et al., 2004). In addition to improved physical health outcomes, CPAP treatment has been associated with improved marital satisfaction, increased bed-sharing, increased embraces, and reduced disagreements between partners (McFadyen, Espie, McArdle, Douglas, & Engleman, 2001).

Unfortunately, adherence rates to CPAP treatment are suboptimal, with 15-30% of patients rejecting CPAP treatment from the outset of diagnosis (Collard, Peiters, Aubert, Delguste, & Rodenstein, 1997), 25-50% of patients initially accepting treatment but failing to demonstrate optimal adherence (Zozula & Rosen, 2001), and 25% of patients ultimately stopping use by the third year of treatment (Engleman & Wild, 2003). The most common reasons for discontinuing CPAP treatment in one study included therapy-related factors, such as mask discomfort, nasal dryness, congestion, difficulty exhaling, sore ribs, and air swallowing (Berthon-Jones, Lawrence, Sullivan, & Grunstein, 1996). Three recent meta-analyses investigating adherence across different pressure-adjusting treatment modalities indicated generally no evidence for increased adherence, except for a significant 11-13 min/night increase for APAP, which is only prescribed to selected patients (Bakker & Marshall, 2012; Ip, D'Ambrosio, Patel, Obadan, Kitsios, Chung, et al., 2012; Smith & Lasserson, 2009). Despite these mechanical advances in CPAP treatment devices made to address adverse side effects, adherence rates have not improved suggesting that there are additional underlying theoretical mechanisms related to CPAP adherence (Olsen, Smith, & Oei, 2008).

In addition to these biomedical factors, psychosocial factors such as social undesirability of apparatus use while in the company of one's partner, either due to embarrassment of having to use the machine or due to partner reports of dissatisfaction with machine noise, were reported as barriers to successful CPAP adherence (Zozula & Rosen, 2001). This could relate to perceived lack of social support, and speaks to the influence of factors within the social domain of the biopsychosocial model (Lewis, Seale, Bartle, Watkins, & Ebden, 2004). CPAP adherence has also been studied using motivational health behavior models, such as the HBM.

The HBM has been utilized to investigate these underlying mechanisms. Sage, Southcott, & Brown (2001) adapted CPAP questionnaire items to assess HBM constructs in 40 patients with OSA after initial CPAP titration. Adherence was measured for one month thereafter. Perceived benefits of using CPAP were positively associated with adherence. Self-efficacy in ability to overcome adherence obstacles was also positively associated to adherence. Concern about barriers to CPAP adherence was inversely associated with adherence rates. These subjective patient factors were overall more predictive of CPAP adherence than were objective severity measures (Sage, Southcott, & Brown, 2001).

Similar findings emerged from a more recent study on nonadherence in OSA. Olsen, Smith, Oei, & Douglas (2008) conducted the same basic procedures as Sage, Southcott, & Brown (2001), but provided the CPAP questionnaire to patients after receiving an OSA diagnosis but before starting CPAP, hoping to explain high rates of initial resistance to CPAP. Assessing patients' beliefs before starting CPAP allowed researchers to gain insight into patient motivations and intentions before patients gained knowledge of side effects to CPAP treatment. Patient beliefs regarding expectancy of effectiveness of CPAP predicted adherence at four

months. Other predictors of adherence consistent with the HBM included low perceived risk and high perceived functional limitations associated with CPAP nonadherence (Olsen et al., 2008).

Poulet, Veale, Arnol, Levy, Pepin, and Tyrell (2009) similarly measured health beliefs of OSA and CPAP via the Apnea Beliefs Scale in 122 OSA patients one month prior and one month after initiating CPAP. A decision-tree analysis identified three baseline factors including the use of responses to the Apnea Beliefs Scale to correctly predict 85.7% of nonadherence.

Golay and colleagues (2006) were interested in designing and testing a workshop-based educational intervention to increase CPAP adherence in 35 patients with OSA. Workshops consisted of groups of three to four patients during patients' 36 hour stay at a hospital, at which time various providers would engage the patients in education regarding the purpose of CPAP treatment, how to use the apparatus, the benefits and disadvantages of daily CPAP use, and discussions with family members regarding the nature of CPAP treatment. Results indicated no significant change in CPAP adherence after three months, but subjective sleepiness was significantly improved as indicated via self-reported symptoms on the Epworth Sleepiness Scale three months later. In a more recent study investigating the influence of CPAP and OSA knowledge on adherence, Trupp, Corwin, and Ahijevych (2011) conducted a randomized controlled trial of educational message framing (i.e., negative and positive frames) to enhance CPAP adherence in 70 patients with OSA and cardiovascular disease. CPAP use was greater in the group who received the negative message frame at thirty days. Furthermore, baseline self-efficacy scores were greater in those patients who used CPAP the first night after receiving health recommendations.

Personality variables have also been considered as possible predictors of CPAP adherence. In one study using the Minnesota Multiphasic Personality Inventory- 2nd Edition

(MMPI-2), self-reported CPAP adherence was associated with lower scores on the Hypochondriasis (measures somatic concerns) and Depression (measures depression associated with personal worth, withdrawal, psychomotor retardation, and other depressive symptoms) clinical scales. It could not be determined whether lower scores on these scales predicted adherence behavior or if adherence behavior alleviated potential elevations on these scales (Chervin, Theut, Bassetti, & Aldrich, 1997). Consistent with studies of nonadherence to other treatment regimens as described in the previous section, neuroticism was found to be a significant predictor of nonadherence (Moran, Everhart, Davis, & Wuensch, 2010). There is variability in the predictive utility of neuroticism in the literature, with Drake (2003) not finding a significant association between this trait and nonadherence. In addition to neuroticism, Moran et al. (2010) identified BIS as the strongest predictor of nonadherence to CPAP among the variables they entered into logistic and multiple regression models. This study did not find any coping strategies as measured in the Ways of Coping Questionnaire (Lundqvist & Ahlstrom, 2006) to be significant predictors of CPAP nonadherence, although previous research demonstrated that Planful Problem Solving and Confrontive Coping subscales of the Active Coping scale to be positively associated with adherence (Stepnowsky et al., 2002).

Purpose and Research Questions

The current study examined individual differences associated with the phenomenological experience of receiving health information. This study addressed questions regarding psychological and neurophysiological predictors of treatment adherence and behavioral intentions to participate in treatment. Using RST to investigate potential mechanisms underlying the person-centered constructs shared across leading theories on health behaviors, two studies

(one laboratory experiment and one clinical study) that answer the following research questions were completed:

Question 1. Does RST predict behavioral intentions and/or behavior? This question was addressed in the following ways:

Study One:

It was hypothesized that BIS would be positively associated with behavioral intentions to adhere to the disadvantage-framed message in the experimental laboratory study due to its association with negative emotion and avoidance-related behaviors. BAS subscales were hypothesized to be positively associated with behavioral intentions to the advantage-framed message due to their associations with positive emotion and approach-related behaviors.

Study Two:

BIS was found to be a significant predictor of nonadherence behavior in previous research (Moran et al., 2010), thus, it was hypothesized that BIS would again predict treatment nonadherence behavior in a convenience sample of OSA patients.

Question 2. Does P300 ERP predict behavioral intentions according to RST? This question was addressed in the following ways:

Study One:

As previously explained, the P300 is an event-related potential that is particularly sensitive to novel incoming information. According to leading health behavior models, subjective beliefs are central to a patient's decision to engage in adherence behaviors. Eliciting the P300 through an active, affective oddball paradigm will allow researchers to investigate the

importance of tailoring health messages to appeal to the emotional tendencies of patients given their predisposing BIS and BAS trait levels. Differences in P300 amplitudes will provide further clarification regarding patients' immediate perceptions of novel incoming health information at the neurophysiological level.

It was hypothesized that higher BAS scores would be associated with larger P300 amplitudes during negative oddball stimuli presentations and overall higher behavioral intentions scores. It was also hypothesized that higher BIS scores would be associated with larger P300 amplitudes during positive oddball stimuli presentations and overall lower behavioral intentions scores.

Question 3. Do resting frontal asymmetry correlates replicate previous findings related to RST, and do these predict behavioral intentions and/or behavior?

Studies One and Two:

It was hypothesized that higher BAS scores would be associated with greater relative left frontal activity while higher BIS scores would be associated with greater relative right frontal activity.

Study One:

It was hypothesized that greater relative left frontal activity would be associated with greater behavioral intentions to adhere to the advantage-framed message, while greater relative right frontal activity would be associated with higher behavioral intentions to adhere to the disadvantage-framed message.

Study Two:

It was hypothesized that greater relative left frontal activity would be associated with greater adherence behavior in the clinical sample, while greater relative right frontal activity would be associated with lower adherence behavior.

CHAPTER V: STUDY ONE

Method

Participants. Based on a priori power analysis to detect medium effects with 80% power using GPower 3.1, 87 right-handed volunteers aged 18 years and older from East Carolina University were recruited using the undergraduate psychology participant pool during fall and spring semesters, with some students recruited during the summer semester (Appendix D). All participants gave informed consent to the protocol, which was approved by the East Carolina University and Medical Center Institutional Review Board (Appendix B & J). Four participants were excluded from analyses because they were receiving psychopharmacological treatment for depression, three were excluded for history of significant head trauma or other neurological history, and three others were excluded because they fell asleep during the experimental EEG procedures. Once adjusted for exclusionary criteria, 77 participants were included in statistical analyses. Of these participants, 38 were women and 39 were men. The mean age of participants was 19.08 years (*SD* = 1.19), and the mean level of education achieved by participants was 12.90 years (*SD* = 1.01). All participants included in statistical analyses had normal or corrected-to-normal vision and no prior significant neurological or psychiatric history. Exclusionary criteria for study one also included current diagnosis of obstructive sleep apnea (OSA), as part of the experimental procedure entailed imagining receiving such a diagnosis.

Materials. Participants completed several self-report measures before and during the experimental procedure to assess exclusionary criteria and factors of interest.

Assessing exclusionary criteria. The Lateral Preference Inventory was administered to assess for handedness and other features of lateral preference to control for possible resting EEG asymmetry confounds (i.e., eye, ear, leg) (Coren, Proac, & Duncan, 1979). Participants also

completed a general information survey, assessing demographic (age, sex, education level) and medical history variables (history of neurological or psychiatric conditions, current psychopharmacological treatment) (Appendix E).

Measuring behavioral inhibition and behavioral activation. Carver and White's (1994) BIS/BAS scales were completed by the participants as a way to measure self-reported behavioral inhibition and behavioral activation of each participant. While the BIS/BAS scales have reasonable support for their construct validity and four-factor structure measured via one BIS subscale and three BAS subscales (BAS Drive, BAS Reward Responsiveness, BAS Fun Seeking; alphas ranging from .66-.76, with two-month test-retest reliabilities ranging from *r* .59-.69; Carver & White, 1994), there has been some criticism of the BAS-Reward Responsiveness subscale (Cogswell, Alloy, van Dulmen, & Fresco, 2006; Gomez, Cooper, & Gomez, 2005). The main criticism was that BAS Reward Responsiveness was positively correlated with BIS and independent from the other BAS subscales, which is not reflective of RST, and this subscale's items were only effective in representing the construct at very low to just around the mean trait levels. Additionally, the BIS facet as it is currently defined within the updated version of RST has not been thoroughly tested. Given these limitations, the Appetitive Motivation Scale (AMS) and the Sensitivity to Punishment Questionnaire (SPQ) were used to approximate these constructs more thoroughly.

The AMS was administered to all participants to investigate features of the BAS related to participants' processing of appetitive stimuli (Jackson & Smillie, 2004). It was developed to assess the tendency to approach experiences resulting in rewarding stimuli, with less emphasis on impulsive behavior that has been a focus of assessment in other RST measures. Another purpose of its development was to return the BAS construct to a one factor structure as opposed

to breaking it into subscales. The AMS has demonstrated good internal consistency (alpha = .81), good convergent validity with other reward-oriented BAS measures (e.g., BAS Drive r = .49, BAS Fun Seeking r = .55, BAS Reward Responsiveness r = .22; all significant $p < .05$), and good discriminant validity with low to moderate negative correlations with BIS measures (Cooper, Smillie, & Jackson, 2008).

The SPQ was administered to all participants in order to best approximate facets of the BIS specifically related to punishment sensitivity, but may not fully represent current BIS construct as defined in the updated RST (Torrubia et al., 2001). The SPQ demonstrated acceptable levels of internal consistency (alphas ranging from .75-.83) and three-month test-retest reliabilities (r of .89; Torrubia et al., 2001).

Measuring coping strategies. The Brief COPE was administered prior to participating in the experiment. This measure is a consolidated version of the COPE, which comprises 60 items assessing various cognitive and behavioral coping strategies. The Brief COPE is a 28-item inventory, consisting of 14 subscales with two items on each scale. The 14 subscales measure 14 constructs, namely, Active Coping, Planning, Positive Reframing, Acceptance, Humor, Religion, Using Emotional Support, Using Instrumental Support, Self-Distraction, Denial, Venting, Substance Use, Behavioral Disengagement, and Self-Blame. A unique characteristic of the Brief COPE is that it has been designed to accommodate retrospective, concurrent, or dispositional formats, allowing researchers flexibility in how they ask each of the questions. This study included the following modification to the first statement: "These items deal with ways you've been coping with the stress in your life since you found out you were diagnosed with obstructive sleep apnea." The Brief COPE has demonstrated acceptable internal reliability (alphas ranging

from .50 [Venting subscale] -.90 [Substance Use subscale]), with a factor structure that was generally consistent with the full COPE (Carver, 1997).

Simulation study stimuli and subjective response measures. During the experimental phase of Study One, participants were asked to pretend that they had just received a diagnosis of a chronic health condition, namely, OSA. They subsequently viewed two separate health information videos describing treatment guidelines that were advantage-framed or disadvantage-framed to elicit relatively different levels (positive and negative) of affect (Shen & Dillard, 2007). They then indicated their affective responses to the messages by completing the Self-Assessment Manikin (SAM), a tool for rating subjective emotion (Lang, 1980), which has been shown to be an effective instrument for measuring existing feeling states (Bradley & Lang, 1994). The SAM assesses three components of emotion, namely valence, arousal, and control, using a nonverbal, visual response system where participants choose which picture best represents how they feel in response to a given stimulus (Bradley & Lang, 1994). Participants indicated their level of behavioral intentions by answering the following item: "Please indicate the likelihood that you would follow the physician's recommendations." The response format was on a scale from 0% (certain that I will not adhere) to 100% (certain that I will adhere) (Dillard & Anderson, 2004).

OSA was chosen due to the complex nature of treatment recommendations and the health consequences associated with nonadherence behaviors. As the second study focuses on a sample of OSA patients and their adherence behaviors, choosing OSA as the disease state for simulation in Study One allows for the potential to study mechanisms that may be treatment-specific (e.g., presentation of the CPAP machine as a visual stimulus may provoke affective activation unique to OSA patients). Furthermore, one of the aims of this study is to better understand the potential

underlying mechanisms driving adherence behaviors in the clinical sample; findings from this simulation study within a lab environment can control and test variables of interest that are otherwise impossible to test in a clinical setting. Such variables include novelty of receiving a health diagnosis, real-time ratings of affective responses to incoming affective health information, and careful tailoring of affective health messages to include the same content while using different frames.

Prior to use in Study One, videos underwent pilot testing on Qualtrics to ensure the two conditions elicited significant differences in affect. All participants gave informed consent to the protocol, which was approved by the East Carolina University and Medical Center Institutional Review Board (Appendix A & I). After viewing each video, 133 undergraduate participants completed the SAM. Pilot test results demonstrated significant differences of elicited affect across each facet of subjective emotion measured by the SAM. Paired samples t-tests indicated that participants rated the advantage-framed message as eliciting significantly more positive affect (M = 5.97, SD = 1.693) than the disadvantage-framed message (M = 3.95, SD = 1.810), $t(122) = 10.456$, $p < 0.001$, $d = 1.333$, 95% CI [1.031, 1.632]. Similarly, they rated the advantage-framed message as eliciting significantly higher levels of control (M = 5.41, SD = 2.100) than the disadvantage-framed message (M = 4.39, SD = 2.231), $t(122) = 5.805$, $p < 0.001$, $d = 0.740$, 95% CI [0.472, 1.006]. The disadvantage-framed message elicited significantly higher levels of arousal (M = 4.46, SD = 1.852) than the advantage-framed message (M = 3.95, SD = 1.894), $t(122) = 2.536$, $p = 0.012$, $d = 0.323$, 95% CI [0.0700, 0.576]. Results from pilot testing indicated that these simulation videos were appropriate to use in the present study.

EEG study equipment and stimuli. The control and presentation of the experimental stimuli and recording of participants' responses was managed with SCAN 4.4 software

(Compumedics Neuroscan, El Paso, TX). Stimuli consisted of two types of pictures (positive, negative) selected from the IAPS, which are matched for valence and arousal (Bradley & Lang, 2007). All items were matched for luminance and size. Event related potentials were recorded during stimuli presentation throughout the duration of the task.

Active affective oddball paradigm. Participants completed a visual oddball paradigm task. As previously explained, an oddball task consists of the presentation of frequent and oddball stimuli. In this experiment, stimuli were chosen from the IAPS based on valence, and were arranged into the following two conditions for presentation: positive-standard, negative-target (PS/NT) and negative-standard, positive-target (NS/PT). The order of condition presentation was counterbalanced across participants. Participants were asked to fixate on a centered "+" symbol on the computer monitor before the beginning of each condition. Participants were asked to silently count the number of target stimuli presentations in each condition. Presentation of stimuli was pseudorandom in order to meet criteria that an odd number of standard stimulus presentations were always between target stimulus presentations and that target stimuli were never presented in series (De Pascalis et al., 2004). For each trial, 125 standard and 25 target stimuli presentations occurred, with a variable interstimulus interval between 900 and 1100ms and stimulus duration of 500ms.

Procedures. Participants were tested in the Cognitive Neuroscience Laboratory located within the Department of Psychology at East Carolina University. Procedures for Study One are summarized in Figure 1. Prior to participation, informed consent forms approved by the University and Medical Center Institutional Review Board of East Carolina University were reviewed orally with each participant and signed (Appendix B). Adherence to the "Ethical Principles of Psychologists and Code of Conduct" was kept with all participants in this study

(American Psychological Association, 2002). Once consent was established, participants completed self-report inventories and health message simulation tasks, acclimated to EEG recording procedures, and were given written instructions for the oddball paradigm task.

Procedures for EEG analysis were adapted from Everhart and Demaree (2003). Participants were seated in an electrically shielded room in a comfortable reclining chair and fitted with a lycra electrode cap (Electro-Cap International, Inc.). Electrodes were arranged according to the 10-20 international system (Jasper, 1958). EEG data were recorded from 32 active electrode sites using linked ears (A1 and A2) as a reference (monopolar montage). Electrode placement included Frontal: F3, F4, F7, F8; Central: Cz, C3, C4; Temporal: T3, T4, T5, T6; Parietal: Pz, P3, P4; and Occipital: O1, O2. In addition, electrodes were placed on the outer cantus of each eye so that eye movement recordings could be obtained. Electrode impedance was maintained below 5000 holms and checked at the beginning and end of the experimental session. Eye movement recordings were used to correct for the presence of eye movement artifact in the ERPs and to determine which trials should be excluded from averaging. Individual trials that contain excessive artifact associated with body and eye movement were excluded during off-line processing and prior to averaging. The EEG and eye movements were recorded with a bandpass of 1 and 100 Hz and a sensitivity of 7.5 μV/mm for EEG recordings. The EEG signal was amplified and converted on line to digital using a NeuroScan 32-channel PC based EEG/Evoked potential brain mapping system. A high-pass filter was used to eliminate slow wave frequencies that were less than 0.2 Hz. A 60 Hz notch filter was used to eliminate 60 Hz line noise. Artifact reduction was completed prior to computing grand averages for EEG and P300 data. Data were stored and analyzed on a PC Pentium Computer. The EEG data were converted on line for display, storage, and analysis (Everhart & Demaree, 2003).

Once they completed informed consent procedures and expressed understanding of all experimental procedures, participants engaged in two phases of research that were counterbalanced to control for order effects. One phase comprised tasks completed within the EEG booth. During this phase, participants' baseline EEG were recorded according to procedures adapted from Davidson (1988), including eight minutes of baseline recording alternating between eyes open and eyes closed conditions, followed by completion of two conditions of the oddball paradigm task [positive-standard, negative-target (PS/NT) and negative-standard, positive-target (NS/PT)]. The other phase of research comprised tasks completed outside of the EEG booth in the Cognitive Neuroscience Laboratory. Tasks included completion of self-report inventories assessing variables of interest, followed by presentations of the two video health messages, SAM ratings, and indication of behavioral intentions. Presentation order of the advantage-framed and disadvantage-framed health messages was counterbalanced in order to control for order effects.

After completion of the study, P300 responses were identified by visual inspection as the most positive peak occurring between 250ms and 500ms after stimulus presentation (Coles & Rugg, 1995). Separate grand averages for all data were created (Figures 2-4). Event related potentials were averaged across participants for emotional valence and stimulus duration.

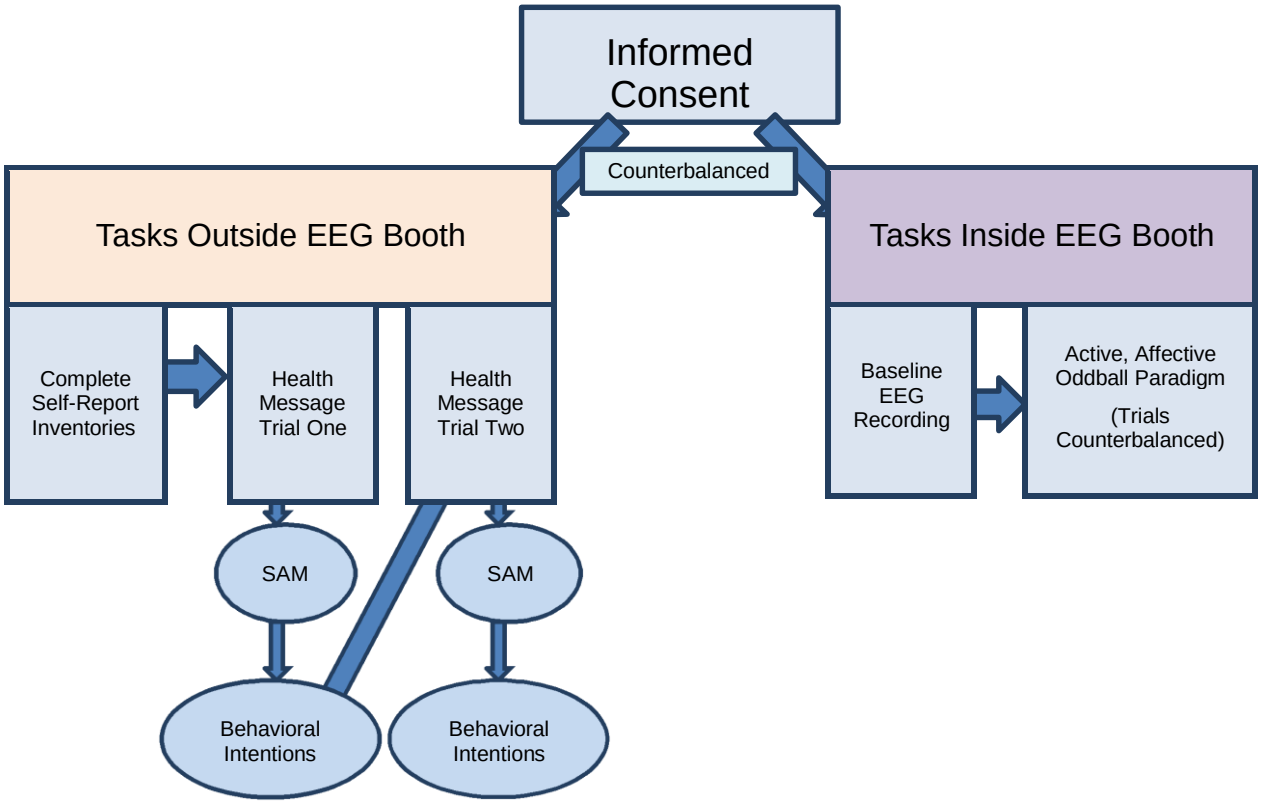

Figure 1. Summary of Study One procedures.

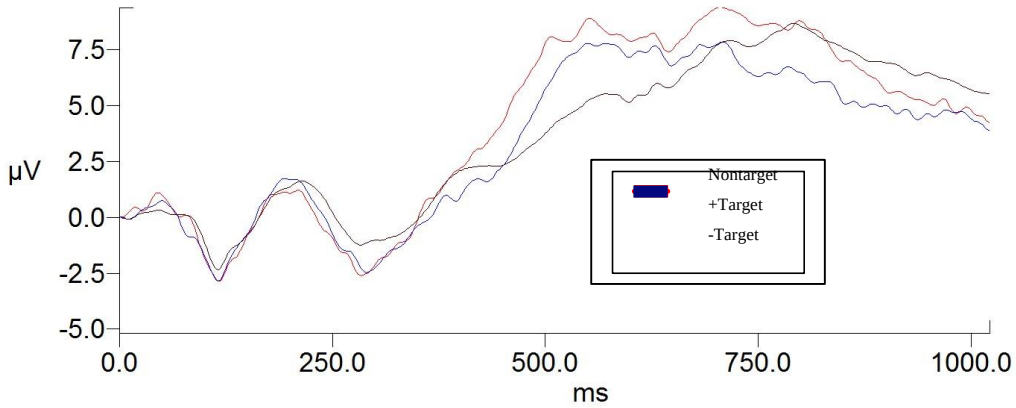

Figure 2. Grand averages of P300 responses to nontarget, positive target, and negative target stimuli presentations at electrode FCz.

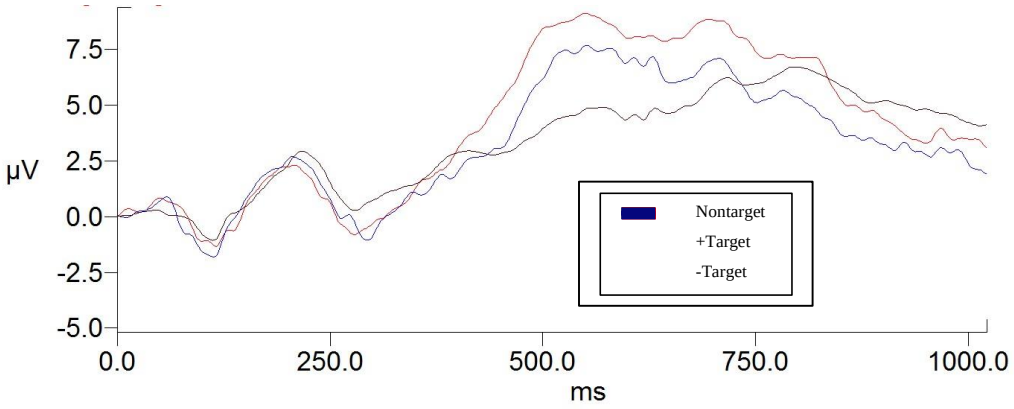

Figure 3. Grand averages of P300 responses to nontarget, positive target, and negative target stimuli presentations at electrode Cz.

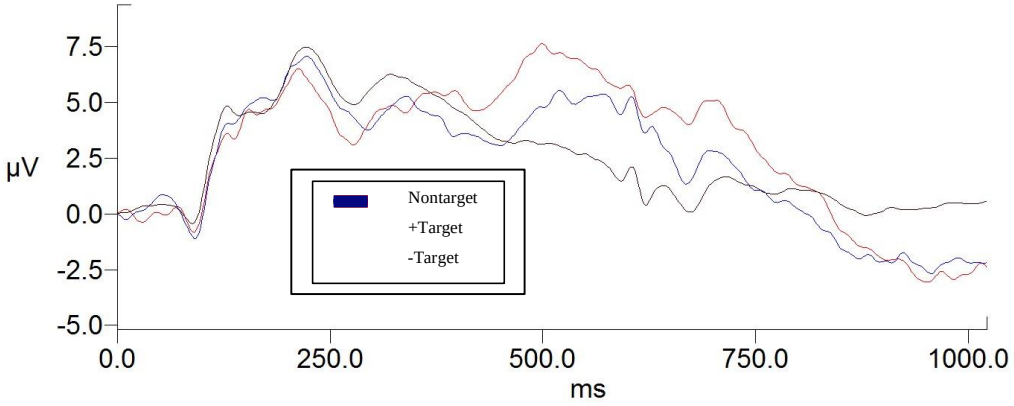

Figure 4. Grand averages of P300 responses to nontarget, positive target, and negative target stimuli presentations at electrode Fz.

Statistical analyses. Primary analyses performed were multiple regression analyses predicting behavioral intentions scores from responses to the BIS/BAS scales, AMS, SPQ, Brief COPE, SAM, P300 amplitudes, and resting frontal asymmetry scores. Correlation analyses were also conducted between trait variables and EEG baseline asymmetry scores to determine if previous findings in the individual differences literature were replicated. Alpha level was set at .05 in tests of statistical significance. Data analyses were performed using SPSS version 17.0.

Results

Multiple regression analyses were employed to test the hypothesis that treatment adherence behavioral intentions would be predicted from self-reported individual differences on BIS and BAS subscales, AMS, SPQ, Brief COPE, SAM responses, P300 amplitudes, and resting frontal asymmetry scores. Prior to conducting separate multiple regression analyses for each health message condition (advantage-framed and disadvantage-framed), Pearson correlations between predictor variables and behavioral intentions scores for each health message condition were investigated. Only those predictors that were significant at the .10 level were retained in subsequent models. The following variables were dropped prior to both multiple regression analyses: BAS Drive, BAS Reward Responsiveness, BAS Fun Seeking, Appetitive Motivation Scale, Sensitivity to Punishment Questionnaire, Brief Cope (BC): Planning, BC: Positive Reframe, BC: Acceptance, BC: Religion, BC: Emotional Support, BC: Instrumental Support, BC: Self-distraction, BC: Denial, BC: Venting, BC: Substance Use, BC: Disengagement, BC: Self-blame, SAM Arousal Responses to Advantage-Framed Message, SAM Valence and Arousal Responses to Disadvantage-Framed Message, Baseline Asymmetry Conditions (Eyes Open 1-2, Eyes Closed 1-2, 4), and all P300 amplitudes. Correlation coefficients for behavioral intentions responses to each health message condition and self-reported predictor variables are displayed in

Table 1. Correlation coefficients for behavioral intentions responses to each health message condition and EEG and ERP predictor variables are displayed in Table 2.

Table 1. Pearson correlations for behavioral intentions responses to each health message condition and self-reported predictor variables.

	Behavioral Intentions for Each Health Message Condition	
Self-Report Predictor Variable	AdvBI	DisBI
RST Variables:		
BIS	.221*	.271**
BAS Drive	.063	.043
BAS Reward Responsiveness	-.020	-.015
BAS Fun Seeking	.075	.166
Appetitive Motivation Scale	-.170	.000
Sensitivity to Punishment Questionnaire	-.078	.013
Brief COPE Subscales:		
Active	.201*	.106
Planning	.052	.025
Positive Reframe	.051	.083
Acceptance	.173	.085
Humor	-.192*	-.197*
Religion	.068	-.004
Emotional Support	.077	.111
Instrumental Support	.114	.099
Self-distraction	-.062	-.118
Denial	.026	.000
Venting	-.075	-.057
Substance Use	-.090	-.136
Disengagement	.055	.058
Self-blame	-.129	-.049
SAM Responses to Advantage-Framed Message		
Valence	.276**	.153
Arousal	-.025	.021
Control	.270**	.305***
SAM Responses to Disadvantage-Framed Message		
Valence	.064	.063
Arousal	-.050	-.079
Control	.157	.240**

*** Correlation is significant at the 0.01 level (2-tailed)
**Correlation is significant at the 0.05 level (2-tailed)
**p* value of correlation is at the 0.10 level (2-tailed)

Table 2. Pearson coefficients for behavioral intentions responses to each health message condition and EEG and ERP predictor variables.

	Behavioral Intentions for Each Health Message Condition	
Electrophysiological Predictor Variable	AdvBI	DisBI
Baseline EEG Variables:		
Eyes Open 1 (EO1)	-.038	-.069
Eyes Open 2 (EO2)	.010	-.081
Eyes Open 3 (EO3)	-.167	-.197*
Eyes Open 4 (EO4)	-.209*	-.222*
Eyes Closed 1 (EC1)	-.034	-.086
Eyes Closed 2 (EC2)	-.057	-.133
Eyes Closed 3 (EC3)	-.152	-.252**
Eyes Closed 4 (EC4)	-.057	-.143
P300 Amplitudes Variables:		
Positive Target at P3 electrode	.097	.094
Positive Target at Pz electrode	.082	.079
Positive Target at P4 electrode	.101	.129
Negative Target at P3 electrode	.099	.091
Negative Target at Pz electrode	.082	.001
Negative Target at P4 electrode	.106	.104

*** Correlation is significant at the 0.01 level (2-tailed)
**Correlation is significant at the 0.05 level (2-tailed)
**p* value of correlation is at the 0.10 level (2-tailed)

Notably, two significant correlations were found between affective response predictor variables and AdvBI. SAM Valence ratings (M = 6.01, SD = 1.805) were significantly, positively correlated with AdvBI (M = 88.37, SD = 14.189), $r(76) = 0.276$, $p = 0.016$, 95% CI [0.054, 0.472], indicating that higher SAM Valence ratings in response to the advantage-framed message (higher scores reflect positively valenced emotion) were associated with higher behavioral intentions to adhere to the advantage-framed health message. SAM Control ratings in response to the advantage-framed message (M = 5.21, SD = 1.995) were significantly, positively correlated with AdvBI (M = 88.37, SD = 14.189), $r(76) = 0.270$, $p = 0.018$, 95% CI [0.048, 0.467], indicating that higher SAM Control ratings in response to the advantage-framed message were

associated with higher behavioral intentions to adhere to the advantage-framed health message.

Four additional correlations were observed between AdvBI and predictor variables that did not reach statistical significance, but achieved a $p < .10$, and were thus included in the multiple regression analysis. These included positive correlations between AdvBI (M = 88.37, SD = 14.189) and BIS (M = 19.28, SD = 1.705), $r(76) = 0.221$, $p = 0.055$, 95% CI [-0.004, 0.425], and BC: Active (M = 6.09, SD = 1.435), $r(76) = 0.201$, $p = 0.082$, 95% CI [-0.025, 0.407], indicating that higher scores on these self-report scales were associated with higher behavioral intentions to adhere to the advantage-framed health message. A negative correlation was observed between AdvBI (M = 88.37, SD = 14.189) and BC: Humor (M = 4.63, SD = 1.799), $r(76) = -0.192$, $p = 0.097$, 95% CI [-0.400, 0.034], indicating that higher BC: Humor scores were associated with lower behavioral intentions to adhere to the advantage-framed health message. Finally, a negative correlation between AdvBI (M = 88.37, SD = 14.189) and EO4 (M = 0.148, SD = .270), $r(75) = -0.209$, $p = 0.072$, 95% CI [-0.416, 0.018], indicating that greater relative left frontal activity was associated with lower behavioral intentions to adhere to the advantage-framed health message.

Four significant correlations were observed between predictor variables and DisBI. A significant, positive correlation was observed between DisBI (M = 86.57, SD = 17.613) and BIS (M = 19.28, SD = 1.705), $r(76) = 0.271$, $p = 0.018$, 95% CI [0.049, 0.467], indicating that higher self-reported BIS scores were significantly associated with higher behavioral intentions to adhere to the disadvantage-framed health message. Two significant, positive correlations were also found between DisBI (M = 86.57, SD = 17.613) and two affective predictor variables: SAM Control responses to the advantage-framed message (M = 5.21, SD = 1.995), $r(76) = 0.305$, $p = 0.007$, 95% CI [0.086, 0.496], and SAM Control responses to the disadvantage-framed message

(*M* = 4.64, *SD* = 2.240), *r*(76) = 0.240, *p* = 0.037, 95% CI [0.016, 0.441]. These correlations indicate that higher control responses to both messages were significantly associated with higher behavioral intentions to adhere to the disadvantage-framed health message. A significant negative correlation was observed between DisBI (*M* = 86.57, *SD* = 17.613) and EC3 (*M* = 0.155 *SD* = 0.187), *r*(75) = -0.271, *p* = 0.029, 95% CI [-0.469, -0.047], indicating that greater relative left frontal activity was significantly associated with lower behavioral intentions to adhere to the disadvantage-framed health message.

Three additional correlations were observed between DisBI and predictor variables that did not reach statistical significance, but achieved a $p < .10$, and were thus included in the multiple regression analysis. These included negative correlations between DisBI (*M* = 86.57, *SD* = 17.613) and two baseline asymmetry measures: EO3 (*M* = 0.106, *SD* = 0.234), *r*(75) = -0.197, *p* = 0.090, 95% CI [-0.405, 0.031], and EO4 (*M* = 0.148, *SD* = 0.270), *r*(75) = -0.222, *p* = 0.056, 95% CI [-0.427, 0.005], indicating that higher relative left frontal activity was associated with lower behavioral intentions to adhere to the disadvantage-framed health message. Another negative correlation was observed between DisBI (*M* = 86.57, *SD* = 17.613) and BC: Humor (*M* = 4.63, *SD* = 1.799), *r*(76) = -0.197, *p* = 0.088, 95% CI [-0.404, 0.029], indicating that higher scores on this self-report scale were associated with lower behavioral intentions to adhere to the disadvantage-framed health message.

Behavioral intentions for advantage-framed message model. A test of the full multiple regression model for behavioral intentions to adhere to the advantage-framed health message included BIS, BC: Active, BC: Humor, SAM Valence and Control Responses to Advantage-framed message (AdvSAMV and AdvSAMC), and EO4 as predictor variables. The assumptions of linearity, independence of errors, homoscedasticity, unusual points, and normality of residuals

were met. These variables statistically significantly predicted behavioral intention responses to the advantage-framed health message, $F(6, 68) = 4.431$, $p = 0.001$, $R^2 = 0.281$, 95% CI [0.0684, 0.368]. BC: Humor (p =.020) and AdvSAMV (p =.016) each added statistically significantly to the prediction, $p < 0.05$. BC: Humor had a significant negative regression weight, indicating that participants who scored higher on this scale were expected to endorse lower levels of behavioral intentions to adhere to the advantage-framed message. AdvSAMV had a significant positive regression weight, indicating that participants who rated the advantage-framed message as eliciting higher levels of valence (positive direction) were predicted to indicate higher levels of behavioral intentions to adhere to the advantage-framed message. All other predictors did not significantly add to the prediction, $p > 0.05$. Regression coefficients and standard errors are displayed in Table 3.

Table 3. Summary of multiple regression analysis for behavioral intentions to adhere to the advantage-framed message.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.530[a]	.281	.218	12.550

a. Predictors: (Constant), EO4FA, BCACTIVE, BCHUMOR, BIS, ADVSAMV, ADVSAMC

b. Dependent Variable: ADVBI

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4187.673	6	697.946	4.431	.001[a]
	Residual	10709.873	68	157.498		
	Total	14897.547	74			

a. Predictors: (Constant), EO4FA, BCACTIVE, BCHUMOR, BIS, ADVSAMV, ADVSAMC

b. Dependent Variable: ADVBI

Coefficients

	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Correlations		
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1 (Constant)	42.830	18.305		2.340	.022	6.304	79.357			
BIS	1.524	.879	.183	1.734	.088	-.230	3.279	.212	.206	.178
BCACTIVE	1.371	1.034	.139	1.326	.189	-.692	3.434	.189	.159	.136
BCHUMOR	-1.948	.819	-.247	-2.380	.020	-3.581	-.315	-.202	-.277	-.245
ADVSAMV	2.225	.904	.283	2.460	.016	.420	4.030	.310	.286	.253
ADVSAMC	.934	.828	.131	1.129	.263	-.718	2.586	.302	.136	.116
EO4FA	-9.702	5.520	-.185	-1.758	.083	-20.717	1.313	-.209	-.208	-.181

a. Dependent Variable: ADVBI

Behavioral intentions for disadvantage-framed message model. A test of the full multiple regression model for behavioral intentions to adhere to the disadvantage-framed health message included BIS, BC: Humor, AdvSAMC, SAM Control Responses to Disadvantage-framed message (DisSAMC), Baseline Asymmetry during Eyes Open 3 (EO3), EO4, and Baseline Asymmetry during Eyes Closed 3 (EC3) as predictor variables. The assumptions of linearity, independence of errors, homoscedasticity, unusual points, and normality of residuals were met. These variables statistically significantly predicted behavioral intention responses to the disadvantage-framed health message, $F(7, 67) = 4.252$, $p = 0.001$, $R^2 = 0.308$, 95% CI [0.151, 0.465]. BIS ($p = .049$), BC: Humor ($p = .013$) AdvSAMC ($p = .022$), and EC3 ($p = .028$) each added statistically significantly to the prediction, $p < 0.05$. BIS, AdvSAMC had significant positive regression weights, indicating participants with higher scores on these scales were expected to indicate higher behavioral intentions to adhere to the disadvantage-framed message. BC: Humor had a significant negative regression weight, indicating participants with lower scores on this scale were expected to indicate higher behavioral intentions to adhere to disadvantage-framed message. EC3 also had a significant negative regression weight, indicating that participants with lower relative left hemisphere baseline cortical activity (i.e., higher right hemisphere activity) were expected to indicate higher behavioral intentions to adhere to the disadvantage-framed message. All other predictors did not significantly add to the prediction, $p > 0.05$. Regression coefficients and standard errors are displayed in Table 4.

Table 4. Summary of multiple regression analysis for behavioral intentions to adhere to the disadvantage-framed message.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.555[a]	.308	.235	15.403

a. Predictors: (Constant), EC3FA, BIS, BCHUMOR, ADVSAMCONTROL, EO3FA, EO4FA, DISSAMCONTROL

b. Dependent Variable: DISBI

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7061.210	7	1008.744	4.252	.001[a]
	Residual	15895.136	67	237.241		
	Total	22956.347	74			

a. Predictors: (Constant), EC3FA, BIS, BCHUMOR, ADVSAMCONTROL, EO3FA, EO4FA, DISSAMCONTROL

b. Dependent Variable: DISBI

Coefficients

	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations		
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1 (Constant)	45.671	21.064		2.168	.034	3.627	87.716			
BIS	2.166	1.081	.210	2.004	.049	.009	4.323	.264	.238	.204
BCHUMOR	-2.617	1.030	-.267	-2.541	.013	-4.673	-.562	-.206	-.296	-.258
ADVSAMC	3.046	1.298	.345	2.347	.022	.455	5.638	.336	.276	.239
DISSAMC	-.022	1.166	-.003	-.019	.985	-2.350	2.306	.261	-.002	-.002
EO3FA	-6.598	9.307	-.088	-.709	.481	-25.176	11.979	-.197	-.086	-.072
EO4FA	1.935	8.162	.030	.237	.813	-14.355	18.226	-.222	.029	.024
EC3FA	-26.523	11.816	-.281	-2.245	.028	-50.108	-2.938	-.252	-.264	-.228

a. Dependent Variable: DISBI

Differences observed across health message conditions. In order to investigate potential differential effects of message-framing on behavioral intentions, Wilcoxon signed-rank test was performed across participants' behavioral intentions to adhere to each health message because difference scores between dependent variables violated assumptions of normality and contained valid outliers needed for conducting paired-samples t-test. Of the 76 participants who completed the study, 26 participants reported higher behavioral intentions after viewing the advantage-framed health message, while 22 participants reported higher behavioral intentions after viewing the disadvantage-framed health message. Twenty-eight participants reported no differences in behavioral intentions across health message conditions. No statistically significant difference was observed between behavioral intentions responses across advantage-framed (*Median* = 92.5% certainty of adhering to treatment recommendations) and disadvantage-framed (*Median* = 93% certainty of adhering to treatment recommendations) health message conditions, $z = -0.981$, $p = 0.327$.

Correlation analyses were conducted to investigate potential associations between self-reported traits and coping strategies and Self-Assessment Manikin (SAM) responses to each health message condition. Several significant correlations were observed from these analyses, and results are displayed in Table 5. The only significant association observed between SAM affective responses to a health message and a factor within the RST framework was the one found between BAS Fun Seeking ($M = 12.14$, $SD = 1.614$) and arousal ratings in response to the advantage-framed condition ($M = 3.53$, $SD = 1.701$), $r(74) = -.344$, $p = 0.002$, 95% CI [-0.528, -0.129]. This finding suggests that people who reported higher levels of this trait also reported lower levels of emotional arousal in response to viewing the advantage-framed health message. Several significant correlations were observed between Brief COPE subscales and SAM

responses to health messages. Those who reported higher levels of using Acceptance (*M* = 5.63, *SD* = 1.394) as a coping strategy were also likely to report higher levels of control (*M* = 5.16, *SD* = 2.040) in response to viewing the advantage-framed health message, *r*(74) = .258, *p* = 0.024, 95% CI [0.035, 0.456]. Four significant correlations were observed between Brief COPE variables and SAM responses to the disadvantage-framed message. Participants endorsing higher levels of using Religion (*M* =4.99, *SD* = 2.176) as a coping strategy were more likely to report negatively valenced (*M* = 3.71, *SD* = 1.598) emotion in response to the disadvantage-framed message, *r*(74) = -.231, *p* = 0.045, 95% CI [-0.433, -0.006]. A significant positive correlation was observed between using self-blame (*M* = 3.95, *SD* = 1.469) as a coping strategy and arousal (*M* = 4.08, *SD* = 1.839) levels after viewing the disadvantage-framed message, *r*(74) = .300, *p* = 0.009, 95% CI [0.0800, 0.492]. A significant negative correlation was observed between substance use (*M* = 2.82, *SD* = 1.383) as a coping strategy and self-reported feelings of control (*M* = 4.59, *SD* =2.264) after viewing the disadvantage-framed message, *r*(74) = -.237, *p* = 0.039, 95% CI [-0.438, -0.013]. A significant positive correlation was found between self-blame (*M* = 3.95, *SD* =1.469) as a coping strategy and self-reported feelings of control (*M* = 4.59, *SD* =2.264) after viewing the disadvantage-framed message, *r*(74) = .234, *p* = 0.042, 95% CI [0.010, 0.436].

Table 5. Pearson correlations between SAM Responses to health messages and self-report RST and Brief COPE variables.

	SAM Responses to Advantage-Framed Message			SAM Responses to Disadvantage-Framed Message				
Self-Report Variables	Valence	Arousal	Control	Valence	Arousal	Control	*Mean*	*SD*
BIS	-.064	-.143	.151	-.051	.141	.191	19.30	1.705
BASD	.063	-.110	.027	-.184	.198	-.063	12.09	1.406
BASRR	-.065	-.155	-.024	-.069	.027	-.108	14.38	1.532
BASFS	-.087	-.344**	.050	-.020	.099	.108	12.14	1.614
AMS	.121	-.189	.204	.189	-.145	.024	13.21	3.255
SPQ	-.206	-.024	-.076	-.055	.114	.035	7.74	4.637
Active	.117	.170	.062	-.095	.027	.060	5.86	1.512
Planning	-.017	.100	.044	-.019	.015	-.003	6.12	1.442
Positive Reframe	.046	.128	-.017	-.019	.012	-.099	6.38	3.749
Acceptance	.184	.056	.258*	.076	.004	.181	5.63	1.394
Humor	.096	-.165	.041	.168	.094	-.046	4.64	1.794
Religion	.172	.135	.003	-.231*	.217	-.071	4.99	2.176
Emotional Support	-.028	.052	.067	-.174	-.048	.063	5.37	2.006
Instrumental Support	.094	.077	-.026	-.164	-.016	.003	5.38	1.918
Self-distraction	.102	.150	.080	-.169	.114	-.005	5.61	1.609
Denial	.052	.185	-.027	-.076	.031	-.031	2.83	1.182
Venting	.016	.108	.153	-.053	-.006	.139	3.82	1.116
Substance Use	-.039	.149	-.089	-.205	.079	-.237*	2.82	1.383
Disengage-ment	.208	.075	.067	-.105	.042	-.026	3.20	3.559
Self-blame	-.168	.107	.141	.113	.300**	.234*	3.95	1.469
Mean	5.96	3.53	5.16	3.71	4.08	4.59		
SD	1.851	1.701	2.040	1.598	1.839	2.264		

*$p < .05$; **$p < .01$

Correlations between RST factors and EEG asymmetry. In order to investigate the hypothesis that high scores on the BIS would be associated with right frontal baseline activity while high scores on the BAS would be associated with left frontal baseline activity, an asymmetry score (Right-Left) for alpha power (8-12 Hz) was calculated. Frontal asymmetry scores were calculated for overall alpha power by:1) taking the natural log of the alpha power scores at each electrode, and 2) subtracting left alpha power scores from right alpha power scores at frontal electrodes (ln[alpha power at F4 electrode] – ln[alpha power at F3 electrode]). The inverse of this asymmetry score is believed to represent increased brain activity, thus negative scores reflect greater relative right hemisphere EEG activity, and positive scores reflect greater relative left activity (Davidson, 1988). Correlation analyses for BIS and BAS scores with the asymmetry scores were then conducted and results are presented in Tables 6-7.

One significant correlation was observed between EC1 (M = .162 microvolts, SD = .203) and SPQ (M = 7.74, SD = 4.637), $r(74) = 0.243$, $p = 0.034$, 95% CI [0.019, 0.444], indicating that higher SPQ trait values were associated with greater relative left frontal baseline activity. As SPQ is thought to be related to the BIS trait, this finding does not support the hypothesis that BIS-related traits would be associated with greater relative right frontal baseline activity as has been observed in previous research. No other significant correlations were observed between alpha asymmetry scores and variables of interest.

Table 6. Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, AMS, SPQ, and eyes closed overall alpha (8-12 Hz) asymmetry scores.

		EC1	EC2	EC3	EC4	AMS	SPQ	BIS	BAS			
									TOT	RR	D	FS
BAS	FS											
	D											.529**
	RR										.547**	.495**
	TOT									.825**	.824**	.829**
BIS									.397**	.256*	.333**	.391**
SPQ								-.027	.058	.001	-.076	.199
AMS							-.265*	-.031	.219	.184	.249*	.118
EC4						.051	.180	.105	.127	.100	.174	.048
EC3					.691**	-.016	.080	.023	.008	.020	.063	-.056
EC2				.728**	.812**	-.051	.141	.063	.108	.021	.169	.085
EC1			.771**	.640**	.761**	-.069	.243*	.110	.112	.082	.122	.076
Mean		.162	.171	.155	.156	13.21	7.74	19.30	38.62	14.38	12.09	12.14
SD		.203	.203	.187	.181	3.255	4.637	1.705	3.759	1.532	1.406	1.614

*$p < .05$; **$p < .01$

Note. AMS = Appetitive Motivation Scale, SPQ = Sensitivity to Punishment Questionnaire, BIS = Behavioral Inhibition System, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EC3 = alpha asymmetry score for eyes closed 3 condition, EC4 = alpha asymmetry score for eyes closed 4 condition.

Table 7. Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, AMS, SPQ, and eyes open overall alpha (8-12 Hz) asymmetry scores.

		EO1	EO2	EO3	EO4	AMS	SPQ	BIS	BAS			
									TOT	RR	D	FS
BAS	FS											
	D											.529**
	RR										.547**	.495**
	TOT									.825**	.824**	.829**
BIS									.397**	.256*	.333**	.391**
SPQ								-.027	.058	.001	-.076	.199
AMS							-.265*	-.031	.219	.184	.249*	.118
EO4						-.076	.189	-.075	-.040	-.019	.045	-.114
EO3					.458**	.001	.166	-.080	.009	.068	.028	-.070
EO2				.394**	.598**	-.146	.218	.020	.080	.164	.063	-.024
EO1			.317**	.423**	.494**	.053	.203	-.016	-.016	-.115	.052	.027
Mean		.140	.163	.106	.148	13.21	7.74	19.30	38.62	14.38	12.09	12.14
SD		.280	.267	.234	.270	3.255	4.637	1.705	3.759	1.532	1.406	1.614

*$p < .05$; **$p < .01$

Note. AMS = Appetitive Motivation Scale, SPQ = Sensitivity to Punishment Questionnaire, BIS = Behavioral Inhibition System, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition, EO3 = alpha asymmetry score for eyes open 3 condition, EO4 = alpha asymmetry score for eyes open 4 condition.

Correlations between RST factors and ERP Amplitudes. In order to investigate the hypothesis BAS scores would be associated with larger P300 amplitudes during negative oddball stimuli presentations and higher BIS scores would be associated with larger P300 amplitudes during positive oddball stimuli presentations, correlation analyses were conducted between P300 target amplitudes at P3, Pz, and P4 electrodes during each affective condition and all RST factors (e.g., BIS, BAS subscales, AMS, and SPQ). Results are presented in Tables 8-9. No significant correlations were observed between P300 amplitudes to either positive or negative targets and variables of interest.

Table 8. Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, AMS, SPQ, and P300 amplitudes for positive targets.

		PTP3	PTPz	PTP4	AMS	SPQ	BIS	BAS			
								TOT	RR	D	FS
BAS	FS										
	D										.529**
	RR									.547**	.495**
	TOT								.825**	.824**	.829**
BIS								.397**	.256*	.333**	.391**
SPQ							-.027	.058	.001	-.076	.199
AMS						-.265*	-.031	.219	.184	.249*	.118
PTP4					-.048	.081	.024	-.014	-.061	.008	.018
PTPz				.927**	-.091	.074	.009	.004	-.037	-.011	.054
PTP3			.011	.003	.061	.084	.051	.072	.044	.073	.063
Mean		51.51	8.031	8.874	13.21	7.74	19.30	38.62	14.38	12.09	12.14
SD		364.0	7.213	7.041	3.255	4.637	1.705	3.759	1.532	1.406	1.614

*$p < .05$; **$p < .01$

Note. AMS = Appetitive Motivation Scale, SPQ = Sensitivity to Punishment Questionnaire, BIS = Behavioral Inhibition System, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, PTP3 = P300 response to positive target condition at electrode P3,PTPz = P300 response to positive target condition at electrode Pz, PTP4 = P300 response to positive target condition at electrode P4.

Table 9. Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, AMS, SPQ, and P300 amplitudes for negative targets.

		NTP3	NTPz	NTP4	AMS	SPQ	BIS	BAS			
								TOT	RR	D	FS
BAS	FS										
	D										.529**
	RR									.547**	.495**
	TOT								.825**	.824**	.829**
BIS								.397**	.256*	.333**	.391**
SPQ							-.027	.058	.001	-.076	.199
AMS						-.265*	-.031	.219	.184	.249*	.118
NTP4					-.112	-.029	-.082	-.063	-.202	.024	.023
NTPz				.932**	-.100	-.052	-.106	-.073	-.158	.001	-.021
NTP3			.288*	.209	.063	.081	.041	.069	.035	.076	.060
Mean		20.721	8.693	9.791	13.21	7.74	19.30	38.62	14.38	12.09	12.14
SD		107.69	8.360	7.666	3.255	4.637	1.705	3.759	1.532	1.406	1.614

*$p < .05$; **$p < .01$

Note. AMS = Appetitive Motivation Scale, SPQ = Sensitivity to Punishment Questionnaire, BIS = Behavioral Inhibition System, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, NTP3 = P300 response to negative target condition at electrode P3,NTPz = P300 response to negative target condition at electrode Pz, NTP4 = P300 response to negative target condition at electrode P4.

Correlations between Brief COPE subscales and EEG asymmetry. Correlation analyses were conducted in order to explore potential associations between Brief COPE subscales and frontal baseline asymmetry scores. As previously stated, the inverse of the calculated asymmetry score is believed to represent increased brain activity, thus negative scores reflect greater relative right hemisphere EEG activity, and positive scores reflect greater relative left activity (Davidson, 1988). Correlation analyses for self-reported Brief COPE subscales scores with the asymmetry scores are presented in Table 10. A significant correlation was observed between EC3 (M = .155 microvolts, SD = .187) and BC: Substance Use (M = 2.82, SD = 1.3837), $r(73) = 0.241$, $p = 0.037$, 95% CI [0.015, 0.443], indicating that higher self-reported tendency to engage in substance use as a coping strategy was associated with greater relative left frontal baseline activity. Another significant correlation was observed between EO3 (M = .106 microvolts, SD = .234) and BC: Disengagement (M =3.20, SD = 3.559), $r(73) = 0.243$, $p = 0.035$, 95% CI [0.017, 0.445], indicating higher self-reported tendency to use disengagement as a coping strategy was also associated with greater relative left frontal baseline activity. No other significant correlations were observed between alpha asymmetry scores and variables of interest.

Table 10. Correlations between Brief COPE scores and eyes closed overall alpha (8-12 Hz) asymmetry scores.

Brief COPE Subscales	EC1	EC2	EC3	EC4	EO1	EO2	EO3	EO4	*Mean*	*SD*
Active	-.022	.052	-.072	-.080	-.055	.102	.094	.039	5.86	1.512
Planning	-.114	-.054	-.008	-.209	-.028	-.085	-.099	.013	6.12	1.442
Positive Reframe	.068	.135	.073	.093	.210	.139	.030	.180	6.38	3.749
Acceptance	.153	.147	.050	.153	-.004	.178	.103	.051	5.63	1.394
Humor	-.110	-.082	-.062	-.059	-.139	.024	-.167	.048	4.64	1.794
Religion	.027	-.014	-.208	-.060	.085	.066	-.066	.217	4.99	2.176
Emotional Support	.066	.097	.003	-.022	-.002	.048	.046	.072	5.37	2.006
Instrumental Support	.067	.079	-.058	-.036	.102	.050	.038	.119	5.38	1.918
Self-distraction	.183	.186	.170	.091	.041	.115	.119	.149	5.61	1.609
Denial	.031	.081	-.013	.132	.187	-.009	.074	.050	2.83	1.182
Venting	.079	.112	.051	.033	.082	-.008	.161	.207	3.82	1.116
Substance Use	.139	.188	.241*	.208	.056	.012	.176	.099	2.82	1.383
Disengagement	-.097	.003	-.004	-.007	-.075	-.069	.243*	-.031	3.20	3.559
Self-blame	.122	.166	.098	.165	.006	.071	.085	-.032	3.95	1.469
Mean	.162	.171	.155	.156	.140	.163	.106	.148		
SD	.203	.203	.187	.181	.280	.267	.234	.270		

*$p < .05$; **$p < .01$

Note. EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EC3 = alpha asymmetry score for eyes closed 3 condition, EC4 = alpha asymmetry score for eyes closed 4 condition. EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition, EO3 = alpha asymmetry score for eyes open 3 condition, EO4 = alpha asymmetry score for eyes open 4 condition.

Correlations between Brief COPE subscales and ERP Amplitudes. Correlation analyses were conducted between Brief COPE scores and P300 responses to positive and negative target stimuli in order to these explore potential associations. Results are presented in Table 15. A significant correlation was observed between Disengagement (M =3.20, SD = 3.559) and P300 amplitudes in response to positive target stimuli presentations at two electrode sites: PTPz (M = 8.031 microvolts, SD = 7.213), $r(70) = -0.285$, $p = 0.015$, 95% CI [-0.49, -0.050], and PTP4 (M = 8.874 microvolts, SD = 7.041), $r(70) = -0.249$, $p = 0.035$, 95% CI [-0.46, -0.012]. As higher P300 amplitudes are thought to indicate a response to novel stimuli, these findings suggest that people who reported having a lower tendency to use disengagement as a coping strategy may be more sensitive to perceiving positively valenced stimuli infrequently presented among negative visual stimuli. No other significant correlations were observed between P300 amplitudes to either positive or negative targets and variables of interest.

Table 11. Correlations between Brief COPE scores and P300 amplitudes for positive and negative targets.

Brief COPE Subscales	PTP3	PTPz	PTP4	NTP3	NTPz	NTP4	*Mean*	*SD*
Active	-.015	-.052	-.066	-.015	.005	.032	5.86	1.512
Planning	.019	.063	.040	.009	-.116	-.121	6.12	1.442
Positive Reframe	-.056	-.003	.038	-.053	-.021	.004	6.38	3.749
Acceptance	-.070	-.111	-.150	-.068	-.047	-.083	5.63	1.394
Humor	-.037	.098	.112	-.032	.059	.000	4.64	1.794
Religion	.060	.127	.111	.060	.119	.027	4.99	2.176
Emotional Support	-.076	.155	.157	-.076	-.028	-.016	5.37	2.006
Instrumental Support	-.082	-.101	-.044	-.083	-.045	-.060	5.38	1.918
Self-distraction	-.045	.165	.133	-.048	-.025	-.094	5.61	1.609
Denial	.019	-.089	-.127	.014	-.080	-.038	2.83	1.182
Venting	.019	-.059	-.039	.019	-.090	-.060	3.82	1.116
Substance Use	-.071	.006	-.028	-.059	.077	.044	2.82	1.383
Disengagement	-.046	-.285*	-.249*	-.049	-.174	-.168	3.20	3.559
Self-blame	-.078	-.081	-.095	-.077	-.033	-.010	3.95	1.469
Mean	51.51	8.031	8.874	20.721	8.693	9.791		
SD	364.0	7.213	7.041	107.69	8.360	7.666		

*$p < .05$; **$p < .01$

Note. PTP3 = P300 response to positive target condition at electrode P3,PTPz = P300 response to positive target condition at electrode Pz, PTP4 = P300 response to positive target condition at electrode P4. NTP3 = P300 response to negative target condition at electrode P3,NTPz = P300 response to negative target condition at electrode Pz, NTP4 = P300 response to negative target condition at electrode P4.

Summary of Findings

In summary, partial support for the major hypotheses was observed. The hypothesis that BIS would be positively associated with behavioral intentions to adhere to the disadvantage-framed treatment recommendations was supported. BIS was a significant positive predictor of behavioral intentions to adhere to the disadvantage-framed message. The hypothesis that BAS subscales would be positively associated with behavioral intentions to adhere to either health message was not supported.

It was hypothesized that higher BAS scores would be associated with larger P300 amplitudes during negative oddball stimuli presentations. It was also hypothesized that higher BIS scores would be associated with larger P300 amplitudes during positive oddball stimuli presentations. Furthermore, oddball P300 amplitudes were expected to significantly contribute to prediction of behavioral intentions across both health messages. Unfortunately, none of the oddball P300 amplitudes significantly contributed to either of the multiple regression models, nor were they found to be significantly associated with facets of RST. Exploratory correlation analyses indicated that BC: Disengagement was significantly, negatively correlated with PTPz and PTP4, suggesting that people who reported having a lower tendency to use disengagement as a coping strategy may be more sensitive to perceiving positively valenced stimuli infrequently presented among negative visual stimuli. In summary, no evidence was found during the current study to support hypotheses associating P300 amplitudes to RST factors or behavioral intentions.

It was hypothesized that higher BAS scores would be associated with greater relative left frontal asymmetry while higher BIS scores would be associated with greater relative right frontal asymmetry. Only one significant correlation was observed between baseline asymmetry values and any facet of RST. A significant, positive correlation was found between EC1 and SPQ,

indicating that higher SPQ trait values were associated with greater relative left frontal baseline activity. As SPQ is thought to be related to BIS trait, this finding does not support the hypothesis that BIS-related traits would be associated with greater relative right frontal baseline activity as has been observed in previous research.

Finally, it was predicted that greater relative left frontal asymmetry would be associated with greater behavioral intentions to adhere to the advantage-framed message, while greater relative right frontal asymmetry would be associated with higher behavioral intentions to adhere to the disadvantage-framed message. In partial support of this hypothesis is the observation that EC3 was a significant, negatively weighted predictor variable within the full multiple regression model predicting behavioral intentions to the disadvantage-framed message. This finding demonstrates partial support for this hypothesis, indicating that participants with lower relative left hemisphere baseline cortical activity endorsed higher behavioral intentions to adhere to the disadvantage-framed message.

Other notable findings from Study One included the non-significant difference observed in behavioral intentions across the message conditions prior to considering individual differences in traits and coping strategies. This is important to note simply because it highlights the importance of carefully considering individual differences in traits prior to tailoring a health message to a specific patient. In other words, neither health message condition elicited a higher level of behavioral intentions over the other, but specific traits, coping strategies, and an EEG biomarker were found to significantly predict behavioral intentions to adhere to different health messages.

Another important finding was the observation that elicitation of affect during the advantage-framed health message significantly contributed to both multiple regression models,

with valence significantly and positively contributing to the advantage-framed message condition and control significantly and positively contributing to the disadvantage-framed message condition. These findings indicate that those who reported higher levels of positive affect in response to the advantage-framed message were more likely to endorse higher levels of behavioral intentions after viewing it. Those who endorsed higher feelings of control after viewing the disadvantage-framed message were more likely to endorse higher levels of behavioral intentions to adhere to it. Furthermore, humor as a coping strategy significantly, negatively contributed to both models, as well, indicating that those who endorsed using higher levels of humor as a coping strategy were more likely to endorse lower levels of behavioral intentions to both health messages.

A facet of RST, BAS Fun Seeking, was found to be significantly, negatively correlated with arousal ratings after viewing the advantage-framed message. Many of the coping strategies were also significantly associated with affect ratings to the health messages. Acceptance was positively related to control ratings after viewing the advantage-framed message. Self-blame was positively related to both arousal and control ratings after viewing the disadvantage-framed message. Religion was negatively associated with valence ratings after the disadvantage-framed message, and substance use was negatively associated with control ratings after the disadvantage-framed message. Substance use was also significantly, positive correlated with EC3, indicating that higher ratings on this coping strategy are associated with greater relative left hemisphere baseline activity. Similarly, a significant, positive correlation was found between EO3 and disengagement, indicating higher ratings on this coping strategy are also associated with greater relative left hemisphere baseline activity.

Although a major strength of this laboratory study was that many variables could be controlled, this unfortunately also poses a threat to generalizability. This sample consisted of young adults who had not actually received a chronic health diagnosis and who could only indicate their behavioral intentions to adhere to simulated treatment recommendations. Additionally, an exclusionary criterion was that participants could not have ever received any other chronic health diagnosis, which is not consistent with the experiences of many patients who suffer from obstructive sleep apnea who have often received multiple chronic health diagnoses and are concurrently managing many treatment regimens in addition to CPAP. The second study will attempt to address many of these factors that threaten generalizability of findings from Study One.

CHAPTER VI: STUDY TWO

Method

Participants. Data were collected from 76 adults recruited from the Vidant Sleep Center in Greenville, NC. This sample of participants is part of an ongoing larger investigation of CPAP nonadherence, chosen based on the availability of longitudinal adherence data needed to complete proposed statistical analyses. Participants were patients who were referred for a diagnostic or follow-up polysomnogram overnight study who subsequently received a diagnosis of obstructive sleep apnea and were prescribed a device to wear each night while sleeping. All participants gave informed consent to the protocol, which was approved by the East Carolina University and Medical Center Institutional Review Board (Appendix C & K).

Procedure. Participants were asked to participate in the study prior to admission into the room in which they would be monitored during their polysomnogram. After consent was obtained, participants completed several self-report inventories including the BIS/BAS, SPQ, and AMS. This process took approximately 30 minutes. Additional demographic information and a subjective severity rating (i.e., one question asking patients to rate the severity of their sleep problem on a scale from 1= mildly upsetting to 5= totally incapacitating) was collected from medical records in accordance with consent documents.

Frontal asymmetry data were collected during eyes open and eyes closed segments of each patient's diagnostic polysomnogram study while lying down in the bed provided at the Vidant Sleep Center. Polysomnogram studies were performed and scored in accordance with standard guidelines and conducted by certified sleep technicians (Iber, Ancoli-Israel, Chesson, & Quan, 2007). All recordings were converted to European Data Format. Electrodes were arranged

according to the 10-20 international system (Jasper, 1958). EEG data were recorded from 32 active electrode sites using linked ears (A1 and A2) as a reference (monopolar montage). Electrode placement included Frontal: F3, Fz, F4; Central: Cz, C3, C4; Temporal: T3, T4; Parietal: Pz, P3, P4; and Occipital: O1, O2. In addition, electrodes were placed on the outer cantus of each eye so that eye movement recordings could be obtained. Excessive artifact associated with body and eye movement was excluded during off-line processing and prior to averaging. Artifact reduction was completed prior to computing averages for EEG data. Data were stored and analyzed on a PC Pentium Computer. The EEG data were converted on line for display, storage, and analysis (Everhart & Demaree, 2003).

Adherence data were obtained from an online database provided by each patient's healthcare company. Treatment adherence was defined as wearing the OSA treatment apparatus >4 hours per night on 70% of the nights, as these criteria support significant improvement in reduction of OSA symptoms (Kryger et al., 2000). Adherence data were collected for analysis at the following time-points after receiving their treatment apparatus: 1) 7 days, 2) 30 days, 3) 60 days, and 4) 90 days (see Figure 5 for summary of procedures).

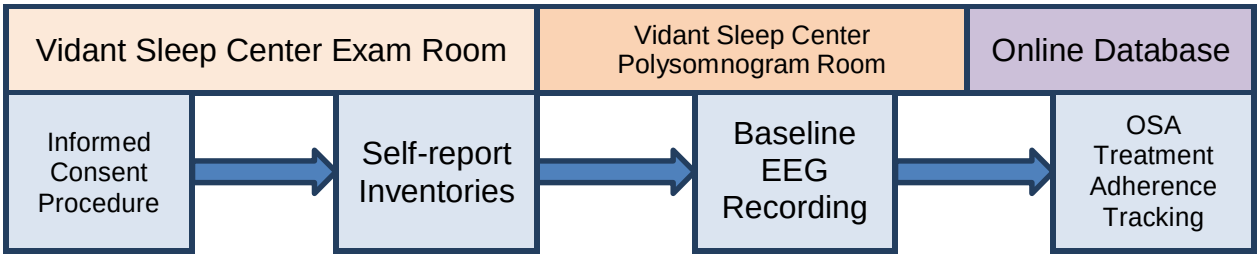

Figure 5. Summary of Study Two procedures.

Apparatuses. Participants included in the present study were prescribed one of the following previously described apparatuses to treat their OSA symptoms: CPAP (continuous

positive airway pressure), BiPAP (Bilevel Positive Airway Pressure), or APAP (Automatic Positive Airway Pressure). CPAP utilizes continuous and direct air pressure to keep the airway unobstructed, delivered from the air compressor-like CPAP machine through a mask placed over the nose and/or mouth. BiPAP provides two levels of pressure and three different modes within the patient's control of adjustment. APAP continuously monitors the patient's breathing using pressure sensors, and adjusts the pressure to accommodate the patient's breathing (e.g., increases the pressure when the patient is unable to breathe) (Moran, Highsmith, Lehockey, & Everhart, 2012). Although biomedical factors such as apparatus adjustments are important to consider when a patient is demonstrating nonadherence behaviors, three recent meta-analyses investigating adherence across different pressure-adjusting treatment modalities indicated generally no evidence for increased adherence, except for a significant 11-13 min/night increase for APAP, which is only prescribed to selected patients (Bakker & Marshall, 2012; Ip et al., 2012; Smith & Lasserson, 2009). Thus, comparisons across different apparatus modalities were not included in the present study. Additionally, as the majority of patients were prescribed CPAP in this sample, outcomes are reported in terms of CPAP adherence, but also include those few patients in this sample that used a different apparatus.

Statistical analyses. Primary analyses performed were logistic regressions predicting nonadherence as defined by Kryger and colleagues (2000) from responses to the BIS/BAS scales, AMS, and SPQ, as well as from baseline asymmetry values obtained from polysomnogram. Logistic regression was chosen as the primary analysis in order to remain consistent with the current criteria for adherence offered by insurance providers. Multiple regression analyses were also employed in order to more fully investigate the continuous nature of adherence as opposed to employing the strict adherence cut-off criteria, in hopes of better

informing motivational health behavior interventions. Correlation analyses for BIS and BAS scores with EEG asymmetry scores were also conducted to investigate these relationships within this clinical sample. Alpha level was set at .05 in tests of statistical significance. Data analyses were performed using SPSS version 17.0.

Results

Descriptive statistics. The current sample consisted of 42 men and 34 women. Demographic characteristics of this sample consisted of individuals self-identifying as Caucasian (49), African American (25), and Bi-racial (1), with one participant declining to answer this demographic item. The mean age of participants was 55.7 years, with a range from 27 to 93 years of age. The average body mass index (BMI) of the current sample was 47.71, indicative of Class III Obesity. BMI range consisted of individuals from the normal BMI classification at 21.70 to very severely obese at 69.41. There were no significant differences in adherence between men and women at any time-point: 7 days, $t(58) = .957$, $p = .342$; 30 days, $t(68) = 1.434$, $p = .156$; 60 days, $t(41) = .996$, $p = .325$; 90 days, $t(45) = 1.360$, $p = .181$. There were also no significant differences in adherence between Caucasians and African Americans at any time-point: 7 days, $t(56) = -.437$, $p = .664$; 30 days, $t(67) = -1.227$, $p = .224$; 60 days, $t(39) = -1.430$, $p = .161$; 90 days, $t(43) = -1.957$, $p = .057$.

Descriptive statistics of the self-report inventories and baseline asymmetry values are provided in Table 12.

Table 12. Descriptive statistics for variables of interest from self-report inventories and baseline asymmetry values.

Predictor Variable	Mean	*SD*
BIS	18.99	4.59
BAS Drive	10.08	3.14
BAS Reward Responsiveness	16.21	4.33
BAS Fun Seeking	10.11	2.98
Appetitive Motivation Scale	10.08	4.01
Sensitivity to Punishment Questionnaire	8.89	5.90
Eyes Open Baseline Asymmetry	0.066	0.25
Eyes Closed Baseline Asymmetry	0.010	0.29

Due to variability in availability of adherence data at each time-point, analyses across each subset consist of different sample sizes. Of the 60 participants with adherence data available at the 7 day time-point, 38 participants (63.3%) met overall criteria for adherence. Out of 70 participants, 42 (60.0%) were adherent at the 30 day time-point, while 25 out of 44 participants (56.8%) were adherent at the 60 day time-point. Out of the 47 participants with adherence data available at the 90 day time-point, 22 participants (46.8%) met adherence criteria (Figure 6). Of the 34 participants who have adherence data available at all time-points, 19 (55.9%) were adherent at 7 days, 17 (50%) were adherent at 30 days, 18 (52.9%) were adherent at 60 days, and 14 (41.2%) were adherent at 90 days (Figure 7).

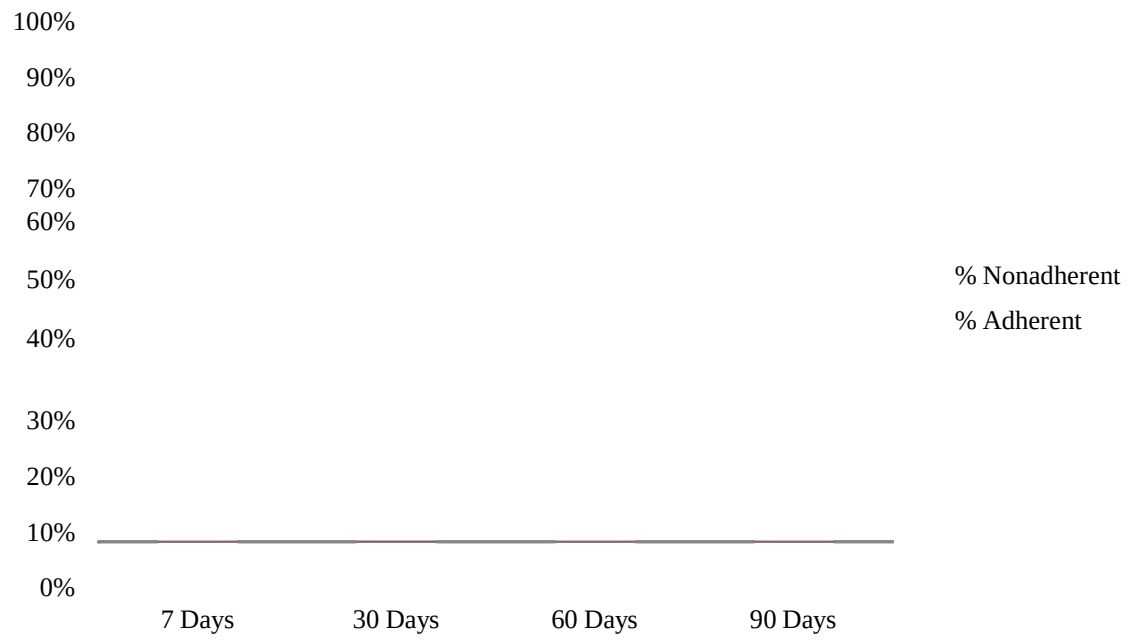

Figure 6. Adherence and nonadherence percentages of all available data at each time-point.

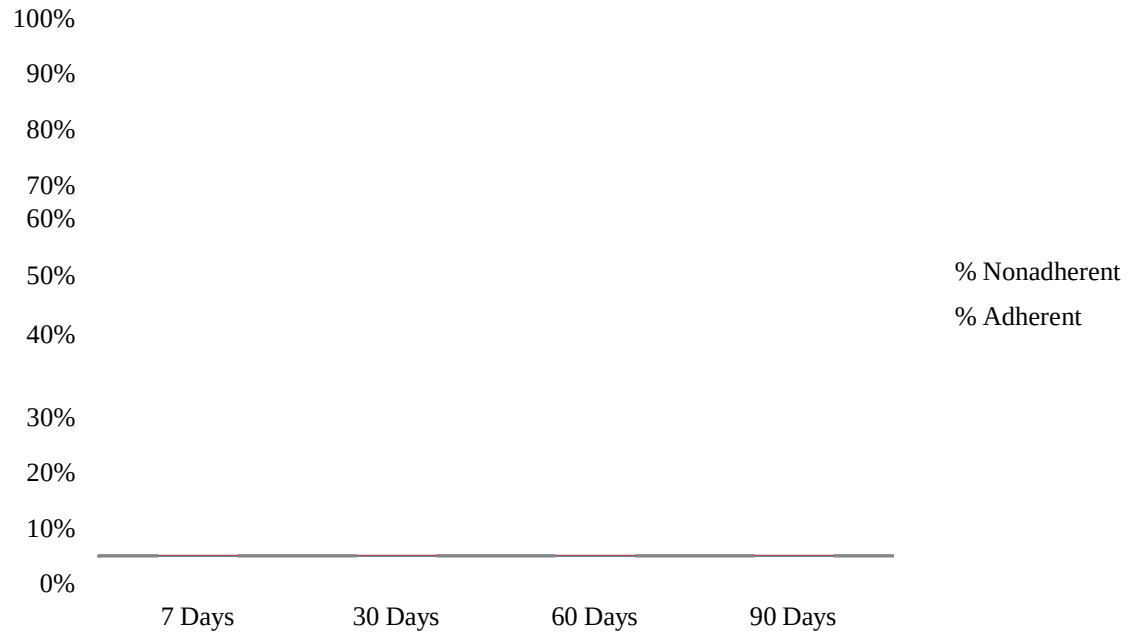

Figure 7. Adherence and nonadherence percentages of participants with available adherence data at each time-point.

Logistic regression analyses. Logistic regression analyses were employed to predict the probability that a participant would be nonadherent at each time-point. Prior to logistic regression analyses, Pearson correlations between predictor variables and adherence as a dichotomous variable were investigated. Predictor variables consisted of BIS, BAS subscales including BAS Drive, BAS Fun Seeking, and BAS Reward Responsiveness, AMS, SPQ, and baseline asymmetry values during eyes open and eyes closed sessions of the overnight polysomnogram. Demographic and health variables were also investigated for inclusion in the models, including age, sex, race (1 = African American, 2 = Caucasian), Body Mass Index (BMI), Subjective Severity Rating, and apnea-hypopnea index (AHI).

Only those predictors that were significant at the .10 level were retained in subsequent models. Among those variables dropped prior to all logistic regression analyses across all time-points were the following: BAS Drive, BAS Reward Responsiveness, BAS Fun Seeking, Eyes Open Baseline Asymmetry, Eyes Closed Baseline Asymmetry, sex, race, BMI, and AHI. Correlation coefficients for adherence (0= adherent, 1= nonadherent) at each time-point and predictor variables are displayed in Table 13.

Table 13. Pearson correlations for nonadherence at each time-point and predictor variables.

	Nonadherence (No or Yes)			
Predictor Variable	7 Days	30 Days	60 Days	90 Days
Sample Size	60	70	44	47
BIS	0.224*	0.190	0.125	0.009
BAS Drive	-0.121	-0.073	-0.188	-0.155
BAS Reward Responsiveness	0.140	0.090	0.189	-0.055
BAS Fun Seeking	-0.069	0.048	0.037	0.037
Appetitive Motivation Scale	0.247*	0.143	0.196	0.146
Sensitivity to Punishment Questionnaire	0.236*	0.138	0.122	-0.043
Eyes Open Baseline Asymmetry	0.011	-0.080	-0.026	-0.112
Eyes Closed Baseline Asymmetry	0.049	-0.049	-0.093	-0.064
Age	-0.202	-0.239**	-0.378**	-0.270*
Sex	0.076	0.094	0.177	0.157
Race	-0.191	-0.063	-0.135	-0.232
BMI	0.180	0.172	0.110	0.237
Subjective Severity Rating	0.097	0.113	0.303*	0.396***
AHI	0.180	0.150	0.128	0.045

*** Correlation is significant at the 0.01 level (2-tailed)

**Correlation is significant at the 0.05 level (2-tailed)

**p* value of correlation is at the 0.10 level (2-tailed)

Separate logistic regression analyses were employed to predict that a participant would be nonadherent at each time-point. A standard 0.5 cutoff for classification was used for all logistic regression analyses. Table 14 displays sensitivity, specificity, positive predictive value, and negative predictive value for each full logistic regression model for each time-point. Table 15 shows the logistic regression coefficient, Wald test, and odds ratio for each of the predictors included in each model for their respective time-points.

Seven days logistic regression model. Three correlations were observed between nonadherence behavior at seven days and predictor variables that did not reach statistical significance, but achieved a $p < .10$, and were thus included in the logistic regression analysis. These included three positive correlations between nonadherence at seven days and BIS (M = 18.986, SD = 4.587), $r(55) = 0.224$, $p = 0.100$, 95% CI [-0.043, 0.461], AMS (M = 10.083, SD = 4.006), $r(56) = 0.247$, $p = 0.067$, 95% CI [-0.017, 0.478], and SPQ (M = 8.889, SD =5.904), $r(56) = 0.236$, $p = 0.080$, 95% CI [-0.028, 0.496], indicating that higher self-reported scores on these questionnaires were associated with higher rates of nonadherence behavior at seven days.

A test of the full logistic model for nonadherence at the seven day time-point included BIS, AMS, and SPQ as predictor variables. The logistic regression model was not statistically significant, $\chi^2(3) = 7.673$, $p = 0.053$. The model explained 18.2% (Nagelkerke R^2) of the variance in nonadherence and correctly classified 70.4% of cases. The model was able to correctly classify 88.6% of those who were adherent and 36.8% of those who were not adherent. Employing a 0.05 criterion of statistical significance, none of the three predictor variables had a significant partial effect: BIS ($p = 0.094$), AMS ($p = 0.051$), and SPQ ($p = 0.555$).

Thirty days logistic regression model. A test of the full logistic model for nonadherence at the thirty day time-point included age as a predictor variable, as age (M = 55.711, SD =

11.747) was significantly, negatively correlated with nonadherence at 30 days (M = 1.40, SD = 0.493), $r(70) = -0.239$, $p = 0.046$, 95% CI [-0.448, -0.005], indicating that higher age was significantly associated with lower rates of nonadherence at 30 days. The logistic regression model was statistically significant, $\chi^2(1) = 4.172$, $p = 0.041$. The model explained 7.8% (Nagelkerke R^2) of the variance in nonadherence and correctly classified 57.1% of cases. The model was able to correctly classify 78.6% of those who were adherent and 25.0% of those who were not adherent. Employing a 0.05 criterion of statistical significance, age as a predictor variable did not have a significant partial effect: age ($p = 0.052$), although the Wald χ^2 test is conservative and thus this finding may indicate the need for further investigation in future research.

Sixty days logistic regression model. A test of the full logistic model for nonadherence at the sixty day time-point included age and subjective severity rating as predictor variables. Age (M = 55.711, SD = 11.747) was significantly, negatively associated with nonadherence at 60 days (M = 1.43, SD = 0.501), $r(44) = -0.378$, $p = 0.011$, 95% CI [-0.606, -0.092], indicating that higher age was significantly associated with lower rates of nonadherence at 60 days. Subjective severity rating (M = 2.420, SD = 1.063) was positively associated with nonadherence at 60 day (M = 1.43, SD = 0.501), $r(39) = 0.303$, $p = 0.061$, 95% CI [-0.013, 0.564], indicating that higher subjective severity ratings were associated with higher rates of nonadherence at 60 days. The logistic regression model was statistically significant, $\chi^2(2) = 9.461$, $p = 0.009$. The model explained 28.9% (Nagelkerke R^2) of the variance in nonadherence and correctly classified 66.7% of cases. The model was able to correctly classify 77.3% of those who were adherent and 52.9% of those who were not adherent. Employing a 0.05 criterion of statistical significance, age had a significant partial effect while subjective severity rating did not: age ($p = 0.034$), subjective

severity rating ($p = 0.058$). A one-unit decrease in age is associated with the odds of being nonadherent increasing by a multiplicative factor of 1.094. In other words, for each one year reduction in age, the risk of nonadherence in this sample increased by a factor of 1.094. This is equivalent to a risk of nonadherence increasing by a factor of 1.094 for every five year decrease in age.

Ninety days logistic regression model. A test of the full logistic model for nonadherence at the ninety day time-point included age and subjective severity rating as predictor variables. Subjective severity rating ($M = 2.420$, $SD = 1.063$) was significantly, positively associated with nonadherence at 90 days ($M = 1.53$, $SD = 0.504$), $r(43) = 0.396$, $p = 0.009$, 95% CI [0.109, 0.622], indicating that higher subjective severity ratings were significantly associated with higher rates of nonadherence at 90 days. A nonsignificant negative correlation was observed between age ($M = 55.711$, $SD = 11.747$) and nonadherence at 90 days ($M = 1.53$, $SD = 0.504$), $r(47) = -0.270$, $p = 0.066$, 95% CI [-0.517, 0.018], indicating that higher age was associated with lower rates of nonadherence at 90 days. The logistic regression model was statistically significant, $\chi^2(2) = 12.288$, $p = 0.002$. The model explained 33.1% (Nagelkerke R^2) of the variance in nonadherence and correctly classified 65.1% of cases. The model was able to correctly classify 66.7% of those who were adherent and 63.6% of those who were not adherent. Employing a 0.05 criterion of statistical significance, age and subjective severity rating as predictor variables had partial significant effects: age ($p = 0.049$), subjective severity rating ($p = 0.011$). At the ninety days time-point, a one-unit decrease in age is associated with the odds of being nonadherent increasing by a multiplicative factor of 1.081. In other words, for each one year reduction in age, the risk of nonadherence in this sample increased by a factor of 1.081. A one-unit increase in

subjective severity rating of obstructive sleep apnea at the time of diagnosis is associated with the odds of being nonadherent by a multiplicative factor of 3.272.

Table 14. Sensitivity, specificity, positive predictive value, and negative predictive value for full models at each time-point.

	Full Model for Each Time-Point			
	7 Days (BIS, SPQ, AMS)	30 Days (Age)	60 Days (Age, Severity Rating)	90 Days (Age, Severity Rating)
Sample Size	60	70	44	47
Sensitivity (Nonadherence)	36.8%	25.0%	52.9%	63.6%
Specificity (Adherence)	88.6%	78.6%	77.3%	66.7%
Positive Predictive Value	63.6%	43.8%	64.3%	66.7%
Negative Predictive Value	72.1%	61.1%	68.0%	63.6%

Table 15. Logistic regression predicting nonadherence.

	Nonadherence (No or Yes)			
Predictor Variable	7 Days	30 Days	60 Days	90 Days
Sample Size	60	70	44	47
BIS				
B	0.133	---	---	---
Wald χ^2	2.806	---	---	---
p	0.094	---	---	---
Odds Ratio	1.142	---	---	---
Appetitive Motivation Scale				
B	0.171	---	---	---
Wald χ^2	3.823	---	---	---
p	0.051	---	---	---
Odds Ratio	1.186	---	---	---
Sensitivity to Punishment Questionnaire				
B	0.035	---	---	---
Wald χ^2	0.349	---	---	---
p	0.555	---	---	---
Odds Ratio	1.036	---	---	---
Subjective Severity Rating				
B	---	---	0.868	1.185
Wald χ^2	---	---	3.601	6.494
p	---	---	0.058	0.011
Odds Ratio	---	---	2.383	3.272
Age				
B	---	-0.044	-0.089	-0.078
Wald χ^2	---	3.776	4.517	3.877
p	---	0.052	0.034	0.049
Odds Ratio	---	0.957	0.914	0.925

Multiple regression analyses. Multiple regression analyses were employed to further investigate the utility of the predictor variables for informing health behavior interventions across each time-point. Prior to conducting separate multiple regression analyses, Pearson correlations between predictor variables and total hours of CPAP use at each time-point were investigated. Predictor variables consisted of the Behavioral Activation subscales (BAS) including BAS Drive, BAS Fun Seeking, and BAS Reward Responsiveness, the Behavioral Inhibition Scale (BIS), the Appetitive Motivation Scale (AMS), the Sensitivity to Punishment Questionnaire (SPQ), and baseline asymmetry values during eyes open and eyes closed sessions of the overnight polysomnogram. Demographic and health variables were also investigated for inclusion in the models, including age, sex, race, BMI, subjective severity rating, and apnea-hypopnea index (AHI).

Only those predictors that had zero-order correlations significant at the .10 level were retained in subsequent models. Among those variables dropped from all multiple regression analyses across all time-points were the following: BAS Drive, BAS Fun Seeking, Appetitive Motivation Scale, Sensitivity to Punishment Questionnaire, Eyes Open Baseline Asymmetry, Eyes Closed Baseline Asymmetry, and sex. Correlation coefficients for total hours of CPAP use at each time-point and predictor variables are displayed in Table 16.

Table 16. Pearson correlations for total hours of CPAP use at each time-point and predictor variables.

	Total Hours of CPAP Use			
Predictor Variable	7 Days	30 Days	60 Days	90 Days
Sample Size	60	70	44	47
BIS	-0.176	-0.229*	0.006	-0.039
BAS Drive	0.069	0.042	0.011	0.040
BAS Reward Responsiveness	-0.232*	-0.186	-0.322**	-0.190
BAS Fun Seeking	0.051	0.038	0.026	0.025
Appetitive Motivation Scale	-0.208	-0.117	-0.201	-0.117
Sensitivity to Punishment Questionnaire	-0.084	-0.138	-0.093	-0.087
Eyes Open Baseline Asymmetry	0.090	-0.009	0.079	0.220
Eyes Closed Baseline Asymmetry	0.084	0.008	0.268	0.148
Age	0.231*	0.209*	0.337**	0.304**
Sex	-0.125	-0.171	-0.154	-0.199
Race	0.101	0.148	0.275*	0.340**
BMI	-0.193	-0.184	-0.125	-0.227
Subjective Severity Rating	-0.248*	-0.196	-0.135	-0.234
AHI	-0.212	-0.172	-0.077	-0.025

*** Correlation is significant at the 0.01 level (2-tailed)

**Correlation is significant at the 0.05 level (2-tailed)

**p* value of correlation is at the 0.10 level (2-tailed)

Seven days multiple regression model. A test of the full multiple regression model for total hours of CPAP use at the seven day time-point included BAS Reward Responsiveness, age, and subjective severity rating as predictor variables. Three correlations were observed between total hours of CPAP use at seven days and predictor variables that did not reach statistical significance, but achieved a $p < .10$, and were thus included in the multiple regression analysis. These included negative correlations between total hours of CPAP use at seven days (M = 36.639, SD = 20.302) and BAS Reward Responsiveness (M = 16.206, SD = 4.327), $r(57) = -0.232$, $p = 0.083$, 95% CI [0.019, 0.444], and subjective severity rating (M = 2.420, SD = 1.063), $r(54) = -0.248$, $p = 0.070$, 95% CI [-0.483, 0.021], indicating that higher scores on these self-report scales were associated with fewer total hours of CPAP use at seven days. There was a positive correlation between total hours of CPAP use at seven days (M = 36.639, SD = 20.302) and age (M = 55.711, SD = 11.747), $r(60) = 0.231$, $p = 0.076$, 95% CI [-0.024, 0.458], indicating that increased age was associated with more total hours of CPAP use at seven days. The assumptions of linearity, independence of errors, homoscedasticity, unusual points, and normality of residuals were met. These variables did not statistically significantly predict total hours of CPAP use at the seven day time-point, $F(3, 47) = 2.492$, $p = 0.072$, $R^2 = 0.137$, 95% CI [0.000, 0.304]. None of the three variables added statistically significantly to the prediction, $p > 0.05$. Regression coefficients and standard errors are displayed in Table 17.

Table 17. Summary of multiple regression analysis at seven day time-point.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.370[a]	.137	.082	17.81538

a. Predictors: (Constant), BASRR, Age, SeverityRating

b. Dependent Variable: Total Hours in 1 week

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2372.651	3	790.884	2.492	.072[a]
	Residual	14917.233	47	317.388		
	Total	17289.884	50			

a. Predictors: (Constant), BASRR, Age, Severity Rating

b. Dependent Variable: Total Hours in 1 week

Coefficients

	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Correlations		
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1 (Constant)	33.551	15.829		2.120	.039	1.707	65.394			
Severity Rating	-2.688	2.511	-.146	-1.070	.290	-7.741	2.364	-.172	-.154	-.145
Age	.461	.233	.270	1.978	.054	-.008	.929	.248	.277	.268
BASRR	-.927	.581	-.219	-1.596	.117	-2.095	.242	-.207	-.227	-.216

a. Dependent Variable: Total Hours in 1 week

Thirty days multiple regression model. A test of the full multiple regression model for total hours of CPAP use at the thirty day time-point included BIS and age as predictor variables. Two correlations were observed between total hours of CPAP use at thirty days and predictor variables that did not reach statistical significance, but achieved a $p < .10$, and were thus included in the multiple regression analysis. A negative correlation was observed between total hours of CPAP use at thirty days (M = 151.660, SD = 79.673) and BIS (M = 18.986, SD = 4.587), $r(65) = -0.229$, $p = 0.067$, 95% CI [-0.447, 0.015], indicating that higher levels of BIS were associated with fewer total hours of CPAP use at thirty days. A positive correlation was observed between total hours of CPAP use at thirty days (M = 151.660, SD = 79.673) and age (M = 55.711, SD = 11.747), $r(70) = 0.209$, $p = 0.082$, 95% CI [-0.027, 0.423], indicating that increased age was associated with more total hours of CPAP use at thirty days. The assumptions of linearity, independence of errors, homoscedasticity, unusual points, and normality of residuals were met. These variables did not statistically significantly predict total hours of CPAP use at the thirty day time-point, $F(2, 62) = 2.593$, $p = 0.083$, $R^2 = 0.077$, 95% CI [0.000, 0.220]. Neither variable added statistically significantly to the prediction, $p > 0.05$. Regression coefficients and standard errors are displayed in Table 18.

Table 18. Summary of multiple regression analysis at thirty day time-point.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.278[a]	.077	.047	74.94635

a. Predictors: (Constant), BIS, Age

b. Dependent Variable: Total Hours in 1 month

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29125.752	2	14562.876	2.593	.083[a]
	Residual	348251.245	62	5616.956		
	Total	377376.997	64			

a. Predictors: (Constant), BIS, Age

b. Dependent Variable: Total Hours in 1 month

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	153.254	65.643		2.335	.023	22.036	284.472			
	Age	1.093	.844	.160	1.294	.201	-.595	2.781	.193	.162	.158
	BIS	-3.349	2.047	-.202	-1.636	.107	-7.441	.742	-.229	-.203	-.200

a. Dependent Variable: Total Hours in 1 month

Sixty days multiple regression model. A test of the full multiple regression model for total hours of CPAP use at the 60 day time-point included BAS Reward Responsiveness, age, and race as predictor variables. Two significant correlations were observed between total hours of CPAP use at 60 days and predictor variables, along with one correlation that did not reach significance but was included in the multiple regression analysis. A significant, negative correlation was observed between BAS Reward Responsiveness (M = 16.206, SD = 4.327) and total hours of CPAP use at 60 days (M = 300.797, SD = 150.908), $r(41) = -0.322$, $p = 0.040$, 95% CI [-0.572, -0.016], indicating that higher levels of BAS Reward Responsiveness was significantly associated with fewer total hours of CPAP use at 60 days. A significant positive correlation was observed between age (M = 55.711, SD = 11.747) and total hours of CPAP use at 60 days (M = 300.797, SD = 150.908), $r(43) = 0.337$, $p = 0.027$, 95% CI [0.041, 0.578], indicating that increased age was associated with more total hours of CPAP use at 60 days. A nonsignificant, positive correlation was observed between total hours of CPAP use at 60 days (M = 300.797, SD = 150.908) and race (M = 1.680, SD = 0.498), $r(42) = 0.275$, $p = 0.078$, 95% CI [-0.031, 0.534], indicating that self-identifying as Caucasian was associated with more total hours of CPAP use at 60 days. The assumptions of linearity, independence of errors, homoscedasticity, unusual points, and normality of residuals were met. These variables statistically significantly predicted total hours of CPAP use at the sixty day time-point, $F(3, 36) = 6.671$, $p = 0.001$, $R^2 = 0.357$, 95% CI [0.080, 0.556]. All three variables added statistically significantly to the prediction, $p < 0.05$. Notably, cooperative suppressor effects were present in this model, as each predictor's standardized coefficient was greater in absolute magnitude than the respective zero-order correlation. Regression coefficients and standard errors are displayed in Table 19.

Table 19. Summary of multiple regression analysis at sixty day time-point.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.598[a]	.357	.304	125.24513

a. Predictors: (Constant), Race, Age, BASRR

b. Dependent Variable: Total Hours in 2 months

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	313937.034	3	104645.678	6.671	.001[a]
	Residual	564708.335	36	15686.343		
	Total	878645.369	39			

a. Predictors: (Constant), Race, Age, BASRR

b. Dependent Variable: Total Hours in 2 months

Coefficients

	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations		
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1(Constant)	75.187	123.235		.610	.546	-174.746	325.119			
Age	4.472	1.683	.357	2.657	.012	1.058	7.885	.327	.405	.355
BASRR	-14.057	4.338	-.449	-3.240	.003	-22.855	-5.259	-.322	-.475	-.433
Race	109.024	41.917	.358	2.601	.013	24.012	194.036	.268	.398	.348

a. Dependent Variable: Total Hours in 2 months

Ninety days multiple regression model. A test of the full multiple regression model for total hours of CPAP use at the ninety day time-point included age and race as predictor variables. Two significant, positive correlations were observed between total hours of CPAP use at 90 days (M = 418.498, SD = 218..742) and predictor variables, including age (M = 55.711, SD = 11.747), $r(47) = 0.304$, $p = 0.038$, 95% CI [0.019, 0.543], and race (M = 1.680, SD = 0.498), $r(46) = 0.340$, $p = 0.021$, 95% CI [0.056, 0.573], indicating that increased age and self-identifying as Caucasian were significantly associated with more total hours of CPAP use at 90 days. The assumptions of linearity, independence of errors, homoscedasticity, unusual points, and normality of residuals were met. These variables statistically significantly predicted total hours of CPAP use at the ninety day time-point, $F(2, 43) = 6.499$, $p = 0.003$, $R^2 = 0.232$ 95% CI [0.0327, 0.431]. Both variables added statistically significantly to the prediction, $p < 0.05$, although cooperative suppression was present in this model as each standardized coefficient was higher in absolute magnitude than the respective zero-order correlation. Regression coefficients and standard errors are displayed in Table 20.

Table 20. Summary of multiple regression analysis at ninety day time-point.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.482[a]	.232	.196	197.94864

a. Predictors: (Constant), Race, Age

b. Dependent Variable: Total Hours in 3 months

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	509333.888	2	254666.944	6.499	.003[a]
	Residual	1684897.627	43	39183.666		
	Total	2194231.515	45			

a. Predictors: (Constant), Race, Age

b. Dependent Variable: Total Hours in 3 months

Coefficients

Model		Unstandardized Coefficients		Stand. Coeffs			95% Confidence Interval for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-192.322	175.143		-1.098	.278	-545.532	160.887			
	Age	6.303	2.466	.342	2.556	.014	1.329	11.276	.317	.363	.342
	Race	157.084	57.911	.363	2.713	.010	40.296	273.872	.340	.382	.362

a. Dependent Variable: Total Hours in 3 months

Correlations between BIS, BAS, and EEG asymmetry. Frontal asymmetry scores were calculated for overall alpha power by: 1) taking the natural log of the alpha power scores at each electrode, and 2) subtracting left alpha power scores from right alpha power scores at frontal electrodes (ln[alpha power at F4 electrode] – ln[alpha power at F3 electrode]). The inverse of this asymmetry score is believed to represent increased brain activity, thus negative scores reflect greater relative right hemisphere EEG activity, and positive scores reflect greater relative left activity (Davidson, 1988).

Correlation analyses were performed to investigate the relationship between facets of Reinforcement Sensitivity Theory (e.g., BIS, BAS subscales, SPQ, and AMS) and overall EEG alpha asymmetry scores, which are presented in Table 21. No significant correlations were observed between alpha asymmetry scores and variables of interest.

Table 21. Correlation matrix showing relationships between BIS, BAS Subscales, SPQ, AMS, and overall alpha (8-12 Hz) asymmetry scores.

		EC	EO	AMS	SPQ	BIS	BAS		
							RR	D	FS
BAS	FS								
	D								.420**
	RR							.008	.205
BIS							.243*	-.199	-.181
SPQ						.409**	-.006	-.198	-.203
AMS					.028	-.244*	-.105	.374**	.351**
EO				-.106	-.102	.101	.109	.047	.137
EC			.663**	-.120	-.024	.202	-.039	-.111	.060
Mean		.10	.066	10.083	8.89	18.99	16.21	10.082	10.11
SD		.29	.25	4.01	5.90	4.59	4.33	3.14	2.98

*$p < .05$; **$p < .01$ (two-tailed)

Note. BIS = Behavioral Inhibition System Total, BAS = Behavioral Activation System, BAS RR = BAS Reward Responsiveness, BAS D = BAS Drive, BAS FS = BAS Fun Seeking, EC = alpha asymmetry score for eyes closed condition, EO = alpha asymmetry score for eyes open condition.

Exploratory analyses. Primary logistic and multiple regression analyses along with primary correlation analyses led to several follow-up investigations regarding the nature of nonadherence behaviors at each time-point.

Correlations at high, mid, and low alpha levels. First, primary correlation analyses investigating relationships between overall alpha asymmetry scores and facets of Reinforcement Sensitivity Theory did not replicate previous findings in the literature suggesting that relatively higher left hemispheric baseline frontal activity is associated with BAS traits while relatively higher right hemispheric baseline frontal activity is associated with BIS traits. Therefore, further correlation analyses were conducted after alpha power was separated into high, mid, and low alpha levels in accordance with previous alpha asymmetry research (Crawford, Clarke, & Kitner-Triolo, 1996; Everhart, Demaree, & Wuensch, 2003). Correlation coefficients and descriptive statistics for these variables at high, mid, and low alpha levels are displayed in Tables 22-24.

One significant correlation was observed between high alpha asymmetry scores (hEO; *M* = 0.078 microvolts, *SD* = 0.33) and BAS Fun Seeking scores (*M* = 10.11, *SD* = 2.98), *r* = 0.269, *n* = 54, *p* = 0.050, 95% CI [0.002, 0.500]. Another significant correlation was observed between low alpha asymmetry scores (lEC; *M* = 0.13 microvolts, *SD* = 0.35) and AMS scores (*M* = 10.083, *SD* = 4.01), *r* = -0.277, *n* = 53, *p* = 0.045, 95% CI [-0.509, -0.008]. No other significant correlations were observed between high, mid, or low alpha asymmetry scores and BIS, BAS subscales, AMS, or SPQ.

Table 22. Correlation matrix showing relationships between BIS, BAS Subscales, SPQ, AMS, and high alpha asymmetry scores.

		hEC	hEO	AMS	SPQ	BIS	BAS		
							RR	D	FS
BAS	FS								
	D								.420**
	RR							.008	.205
BIS							.243*	-.199	-.181
SPQ						.409**	-.006	-.198	-.203
AMS					.028	-.244*	-.105	.374**	.351**
hEO				.029	.129	.253	.154	-.009	.269*
hEC			.640**	.078	.008	.221	.061	-.045	.188
Mean		.078	.078	10.083	8.89	18.99	16.21	10.082	10.11
SD		.35	.33	4.01	5.90	4.59	4.33	3.14	2.98

*$p < .05$; **$p < .01$ (two-tailed)

Note. BIS = Behavioral Inhibition System Total, BAS = Behavioral Activation System, BAS RR = BAS Reward Responsiveness, BAS D = BAS Drive, BAS FS = BAS Fun Seeking, hEC = high alpha asymmetry score for eyes closed condition, hEO = high alpha asymmetry score for eyes open condition.

Table 23. Correlation matrix showing relationships between BIS, BAS Subscales, SPQ, AMS, and mid alpha asymmetry scores.

		mEC	mEO	AMS	SPQ	BIS	BAS		
							RR	D	FS
BAS	FS								
	D								.420**
	RR							.008	.205
BIS							.243*	-.199	-.181
SPQ						.409**	-.006	-.198	-.203
AMS					.028	-.244*	-.105	.374**	.351**
mEO				-.058	-.105	.035	.171	.135	.169
mEC			.479**	-.120	-.032	.130	-.129	-.096	-.020
Mean		.11	.057	10.083	8.89	18.99	16.21	10.082	10.11
SD		.29	.30	4.01	5.90	4.59	4.33	3.14	2.98

*$p < .05$; **$p < .01$ (two-tailed)

Note. BIS = Behavioral Inhibition System Total, BAS = Behavioral Activation System, BAS RR = BAS Reward Responsiveness, BAS D = BAS Drive, BAS FS = BAS Fun Seeking, mEC = mid alpha asymmetry score for eyes closed condition, mEO = mid alpha asymmetry score for eyes open condition.

Table 24. Correlation matrix showing relationships between BIS, BAS Subscales, SPQ, AMS, and low alpha asymmetry scores.

		lEC	lEO	AMS	SPQ	BIS	BAS		
							RR	D	FS
BAS	FS								
	D								.420**
	RR							.008	.205
BIS							.243*	-.199	-.181
SPQ						.409**	-.006	-.198	-.203
AMS					.028	-.244*	-.105	.374**	.351**
lEO				-.176	-.077	.034	-.079	-.156	-.213
lEC			.496**	-.277*	-.033	.123	.003	-.122	.035
Mean		.13	.14	10.083	8.89	18.99	16.21	10.082	10.11
SD		.35	.33	4.01	5.90	4.59	4.33	3.14	2.98

*$p < .05$; **$p < .01$ (two-tailed)

Note. BIS = Behavioral Inhibition System Total, BAS = Behavioral Activation System, BAS RR = BAS Reward Responsiveness, BAS D = BAS Drive, BAS FS = BAS Fun Seeking, lEC = low alpha asymmetry score for eyes closed condition, lEO = low alpha asymmetry score for eyes open condition.

Follow-up call investigations. Second, a small subset of participants (*n* = 20) was contacted via telephone after receiving an OSA diagnosis and their treatment apparatus. Patients were chosen for follow-up contact at random until the sample size of the primary adherence study achieved satisfactory power for completion of logistic and multiple regression analyses. The follow-up call consisted of a brief qualitative check-in regarding the patient's understanding of the new diagnosis, as well as several forced-choice style questions regarding the patient's recollections of the diagnostic visit with the healthcare provider. Patients were asked whether or not they remembered their healthcare provider explaining the benefits of adherence and the consequences of nonadherence, the valence of their emotional reaction to that information, and an indication of their adherence behavioral intentions on a 0-100 scale. Please refer to Appendix H to review the entire follow-up call script.

Exploratory analyses were conducted to investigate the following questions:

1. Did behavioral intentions of this sample predict adherence behavior?
2. Did patients have a bias towards remembering positive/negative valence according to self-reported traits (i.e., BIS, BAS, SPQ, AMS)?
3. Did remembering the benefits and/or consequences predict adherence behaviors?

Descriptive statistics of exploratory analyses sample. The current sample consisted of 12 men and 8 women. Demographic characteristics of this sample comprised of individuals self-identifying as Caucasian (n = 15) and African American (n = 5). The mean age of participants was 59.1 years, with a range from 38 to 93 years of age. The average BMI of the current sample was 38.774, indicative of Class II Obesity. BMI range consisted of individuals from the overweight BMI classification at 26.38 to very severely obese (Class III) at 69.41. There were no significant differences in adherence behavior between men and women at any time-point: 7 days,

$t(13) = -1.022$, $p = .326$; 30 days, $t(18) = -.976$, $p = .342$; 60 days, $t(8) = .300$, $p = .771$; 90 days, $t(7) = -.244$, $p = .814$. There were also no significant differences in adherence among Caucasians and African Americans at any time-point: 7 days, $t(13) = -1.487$, $p = .161$; 30 days, $t(18) = -.552$, $p = .588$; 60 days, $t(8) = -1.825$, $p = .105$; 90 days, $t(7) = -1.998$, $p = .086$. Descriptive statistics of the self-report inventories, baseline asymmetry values, and behavioral intentions from the subsample of patients who participated in follow-up call are provided in Table 25. Frequency counts of participant responses to each follow-up question are displayed in Table 26.

Table 25. Descriptive statistics of exploratory analyses subsample for variables of interest from self-report inventories and baseline asymmetry values.

Predictor Variable	Mean	SD
Age	59.100	14.768
BMI	38.774	11.551
Subjective Severity Rating	2.000	1.085
AHI	23.521	18.086
BIS	19.737	4.712
BAS Drive	10.350	3.573
BAS Reward Responsiveness	16.850	4.522
BAS Fun Seeking	11.150	2.601
Appetitive Motivation Scale	9.947	4.625
Sensitivity to Punishment Questionnaire	9.579	6.535
Eyes Open Baseline Asymmetry	0.0457	0.240
Eyes Closed Baseline Asymmetry	0.0135	0.254
Behavioral Intentions	91.316	16.317

Table 26. Frequencies of participant responses to follow-up questions.

Question 1: Did your physician explain the *benefits* of following treatment recommendations regularly?		**Yes**	**No**
		13	7
Question 2: Did your physician explain the *consequences* of **not** following treatment recommendations regularly?		**Yes**	**No**
		10	10
Question 3: Which would you say your doctor spent the most time highlighting: consequences or benefits?	**Consequences**	**Benefits**	**Equal**
	3	12	5
Question 4: How did you feel after your physician gave you this information? (valence)	**Positive**	**Neutral**	**Negative**
	6	4	10

Behavioral intentions and adherence behavior. In order to investigate the predictive utility of self-reported behavioral intentions on adherence behavior, linear regression analyses were conducted for each time-point. A .05 criterion of statistical significance was employed for all tests. The linear regression between behavioral intentions and total hours of apparatus use in seven days was not significant, $F(1, 13) = .230$, $p = .639$, $r^2 = 0.017$, 95% CI [0.000, 0.324]. Similarly, the linear regression between behavioral intentions and total hours of apparatus use in thirty days was not significant, $F(1, 17) = .064$, $p = .803$, $r^2 = 0.004$, 95% CI [0.000, 0.207]. Linear regressions between behavioral intentions and total hours of apparatus use in both sixty and ninety day time-points were also not significant: sixty days, $F(1, 8) = .001$, $p = .978$, $r^2 = 0.0001$, 95% CI [0.000, 0.000]; ninety days, $F(1, 7) = .046$, $p = .836$, $r^2 = 0.007$, 95% CI [0.000, 0.359]. While these findings do not support previous research findings indicating that behavioral intentions predict adherence behaviors (Blanchard, Courneya, Rodgers, Daub, & Knapic, 2002; Gatch & Kendziershi, 1990; Plotnikoff, Lippke, Trinh, Courneya, Birkett, & Sigal, 2010; Tulloch et al., 2009; White et al., 2010), it is important to note that the low sample size provides low power for these analyses. Thus, these results may represent a Type II error, as power was between 28-54% for a large effect (rho = .5).

Self-reported traits associated with emotional bias. Spearman rank-order correlation analyses were conducted between self-reported trait characteristics, baseline asymmetry values, and overall emotional valence participants reported experiencing after receiving their OSA diagnosis and receiving treatment recommendations for using their apparatus. This was completed in order to explore the possible associations between predisposing traits and tendencies to remember positive or negative emotions, as consistent with Reinforcement Sensitivity Theory. In summary, no significant correlations were found between reported

emotional valence after diagnostic appointment and any self-reported trait characteristics or baseline asymmetry values in this follow-up sample.

As processing the consequences of nonadherence and benefits of adherence during a diagnostic appointment could potentially evoke emotions, correlation analyses were also conducted between self-reported traits and reported consequences and benefits during follow-up call. One significant correlation was observed between reported consequences (Yes = 1, No = 2) and BAS Reward Responsiveness, $r_s(18) = 0.523$, $p = 0.018$, 95% CI [0.105, 0.784], indicating that people who reported higher levels of this trait were less likely to report remembering their healthcare provider explaining the consequences of nonadherence to their OSA apparatus. No other significant correlations were observed.

Adherence behaviors associated with remembered benefits or consequences. Spearman rank-order correlation analyses were conducted between reported consequences and benefits during follow-up call and adherence behaviors at each time-point. One significant correlation was observed between reported consequences (Yes = 1, No = 2) during follow-up call and total hours of apparatus use in three months, $r_s(7) = -0.693$, $p = 0.039$, 95% CI [-0.929, -0.054], indicating that remembering the consequences of nonadherence explained by their healthcare provider during the diagnostic appointment was associated with higher total hours of use in three months. No other significant correlations were observed at any other time-point.

Summary of Findings

In summary, partial support was observed for several of the main hypotheses for Study Two. It was hypothesized that BIS would be a predictor of nonadherence behavior, however, BIS was not found to be a significant predictor in any of the logistic or multiple regression models at any time-point. This is in contrast to prior research which established BIS as a predictor variable

of nonadherence in a similar clinical sample (Moran et al., 2010), and does not support the present hypothesis. Although not specifically hypothesized, another facet of RST, BAS Reward Responsiveness, was found to be a significant, negative predictor of total hours of CPAP use at the 60 day time-point, indicating that patients who reported lower levels of this trait engaged in more hours of apparatus use by the 60 day time-point. As this subscale assesses anticipation of reward and is thought to be associated with approach-related behaviors consistent with the BAS construct, this finding appears to be incongruent with RST. However, BAS Reward Responsiveness as a construct has been criticized for being positively correlated with BIS and independent from the other BAS subscales in previous research (Cogswell, Alloy, van Dulmen, & Fresco, 2006; Gomez, Cooper, & Gomez, 2005). No other RST factors were significant predictors in any of the logistic or multiple regression models.

It was also hypothesized that higher BAS scores would be associated with greater relative left frontal asymmetry while higher BIS scores would be associated with greater relative right frontal asymmetry from polysomnogram recordings. No significant correlations were observed between overall alpha asymmetry scores and variables of interest, which does not support the current hypothesis. Two significant correlations were observed when alpha power was stratified into high, mid, and low levels. One positive correlation was observed between high alpha values and BAS Fun Seeking, indicating patients who self-reported higher levels of this trait also had relatively greater left hemisphere baseline activity during polysomnogram study, which is in support of the current hypothesis. A negative correlation was observed between low alpha asymmetry and AMS scores, indicating patients who self-reported higher levels of this trait also had relatively greater right hemisphere baseline activity during polysomnogram, which does not support the current hypothesis as AMS is thought to approximate BAS.

Finally, it was predicted that greater relative left frontal asymmetry would be associated with greater adherence behavior while greater relative right frontal asymmetry would be associated with lower adherence behavior. None of the baseline asymmetry variables were found to be significant predictors of any of the logistic or multiple regression models. Furthermore, exploratory analyses did not indicate any of the stratified alpha power variables to significantly predict total hours of use at any time-point using separate linear regression analyses. In summary, no support was found for the current hypothesis in the clinical sample.

Several additional notable findings were observed from Study Two. Nonadherence was not predicted by any variables of interest in either logistic or multiple regression models at the seven day time-point. The logistic regression model at 30 days explained 7.8% of the variance of a model with age as a predictor variable. The logistic regression model at the 60 day time-point explained 28.9% of the variance in observed nonadherence and included one significant predictor, age, which indicated that for each one year reduction in age of this sample, the risk of nonadherence increased by a factor of 1.094. The multiple regression model at the 60 day time-point also included age as a significant predictor of total hours of CPAP use, but additionally included race (higher use associated with higher likelihood of identifying as Caucasian) and BAS Reward Responsiveness (higher use associated with lower endorsements of this trait) as predictor variables.

The logistic regression model at the 90 day time-point explained 33.1% of the variance in nonadherence and included age and subjective severity rating as significant predictor variables. Interestingly, a one-unit increase in subjective severity rating of obstructive sleep apnea at the time of diagnosis is associated with the odds of demonstrating nonadherence by a multiplicative factor of 3.272. However, subjective severity rating was not a significant predictor of total hours

of CPAP use at the 90 day time-point as it was demonstrated through multiple regression analysis. Age and race were the only predictor variables shown to significantly add to the prediction.

CHAPTER VII: GENERAL DISCUSSION

OSA is a common chronic sleep disorder with a demanding and complex treatment regimen. Fortunately, CPAP treatment is highly effective; unfortunately, many patients are unable to overcome complex barriers to adherence. The field is now recognizing the extent of these complexities and thus has called for a biopsychosocial approach to CPAP adherence. This dissertation aimed to investigate individual differences in predisposing traits and electrophysiology in accord with this biopsychosocial framework. In summary, two studies were conducted in an effort to delineate predictors of behavioral intentions and adherence behaviors, as well as investigate a practical message framing approach that is informed by individual differences.

A specific aim of this study was to investigate predictive variables of behavioral intentions and CPAP adherence. This was addressed in both studies through multiple regression analyses as well as through logistic regression analyses in the clinical study in accordance with current CPAP adherence criteria. Two multiple regression models were tested in Study One. A full multiple regression model predicting behavioral intentions to adhere to the advantage-framed health message was significant, including BIS, Active Planning, Humor, Valence and Control SAM ratings to the advantage-framed message, and eyes open baseline asymmetry values. The full model explained 28.1% of the variance in behavioral intentions, and revealed two significant predictors: Valence ratings and BC: Humor, such that more positive valence ratings on the SAM and lower Humor ratings on the Brief COPE were associated with higher behavioral intentions. A full multiple regression model predicting behavioral intentions to adhere to the disadvantage-framed health message was also significant, including BIS, BC: Humor, AdvSAMC, DisSAMC, and baseline asymmetry values at two eyes open conditions and one eyes closed condition. The

full model predicted 30.8% of the variance, and revealed SAM Control ratings to the advantage-framed message, baseline asymmetry during the eyes closed condition, and BC: Humor as significant predictors. Specifically, participants with higher scores on AdvSAMC and lower scores on BC: Humor were expected to indicate higher behavioral intentions to adhere to the disadvantage-framed message. EC3 also had a significant negative regression weight, indicating that participants with higher relative right hemisphere baseline cortical activity were expected to endorse higher behavioral intentions to adhere to the disadvantage-framed message.

Study Two indicated that both logistic and multiple regression models were significant at the 60 and 90 day time-points. Age and subjective severity rating explained 28.9% of the variance in nonadherence at the 60 day time-point and correctly classified 66.7% of cases, although age was the only significant predictor variable, most likely reflecting the general increased risk of nonadherence with younger age as described in the literature. The same variables were found to explain 33.1% of the variance in nonadherence at the 90 day time-point, and correctly classified 65.1% of cases. Both variables were significant predictors at the 90 day time-point, with a one-unit increase in self-reported subjective severity rating associated with the odds of being nonadherent by a multiplicative factor of 3.272. Multiple regression models at these time-points similarly include age as a significant predictor, but with the addition of race in both models and BAS Reward Responsiveness as a negative predictor of total hours of CPAP use at the 60 day time-point model. A summary of findings is displayed in Table 27.

Table 27. Significant predictors of each significant regression model.

Lab Study: Behavioral Intentions	
Dependent Variable:	Behavioral intentions to adhere to advantage-framed message.
Significant Predictors:	(+) SAM Valence ratings to advantage-framed message, and (-) BC: Humor
Dependent Variable:	Behavioral intentions to adhere to disadvantage-framed message.
Significant Predictors:	(+) BIS, (+) SAM Control ratings to advantage-framed message, (-) baseline asymmetry during the eyes closed condition, and (-) BC: Humor
Follow-Up Calls	
Dependent Variable:	Behavioral intentions to adhere to CPAP treatment.
Significant Predictors:	No significant predictors (low sample size, low power)
CPAP Nonadherence: Logistic Regression Models	
Dependent Variable:	Nonadherence at the 60 day time-point.
Significant Predictors:	Age
Dependent Variable:	Nonadherence at the 90 day time-point.
Significant Predictors:	Age and Subjective Severity Rating
Total Hours CPAP Use: Multiple Regression Models	
Dependent Variable:	Total hours of CPAP use at 60 day time-point.
Significant Predictors:	(-) BAS Reward Responsiveness, (+) Age, and (+) Race
Dependent Variable:	Total hours of CPAP use at 90 day time-point.
Significant Predictors:	(+) Age, and (+) Race

Another aim of this study was to investigate a practical message framing approach that is informed by individual differences from formal hypothesis testing and exploratory analyses. Importantly, no significant differences were found between behavioral intentions ratings after viewing either of the health messages without taking into account individual differences in traits, coping strategies, and resting frontal cortical asymmetry, emphasizing the importance of

considering patient characteristics at the individual level instead of assuming one general approach will work across all patients. Some practical information that can perhaps be garnered from findings across health message conditions is the importance of considering elicitation of affect throughout provision of diagnosis and treatment recommendations. For example, clinicians may help patients to better connect with advantage-framed health messages by ensuring that they are concurrently experiencing positively valenced emotions in immediate response to receiving the information. If clinicians are delivering disadvantage-framed health messages, it may be beneficial for clinicians to enhance the patient's feelings of control by engaging in motivational interviewing techniques and also being willing to process feelings of anxiety or fear associated with receiving such a health message.

Regarding the association between relatively greater right hemisphere activity and behavioral intentions to adhere to the disadvantage-framed message, right hemisphere activity has been previously associated with traits that are sensitive to punishment stimuli, meaning they are more likely to orient to negative cues in their environment. Perhaps this finding is a biomarker of this tendency to seek out threatening cues or to attend more highly to consequences. This could indicate that when delivering health information in a clinical setting, providers could deliver disadvantage-framed information in a way that meaningfully and safely highlights what is most important to people based on their trait characteristics. In the case of someone who may perhaps have this biomarker, and thus may appear more behaviorally anxious, highlighting the disadvantages of nonadherence while concurrently activating the patient's feelings of control could provide an optimal environment for increased behavioral intentions to adhere to CPAP treatment.

Although the follow-up call exploratory analyses were limited by low power due to low sample size, two significant findings were revealed. A significant correlation was observed between remembering the healthcare provider explaining the consequences of nonadherence and BAS Reward Responsiveness, indicating that people who reported higher levels of this trait were less likely to report remembering their healthcare provider explaining the consequences of CPAP nonadherence. Another significant correlation was observed between remembering the healthcare provider explaining the consequences of nonadherence and total hours of apparatus use at the 90 day time-point. This indicates that self-reported remembering the consequences of nonadherence explained by their healthcare provider during the diagnostic appointment was associated with higher total hours of use in three months. While BAS Reward Responsiveness was not significantly correlated with total hours of apparatus use at the 90 day time-point, the potential exists that people who are higher on this trait could be at higher risk of not orienting to the consequences of nonadherence explained during a diagnostic visit, and may need to have such health messages framed to enhance their likelihood of adherence in another way.

Regarding coping strategies, it is interesting to note that humor was a negatively weighted significant predictor of behavioral intentions to adhere to both health messages. Out of the three previously described health behavior models, coping is most directly measured in the PMT in the coping appraisal construct of the cognitive decision-making process. Perhaps humor as a general coping strategy that may be mostly adaptive in other contexts may actually be working against an individual's ability to emotionally process the negative consequences associated with CPAP nonadherence, thus leading to less behavioral intentions to protect oneself from those consequences. This is consistent with PMT in that fear arousal is a mechanism driving an individual's motivation to avoid the negative consequences of not adopting a health

behavior. It could be that humor as a coping strategy acts as a moderator of this fear arousal mechanism, thus leading to decreased behavioral intentions.

Findings from Study Two indicated that patients identifying as African American were at higher risk of nonadherence to CPAP, especially after 60 days. This is consistent with recent findings highlighting adherence disparities particularly among black CPAP patients when compared to white and Hispanic/Latino patients (Billings et al., 2011). Findings in the literature also suggest that follow-up with health care providers for CPAP-treated OSA may also be lower among minority groups (Greenberg et al., 2004), which increases the chances that patients will suffer continued OSA symptoms and exacerbation of symptoms of other common co-occurring health problems, such as cardiovascular and metabolic diseases (Javaheri, 2011).

It is also worth noting that during the current study, multiple regression analyses using total hours of CPAP use as the dependent variable were more sensitive at identifying those at risk of nonadherence (i.e., African Americans in this sample) than logistic regression analyses using the more restrictive current adherence criteria (i.e., over four hours of use 70% of nights). This is consistent with a recent call for future research that includes investigations of factors that could provide more meaningful translation to clinical practice, especially in light of findings suggesting such disparities exist among minority groups, those living in urban environments or neighborhoods of low socioeconomic levels, and those with lower education and literacy levels (Sawyer, 2013).

Younger patients in the current clinical sample were also at increased risk of nonadherence, consistent with previous research. Findings also indicated that patients were at higher risk of nonadherence after 90 days if they reported higher subjective severity of their sleep problem prior to diagnosis. This finding could possibly indicate that these patients had

given up on attaining symptom relief from using CPAP given their high severity of symptoms at diagnosis. It could also indicate that they had discontinued CPAP use due to achieving relative symptom relief. Risk of nonadherence was also associated with higher BAS Reward Responsiveness trait and not remembering the consequences of nonadherence from their healthcare provider at diagnosis. Humor as a coping strategy was associated with decreased behavioral intentions to adhere to both health messages in the laboratory study.

Strengths from the laboratory study included the ability to control for variables otherwise impossible to control in a clinical sample, while strengths from the clinical study allowed for possible generalizability to other patients suffering from OSA. A limitation of the laboratory study was that although much practical information has been gained from testing two differently framed health messages, it should be emphasized that this was not an intervention study as there was no control group for comparison of the effect of the health messages. A major assumption made during Study One was that behavioral intentions reliably predicted adherence behavior, as demonstrated in the health behavior literature. The follow-up call investigation was designed to test the predictive utility of behavioral intentions on CPAP adherence in the clinical sample, but unfortunately the small sample size provided low power to test this assumption, and thus reflects a significant limitation of the present study. Furthermore, although the follow-up call investigation was focused on patients' subjective recall of the content of their diagnostic appointments, it should be noted that it was impossible to determine the extent to which each provider reviewed the consequences and benefits of CPAP adherence as no observers were present during these appointments.

A significant limitation of the clinical study was that not all participants had adherence data available at all time-points. At present, there is no unified way to determine adherence, as

the home health care companies each have their own method and format for CPAP use data collection. Furthermore, they do not always release these data to providers, even though CPAP use data are crucial for determining whether or not patients are able to keep the CPAP machine for treatment. Notably, suppressor effects were identified in the 60 and 90 day time-points models and represent limitations in interpretation of these data. Additionally, the method of eliminating variables for inclusion into regression models based on Pearson correlations to account for power limitations given the number of variables currently under investigation in the behavioral sleep medicine literature may have also resulted in additional limitations at identifying significant predictors of nonadherence. An additional limitation is that those patients who chose to participate in the clinical study may be qualitatively different in some way than those who chose not to participate, which may threaten generalizability to the OSA population.

Future research should continue similar investigations of individual differences in predisposing traits and neurophysiology that attempt translation of laboratory experimental study into clinical investigations of tested constructs. It will be especially important to focus future research on those identified as at higher risk of CPAP nonadherence in order to enhance likelihood of adherence given the many health benefits of OSA treatment. Findings from the current study indicated that African Americans were at higher risk of CPAP nonadherence through multiple regression analyses, but not through logistic regression analyses using more restrictive current adherence criteria. This is important because additional health benefits and OSA symptom relief are associated with increased CPAP use beyond the current adherence criteria, thus using total hours of CPAP use instead of a dichotomous adherence outcome variable may help to identify possible disparities in care. Additionally, continuing similar investigations of individual differences in predisposing traits, neurophysiology, and coping

strategies will allow providers to tailor their approach with patients to enhance likelihood of adherence.

Future research could focus on testing the assumption that behavioral intentions predict adherence behaviors by completing a similar follow-up call investigation with a greater sample size to increase power. Given the practical information gained from Study One regarding health message framing, it would be beneficial to test the effects of these messages by including a control group in a follow-up laboratory study. Ideally, these findings could then be used to deliver education to providers on message framing to enhance CPAP adherence, which could then be subsequently tested in a clinical setting.

It is important to continue uncovering additional mechanisms driving CPAP nonadherence through a biopsychosocial framework. As patients face many barriers to adherence, it is tempting as health professionals to try to help patients by assuming we conceive of these barriers in the same manner as our patients, when in actuality it is the patients' unique perspectives that are crucial for enhancing their experience with a complex treatment such as CPAP.

Boyer's (2007) statement especially rings true in this manner:

> Health professionals of all disciplines need to resist the temptation to conceive of noncompliance or nonadherence as a condition that "a patient has." More instrumentally useful is the investigation of the factors that facilitate a patient's success with self-management or follow-through with the medical regimen, and factors that increase a patient's difficulties or failures with self-management or follow-through with the medical regimen. By identifying the factors that contribute to either success or difficulties with self-management, the medical team can identify the means to help a patient, or the patient's family, succeed with the demands of that particular treatment regimen. (p. 15)

This is consistent with the formal call from Crawford and colleagues (2014) for a biopsychosocial approach to addressing CPAP adherence. This approach emphasizes movement away from a "doctor-centered" model of compliance where the main mechanism of change is the

passive obedience of the patient to a doctor's recommendations, and towards a more holistic model emphasizing the multidimensional nature of adherence. The current study was designed to investigate nonadherence from a biopsychosocial standpoint by considering the barriers of success from the patient's subjective experiences of receiving a health diagnosis and subsequent treatment recommendations given their predisposing traits. By considering these complex patient-centered factors, significant predictors were revealed, such as subjective severity ratings of the sleep problem prior to diagnosis, and subjective reports of remembering nonadherence consequences explained during diagnostic appointment.

Studying patient-centered factors through the laboratory study uncovered matters with potentially significant clinical applicability. For example, this investigation revealed that humor as a coping strategy was a significant negative predictor of behavioral intentions to adhere to both advantage- and disadvantage-framed health messages, suggesting that people with this coping strategy may require different approaches to enhance adherence likelihood. Furthermore, the findings associated with participants' emotional responses to advantage- and disadvantage-framed health messages can also provide clinical utility to enhance the transactions between patients and providers. This focus on the transactions between patients and providers is in line with the call for a biopsychosocial approach. This focus emphasizes the importance of collaborating with patients in consideration of not only condition- and therapy-related factors wherein providers can offer their expertise, but also in consideration of patient-related factors wherein patients can offer their expertise in their subjective experiences within the healthcare system as well as the unique coping strategies they bring with them into a likely stressful point of intervention. Continued research with this biopsychosocial focus will allow providers to consider

practical approaches to delivering novel health information that can enhance the likelihood of adherence based on patient-centered factors.

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APPENDIX A

East Carolina University

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Responses to Health Information
Principal Investigator: Katie Lehockey, M.A.
Faculty Sponsor: Erik Everhart, Ph.D.
Institution/Department or Division: Psychology
Address: 104 Rawl
Telephone #: 252-561-5436

Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?
The purpose of this research is to understand the ways health messages may help people adhere to treatment recommendations by evoking emotions. The decision to take part in this research is yours to make. By doing this research, we hope to learn how health messages can be tailored to fit the needs of individuals with different personalities and ways of coping to enhance treatment adherence.

Why am I being invited to take part in this research?
You are being invited to take part in this research as a volunteer. If you volunteer to take part in this research, you will be one of about 150 people to do so.

Are there reasons I should not take part in this research?
You should not participate in this research if you are under 18 years of age or if you have ever received a diagnosis of obstructive sleep apnea.

What other choices do I have if I do not take part in this research?
You can choose not to participate. During Spring and Fall semesters, you can fulfill your research requirement in Introduction to Psychology by participating in any of a number of available research studies which are listed on the Sona website (http://ecu.sona-systems.com). You can also participate in alternative activities to research to fulfill this requirement. The primary research alternative is reading articles and completing knowledge quizzes on these articles. Times when you can sign up to complete these knowledge quizzes are also listed on the Sona website. During Summer sessions, your instructor will provide you with information about ways to fulfill any research requirement in Introduction to Psychology. If you are enrolled in another Psychology course, your instructor can provide you with information about alternatives to participating in this research.

Where is the research going to take place and how long will it last?
The research procedures will be conducted online, and can be completed online. You will not need to come in to complete the study. The total amount of time you will be asked to volunteer for this study is 60 minutes.

What will I be asked to do?
You are being asked to do the following: You will be asked to complete several questionnaires about your personality traits and ways you cope with stress, including the BIS/BAS Scales, Appetitive Motivation Scale, Sensitivity to Punishment Questionnaire, and Brief COPE. You will then be asked to view three messages about receiving a diagnosis of obstructive sleep apnea and the advantages and disadvantages of adhering to treatment. You will then be asked about your reactions to the messages.

What possible harms or discomforts might I experience if I take part in the research?
It has been determined that the risks associated with this research are no more than what you would experience in everyday life.

What are the possible benefits I may experience from taking part in this research?
There may be no personal benefit other than learning about obstructive sleep apnea from your participation. However, we hope the information gained by doing this research may help healthcare providers enhance patient care.

Will I be paid for taking part in this research?
We will not pay you for the time you volunteer while being in this study. If you participate in this study, you are eligible to receive 1 hour of research credit for your Introduction to Psychology course (if research is required). If you are enrolled in another Psychology course, please contact your instructor to determine what credit you can receive for participating, if any.

What will it cost me to take part in this research?
It will not cost you any money to be part of this research.

Who will know that I took part in this research and learn personal information about me?
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

How will you keep the information you collect about me secure? How long will you keep it?
Data collected from this study will be kept securely for seven years. All identifying information (email address) will be separated from responses. Additionally, email addresses (collected for the purposes of class credit) will be destroyed as soon as credit is granted.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator, Katie Lehockey at 252-561-5436 (days), or the faculty sponsor, Dr. Erik Everhart at 252-328-4138 (days).

If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.

I have decided I want to take part in this research. What should I do now?

Read the following and if you agree, you should consent to participate:

I have read all of the above information.
I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
I know that I can stop taking part in this study at any time.
By consenting to participate, I am not giving up any of my rights.
I can print a copy of this consent document, and it is mine to keep.

By checking this box and clicking continue, you are consenting to participate in this research:

☐ Continue

☐ I do not consent, do not continue

APPENDIX B

East Carolina University

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Psychophysiological Responses to Health Information
Principal Investigator: Katie Lehockey, M.A.
Faculty Sponsor: Erik Everhart, Ph.D.
Institution/Department or Division: Psychology
Address: 104 Rawl
Telephone #: 252-561-5436

Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?
The purpose of this research is to find out how people with different personalities perceive incoming health information, like receiving a health diagnosis By doing this research, I hope to learn more about how personality is related to intentions to adhere to treatment and mood states.

Why am I being invited to take part in this research?
You are being invited to take part in this research as a volunteer. If you volunteer to take part in this research, you will be one of about 100 people to do so.

Are there reasons I should not take part in this research?
You should not participate in this research if you are under 18 years of age, have ever experienced any significant psychiatric or neurological concerns, or if you have ever received a diagnosis of obstructive sleep apnea.

What other choices do I have if I do not take part in this research?
You can choose not to participate. During Spring and Fall semesters, you can fulfill your research requirement in Introduction to Psychology by participating in any of a number of available research studies which are listed on the Sona website (http://ecu.sona-systems.com). You can also participate in alternative activities to research to fulfill this requirement. The primary research alternative is reading articles and completing knowledge quizzes on these articles. Times when you can sign up to complete these knowledge quizzes are also listed on the Sona website. During Summer sessions, your instructor will provide you with information about ways to fulfill any research requirement in Introduction to Psychology. If you are enrolled in another Psychology course, your instructor can provide you with information about alternatives to participating in this research.

Where is the research going to take place and how long will it last?
The research procedures will be conducted at the Rawl Building. You will need to come to the Cognitive Neuroscience Laboratory in Rawl 237 one time to complete this study. The total amount of time you will be asked to volunteer for this study is 120 minutes.

What will I be asked to do?
You are being asked to do the following:
1. (30 minutes) Complete several questionnaires about your personality traits and ways you cope with stress, including the BIS/BAS Scales, Appetitive Motivation Scale, Sensitivity to Punishment Questionnaire, and Brief COPE

2. (30 minutes) Participate in baseline electroencephalography (EEG) recording and complete an event-related potential (ERP) task. This entails allowing researchers to apply a noninvasive electrode Quick-Cap to your scalp using a saline gel for conductance in order to record your brain activity while relaxed and during an ERP task.

3. (30 minutes) View three messages about receiving a diagnosis of obstructive sleep apnea and the advantages and disadvantages of adhering to treatment. You will then be asked about your reactions to the messages.

What possible harms or discomforts might I experience if I take part in the research?
It has been determined that the risks associated with this research are no more than what you would experience in everyday life.

Some participants may feel nervous about EEG/ERP procedures, and researchers are available to you to answer any questions or address any concerns you may have about this study throughout its entirety. The researcher will orient you to all procedures and settings including allowing you to view the following:

- Electrode cap and blunted syringe used to noninvasively apply gel for conductance
- Sound-proof booth where you will sit while participating in the EEG/ERP tasks
- Any other elements of the study of which you may have questions or concerns.

You may choose to discontinue participation at any time throughout the duration of this study.

What are the possible benefits I may experience from taking part in this research?
There may be no personal benefit other than learning about obstructive sleep apnea from your participation. However, we hope the information gained by doing this research may help healthcare providers enhance patient care.

Will I be paid for taking part in this research?
We will not pay you for the time you volunteer while being in this study. If you participate in this study, you are eligible to receive 1 hour of research credit for your Introduction to Psychology course (if research is required). If you are enrolled in another Psychology course, please contact your instructor to determine what credit you can receive for participating, if any.

What will it cost me to take part in this research?
It will not cost you any money to be part of this research.

Who will know that I took part in this research and learn personal information about me?
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

How will you keep the information you collect about me secure? How long will you keep it?
Data collected from this study will be kept securely for seven years. This study will be conducted in the Cognitive Neuroscience Laboratory, Rawl 237, a locked room within the Rawl Building. Self-report inventory responses will be collected online when participants arrive to participate in the study, and no identifying information will be collected. Participant responses will be coded and informed consent forms will be kept separately from collected data in a locked filing cabinet. Electrophysiological data and behavioral responses will be coded and stored on a password-protected hard drive within the Cognitive Neuroscience Laboratory. Only research team members will have access to these data.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator, Katie Lehockey at 252-561-5436 (days), or the faculty sponsor, Dr. Erik Everhart at 252-328-4138 (days).

If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.

I have decided I want to take part in this research. What should I do now?
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

_____ _____ _____
Participant's Name (PRINT) **Signature** **Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

_____ _____ _____
Person Obtaining Consent (PRINT) **Signature** **Date**

[Optional]

_____ _____ _____
Principal Investigator (PRINT) ***Signature*** ***Date***
(If other than person obtaining informed consent)

APPENDIX C

East Carolina University

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Coping with Treatment
Principal Investigator: Erik Everhart, PhD, ABPP, CBSM
Institution/Department or Division: East Carolina University
Address: 237 Rawl Building, Department of Psychology, East Carolina University
Telephone #: (252) 328-4138

Researchers at East Carolina University (ECU) and Vidant Sleep Center study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?
The purpose of this research is to understand how patients may cope with treatment of health conditions, and in this particular case, Obstructive Sleep Apnea. The decision to take part in this research is yours to make. By doing this research, we hope to learn how individuals cope with Obstructive Sleep Apnea.

Why am I being invited to take part in this research?
You are being invited to take part in this research because you have Obstructive Sleep Apnea. If you volunteer to take part in this research, you will be one of about 200 people to do so.

Are there reasons I should not take part in this research?
Participating in this study is voluntary. You may decide to withdraw from this study at any time without penalty.

What other choices do I have if I do not take part in this research?
You can choose not to participate.

Where is the research going to take place and how long will it last?
The research will be conducted at Vidant Sleep Center. By participating in this research study, you will be donating about 30 minutes of your time to complete the questionnaires.

What will I be asked to do?
You are being asked to do the following:

- Read and sign this informed consent document and HIPAA Privacy Authorization form.
- Complete a packet of questionnaires.
- Permit researchers to review information pertaining to your medical history, current medical records, polysomnogram (overnight sleep study) results, and information pertaining to treatment of sleep apnea for one year following the completion of the polysomnogram.

What possible harms or discomforts might I experience if I take part in the research?

There is a very slight chance that you may experience unwanted emotions from answering the questionnaires. It has been determined that the risks associated with this research are no more than what you would experience in everyday life.

What are the possible benefits I may experience from taking part in this research?
There is no personal benefit from your participation. However, the information obtained from this study may be helpful in understanding how individuals cope with Obstructive Sleep Apnea.

Will I be paid for taking part in this research?
We will not be able to pay you for the time you volunteer while being in this study.

What will it cost me to take part in this research?
It will not cost you any money to be part of the research.

Who will know that I took part in this research and learn personal information about me?
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections.
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.
- People designated by PCMH and University Health System.

How will you keep the information you collect about me secure? How long will you keep it?
Your privacy and confidentiality will be maintained in the following ways. The records of this research will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a participant. Research records will be kept in a locked file, and access will be limited to the researchers, the University review board responsible for protecting human participants, and regulatory agencies. In addition, your name and any information that could be used to identify you will be stripped from the electronic file prior to analysis of the information.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator, Dr. Everhart at (252) 328-4138 (8:30 am–5:00 pm). If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number (252) 744-2914 (8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at (252) 744-1971 and the Vidant Risk Management Office at (252) 847-5246.

I have decided I want to take part in this research. What should I do now?
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

Participant's Name (PRINT)	**Signature**	**Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

Person Obtaining Consent (PRINT)	**Signature**	**Date**

APPENDIX D

Summer Recruitment Script

Greetings,

My name is Katie Lehockey and I am a clinical health psychology doctoral student conducting research to complete my dissertation. I'm here today to see if anyone is interested in participating in my experiment.

The purpose of my research is to find out how people with different personalities perceive incoming health information, like receiving a health diagnosis. By doing this research, I hope to learn more about how personality is related to intentions to adhere to treatment and mood states.

If you are interested in participating, you will be asked to come to the Cognitive Neuroscience Lab in the Rawl building for two hours. During the first half hour, you will complete some surveys about your personality and feelings. The rest of the time you will be completing the experiment. It is important to note that this study will use electroencephalogram (EEG). EEG is a recording of your brain's electrical activity, which is very useful for studying inhibition.

If you are 18 years of age or older, right-handed, have corrected-to-normal vision, do not have any neurological or psychiatric conditions like a seizure disorder, anxiety, or depression, and have never received a diagnosis of obstructive sleep apnea, then you are eligible to participate in this study. Please indicate your interest in participating by printing your name and contact information on the paper provided. I will contact you with more information about the study as soon as possible. You may also contact me with any questions or concerns you may have about the experiment or your eligibility to participate. Thank you for your time and consideration.

APPENDIX E

Demographic Information Interview Form

General Information

Age: _____ Years of Education (from 1st Grade): _____ Sex: Male___ Female___

Are you left or right-handed? Left_____ Right_____

Have you ever been diagnosed with obstructive sleep apnea? Yes_____ No_____

Medical History Questionnaire

Have you ever experienced or been diagnosed with any of the following, or are you experiencing any of the following at present? Please circle the appropriate response and explain any "Yes" answers below.

1. Visual difficulties, blurred vision, or eye disorders	Yes	No
2. Blindness in either eye	Yes	No
3. If Yes to either of the above, have problems been corrected	Yes	No
4. Hearing problems	Yes	No
5. Learning disabilities (problems of reading, writing, or comprehension)	Yes	No
6. Cognitive problems	Yes	No
7. Severe head trauma/injury	Yes	No
8. Stroke	Yes	No
9. Epilepsy or seizures	Yes	No
10. Neurological surgery	Yes	No
11. Paralysis	Yes	No
12. Anxiety disorders	Yes	No
13. Depression	Yes	No
14. Other Neurological, Psychological, or Emotional problems	Yes	No

APPENDIX F

Instructions for Health Messages Task

Pretend that you have completed an overnight sleep study because your close friend, roommate, relative, or significant other noticed that you snore very loudly at night. You have also noticed that you are feeling sleepy during class and are experiencing headaches every week. You have now returned to speak with your physician about the results and treatment recommendations. Please pay close attention to each message and the researcher will guide you through your remaining tasks.

Advantage-Framed OSA Message Script

Hi, my name is Dr. Jones and we are going to go over your sleep study results. It appears that you do in fact have obstructive sleep apnea. Obstructive sleep apnea is a condition where the flow of air pauses or decreases when you are sleeping. This generally happens because the airway has become narrowed, blocked, or floppy. The snoring you have been experiencing is caused by the air trying to squeeze through the narrowed airway.

Since your airway becomes blocked when you sleep, the goal of treatment is to keep the airway open so that your breathing does not stop. The device that you will be given does just that. The CPAP machine will deliver slightly pressurized air at night when you wear it, keeping your airway open. It is recommended that you wear your CPAP every night while you sleep.

People who regularly wear their CPAP report experiencing feeling more alert and less sleepy during the day. They also say that their concentration and memory is better, and they are more productive during the day. People typically report less anxiety and are in a better mood overall. An added bonus is that their partner or roommate's sleep also improves. People who regularly wear their CPAP are decreasing risk of hypertension, Type II diabetes, and stroke.

Disadvantage-Framed OSA Message Script

Hi, my name is Dr. Jones and we are going to go over your sleep study results. It appears that you do in fact have obstructive sleep apnea. Obstructive sleep apnea is a condition where the flow of air pauses or decreases when you are sleeping. This generally happens because the airway has become narrowed, blocked, or floppy. The snoring you have been experiencing is caused by the air trying to squeeze through the narrowed airway.

Since your airway becomes blocked when you sleep, the goal of treatment is to keep the airway open so that your breathing does not stop. The device that you will be given does just that. The CPAP machine will deliver slightly pressurized air at night when you wear it, keeping your airway open. It is recommended that you wear your CPAP every night while you sleep.

People who do not regularly wear their CPAP continue to experience excessive sleepiness and fatigue during the day, and often continue to perform worse at school and work. They also say that their concentration and memory gets worse. People also say that they become more anxious and depressed as time goes on. In addition, their partner or roommate's sleep also suffers if they do not regularly wear their CPAP because they continue to snore. People who do not regularly wear their CPAP are putting themselves at higher risk of hypertension, Type II diabetes, and stroke.

APPENDIX G

General Instructions

You are now ready to begin the experimental phases of this study. You are sitting in a sound-proof booth, so I will be talking to you through an intercom to your left.

It is very important that you remain still and relaxed during these sessions. Please do not grind your teeth or clinch your jaw. Please do not move your face more than usual, and try not to touch your face. If you feel one of the electrodes falling off of your face or ears, I'll be able to tell on the software and will come in after the task session is finished to fix it. Please do not try to fix it yourself.

Please pay attention to the pictures on the screen and remain alert at all times. At the end of the experiment, you will complete a brief quiz about what you saw during the study. You should do very well on it if you pay close attention.

Eyes Open, Eyes Closed (Baseline Recording)

For the next 8 minutes, I will be asking you to open and close your eyes over the intercom.

When I ask you to open your eyes, please keep your eyes open normally and keep your gaze forward toward the computer monitor. You may blink normally.

When I ask you to close your eyes, simply close your eyes naturally without squinting or moving many of your facial muscles.

Positive Target

For the next several minutes, you will see many different pictures on the computer screen. Many of them will make you feel negative emotions, while some of them will make you feel positive emotions.

Please count silently to yourself the number of positive pictures you see on the screen. Please pay attention to each picture, and be ready to report the number of positive pictures you see to me at the end of the task.

Negative Target

For the next several minutes, you will see many different pictures on the computer screen. Many of them will make you feel positive emotions, while some of them will make you feel negative emotions.

Please count silently to yourself the number of negative pictures you see on the screen. Please pay attention to each picture, and be ready to report the number of negative pictures you see to me at the end of the task.

APPENDIX H

Post-Diagnosis Session Follow-Up Script

Hi, my name is _____ and I'm calling from the Vidant Sleep Center Research Team.

This is the follow-up call from the study you participated in before your polysomnogram. Do you have about 5 minutes to answer a few questions?

My records indicate that you had a recent appointment for sleep apnea with Dr. _____. Please tell me a little bit about what happened during the appointment. (Confirm sleep apnea diagnosis)

_____

_____

_____

Thank you for this information! I have a few more questions for you.

Did your physician explain the *benefits* of following treatment recommendations regularly?

If so, please list them.

_____

_____

_____

Did your physician explain the *consequences* of **not** following treatment recommendations regularly?

If so, please list them.

_____

_____

_____

Which would you say your doctor spent the most time highlighting: **consequences or benefits**?

How did you feel after your physician gave you this information?

_____

_____

Please tell me on a scale from 0-100% how likely you are to adhere to treatment:

0------- 10------20------30------40------50------60------70------80------90------100

Not at all likely Absolutely certain

APPENDIX I

EAST CAROLINA UNIVERSITY
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600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Katie Lehockey
CC: Daniel Everhart
Date: 2/19/2013
Re: UMCIRB 12-002254
Responses to Health Information

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 2/19/2013 to 2/18/2014. The research study is eligible for review under expedited category #7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

The approval includes the following items:

Name	Description
Appetitive Motivation Scale | History	Surveys and Questionnaires
BIS/BAS Scales | History	Surveys and Questionnaires
Brief COPE | History	Surveys and Questionnaires
Demographic Questions | History	Surveys and Questionnaires
Experimentrak Recruitment Script.docx | History	Recruitment Documents/Scripts
Informed Consent Responses to Health Information.doc | History	Consent Forms
Lehockey Dissertation IRB.docx | History	Study Protocol or Grant Application
SAM- Self-Assessment Manikin | History	Surveys and Questionnaires
SPQ | History	Surveys and Questionnaires

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

APPENDIX J

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Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Katie Lehockey
CC: Daniel Everhart
Date: 3/18/2013
Re: UMCIRB 13-000433
Psychophysiological Responses to Health Information

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 3/17/2013 to 3/16/2014. The research study is eligible for review under expedited categories #4 and #7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

The approval includes the following items:

Name	Description
Appetitive Motivation Scale.doc | History	Surveys and Questionnaires
BISBAS.docx | History	Surveys and Questionnaires
Brief COPE.docx | History	Surveys and Questionnaires
Demographic Information Lab.docx | History	Surveys and Questionnaires
Experimentrak Recruitment Script EEG.docx | History	Recruitment Documents/Scripts
Informed Consent Template-No More Than Minimal Risk Psychophysiological Responses to Health Information.doc | History	Consent Forms
Lateral Preference Inventory.docx | History	Surveys and Questionnaires
Lehockey Dissertation IRB.docx | History	Study Protocol or Grant Application
SAM- Self Assessment Manikin.docx | History	Surveys and Questionnaires
SPQ.doc | History	Surveys and Questionnaires
Summer Recruitment Script.doc | History	Recruitment Documents/Scripts

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

APPENDIX K

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Notification of Initial Approval: Expedited

From: Biomedical IRB
To: Daniel Everhart
CC: Lisa Hardin
Date: 4/9/2012
Re: UMCIRB 11-001493
Coping with treatment.

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 4/9/2012 to 4/8/2013. The research study is eligible for review under expedited category #5 and 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

The approval includes the following items:

Name	Description
Appetitive Motivation Scale | History	Surveys and Questionnaires
Application for Alteration of Authorization for Recruiting | History	Recruitment Documents/Scripts
Approval Signatures from Doctors | History	Additional Items
BISBAS | History	Surveys and Questionnaires
Consent | History	Consent Forms
Mini-IPIP | History	Surveys and Questionnaires
PANAS | History	Surveys and Questionnaires
Protocol | History	Study Protocol or Grant Application
SF-12 Questionnaire | History	Surveys and Questionnaires
Sleep Measure Survey | History	Surveys and Questionnaires
SPQ | History	Surveys and Questionnaires

The Chairperson (or designee) does not have a potential for conflict of interest on this study.