THE ASSOCIATION BETWEEN EXECUTIVE FUNCTIONING AND SELF-REGULATION STRATEGIES IN RELATION TO THE PROTECTIVE HEALTH BEHAVIORS OF PHYSICAL ACTIVITY AND HEALTHY EATING.

by

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Dedication

بسم الله الرحمن الرحيم

This project is dedicated to my parents. God willing, they have finally seen the fruits of their tireless upbringing of me and my brothers. My education is a result of your support and encouragement. May God bless you both and protect you always, Ameen.

أسأل الله أن يجعل هذا العمل خالص لوجه

قَالَ عَلِيُّ بْنُ أَبِي طَالِبٍ - رَضِيَ اللهُ عَنْهُ - لِرَجُلٍ مِنْ أَصْحَابِهِ:
"يَا كُمَيْلُ العِلْمُ خَيْرٌ مِنَ المَالِ ، العِلْمُ يَحْرُسُكَ وَأَنْتَ تَحْرُسُ المَالَ ،
والعِلْمُ حَاكِمٌ والمَالُ مَحْكُومٌ عَلَيْهِ ، والمَالُ تُنْقِصُهُ النَّفَقَةُ والعِلْمُ يَزْكُوا بِالإِنْفَاقِ"
إحياء علوم الدين للغزالي (١/١٧، ١٨)

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Abstract

THE ASSOCIATION BETWEEN EXECUTIVE FUNCTIONING AND SELF-REGULATION STRATEGIES IN RELATION TO THE PROTECTIVE HEALTH BEHAVIORS OF PHYSICAL ACTIVITY AND HEALTHY EATING.

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The University of Texas at Arlington, 2013

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Protective health behavior influences health outcomes. Physical activity (PA) and healthy eating (HE) are two important protective health behaviors that ward off many chronic diseases later in life. Nevertheless, these behaviors are seldom practiced. Executive functioning (EF) has been used as another predictor of health behavior. However, there is an inconsistency in using EF, especially with similar measures that assess self-regulation (SR). In this paper, it will be argued that EF and SR share many similarities with subtle differences. The primary question of this study was to consequently answer whether EF has predictive validity to physical activity and healthy eating. EF performance was assessed using both an objective and a subjective measure. Additionally, a questionnaire was created by the researcher to assess specific SR behaviors for both PA and HE. It was hypothesized that the four facets of EF used in this study (initiation, working memory, inhibition, and flexible switching) would predict both PA and HE. A cross-sectional design was used to assess participants' (n = 162) EF in relation to their PA and HE. All four facets of EF failed to predict both health behaviors except for the self-report sub-scale of Shifting. However, this effect was very small with little practical relevance. In addition, it was hypothesized that specific EF facets and SR strategies will share a significant statistical association; however, all proposed relationships were non-significant. On the other hand, posthoc analyses between the Behavioral Dyscontrol Scale (BDS) and health behavior yielded statistically significant correlations.

Moreover, the SR questionnaires showed moderate correlation between the majority of the sub-scales. The main implication from this study was to caution researchers to use proper measures of EF, otherwise, much of the current research utilizing EF measures may be inaccurate with inflated results. Additionally, the context-specific SR strategies were found to share no association with EF abilities. However, further research is needed to determine how EF and SR function together to produce health behaviour.

Keywords: Executive Functioning (EF), Self-Regulation (SR), Physical Activity (PA), Healthy Eating (HE), Performance based measure of initiation (Initiation-P), Performance based measure of working memory (WM-P), Performance based measure of shifting (Shifting-P), Performance based measure of inhibition (Inhibition-P), Self-report based measure of initiation (Initiation-S), Self-report based measure of working memory (WM-S), Self-report based measure of shifting (Shifting-S), Self-report based measure of inhibition (Inhibition-S), self-report of self-regulation physical activity strategies (SR-PA), and self-report of self-regulation healthy eating strategies (SR-HE).

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Chapter 1

Introduction to Background and Significance

Many factors play a role in causing disease, such as genetic predisposition, toxic agents, bacteria, and viruses. Most importantly, an additional factor that can cause disease is behavior. Leading a habitual sedentary lifestyle and frequently eating unhealthy foods, for example, are associated with cardiovascular disease and diabetes (Schneiderman, 2004). In fact, harmful, life-threatening conditions such as cancer caused from smoking, and unsafe sexual practices that could lead to sexually transmitted diseases are caused by behavior (Schneiderman, Antoni, Saab, & Ironson, 2001). There are many behaviors that can further improve health as well as ward off chronic conditions in the future. Above all, two of the most important behaviors associated with health outcomes are physical activity and healthy eating (Brannon & Feist, 2010).

1.1 Protective Health Behaviors

According to Mokdad, Marks, Stroup, and Gerbending (2004) about half (48%) of deaths in the U.S. are due to preventable life-style conditions. Physical inactivity and poor diet together contributed to 16.5% (400,000) of deaths in 2000 in the United States. Yet, performing these behaviors still remains a problem for many. The Centers for Disease Control and Prevention (CDC, 2011) stated that the national average of Americans who met the recommended physical activity on a weekly basis was roughly 49%. Thirty-eight percent had insufficient physical activity, with the remaining 13% being physical inactive. Furthermore, less than 1 in 10 Americans met their United States Department of Agriculture's (USDA) MyPyramid dietary guidelines (Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009).

Physical activity (PA) has been defined as "any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level" (US Department of Health and Human Services, 2008, p.2). PA consists of aerobic PA, muscle strengthening PA, and bone strengthening PA. Research suggests that aerobic PA, compared to muscle strengthening PA, has shown greater effects on reducing cardiovascular disease and diabetes. PA has three parameters that affect the overall quality of health. These parameters are intensity, frequency, and duration. Based on these parameters, only two types of aerobic PA have been shown to be effective. The first type is moderate-intensity activities "that cause small increases in breathing or heart rate" (CDC, 2011, U.S. "Physical

Activity Statistics", para. 1). For maximum benefit, moderate-intensity activities should be practiced for "at least 30 minutes per day, at least 5 days per week" (CDC, 2011, U.S. "Physical Activity Statistics", para. 2). Examples of moderate-intensity activities include brisk walking, vacuuming, and gardening (CDC, 2011). The second type of aerobic PA is vigorous-intensity activities "that cause large increases in breathing or heart rate" which should be practiced for "at least 20 minutes per day, at least 3 days per week" (CDC, 2011, U.S. "Physical Activity Statistics", para. 1). Running, aerobics, and heavy yard work are examples of vigorous-intensity activities (CDC, 2011).

Although there is not a strong consensus on what constitutes healthy eating, it is suggested that dietary behavior in accordance with the United States Department of Agriculture "MyPlate", "MyPyramid" or "Food Pyramid" dietary guidelines closely resembles healthy eating (United States Department of Agriculture, 2013). Fruits and vegetables, in adequate amounts, are said to provide protection against obesity, diabetes, cardiovascular disease, cancer, and strokes (Van Duyn & Pivonka, 2000). The main mechanism fruits and vegetables provide health protection is through antioxidants.

Numerous models[1] are used to understand health behavior. They generally follow the theoretical schematic diagram in Figure 1. It is important to note that in the theoretical diagram, the determinant variables and the control variables (i.e., moderators) can be exchanged with one another depending on the theory and the conceptual framework. Several of the variables listed in Figure 1 have been traditionally used in correlational studies which, at best, only establish an association without proving causal mechanisms to explain the relationship (Gottfredson & Deary, 2004; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). Although this is the main weakness of correlational studies, establishing empirical evidence (albeit correlational) of proposed explanatory mechanisms can be a starting point and can lead to further improvement in understanding the determinants of health behavior. For example, research concerning individual differences in brain functioning has shown some promising associations between neuropsychological skills and health outcomes (Williams & Thayer, 2009). Specifically, the

[1] Subjective Expected Utility Theory (Edwards, 1954), Health Belief Model (Becker, 1974), Protection Motivation Theory (Rogers, 1975), Theory of Interpersonal Behaviour (Triandis, 1977), Theory of Reasoned Action (Ajzen & Fishbein, 1980), Common Sense Model (Leventhal, Meyer, & Nerenz, 1980), Transtheoretical Model (Prochaska & DiClemente, 1982), Self-Determination Theory (Deci & Ryan, 1985), Theory of Planned Behaviour (Ajzen, 1985), Health Action Process Model (Schwarzer, 1992), Self-Regulation Theory (Leventhal, Leventhal, & Contrada, 1998), Social Cognitive Theory (Bandura, 1998), and Temporal Self-Regulation Theory (Hall & Fong, 2007).

neuropsychological concept of executive functioning (EF) and self-regulation (SR) is being used to further explore the nuances of associations with, and causes of, protective health behavior.

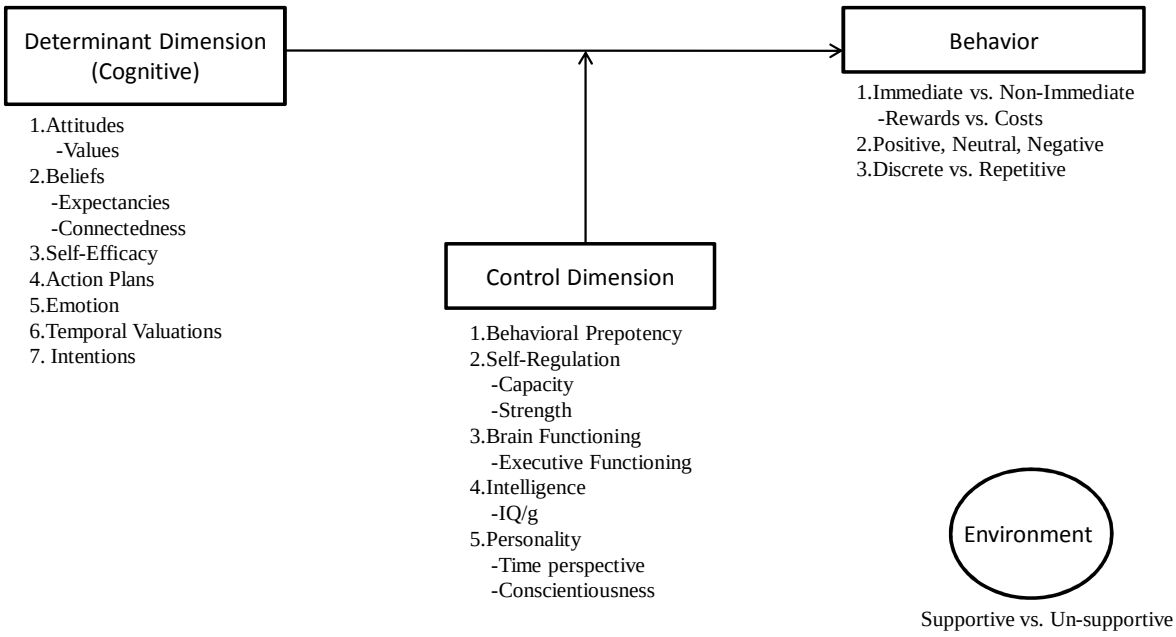

Figure 1. Determinants and Moderators of Health Behavior.
Information borrowed and modified from Hall and Fong (2007).

1.2 Executive Functioning

Executive functioning (EF) can be a difficult construct to define and measure (Etnier & Chang, 2009). The best way to understand EF is to explain its function. Rabbit (1997) states that "executive control is necessary to deal with novel tasks that require us to formulate a goal, to plan, to compare these plans in respect of their relative probabilities of success and their relative efficiency in attaining the chosen goal, to initiate the plan selected and to carry it through, amending it as necessary, until it is successful or until impending failure is recognized" (Rabbitt, 1997, p.3).

Based on this conceptualization, several functions of EF are listed (Rabbitt, 1997):

(1) EF deals with novel tasks, which require formation of goals, their execution, and maintenance of the goals.
(2) EF deals with deploying memory search plans, and not merely recollection of information.
(3) EF deals with initiating new sequences of behavior, inhibiting ongoing behavior, and switching between the two.
(4) EF deals with preventing contextually inappropriate responses to the task.
(5) EF deals with monitoring behavioral performance in order to correct errors. Additionally, based on concurrent evaluation of behavior and goals, EF helps in altering plans based on the task at hand.
(6) EF deals with sustaining attention continuously over long periods of time.
(7) EF deals with making a person consciously aware of their behavior.

By using Suchy's (2009) topology, executive functioning can be conceptualized as a multi-skill concept that encompasses "(1) forming, (2) maintaining, and (3) shifting mental sets, corresponding to the abilities to (1) reason and generate goals and plans, (2) maintain focus and motivation to follow through with goals and plans, and (3) flexibly alter goals and plans in response to changing contingencies" (p.106). EF is considered an evolutionary adaptation to cultural and social competition (Barkley, 2001). As such, it is considered one of the higher order cognitive abilities that are unique to humans (Suchy, 2009). It appears that the concept of self-awareness is closely tied to EF. That is, being cognizant of the abstract mental representations of the alternative choices that EF switches to, from, and between, aids in giving

humans self-awareness (Stuss, 1992). Several processes exist that contribute to overall EF, such as working memory, initiation, inhibition, attentional shifting, and conflict resolution (Suchy, 2009). Together, these neurocognitive processes contribute to the initiation and maintenance of goals, and if needed, to the changing and altering of goals in response to situational changes (see Figure 2 for more details).

EF can be measured through objective behavioral performance on experimental tasks, relatively objective observation of behavior, subjective self-reported and informant-reported behavior that correspond to EF skills, as well as clinical tests. Many models of EF have been proposed such as those by Baddeley and Hitch (1974), Norman and Shallice (1986), Stuss (1992), Fuster (1993), and Zelazo, Carter, Reznick, and Frye (1997). However, EF methodology is still in its infancy, and as a result, no single framework provides the best integration of research findings thus far.

The predictive validity of using EF is encouraging. For example, after controlling for demographics, education, and overall IQ, EF predicted health behavior over and above these control variables (Hall, Elias, & Crossley, 2006). Moreover, after adjusting for age, sex, education, and body mass index (BMI), it was found that the relationship of EF predicting survival time was still maintained (Hall, Crossley, & D'Acry, 2010). An added advantage of measuring this construct is that by knowing the levels of EF, individualized intervention strategies can be selected to maximize medical adherence, initiate protective health behaviors, and maintain health goals over a longer period of time (Williams & Thayer, 2009).

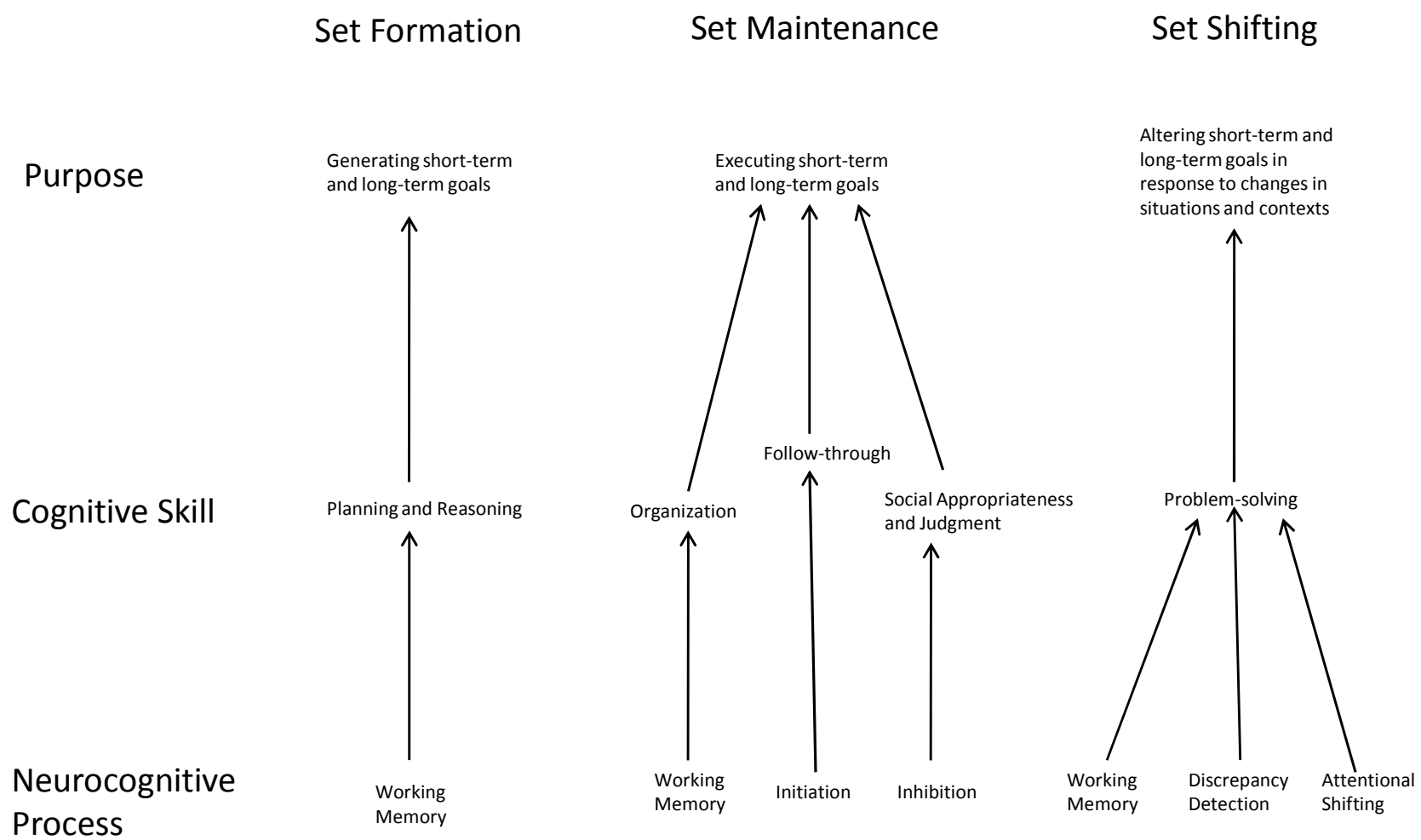

Figure 2. Diagram of Executive Functioning.
Information borrowed and abridged from Suchy (2009).

1.3 Self-Regulation

The neuropsychological concept of EF is closely related to the psychological construct of self-regulation (SR) (Williams & Thayer, 2009). Self-regulation, in general, is the "propensity of a person to invest cognitive, emotional, and behavioral resources to achieve a desired goal or outcome" (Hagger, 2009, p. 208). In essence, it is the ability of an organism to use and modify resources in order to attain goals (Mora & Ozakinci, 2012). These resources can be cognitive heuristics, behaviors, or even other strategies which individuals use in order to achieve their goals. On a side note, some theorists (Ajzen, 1985; Sansone & Smith, 2000) view SR as a function of cognitions (beliefs, attributions, preferences, expectations, attitudes, intentions, etc...) while other theorists (Karoly, 1993) state that SR skills are conceptually distinct from cognitions. For the purposes of this research, a comprehensive definition is needed to accommodate the various aspects of SR. Thus SR is defined as:

> "The control of one's own behavior through self-monitoring of the conditions that evoke desired and undesired behavior, structuring the personal environment to facilitate desired behavior and circumvent situations that tend to elicit undesired behavior, self-evaluation and self-administration of punishments and rewards, or some combination of these" (VandenBos, 2007, p.832).

According to Karoly (1993, p.25) SR involves five element phases: "(1) goal selection, (2) goal representation, (3) directional maintenance, (4) directional change or reprioritization, and (5) goal termination." When one first compares the definitions of EF and SR, it is noticeably the same concept except for one important difference. A quote from Karoly describes this distinction:

> "Regulation implies modulation of thought, affect, behavior, or attention via deliberate or *automated use* (emphasis added) of specific mechanisms and supportive metaskills" (Karoly, 1993, p.25).

That is, what differentiates EF from SR is the use of automated processes and skills. EF can only be deliberate, controlled, and conscious (Rabbitt, 1997). SR while using EF can also use automated and unconscious processes.

SR can be measured by experimental tasks or self-report/informant-report questionnaires (Brown, Miller, & Lawendowski, 1999; Tangney, Baumeister, & Boone, 2004). Experimental tasks consist of the same tasks measuring EF. However, the research field of self-regulation has been plagued by several

limitations. First, the psychological construct of self-regulation has been “difficult to define theoretically as well as to operationalize empirically” (Boekaerts, Pintrich, & Zeidner, 2000, p.4). Second, two terms are used interchangeably to indicate self-regulatory behavior, namely, self-regulation and self-control (Baumeister, Vohs, & Tice, 2007; Hofmann, Rauch, & Gawronski, 2007). This causes theoretical confusion in the field with debates about whether self-control is a subcategory of self-regulation, whether the two terms are synonymous, and discussions about which term is more general or which term is more specific. For our purposes, self-regulation is used as the general umbrella term while self-control is a more specific strategy of self-regulation.

Concerning health outcomes, initiation and maintenance of health behaviors, specifically physical activity and healthy eating, require self-regulation (Hall et al., 2006; Hofmann et al., 2007). For example, lack of self-regulation, or self-regulatory failure, has shown to be associated with low physical activity and poor dieting (Hagger, Chatzisarantis, & Biddle, 2002; Hagger, Chatzisarantis, & Harris, 2006) and therefore, by extension, can be implicated in cardiovascular disease and diabetes (Hagger, Wood, Stiff, & Chatzisarantis, 2009).

Interestingly, research in self-regulation has identified several factors that play a role in protective health behavior (Hagger et al., 2009), but a significant portion of the variance in explaining health behavior still remains unexplained (Sutton, 1998). Research has already shown that EF moderates the association between intention and health protective behavior of exercising and dietary choice (Hall, Fong, Epp, & Elias, 2008). Therefore, by looking at EF, further research can elucidate the mechanisms of initiating and maintaining protective health behavior.

1.4 Conceptual Framework

The goal of this study is to provide a prediction model as a suitable first step in theory building and interventions (Sutton, 1998). Despite the overreliance on correlational data to infer causal relationships (Weinstein, 2007), correlations are usually the most convenient way to set priorities of a research area before using more intensive methodologies, such as experimental or quasi-experimental designs (Weinstein, 2007). The goal of this study is purely to test new variables to improve prediction of health behavior. However, *a priori* theoretical thinking must first be used in order to justify the usage of such variables in a prediction model. Therefore, we emphatically state that the goal of this study is *not* to

infer causal relationships but rather to pave the first step in theory building by determining significant predictions of health behavior.

Many protective health behaviors require long term commitment with initial high costs that will yield a benefit only after many years (Hall et al., 2006; Hall & Fong, 2007). Therefore, it is important to provide empirical justification to identify what might be the primary causal mechanism involved in initiating and maintaining protective health behavior. For example, in relation to physical activity, behavioral habits such as living an inactive lifestyle must be inhibited, and health protective behavior, such as exercise, must be initiated and maintained indefinitely. Having the ability to initiate and maintain health goals requires a high level of EF. Indeed, complications in EF have been associated with heart disease, diabetes, and sexually transmitted diseases (Grodstein, Chen, & Wilson, 2001; Stern et al., 1995; Waldstein et al., 1996).

In relation to EF, a large degree of SR is required to modify behavior in order to achieve a specified goal. SR, in turn, requires strong executive functioning in order to meet the cognitive and behavioral demands of remembering, initiating, achieving, and finally maintaining the specified goal (Banfield, Wyland, Macrae, Munte, & Heatherton, 2004). Therefore, EF and SR are strongly correlated. However, there is a subtle difference. For example, Barkley (2001) argues that inhibition forms the foundation for SR. However, the foundation that forms EF is the ability to consider both the immediate and delayed consequences of behavior. Interestingly, some researchers argue that both EF and SR are dependent on a common resource that is finite (i.e., attention; see Banfield et al., 2004; Kaplan & Berman, 2010). Because directed attention can be depleted quickly, these authors suggest possible interventions to increase the rate of recovery of this depleted resource by sleeping, meditating, laughing, or even utilizing implementation intentions (Kaplan & Berman, 2010).

Between EF and SR, either one can be used as the outcome, the predictor, the moderator, or the mediator (Hofmann, Schmeichel, & Baddeley, 2012), or from another point of view, either one can be the mechanism or process involved with health behavior. A mechanism is the actual agency that produces a given effect while a process is a series of actions/events to lead to an end. It will be argued that EF is the main mechanism of health behavior.

The differences and similarities between EF and SR yield several interesting relationships. For example, while EF tends to be biological in nature, SR is considered psychological (emphasizing behavioral strategies). Both variables are processes involved with health behavior; however, EF is the actual mechanism involved in activating health behavior. EF is comprised of the overall neurocognitive brain mechanisms that function to generate, execute, or change goals. On the other hand, SR centers attention on the dynamic behavioral processes in the attainment and/or maintenance of goals (Mora & Ozakinci, 2012). Hence, the commonality between EF and SR is goal pursuit while the differences are about mechanisms and processes (see Table 1 for a summary). Although SR is defined as a process, it is not considered the initial mechanism for causing protective health behavior. As stated by Bunge (1996), every mechanism is a process but not every process is a mechanism. It logically follows to use EF as the causal agent, that is, the mechanism that directs individuals to use processes to think and act. Several lines of evidence support this claim. It is widely accepted that neural function always precedes purposeful musculoskeletal activity (i.e., observable behavior). For example, Libet, Gleason, Wright and Pearl (1983) instructed participants to randomly lift their wrist at their own choosing. What Libet and colleagues (1983) found was that preparatory brain activity recorded via EEG, called the “readiness potential”, was initiated milliseconds before any muscle activity was recorded using EMG. Additionally, the readiness potential was observed before a participant self-reported that they had the intention to move. Moreover, various researchers typically record event related potentials using EEG before and after motor responses (Phan & Tucker, 2003). Others looked at brain imaging data and used a novel-pattern classification algorithm to predict behavior up to 8 seconds before an intention or action is made (Soon, Brass, Heinze, & Haynes, 2008). However, a word of caution must be noted. Neural activity may represent random cognitions, sensory stimulation, or other irrelevant brain activity. Nevertheless, the commonality between most of this research is the dependent variable, namely, motor behavior, and the EEG measurement of the motor cortex and frontal areas. It is known that executive functions recruit various brain areas necessary for cognitive operations and motor behavior (Phan & Tucker, 2003), which explains the EEG measurement of these areas. Additionally, initiation of motor output is one facet of EF (Suchy & Kraybill, 2007), which follows that the research discussed previously would fall within the domain of EF.

Table 1.Comparing EF and SR.

Executive Functioning	Self-Regulation
Mechanism	Process
Involved in generating, executing, or changing goals	Involved in attaining or maintaining goals
Deliberate	Both deliberate *and* automatic
Novel situations	Both novel *and* old situations
Small quantity of processes	Large quantity of strategies

1.5 Neuropsychological Mechanisms

According to Bunge (1996), "psychology can tell what and when, but only neuropsychology can find out where and how" (p. 418). This is due to the explanatory power of mechanisms. There are two types of causal mechanisms. The first or "Type I" involves energy transfer from one variable to another until an effect is observed (similar to a molecular cascade). The second or "Type II" involves a triggering signal that has a small cause but a large disproportionate effect, similar to a spark causing a keg full of gun-powder to explode. EF to behavior tends to follow an energy transfer mechanism. EF can explain the initiation and maintenance of protective health behavior through the following four mechanisms of initiation, working memory, flexible switching, and inhibition (see Figure 2).

1.5.1 Initiation. Initiation is the ability to independently generate ideas or to begin behavioral responses (Kahn & Dietzel, 2008) as well as follow-through with a decision and persevere (Suchy, Derbidge, & Cope, 2005). Brain areas associated with initiation include premotor area, motor cortex, and network circuits between the basal nuclei, thalamus and cerebellum (Brooks, 1995; Gerloff, Corwell, Chen, Hallett, & Cohen, 1998). Everyday problems associated with initiation include getting out of bed and starting a homework assignment. The clinical manifestation of not having initiation is apathy. This important elementary neurocognitive process is related to protective health behavior in that many behaviors require a significant amount of time and energy to be started. For example, after an individual decides to engage in physical activity, they must transport themselves to a suitable location for exercising

(i.e., the gym), initiate more than one type of workout and persevere with a workout for a specific length of time. Therefore, forming intentions to engage in protective health behavior and actually starting the behavior is an important causal mechanism of health behavior.

1.5.2 Working Memory. Working memory is a memory system that can hold limited amounts of information temporarily in order to evaluate and manipulate this information for decision making purposes (Baddeley, 2003; Knudsen, 2007). Brain areas associated with working memory include the anterior and posterior cerebral areas, specifically the frontal areas, orbitofrontal area, parietal lobe, and cerebellum (Collette et al., 2005). Forgetting a telephone number seconds after it was dictated is a common occurrence. However, significant deficits in working memory are associated with reduced memory storage and retrieval. Consequently, cognitive manipulation of information will be strongly affected. Working memory is important in the regulation of physical activity and healthy eating because an individual must constantly remind themselves of health goals in order to be aware of initiating protective health behavior. An individual must keep track of health appointments (e.g., gym schedule) and juggle between different priorities and daily errands by manipulating all this information for decision making purposes. Therefore, being constantly reminded of health goals is an important causal mechanism of health behavior (Hofmann et al., 2012).

1.5.3 Flexible Switching/Shifting. A closely related neurocognitive process to working memory is flexible switching. It is the ability to switch attentional resources from one stimulus to another as well as switching between cognitions and motor commands. For example, flexible switching is used when an individual must attend from reading a word to stating only the color of that word on a stroop color task. The parietal lobe and left middle and inferior frontal gyri are both associated with flexible switching (Collette et al., 2005). Common everyday problems associated with flexible switching include the inability to multi-task. This neurocognitive process is related to protective health behavior in that the individual must be able to switch from "abandoning sub-optimal means" to adopting alternative means to the goal (Hofmann et al., 2012).

1.5.4 Inhibition. Inhibition is the deliberate and intended ability to stop a motor command from being carried out into musculoskeletal activity and observable behavior. It is also commonly associated with thought suppression and not acting on impulse (Gioia, Guy, & Isquith, 2001). Brain areas associated

with inhibition include parietal areas, left middle frontal gyrus, and inferior frontal cortex bilaterally (Collette et al., 2005). Common daily occurrences with inhibition include anger outbursts or not being able to resist eating something pleasurable but unhealthy to the individual. Clinical manifestations include disinhibition, perseveration, poor impulse control, and social inappropriateness. Inhibition is important in protective health behavior because many unhealthy behavioral responses, whether prepotent or volitional, must be inhibited. Examples include inhibiting discomfort and even pain that may stop exercise, inhibiting urges to eat unhealthy snacks, and even inhibiting competing cognitions not to exercise. Therefore, by looking at the opposite situation, inhibiting anything that causes unhealthy behavior is an important mechanism of protective health behavior.

1.6 Psychological Processes

As previously stated, by studying SR, researchers can look at the dynamic behavioral *processes* involved in the attainment and/or maintenance of goals. The following SR strategies have been identified as having a theoretical relationship between EF and protective health behavior.

1.6.1 Goal Setting. Goal setting is the cognitive decision to select a result or reference point that an individual wants to attain (Karoly, 1993). According to Gollwitzer (1999, p.21), this usually follows the form "I intend to reach *x*". Individuals can focus on ongoing behaviors such as jogging every day for 20 minutes or individuals can focus on an overall endpoint result (e.g., to lose 20 lbs by New Year's Eve). Goal setting requires an educational component, in that individuals must be able to understand the goal in and of itself as well as how to achieve the goal.

1.6.2 Implementation Intentions. Implementation intentions follow goal setting by "specifying the when, where, and how responses leading to goal attainment" (Gollwitzer, 1999, p.21). According to Gollwitzer (1999, p.21), this follows the form "When situation *x* arises, I will perform response *y*".

Both goal setting and implementation intentions are theoretically linked to the neurocognitive process of initiation. Before an individual engages in the protective health behavior of exercising, they must first act, via initiation, to achieve the result of being fit and healthy. Furthermore, they must also engage in cognitive implementation intention, again via initiation, to actually link situational opportunities with protective health behavior.

1.6.3 Goal Reminders. Various objects can remind an individual of the goal itself. It is used as a strategy to aid or sometimes substitute working memory. For example, when an individual wakes up they will position specific objects in their environment that will remind them to go out for a run (e.g., placing running shoes near the front door). Utilizing alarms, agendas, check lists, as well as using people to remind them of their goals is also a common strategy. Interestingly, at first glance, goal reminders may seem to be the opposite of working memory. However, the only accomplishment of this strategy is to introduce a piece of information back into working memory. Hence, even if an individual is reminded to exercise without initially using working memory, that information must be taken into working memory for evaluation, manipulation, as well as decision making. Therefore, working memory is sometimes used to introduce goal reminders to the individual; although, sometimes people use other strategies to remind themselves of their goals. Even after they are reminded, nevertheless, working memory takes over again for further evaluation and decision making.

1.6.4 Self-Monitoring. Self-monitoring is the meta-cognitive skill and self-regulatory strategy of constantly observing and checking one's behavior against a set point and evaluating significant discrepancies (Karoly, 1993). Once a significant discrepancy is examined the individual must find a solution in order to maintain goal achievement (Carver, 1979; Carver & Scheier, 1998). It is commonly used when an individual is questioning whether they should skip on the workout and go instead to the movies or when an individual is questioning whether they should eat the extra calories in their dinner selection. A common problem associated with self-monitoring is the failure to observe behavior that is incompatible with protective health behavior.

Goal reminders and self-monitoring are both theoretically linked to the neurocognitive process of working memory and flexible switching. Working memory provides individuals with a temporary store of information to evaluate. Therefore, those who can hold this information longer and can manipulate this information more effectively are more likely to use these strategies. Working memory is important in the SR of physical activity and healthy eating because an individual can use various forms of prospective memory to remind themselves of health goals. Prospective memory is where an individual associates an important cue in the future with a behavior they should perform. This is essentially identical to the SR strategies of goal reminders and implementation intentions.

1.6.5 Self-Control. Self-control is the behavioral manifestation of inhibition and the two terms tend to be used synonymously. Self-control as defined by Hagger, Wood, Stiff, and Chatzisarantis (2010) as the "the effortful capacity of the individual to regulate his or her emotions, thoughts, impulses, or other well-learned or automatic behavioral responses" (p.496) via altering, modifying, changing, or overriding these responses (Baumeister & Heatherton, 1996). Many of the features of self-control are the same as inhibition. Therefore, the previous discussion concerning inhibition is sufficient for this section. For a full-review of various self-control measures please see the meta-analysis by Duckworth and Kern (2011), and by Hagger et al. (2010). Figure 3 provides a graphical representation of these relationships.

1.6.6 Automaticity. Automaticity is synonymous with classical conditioning, as well as prepotent responses. Classical conditioning is when behavior is modified to respond to cues that predict the occurrence of another cue (Pavlov, 1927). A prepotent response is a reflex motor command that responds to specific cues or internal drives that tends to be initiated automatically. Hall and Fong (2007) made a distinction between discreet and repetitive behavior, with prepotent responses being heavily influenced by repetitive behavior. Interestingly, a prepotent response can be either good or bad. An example would include an individual with a habit of eating anything on their plate, thus increasing intake of potential junk food. On the other hand, some individuals have prepotent responses to walk fast, thus improving their overall physical fitness.

1.6.7 Self-Consequating. Self-consequating is in essence the usage of operant conditioning in relation to regulating behavior to attain specific goals. Any reinforcement of behavior will increase the probability of that behavior occurring again. Conversely by punishing a behavior, the behavior is likely to become less frequent, or extinct. A common technique individuals use is to "treat themselves" if they perform a behavior that should be reinforced. However, this type of reinforcement can potentially be negative if individuals go run for 40 minutes then treat themselves to their favorite ice cream.

Both automaticity and self-consequating are not considered to be influenced by executive functioning due to the non-novelty of the stimulus as well as the non-deliberate performance from the individual (Rabbitt, 1997). One of the main requirements of a task that involves EF is its novelty. If a task is encountered more than once then non-EF systems take over. Also, only if an individual is consciously aware of the situation at hand and uses deliberate strategies to deal with a problem, then we can

confidently say EF was being used (Rabbitt, 1997). Therefore, these strategies are not influenced by prefrontal cortical areas but rather by sub-cortical systems (Heatherton & Wagner, 2011; Stuss, 1992). Refer to Figure 4 for further information.

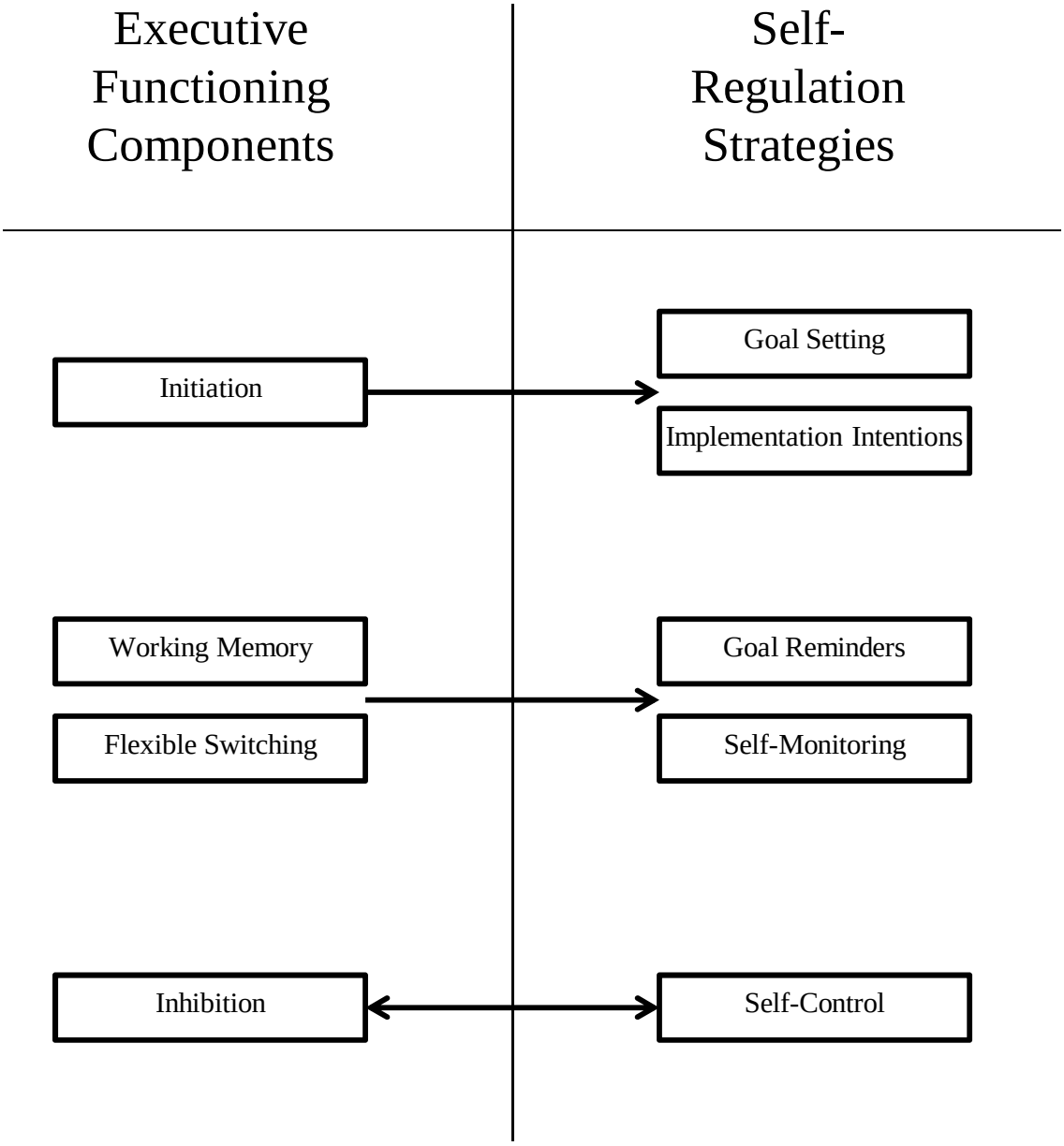

Figure 3. Theoretical Linkage of EF and SR Facets.

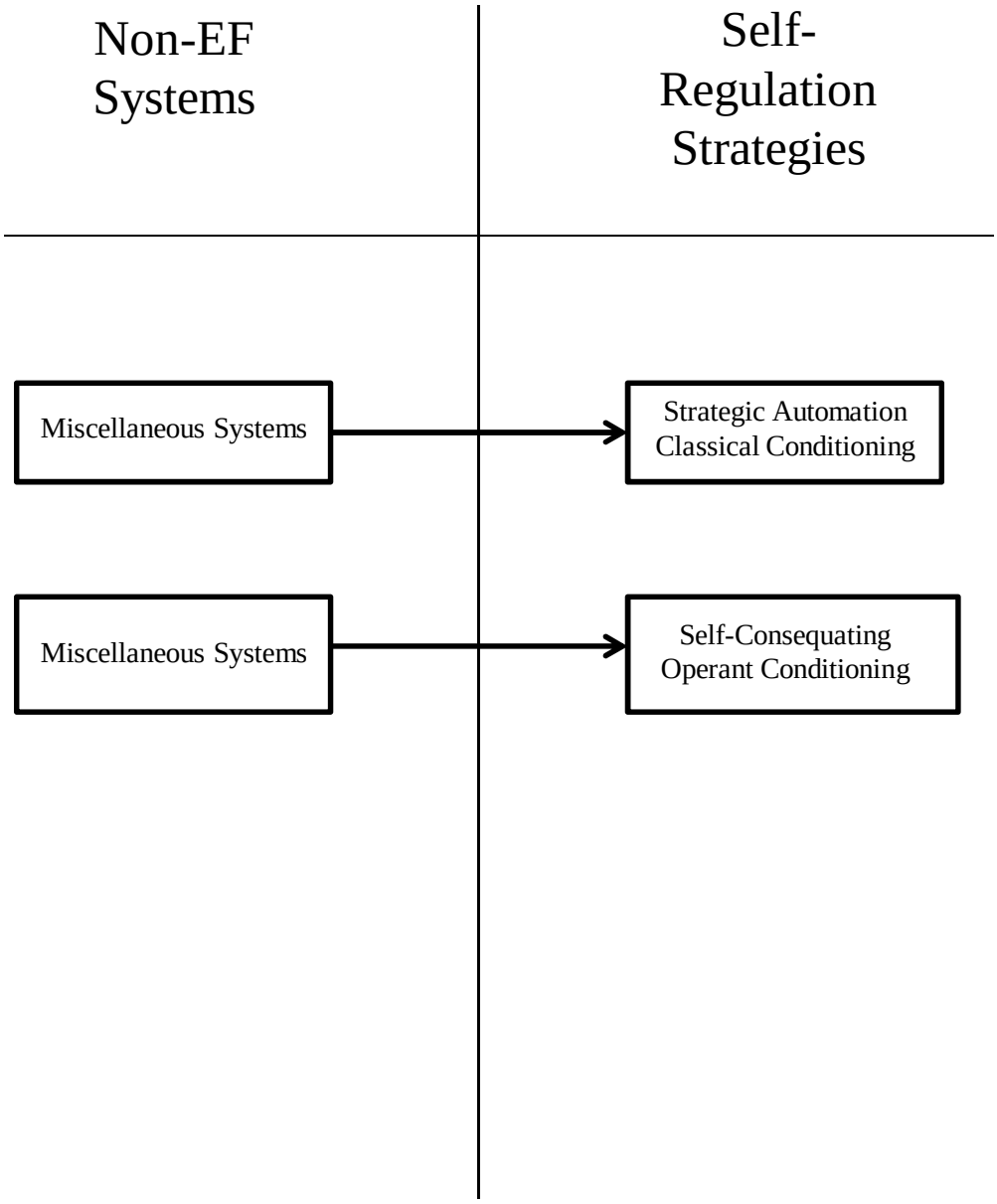

Figure 4. Non-EF SR Strategies.

1.7 Proposed Model of EF and SR

Although others have preliminarily discussed the possible link between EF and SR (Hofmann et al., 2012; Kaplan & Berman, 2010), there is still a dearth of literature concerning the nuanced relationships between the two constructs. Therefore, a model is proposed (see Figure 5) to clarify the relationship between the different facets of EF and SR with behavior. The boxed variables in red represent the different facets of EF while the blue boxes represent the various SR strategies. Finally, outcome behavior is represented in yellow color and the cue from the environment is in green. Please note that working memory is an indispensable component in almost every single step of this process because of its relationship with conscious awareness, and thus was not included with all the variables for simplicity's sake. To elaborate, without working memory an individual would not be aware (i.e., consciously evaluating information for decision making purposes) of the various options provided by EF to solve a problem at hand. If they are not aware of these various options, then they would not have a deliberate and intended performance, which is one of the main features of EF. Without working memory a person will just react via classical and operant conditioning. It is also important to note that initiation, inhibition, and flexible switching are not markers of working memory but are rather *statistically* distinct and separate processes of EF (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). The assumptions of this model are (1) a cue initiates most of these processes, (2) the relationships are not strictly one-way, (3) and most of these processes occur together in a multi-level arrangement.

The first EF to be discussed is inhibition. As stated previously, inhibition is simply the ability to control emotions, cognitions, as well as restraining motor output. Inhibition and the SR concept of self-control are essentially identical. Whenever a cue is present that will elicit an unhealthy response, inhibition is required to eliminate the associated response.

The second step in the diagram of Figure 5 explains the *initiation* of behavior by focusing on the interrelationships between EF facets, SR strategies, outcome behavior, and feedback loops. First, information is obtained in working memory from a cue in the environment. The EF facet of cognitive initiation will help an individual produce a selection of goals as well as implementation intentions based upon the individual’s preference. Once an implementation intention is selected and situations arise that

activate the intention, the motor aspect of initiation will become operational and presumably produce behavior that is in line with the goals selected.

Working memory uses the information about goals and implementation intentions to constantly maintain a conscious awareness of this information (Stuss, 1992). This causes the individual to become aware of the goals with reminders which leads back to the EF facet of initiation and then to outcome behavior. Goal reminders also have a direct effect on initiation.

Lastly, a feedback loop from the outcome behavior itself is directed towards the SR behavior of self-monitoring, which leads to working memory and flexible switching. This is where the individual takes the information in working memory and evaluates the behavior against specified criteria and evaluates discrepancies between the behavior and the goal. If a significant discrepancy is detected, then flexible switching takes over and initiates a different behavior in order to achieve the goal (Carver, 1979; Carver & Scheier, 1998).

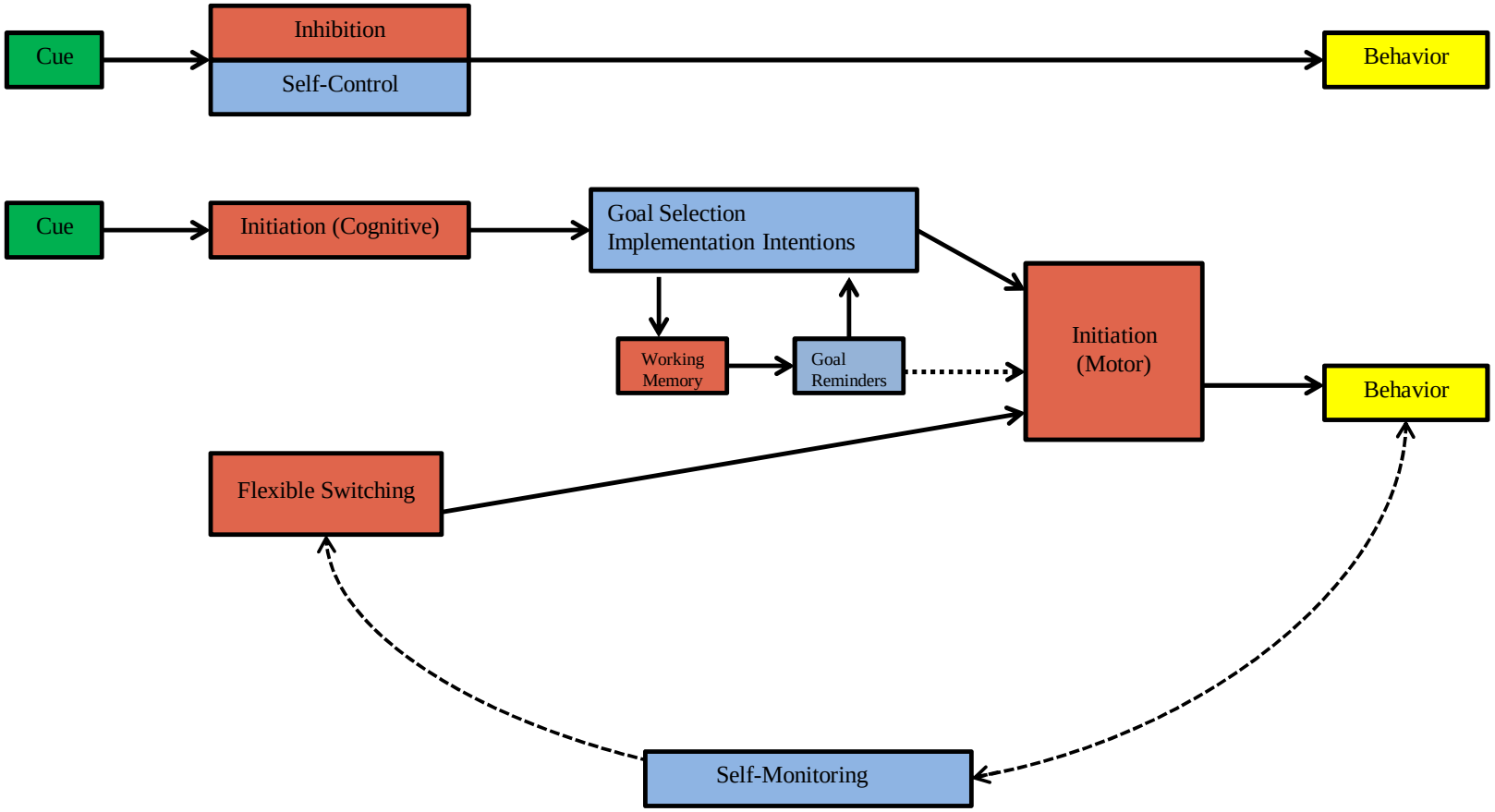

Figure 5. Proposed Model of EF and SR.

1.8 Proposed Context-Specific Models of PA and HE

A context-specific model for PA (see Figure 6) and HE (see Figure 7) in relation to EF and SR is proposed. This model is novel, but more importantly, this model is unique because of its inclusion of the context-specific variables that moderate the relationship between EF and health behavior.

Exercise behavior affects many physiological parameters. For example, exercise decreases BMI (Omondi, Othoun, & Mbagaya, 2012), inflammation (Pinto et al., 2012; Wilund, 2007), cholesterol (Durstine, Grandjean, Cox, & Thompson, 2002), as well as heart rate, which is inversely related to increase in heart rate variability (HRV; see Levy et al., 1998). Remarkably, exercise also has a positive feedback effect on executive functioning (Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Colcombe & Kramer, 2003) via increasing cerebral blood flow (Suzuki et al., 2004), increasing expression of neurotrophins such as brain-derived neurotrophic factor and nerve growth factor (Gold et al., 2003), increasing release of catecholamine neurotransmitters (dopamine, epinephrine, norepinephrine) (Winter et al., 2007), and increasing brain glucose levels up to a certain threshold, after which glucose uptake decreases and lactate concentration increases (Dalsgaard, 2006). Similarly, research with animals has shown that exercise reduces brain inflammation (Wu et al., 2011). Finally, exercise itself increases HRV (Levy et al., 1998); this change is positively associated with changes in performance on EF tasks (Thayer, Hansen, Saus-Rose, & Johnsen, 2009). Research has shown that inhibition benefits the most from exercise and that even a single bout of exercise is apparently sufficient to increase inhibition (Barenberg, Berse, & Dutke, 2011).

Alternatively, research has shown that EF and SR can be attenuated from certain variables and during specific situations. For example, factors that decrease EF include drugs (Crews & Boettiger, 2009), stressors (Arnsten & Goldman-Rakic, 1998), threats to self (Friese & Hofmann, 2008; Gailliot, Schmeichel, & Baumeister, 2006; Inzlicht, McKay, & Aronson, 2006; Richeson & Shelton, 2003; Steele & Aronson, 1995), and low socio-economic status (Sarsour et al., 2011). When the prefrontal cortex, which is mainly responsible for EF, is temporarily weakened during periods of stress or negative emotions, subcortical areas are thus disinhibited which gives these brain areas the chance to regulate behavior via automatic prepotent responses (Arnsten & Goldman-Rakic, 1998). These prepotent responses can sometimes be unhealthy habits, depending on the individual.

Unsurprisingly, the factors that increase and decrease SR tend to be the same that impact EF. For example, factors that decrease SR include cognitive load (Friese, Hofmann, & Wänke, 2008; Hofmann, Gschwendner, Castelli, & Schmitt, 2008; Ward & Mann, 2000), ego depletion (Hagger et al., 2010; Vohs & Heatherton, 2000), low socio-economic status (Sarsour et al., 2011), and threats to self (Friese & Hofmann, 2008; Gailliot et al., 2006; Inzlicht et al., 2006; Richeson & Shelton, 2003; Steele & Aronson, 1995). Related to the above explanation, self-regulation failure will occur if the balance between two competing brain areas (prefrontal vs. subcortical) is tipped in favor of the "immediate outcomes" emotional and reward centers (Heatherton & Wagner, 2011). SR failure can occur if either the subcortical areas are strengthened or if the prefrontal areas are weakened. On the other hand, several factors increase SR, including social support (Anderson, Wojcik, Winett, & Williams, 2006; Sims, Levy, Mwendwa, Callender, & Campbell, 2011), motivation (Baumeister & Vohs, 2007), and positive emotions (Tice, Baumeister, Shmueli, & Muraven, 2007).

Although much research has looked at physical activity, research concerning healthy eating is still in the beginning phases. Questions still remain concerning whether there is a positive feedback effect from eating healthy and how that affects EF. This is due to the fact that the research is limited to animal disease models investigating how to halt cognitive decline only. Nevertheless, researchers have proposed numerous mechanisms as to how specific diets can affect cognitive functioning. Along the same lines of research with physical activity, healthy eating can affect EF by providing precursor anti-inflammatory molecules (n-3 long-chain polyunsaturated fatty acids) throughout the body (Rogers, 2001). Specifically for the nervous system, antioxidant vitamins provided via diet (Vitamin C, E, and β-carotene) serve a protective function for neuronal cell membranes by preventing oxidative damage (Rogers, 2001). As a result, receptors, ion channels, and other proteins within the membrane are preserved (Yehuda, 2003). Additionally, consumption of carbohydrates provides precursor molecules (tryptophan) for neurotransmitters which increase uptake and turnover (Rogers, 2001). Moreover, fish oil, for example, provides precursor molecules (docosahexaenoic acid) that become active neuroprotective molecules that prevent neurotoxicity (Kim, 2007; Lukiw et al., 2005) and by providing precursor molecules that promote neurogenesis (Kawakita, Hashimoto, & Shido, 2006).

Many research techniques can be used to evaluate the theoretical models proposed. A cross-sectional study can be sufficient to establish the association between the different EF tasks and SR strategies. Additionally, intervention studies can establish the practicality of this proposed model. However, a recent meta-analysis indicated that it might be better to use informant-report or self-report measures of self-control instead of experimental tasks due to the low convergent validity among EF task measures with each other (Duckworth & Kern, 2011). This may be due to significant error variance both from random and task-specific sources (Duckworth & Kern, 2011).

The utility of this model will depend on how targeted interventions can affect health behavior. That is, researchers can utilize ways to increase EF and SR, while at the same time looking at means to block the effects of various variables that decrease EF and SR. By understanding all the important variables involved with this protective health behavior, various individualized interventions can be developed to initiate and maintain health behavior.

By following through with this model (all things being equal), it is inferred that habit formation will develop with exercise (Aarts & Dijksterhuis, 2000), which follows that EF will not be used anymore because sub-cortical systems would take over as well as the other SR strategies discussed in Figure 5. That is to say, initiation of exercise takes a significant amount of EF; however, after successful application of several trials, the individual will start using sub-cortical brain areas responsible for more automatic prepotent regulation of behavior. Yet, despite the fact EF will come most likely off-line during *maintenance* of exercise; exercise itself will still benefit EF due to the positive feedback mechanism. Therefore, EF is technically only needed for *initiation* of several successful trials of exercise, after which *maintenance* of exercise will depend on non-EF systems. It is important to note that the moderators of this relationship will affect the overall association between EF and protective health behavior (e.g., social support, motivation, positive emotions or cognitive load, ego depletion, threats to self). Thus, individuals may have high EF but may not engage in exercise behavior due to these moderators. On the other hand, individuals who have low EF may exercise regularly due to the influence from the moderator variables.

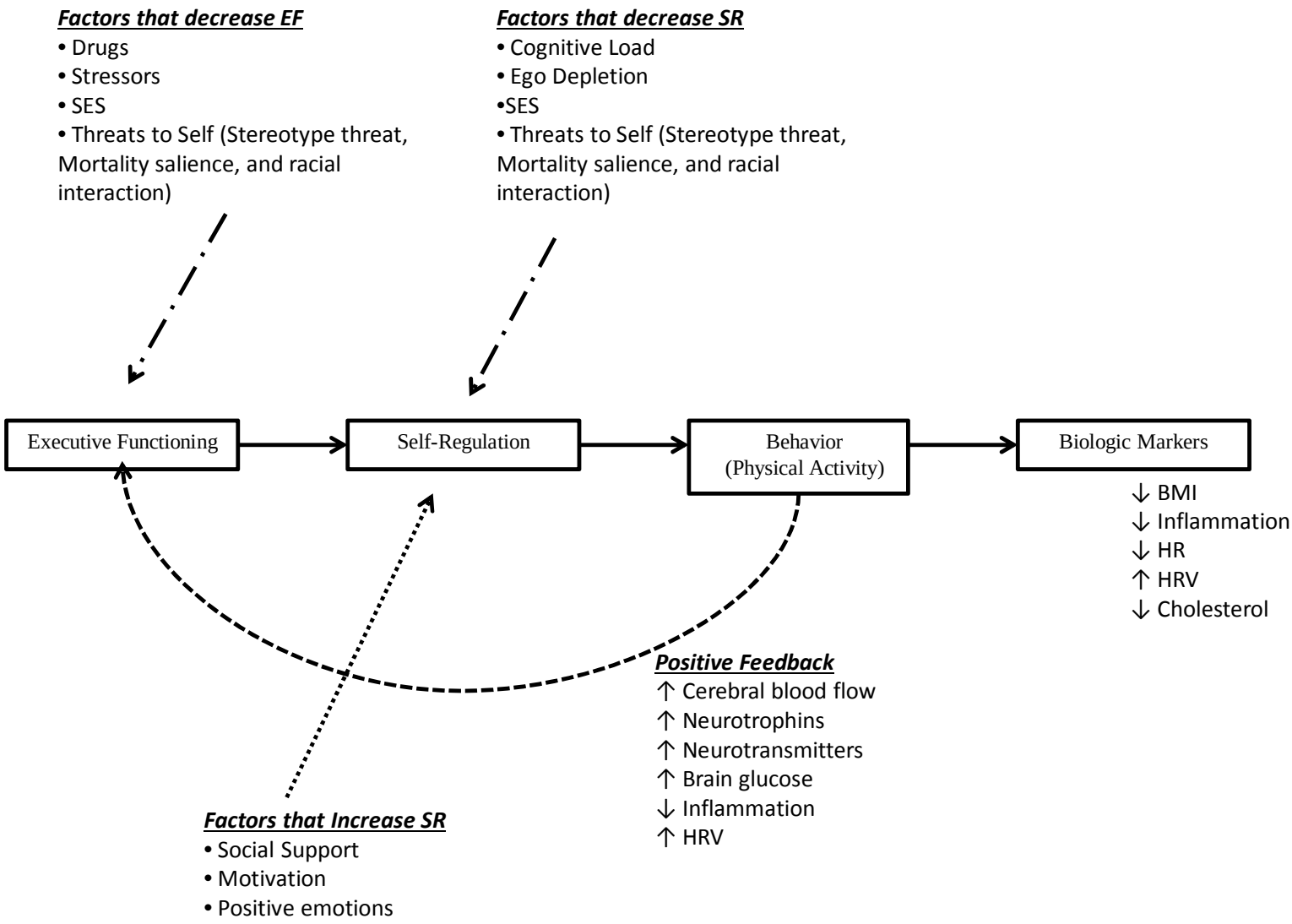

Figure 6. Proposed Model of Physical Activity.

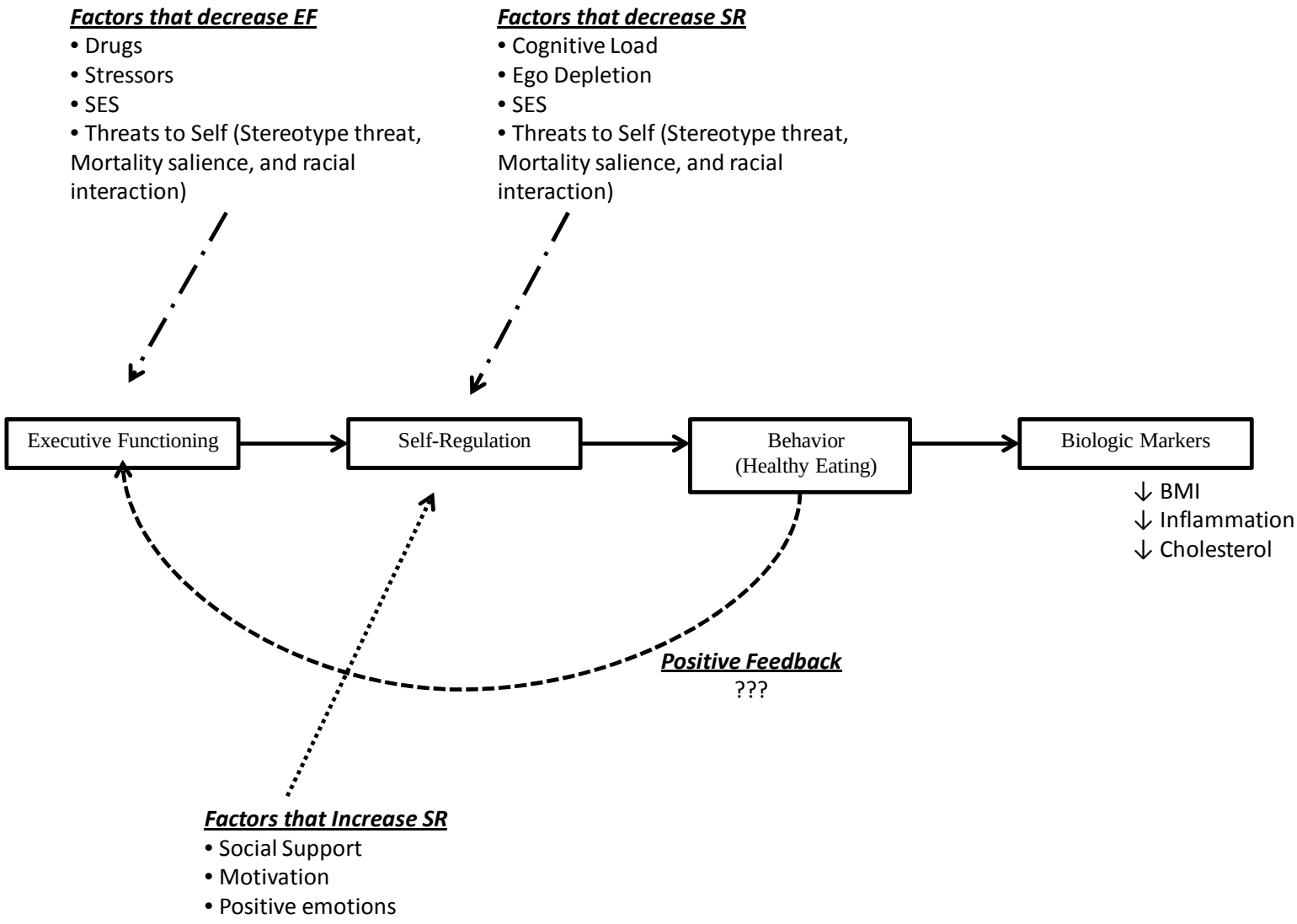

Figure 7. Proposed Model of Healthy Eating

1.9 Gaps in Existing Knowledge Base

A recent systematic review assessed the overall meta-relationship between EF and protective health behaviors. All subcategories of EF were used (e.g., working memory, inhibition, etc.), in addition to coding whether the EF categories were objective or subjective measures. The first finding from this research is that information about which specific facet of EF best predicts protective health behavior is inconsistent (Desouky, 2012). The second finding is that information about the comparison of objective vs. subjective measures of EF is available; however, the application of such information to health behavior is still limited (Desouky, 2012). Finally, it was concluded that empirical information about the relationship between EF and SR behaviors is non-existent (Desouky, 2012).

1.10 Purpose of Research

The purpose of this study is to elucidate the relationships between EF and health behaviors as well as between EF and SR. EF and SR will be tested in a correlational and regression analysis to test the theoretical relationships proposed.

1.11 Focus of Research

The central focus of this study is behavior. Therefore, the outcome variables will be the number of hours engaging in the behavior of exercising as well as behavioral consumption of healthy food items. Specific behaviors associated with SR will be examined. Finally, the EF variable will be studied from an objective point of view of performance behavior as well as self-reported information on the behavioral outputs of specific EF categories (e.g., working memory category of EF and self-reporting that “I forget a lot”).

1.12 Research Questions

As a result of the previously discussed study (Desouky, 2012), several questions have been proposed in order to further understand the relationships between EF and SR and EF and protective health behavior.

1. Which of the various four facets of EF predicts physical activity?
2. Which of the various four facets of EF predicts healthy eating?

3. Are self-reports of EF better to use or experimental tasks in relation to predicting protective health behaviors?
4. Are the various facets of EF related to the various strategies of SR?

1.13 Assumptions

First, EF facets and SR strategies are conceptually different and therefore are not considered to be the same constructs from a theoretical point of view. For example, goal reminders and working memory are conceptually different. However, some exceptions do exist. The EF facet of inhibition is the same as the SR behavior of self-control. Second, EF and SR interact in a multi-level arrangement to produce outcome behavior. Third, EF both causes and limits SR behaviors. Therefore, EF can be viewed as a moderator of SR strategies and health behavior. Additionally, SR strategies can be viewed as a mediator of EF and health behavior. Finally, by using a context-specific framework, different facets of EF will have differential effects on behavior.

1.14 Conceptual Definitions

A *function* is defined as “the use or purpose of something” (VandenBos, 2007, p. 392). EF has various functions to generate, execute, and change goals. *Self-Regulation* is defined as the ability of an organism to use and modify resources in order to attain goals (Mora & Ozakinci, 2012). SR consists of many strategies, a *strategy* is defined as “a program of action designed to achieve a goal or accomplish a task” (VandenBos, 2007, p. 897). For example, goal setting, goal reminders, and self-monitoring are all strategies. A strategy can be either cognitive or behavioral. While discussing EF and SR it was stated that each variable has a specific role either as a process or mechanism. A *process* is defined as “a sequence of events leading to some change or alteration in the state of a dynamic system” (Colman, 2001, p.586). For example, EF and SR are processes involved with health behavior. A *mechanism* is “a property by which something is accomplished, or an explanation that relies on such a device or property” (VandenBos, 2007, p. 561). As previously stated, every mechanism is a process, but not every process is a mechanism (Bunge, 1996). The focus of this study is to look at the overall behavioral output of the EF and SR variables. *Behavior* is defined as the observable activity usually assessing musculoskeletal changes. Behavior can be measured objectively from performance on tasks, relatively objective

observation of behavior, or subjective self-report and informant-report behavior. Both terms of “physical activity” and “exercise” will be used interchangeably throughout this paper.

1.15 Hypotheses

1.15.1 Hypotheses for Executive Functioning and Protective Health Behavior. The following hypotheses provide a new way of understanding how certain experimental tasks are related to protective health behavior. Current literature either shows no effect overall on physical activity or a selective effect only on healthy eating (Desouky, 2012).

The following hypotheses were proposed for the experimental tasks concerning physical activity (see Figure 8):

1. The experimental task of *Initiation* will predict physical activity.
2. The experimental task of *Working Memory* will predict physical activity.
3. The experimental task of *Flexible Switching* will predict physical activity.
4. The experimental task of *Inhibition* will predict physical activity.

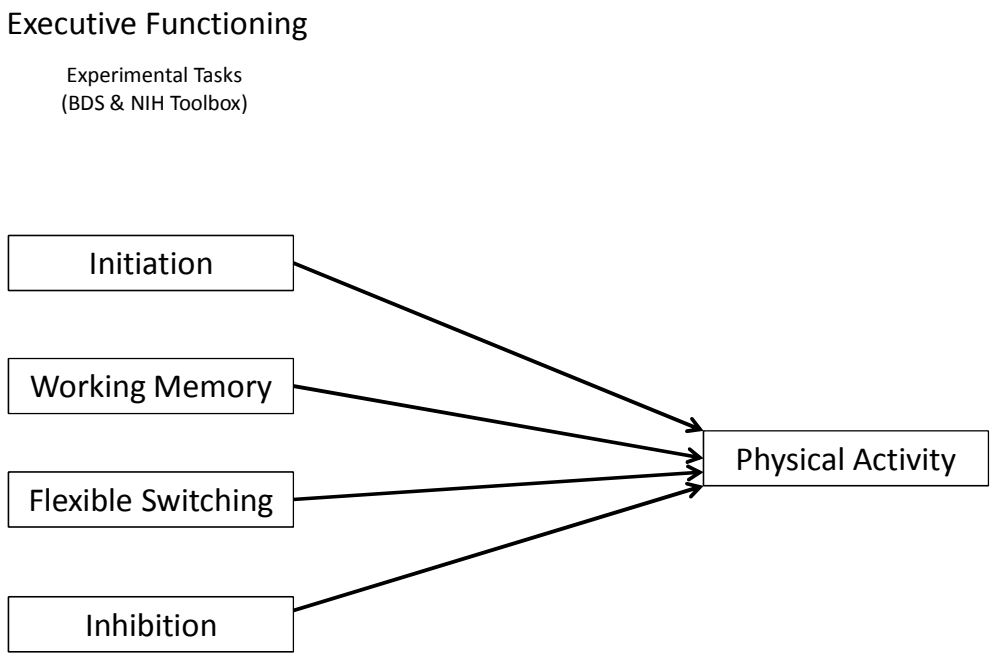

Figure 8. Hypotheses 1-4 of Performance EF and Physical Activity.

The following hypotheses were proposed for the experimental tasks concerning healthy eating (see Figure 9):

5. The experimental task of *Initiation* will predict healthy eating.
6. The experimental task of *Working Memory* will predict healthy eating.
7. The experimental task of *Flexible Switching* will predict healthy eating.
8. The experimental task of *Inhibition* will predict healthy eating.

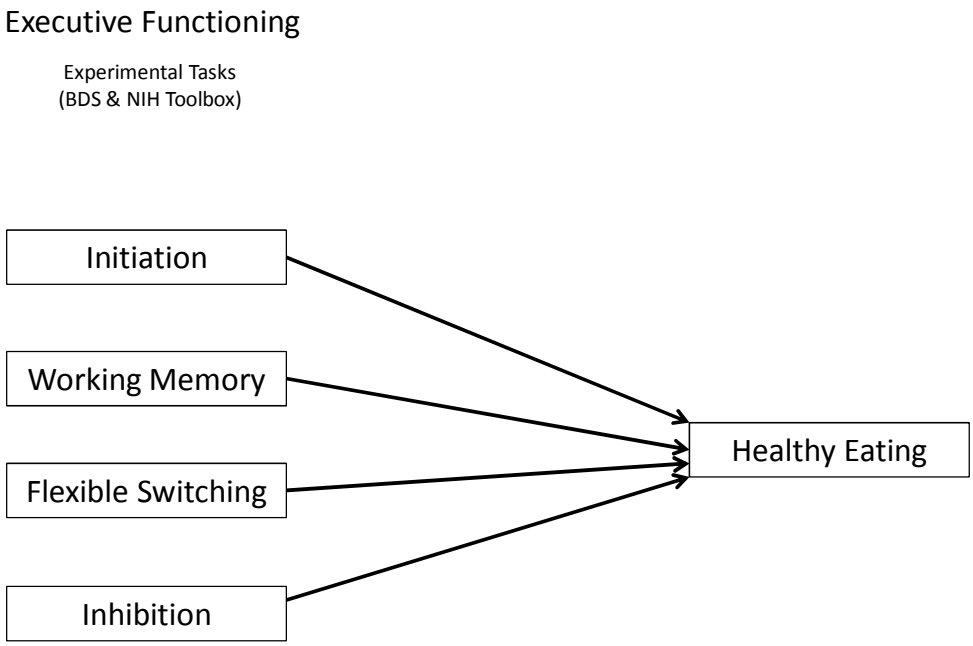

Figure 9. Hypotheses 5-8 of Performance EF and Healthy Eating.

The next additional hypotheses were proposed in order to provide a new way of understanding how certain self-reports are related to protective health behavior. However, correlational data cannot provide conclusions about whether there is a significant causal effect or which variable is the strongest causal effect (Weinstein, 2007).

The following hypotheses have been proposed for the self-report measure of EF in relation to physical activity (see Figure 10):

9. The self-report BRIEF®-A sub-scale of *Initiate* will predict physical activity.
10. The self-report BRIEF®-A sub-scale of *Working Memory* will predict physical activity.
11. The self-report BRIEF®-A sub-scale of *Shift* will predict physical activity.
12. The self-report BRIEF®-A sub-scale of *Inhibit* will predict physical activity.

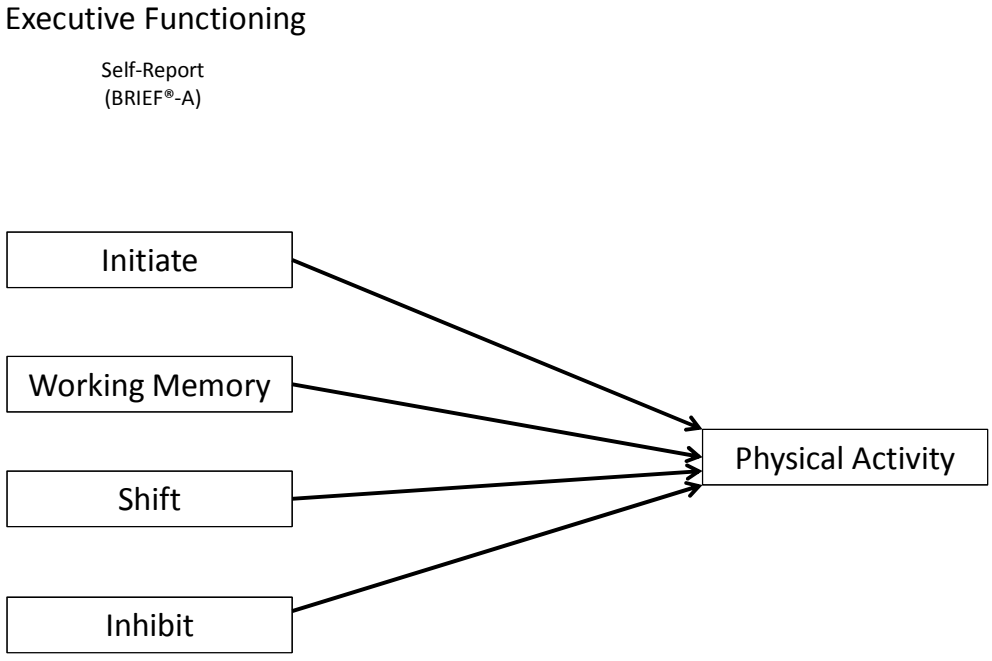

Figure 10. Hypotheses 9-12 of Self-Report EF and Physical Activity.

The following hypotheses have been proposed for the self-report measure of EF in relation to healthy eating (see Figure 11):

13. The self-report BRIEF®-A sub-scale of *Initiate* will predict healthy eating.
14. The self-report BRIEF®-A sub-scale of *Working Memory* will predict healthy eating.
15. The self-report BRIEF®-A sub-scale of *Shift* will predict healthy eating.
16. The self-report BRIEF®-A sub-scale of *Inhibit* will predict healthy eating.

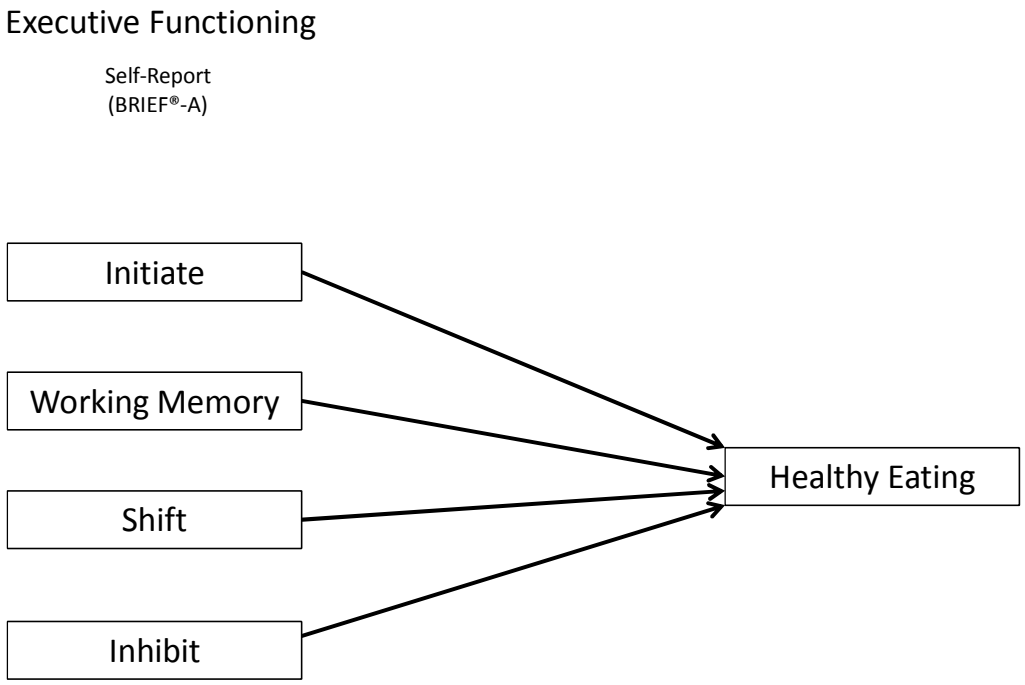

Figure 11. Hypotheses 13-16 of Self-Report EF and Healthy Eating.

1.15.2 Hypotheses for EF Experimental Tasks and SR Strategies. The following hypotheses were proposed in order to establish whether the experimental tasks of EF are related to the SR strategies in relation to physical activity and healthy eating.

For the experimental tasks of EF in relation to physical activity, the following hypotheses have been proposed (see Figure 12):

17. The EF experimental task of *Initiation* will show a significant relationship with the SR strategy of *goal setting* and *implementation intentions* for physical activity.
18. The EF experimental task of *Working Memory* will show a significant relationship with the SR strategy of *goal reminders* for physical activity.
19. The EF experimental task of *Working Memory* will show a significant relationship with the SR strategy of *self-monitoring* for physical activity.
20. The EF experimental task of *Flexible Switching* will show a significant relationship with the SR strategy of *self-monitoring* for physical activity.
21. The EF experimental task of *Inhibition* will show a significant relationship with the SR strategy of *self-control* for physical activity.

For the experimental tasks of EF in relation to healthy eating, the following hypotheses have been proposed (see Figure 13):

22. The EF experimental task of *Initiation* will show a significant relationship with the SR strategy *of goal setting* and *implementation intentions* for physical activity.
23. The EF experimental task of *Working Memory* will show a significant relationship with the SR strategy of *goal reminders*.
24. The EF experimental task of *Working Memory* will show a significant relationship with the SR strategy of *self-monitoring*.
25. The EF experimental task of *Flexible Switching* will show a significant relationship with the SR strategy of *self-monitoring*.
26. The EF experimental task of *Inhibition* will show a significant relationship with the SR strategy of *self-control*.

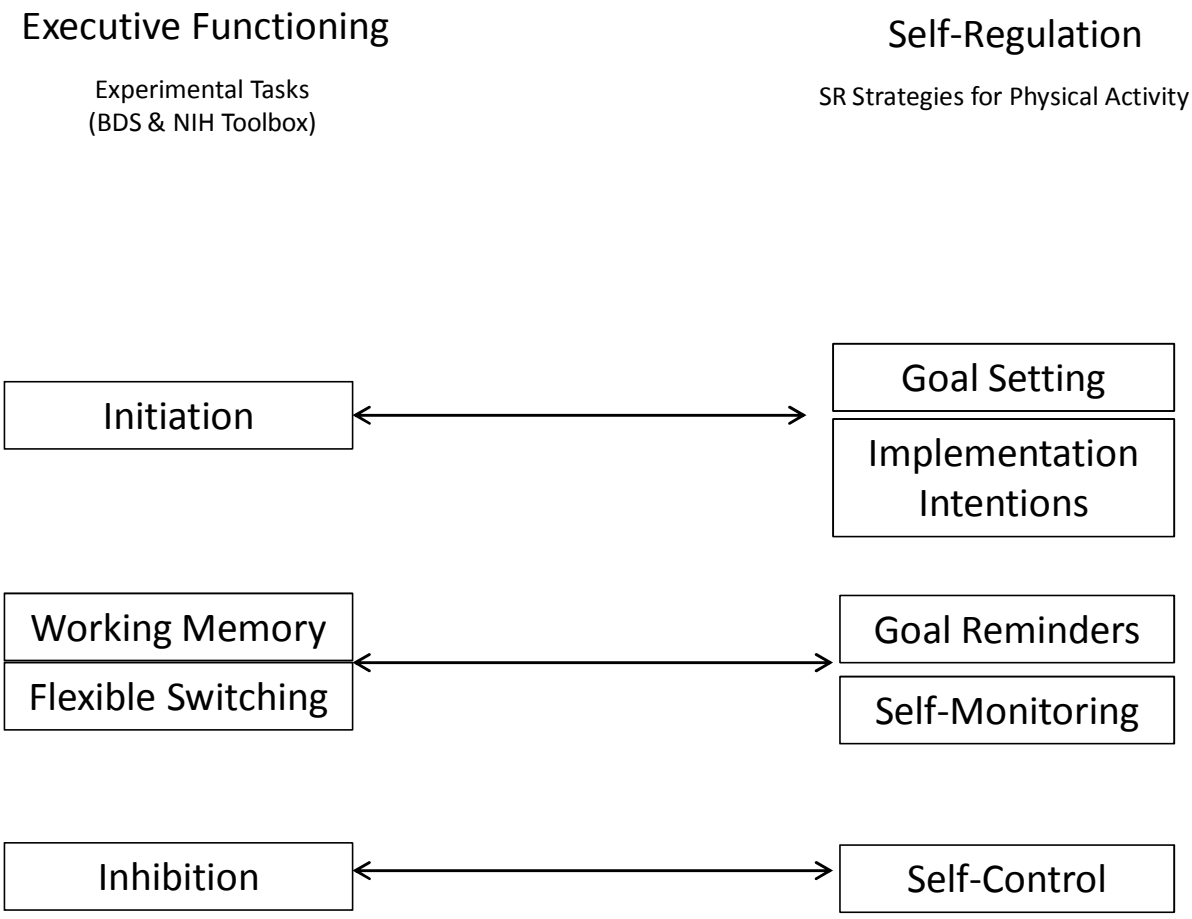

Figure 12. Hypotheses 17-21 of EF Performance and SR Strategies for Physical Activity.

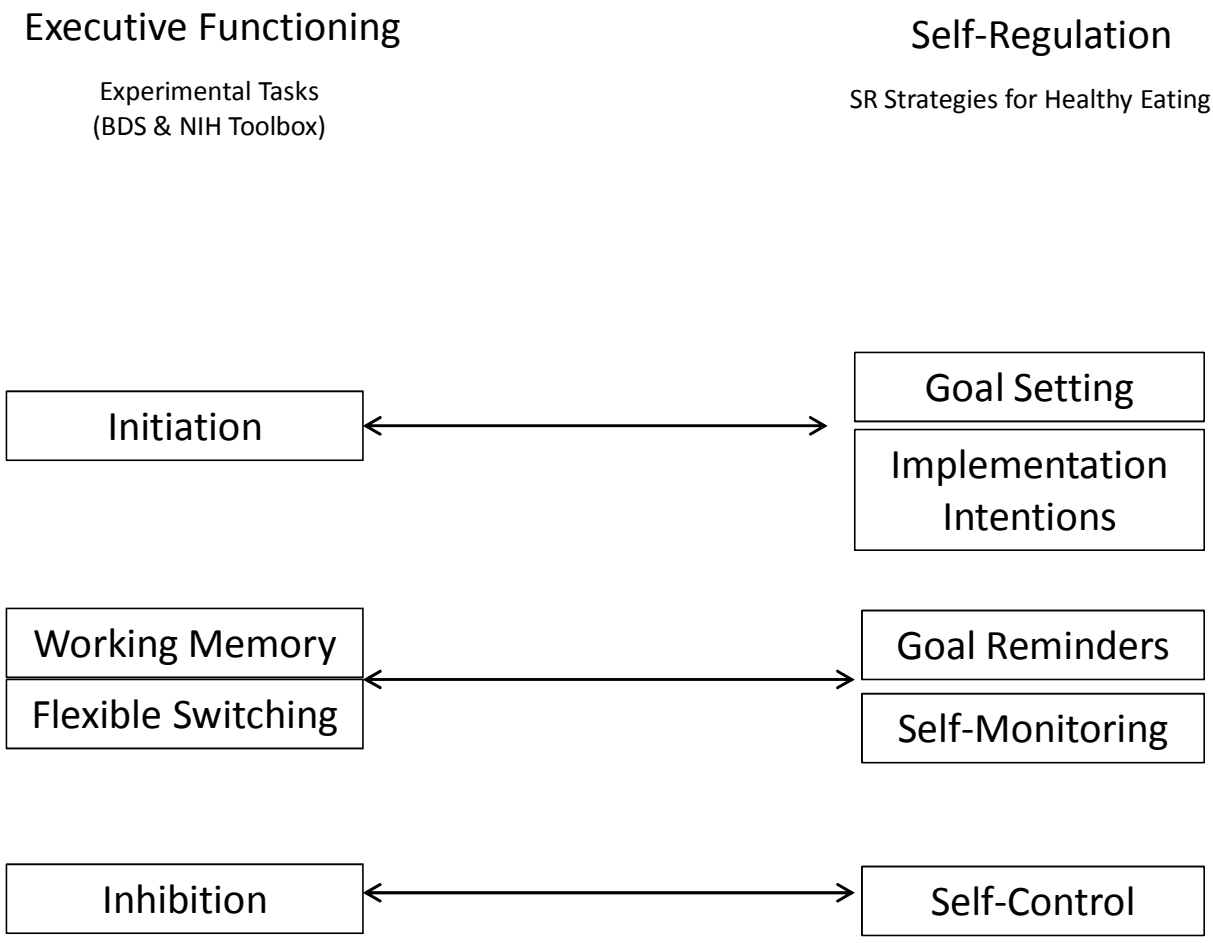

Figure 13. Hypotheses 22-26 of EF Performance and SR Strategies for Healthy Eating.

Chapter 2

Methods

2.1 Sample

Participants (*n* = 162) consisted of college students from The University of Texas at Arlington as well as young adults from the surrounding community. All participants were between the ages of 18 to 49 years. Data was collected between April and September of 2013 through an on-line recruitment website called Sona Systems.

Exclusionary criteria for participating included the following: (1) Children, because their executive functioning is not fully developed (De Luca et al., 2003; Schaie, 1994), (2) Older adults past age of 50 because EF declines (De Luca et al., 2003; Horn & Cattell, 1967; Schaie, 1994), (3) Individuals with neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with higher brain functions, (4) Individuals with health conditions that require lifestyle changes such as those with heart disease, diabetes, old age ($\geq$ 50), obesity, as well as antepartum and postpartum women, and (5) Individuals who are athletes whether officially on a school team or unofficially through intramural sports or other informal settings. This is due to the mechanism of exercise improving EF (Colcombe & Kramer, 2003).

As a result from post-screening the data, four participants were excluded due to being above the age of fifty. One participant was excluded due to being under the age of 18. One participant was excluded due to a medical disqualification of having Autism while another participant was excluded due to having diabetes. Two participants were taken out of the analysis due to pregnancy. Twenty-three participants were excluded due to obesity. Finally, eleven participants were excluded due to being student athletes. See Figure 14 for more details.

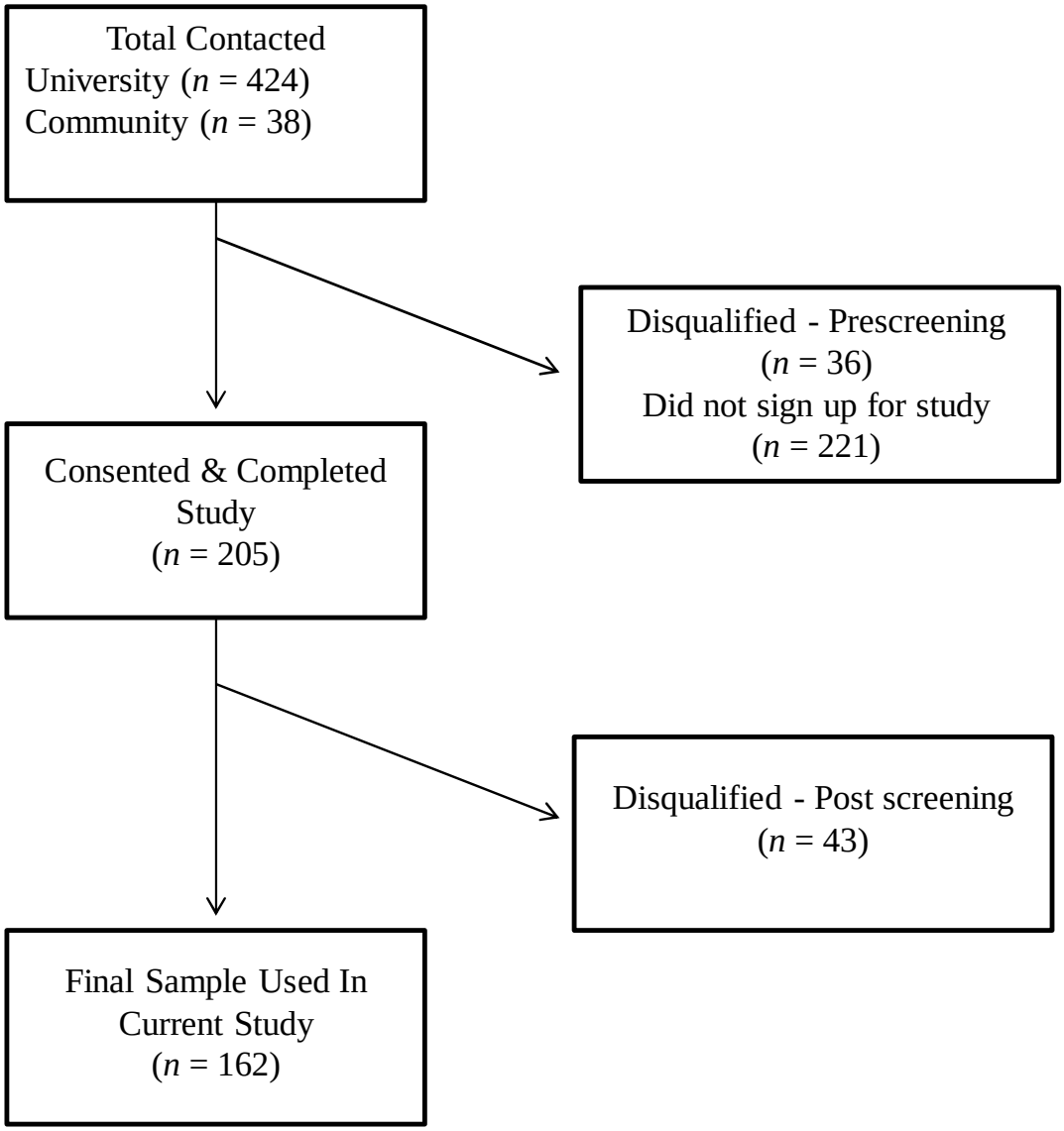

Figure 14. Sample Size.

2.2 Materials and Measures

2.2.1 Consent Form. A standard informed consent form approved by the Institutional Review Board from The University of Texas at Arlington was used.

2.2.2 Demographics. Questions about age, gender, ethnicity, race, education, household income, relationship status, positive outlook on life, and overall satisfaction with life were assessed.

2.2.3 Executive Functioning[2]

***2.2.3.1 Behavioral Dyscontrol Scale - Original*.** The Behavioral Dyscontrol Scale (BDS) is a standardized behavioral interview-based measure that assesses initiation, inhibition, working memory, flexible switching (also known as shifting), and insight. It is based on the works of Luria (1966). The main purpose of the BDS was to assess the capacity for self-regulation and independent functioning from elderly clinical patients. The BDS has 9 tasks, with a score range from 0 to 3, that take 10 minutes to administer. In order to control for ceiling effects in this study, the BDS-Version 2 was used because it substantially increases the scoring range from a maximum of 19 of the original BDS to a maximum of 27 and is appropriate for use on young adults (Grigsby & Kaye, 1996). The BDS has very good reliability (Grigsby, Kaye, & Robbins, 1992) and has been shown to have exceptional validity (Grigsby, Kaye, Eilertsen, & Kramer, 2000; Suchy, Blint, & Osmon, 1997). Factor analysis has revealed three overall factors (Ecklund-Johnson, Miller, & Sweet, 2004). The motor programming factor (BDS-MP) consisted of tasks 1, 2, 5, and 6. This factor was the *Initiation-P* variable that was used for subsequent analyses. The environmental independent factor (BDS-EI) consisted of tasks 3, 4, and 7. Finally, the fluid intelligence factor (BDS-FI) consisted of task 8 and 9. Note the factor variables that were computed in the analysis were the non-weighted sums of the relevant items (see Table 2 for more details).

[2] All executive functioning variables ending with "P" denote *performance* based measures. All variables ending with "S" denote *self-report* measures.

Table 2. Tasks of the Behavioral Dyscontrol Scale (Grigsby & Kaye, 1996, p.6)

Behavioral Dyscontrol Scale - Version 2	
Task 1	Tap twice with the dominant hand and once with the nondominant hand, repetitively.
Task 2	Tap twice with the nondominant hand and once with the dominant hand, repetitively.
Task 3	Patient squeezes examiner's hand when examiner says "red" and does nothing on "green".
Task 4	If examiner taps twice, patient taps once. If examiner taps once, patient taps twice.
Task 5	Alternate touching tip of thumb and each finger, in succession, to table top.
Task 6	Repeat this sequence of hand positions with dominant hand: fist – edge - palm.
Task 7	Adaptation of Head's test.
Task 8	Alphanumeric sequencing (1..a..2..b..3..c..4..d..).
Task 9	Examiner rating of patient's insight into accuracy of his or her performance.

2.2.3.1.1 Initiation-P. The motor programming factor from the BDS was the main variable used to represent a performance-based measure of initiation. The maximum score for this factor is 12.

***2.2.3.2 NIH ToolBox – Executive Functioning Tasks*.** The NIH Toolbox is an assessment of neurological and behavioral function. It was created with the purpose of creating a "common currency" (Gershon et al., 2010, p.S2) across studies. It consists of four domains: cognition, emotion, motor, and sensation. Only the cognition domain was used, specifically, the executive function and working memory measures.

2.2.3.2.1 Working Memory (WM-P). The experimental task of *working memory* was measured by the NIH Toolbox List Sorting Working Memory Test. This task requires the processing of both visual and auditory stimuli and temporary manipulation of information. Pictures of food items and animals were presented in a flashing manner along with the audible pronunciation of the items. In the first condition, participants must mentally re-arrange the order of the items from smallest size to largest for food-only lists or animal-only lists. In the second condition, participants were provided with a mixed list of food and animals items and must mentally re-arrange the objects with food items first from smallest to largest then animals from smallest to largest. Each condition had lists that started with two items that then increased progressively to seven items. Participants had two practice lists (two items then three items) for both conditions. Scores were computed by summing the total number of correctly recalled and sequenced items on both conditions which can range from 0-27. This score was then converted to a nationally representative normed performance scale with a mean of 100 and a standard deviation of 15. Higher scores indicated higher levels of working memory.

2.2.3.2.2 Shifting (Shifting-P). The experimental task of *flexible switching/shifting* was measured by the NIH Toolbox Dimensional Change Card Sort Test. This task consisted of matching one of two pictures (yellow ball and blue truck) with a target picture. The target picture varied along the dimensions of shape and color. “Same” trials used the cue of one dimension to match the target picture along the same dimension (truck with truck). “Switch” trials were used where the participant must switch the dimensions. Prior to the presentation of the target picture, a cue word was presented (SHAPE or COLOR) in order to alert the participant as to which dimension they had to focus on. If the color cue is given, then the participant must match the color of target picture despite their different shapes. For example, if a target picture of a yellow truck is given, then the participant must choose the yellow ball. For the shape cue, if a target picture of a blue ball is presented, the participant must choose the yellow ball. Practice was first conducted with 4 trials using pictures of a rabbit and a boat as shapes and white and brown as colors. The actual test consisted of a mixed block of 30 items. Both speed and accuracy were factored into the overall score by producing an accuracy vector and a reaction time vector. Finally the combination score was converted to a scale score with a mean of 100 and a standard deviation of 15. Higher scores indicated higher levels of cognitive flexibility.

2.2.3.2.3 Inhibition (Inhibition-P). The experimental task of *Inhibition* was measured by NIH Toolbox Flanker Inhibitory Control and Attention Test. This task presented a row of 5 arrows and required the participant to focus on one specific stimulus while inhibiting attention to similar stimuli flanking it. For this task, participants focused on the middle arrow while ignoring two arrows to either side of the middle one. The test consisted of congruent trials and incongruent trials. For the congruent trials, all arrows point either left or right; the incongruent trials had flanking arrows point the opposite direction of the middle arrow. Twenty mixed congruent and incongruent trials were used for the test. Scores were computed using an accuracy vector and a reaction time vector which was converted to a standard performance score with a mean of 100 and a standard deviation of 15. Higher scores indicated higher levels of inhibitory control.

For all the NIH Toolbox tasks, a rigorous qualitative approach was used to validate the batteries, items, and tasks. For example, 152 experts selected the initial criteria for the tests, followed by focus

group interviews and expert interviews. However, specific reliability and validity estimates are not yet reported. Only the fully adjusted scale scores were used for all three NIH Toolbox measures. The fully adjusted scale score adjusts for key demographic variables such as age, gender, race (white, black, other), ethnicity, and educational attainment.

For more information, please refer to the following article and manuals (*NIH Toolbox Administration Manual – English Version.* 2012; *NIH Toolbox Training Manual – English Version.* 2012; Beaumont et al., 2013; Gershon et al., 2013; Hodes, Insel, & Landis, 2013; Nowinski, Victorson, Debb, & Gershon, 2013; Slotkin et al., 2012; Weintraub et al., 2013).

2.2.3.3 Behavior Rating Inventory of Executive Function®–Adult Version (BRIEF®-A). The BRIEF®-A is a self-report questionnaire published by Psychological Assessment Resources (PAR) with 75 items consisting of nine sub-scales: Inhibit, Self-Monitor, Plan/Organize, Shift, Initiate, Task Monitor, Emotional Control, Working Memory, and Organization of Materials. The nine subscales form two indexes: the Behavioral Regulation index (BRI) and the Metacognition Index (MI). The BRI Index consists of the Inhibit, Shift, Emotional Control, and Self-Monitor sub-scales. The MI Index is made up of Initiate, Working Memory, Plan/Organize, Task Monitor, and Organization of Materials sub-scales. A global executive composite score (GEC) incorporates all nine sub-scales. The amount of time to complete the questionnaire is 10 to 15 minutes. For the self-report version using healthy subjects, Cronbach's alpha was .94 and test-retest stability ranged from .82 to .93. Both convergent and discriminant validity were adequate (Roth, Isquith, & Gioia, 2005). In the current sample, Cronbach's alpha was .95. For the current analysis, scores were reversed. Higher scores indicated higher working memory capacity, inhibitory control, initiation, and shifting. See Appendix F for an example of some items from the BRIEF®-A.

2.2.3.4.1 Initiation-S: Self-report based measure of initiation from BRIEF®-A. Eight items were summed to create this sub-scale. This sub-scale "reflects an individual's ability to begin a task or activity and to independently generate ideas, responses, or problem-solving strategies" (Roth et al., 2005, p.21). The maximum score for this sub-scale is 24.

2.2.3.4.2 WM-S: Self-report based measure of working memory from BRIEF®-A. Eight items were summed to create the sub-scale of working memory. Roth and colleagues define working memory

as “the capacity to hold information in mind for the purpose of completing a task, encoding information, or generating goals, plans, and sequential steps in achieving goals” (Roth et al., 2005, p.21). The maximum score for this sub-scale is 24.

2.2.3.4.3 Shifting-S: Self-report based measure of shifting from BRIEF®-A. Six items were summed to create the sub-scale of flexible switching/shifting. According to Roth et al. (2005, p. 21) shifting is defined as “the ability to move with ease from one situation, activity, or aspect of a problem to another as the circumstances demand”. The maximum score for this sub-scale is 18.

2.2.3.4.4 Inhibition-S: Self-report based measure of inhibition from BRIEF®-A. Eight items were summed to create the inhibition sub-scale. Inhibition is defined as “inhibitory control and impulsivity” (Roth et al., 2005, p.20). The maximum score for this sub-scale is 24.

2.2.4 Self-Regulation

2.2.4.1 Self-Regulation of Physical Activity (SR-PA). A questionnaire consisting of 28 items was used to assess the self-regulation strategies of goal selection, goal setting, goal reminders, implementation intentions, self-monitoring, and self-control in relation to physical activity. This questionnaire is a self-report measure that required approximately seven minutes to complete. The recall period for the questionnaire was the past seven days. During construction of the scale, a content validity index scoring rubric was sent to ten subject matter experts (SMEs). Six SMEs responded to the survey and rated the overall content validity of the scale in addition to the individual items. The SMEs consisted of Ph.D. credentialed researchers and doctoral candidates from Psychology, Nursing, and Public Policy departments. The content validity for the overall questionnaire is 0.93. Cronbach’s α was .91 in our sample. A higher score indicated a high-level of self-regulation behavior with respect to physical activity (see Appendix E for more details).

2.2.4.1.1 Goal Setting. Goal setting was measured by averaging items 7 and 8. These items assessed if specific and easy physical activity goals were set to be achieved each week. Cronbach’s α = .80.

2.2.4.1.2 Implementation Intentions. Items 9 and 10 were averaged in order to create the implementation intentions sub-scale. These items assessed if the individual had planned *when* and *where* to exercise each week (Ziegelmann, Luszczynska, Lippke, & Schwarzer, 2007). Cronbach's α = .86.

2.2.4.1.3 Goal Reminders. This variable was actually represented by one item (item 11). This item assessed if a person had setup reminders for weekly physical activity goals such as alarm clocks, putting jogging shoes in front of the door, etc. Cronbach's α cannot be computed due to the fact that this sub-scale is represented by one item.

2.2.4.1.4 Self-Monitoring. Items 12, 13, 14, 15, and 16 were averaged to create this sub-scale. This variable assessed the individual's ability to monitor behavior, progress towards goals, physical fitness, and consequences of physical activity. Most of these items were modified from Clark, Gong, and Kaciroti (2001). Cronbach's α = .91.

2.2.4.1.5 Self-Control. Items 17, 18, and 19 were averaged to create this sub-scale to represent inhibitory control. Cronbach's α = .62.

2.2.4.2 Self-Regulation of Healthy Eating (SR-HE). A questionnaire consisting of 27 items was used to assess the self-regulation strategies of goal selection, goal setting, goal reminders, implementation intentions, self-monitoring, and self-control in relation to healthy eating. This questionnaire was a seven minute self-report measure. The recall period for the questionnaire was the past seven days. Based upon a panel of six SMEs, the content validity index for the overall questionnaire was 0.85. Cronbach's alpha reached a value of .84 in our sample. A higher score indicated high level of self-regulation behavior with respect to healthy eating (see Appendix E for more details).

2.2.4.2.1 Goal Setting. Goal setting was measured by averaging items 7 and 8. These items assessed if specific and easy healthy eating goals were set to be achieved each week. Cronbach's α = .67.

2.2.4.2.2 Implementation Intentions. Items 9 and 10 were averaged in order to create the implementation intentions sub-scale. These items assessed if the individual had planned *when* and *where* to eat healthy each week (Ziegelmann et al., 2007). Cronbach's α = .87.

2.2.4.2.3 Goal Reminders. This variable was represented by one item (item 11) assessing if a person had setup reminders of weekly healthy eating goals. Cronbach's α cannot be computed due to the fact that this sub-scale is represented by one item.

2.2.4.2.4 Self-Monitoring. Items 12, 13, 14, 15, and 16 were averaged to create this sub-scale. This variable assessed an individual's ability to monitor behavior, progress towards goals, their physical health, and consequences of their healthy eating. Most of these items were modified from Clark et al. (2001). Cronbach's α = .83.

2.2.4.2.5 Self-Control. Items 17, 18, and 19 were averaged to create this sub-scale, representing inhibitory control with respect to healthy eating. Cronbach's α = .58.

2.2.5 Protective Health Behaviors. The following two health behaviors were the main dependent variables in our study.

2.2.5.1 Physical Activity (PA). The Seven-Day Physical Activity Recall was used to measure overall minutes of physical activity in the past week (Sallis et al., 1985). The focus of this research was to measure behavior, therefore, the number of minutes spent engaging in moderate or vigorous physical activity was used as the main dependent variable. The protocol used in the study utilized the terms, "hard" for moderate-intensity activities and "very hard" for vigorous-intensity activities. Behavioral criteria were used to indicate what constitutes moderate or vigorous physical activities (Sallis et al., 1985). According to the protocol, moderate-intensity activity is similar to the way a person feels when they are jogging and a vigorous-intensity activity is similar to the way a person feels when they are all out running. Typically, the "talk test" was used as behavioral benchmark to delineate the two types of activities. If a person cannot speak while doing a certain activity, it usually fell within vigorous-intensity. The seven-day recall interview has been validated with tri-axial accelerometers (r^2 =.60, p < .001; Hall, 2006). In the current study, various questions were used to prompt appropriate memories (see list of prompt questions from Sallis et al., 1985). Additionally, the researcher encouraged the participants to use anything that may remind them of what they did on a given day. For example, planners, calendars, check lists, phone logs, physical activity apps on smart phones, diaries, e-mails, text messages, Facebook status updates, and class schedules, as well as class syllabi were used if participants had forgotten what they did. However,

the vast majority of participants had a routine schedule and did not resort to these methods for recollection of what they did in the past week. For this study, the data were converted to total minutes, combining both moderate and vigorous physical activity. Higher numbers indicated more time spent engaging in physical activity.

2.2.5.2 Healthy Eating (HE). The Dietary Screener Questionnaire (DSQ) administered in the 2009-2010 National Health and Nutrition Examination Survey (NHANES) was used to assess healthy eating (National Cancer Institute, n.d.). The questionnaire consisted of 26 items that assessed the frequency of consumption of fruits, vegetables, dairy, whole grains, sugar, red meat, and processed meat. The recall period for this screener was the past month. A scoring algorithm from the Dietary Screener in the NHANES 2009-10 website was used to convert the responses to predicted estimates of usual daily intake for several dietary factors. The main factor used in the analysis was fruits and vegetables (including legumes but excluding French Fries) given in cup equivalents per day. Based on unpublished evaluation of the DSQ, it was shown to have adequate agreement with estimates from the standard 24 hour recall questionnaires. More information about this screener can be found in the Dietary Screener in the NHANES 2009-10 website (http://appliedresearch.cancer.gov/studies/nhanes/dietscreen/).

2.3 Apparatus

A laptop with a dual monitor setup was used for administering the EF tasks. A small bistro table was used for administering the BDS tasks (see Figure 15 for actual study setting).

Figure 15. Study Setting.

2.4 Design and Procedure

This study was considered to be a cross-sectional correlational study. The selection of this design was in line with the basic research questions.

Table 3 includes details concerning the procedure of the study. A balanced Latin square design for administering the various questionnaires as well as the experimental tasks was used in order to control for order effects (see Appendix D). The study was conducted from 10am to 8pm in in order to align study time slots with the waking schedule of the participant pool. Every fifteen minutes there was a short one minute stretch break to control for fatigue and tediousness. All the NIH EF tasks were administered through (https://www.assessmentcenter.net), the dietary questionnaire was administered through (https://riskfactor.cancer.gov/), and the rest of the measures were administered through (www.surveygizmo.com/).

Table 3. Study Procedure.

Measure	Time
Consent Form	2 minutes
Demographics	1 minute
(1) Executive Functioning (a) Initiation (b) Working Memory (c) Flexible Switching/Shifting (d) Inhibition	25 minutes
(2) BRIEF®-A	15 minutes
(3) Physical Activity Seven-Day Recall	10 minutes
(4) Dietary Screener Questionnaire	10 minutes
(5) Self-Regulation of Physical Activity	7 minutes
(6) Self-Regulation of Healthy Eating	7 minutes
Total Time	1 hour and 30 minutes (with breaks)

Note: The above arrangement from 1-6 was counterbalanced.
Additionally, the four measures of EF (a-d) were counterbalanced.

2.5 Analytic Plan

2.5.1 A Priori Power Analysis. To determine the necessary sample size for this study, consideration was given to the evidence that provided small effect size of practical relevance. Thus, results were used from Hall (2012) showing an association between EF and healthy eating (r = .21). A sample of 138 subjects provided enough power to detect such a correlation coefficient with power =.80 at an α level = .05 (one-tailed). For regression analysis, a sample of 153 individuals provided power equal to 0.80 (α =.05) to detect an effect size for a single variable f^2=.08 (small to medium) in a regression model using 4 predictors. For this study, a total of 205 individuals were recruited. The final tally of participants was 162 after exclusionary criteria were implemented. All power analyses were conducted using GPower 3.1.3 (Erdfelder, Faul, & Buchner, 1996) and Daniel Soper's Free Statistics Calculator Website (Soper, 2013).

2.5.2 Statistical Tests. Parametric statistical tests were conducted. Specifically, multiple regression analyses were conducted for hypotheses 1-16 and a correlation analyses for hypothesis 17-26.

2.6 Data Preparation

The data was set up to be entered automatically into a dataset (excluding the BDS measure which was entered manually). Data verification was done using two different individuals in order to confirm the accuracy of the scores. For the rest of the measures, each dataset was checked for accuracy of sample size and score ranges.

2.7 Test Development and Conceptualization of SR-PA and SR-HE

The purpose behind creating these two scales was to provide a measure that captured the majority of the self-regulation strategies that individuals use in relation to physical activities and healthy eating. The various strategies were identified via a literature-driven approach under the direction of a faculty mentor and psychology expert. Subsequently, a scale was created that included all of these dimensions (see Figure 16 for the nomological network).

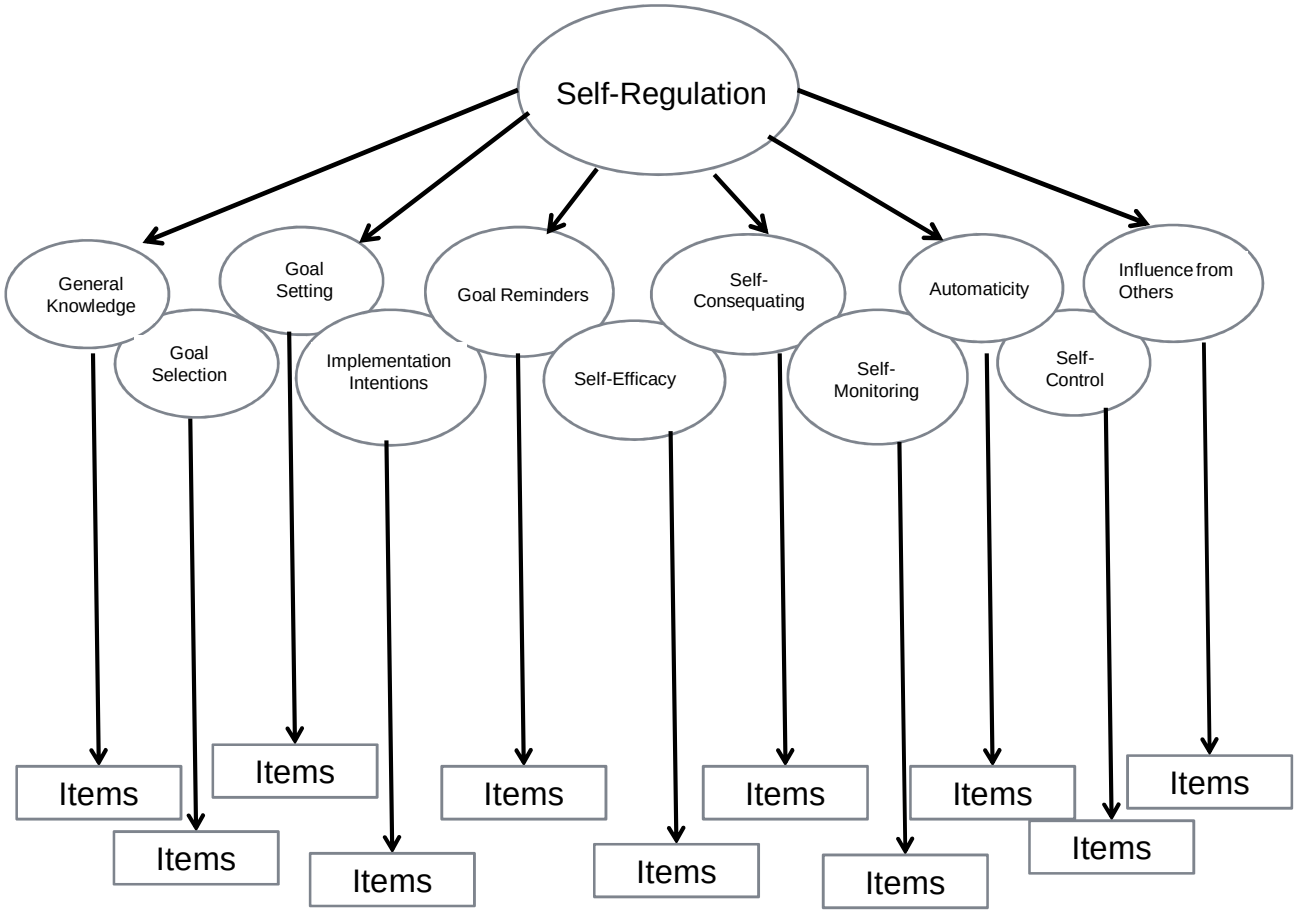

Figure 16. Nomological Network of the SR Scales.

This scale met an unaddressed need of assessing specific SR strategies in relation to specific health behaviors. Although there are general measures of SR, none use context-specific strategies to particular health behaviors.

2.8 Test Construction

The scale was created mainly by the researcher after reviewing several articles (Biddle, Wang, Chatzisarantis, & Spray, 2003; Burnette, 2010; Carver & Scheier, 1998; Kasimatis, Miller, & Marcussen, 1996; Ommundsen, 2003; Stevenson & Lochbaum, 2008) and modifying some items from an existing scale (Clark et al., 2001). Additionally, a focus group of 6 SMEs was consulted for validation purposes.

Initially 37 items were developed for the SR-PA measure and 36 items for the SR-HE scale. However, the general knowledge items consisting of seven items were removed from both scales due to having a low content validity index. As a result, the SR-PA scale consists of 28 items and the SR-HE scale is comprised of 27 items. The recall period for all items was the past seven days. The items were scaled on a six-point range due to the fact that the six-point scale gives higher reliability and discrimination values compared to five-point scale (Chomeya, 2010). However, there is still a great deal of controversy concerning the optimal number of scale points (Cox III, 1980; Cummins & Gullone, 2000). Additionally, the six-point scale was chosen in order to preclude the selection of a neutral point. This method was favored in order to force participants to choose an item in case of indecisiveness. It was believed that being neutral about health behavior is extremely rare and thus commitment from participants to choose either negative or positive responses was preferred.

The recall period in the questionnaires was identical with the recall period used in the Seven-Day Physical Activity Recall to avoid violating the principle of compatibility (Sutton, 1998). According to Sutton (1998), all measures assessing health behavior should be matched with respect to action, target, time, and context. Additionally, a six-point range scale was chosen so that all SR variables have similar magnitudes, frequencies, or response formats. Otherwise, using different scales may contribute to weak models predicting health behavior (Sutton, 1998). Finally, an end-defined Likert format was used; the anchors were only put on the extreme scores (1 and 6) in order to make the scale interval rather than ordinal level (Cummins & Gullone, 2000).

2.9 Item Analysis

A basic approach to validation and reliability was used (see Tables 4 and 5). The majority of analyses were conducted in order to elucidate content validity. The goal of the item analysis was to mainly determine content validity and internal reliability of the scale.

Table 4. Validity Analyses

Type	Technique
Face Validity	Subject Matter Experts
Content Validity	Subject Matter Experts Content Validity Index

Table 5. Reliability Analyses

Type	Technique
Internal Consistency	Cronbach's α
	Overall Scale Reliability
	Individual Item Reliability

2.9.1 Validity

2.9.1.1 Face Validity. Face validity means that the scale, upon a superficial look at the items, seems to measure the construct. All items were rated as measuring the construct of self-regulation strategies as indicated by SMEs.

2.9.1.2 Content Validity. Content validity "indicates whether the items in the scale sample the complete range of attributes under study" (Devon et al., 2007, p.157). For content validity 6 SMEs were used to indicate whether the items represented the construct using a CVI technique.

2.9.1.2.1 Content Validity Index (CVI). A CVI was used in order to measure the level of agreement amongst SMEs concerning the content validity of each item. The CVI can provide information about the specific items (I-CVI) or the overall scale (S-CVI). Six SMEs rated each item according to whether the item was essential to what the researcher was measuring (1 point), useful but not essential to what the researcher was measuring (1 point), or not essential to what the researcher was measuring (0 point). The CVI is essentially the average of the item ratings. The SR-PA and SR-HE questionnaires received an overall S-CVI of .93 and .86, respectively (see Tables 6 and 7 for detailed I-CVI).

Table 6. S-CVI for Self-Regulation of Physical Activity Items

Item #	SME 1	SME 2	SME 3	SME 4	SME 5	SME 6	# Agreement	Item CVI
Item1	1	1	1	1	1	1	6	1
Item2	1	1	1	1	1	1	6	1
Item3	1	0	1	0	1	1	4	0.67
Item4	1	1	1	0	1	1	5	0.83
Item5	1	0	1	1	1	1	5	0.83
Item6	1	1	1	1	1	1	6	1
Item7	1	1	1	1	1	1	6	1
Item8	1	0	1	1	1	0	4	0.67
Item9	1	1	1	1	1	1	6	1
Item10	1	1	1	1	1	1	6	1
Item11	1	0	1	1	1	1	5	0.83
Item12	1	1	1	1	1	1	6	1
Item13	1	1	1	1	1	1	6	1
Item14	1	1	1	1	1	1	6	1
Item15	1	1	1	1	1	1	6	1
Item16	1	1	1	1	1	1	6	1
Item17	1	1	1	1	1	1	6	1
Item18	1	1	1	1	1	1	6	1
Item19	1	1	1	1	1	1	6	1
Item20	1	0	1	0	1	1	4	0.67
Item21	1	0	1	0	1	1	4	0.67
Item22	1	1	1	1	1	1	6	1
Item23	1	1	1	1	1	1	6	1
Item24	1	1	1	1	1	0	5	0.83
Item25	1	1	1	1	1	1	6	1
Item26	1	1	1	1	1	1	6	1
Item27	1	1	1	1	1	1	6	1
Item28	1	1	1	1	1	1	6	1

Table 7. S-CVI for Self-Regulation of Healthy Eating Items.

Item #	SME 1	SME 2	SME 3	SME 4	SME 5	SME 6	# Agreement	Item CVI
Item1	1	0	1	1	1	1	5	0.83
Item2	1	1	1	1	1	1	6	1
Item3	1	0	1	1	1	1	5	0.83
Item4	1	0	1	1	1	1	5	0.83
Item5	1	0	1	1	1	1	5	0.83
Item6	1	1	1	1	1	1	6	1
Item7	1	1	1	1	1	1	6	1
Item8	1	0	1	1	1	0	4	0.67
Item9	1	0	1	1	1	0	4	0.67
Item10	1	0	1	1	1	0	4	0.67
Item11	1	1	1	1	1	1	6	1
Item12	1	1	1	1	1	1	6	1
Item13	1	1	1	1	1	1	6	1
Item14	1	0	1	1	1	1	5	0.83
Item15	1	0	1	1	1	1	5	0.83
Item16	1	1	1	1	1	1	6	1
Item17	1	0	1	1	1	1	5	0.83
Item18	1	1	1	1	1	1	6	1
Item19	1	1	1	1	1	1	6	1
Item20	1	0	1	1	1	1	5	0.83
Item21	1	0	1	1	1	1	5	0.83
Item22	1	0	1	1	1	1	5	0.83
Item23	1	0	1	1	1	1	5	0.83
Item24	1	1	1	1	1	0	5	0.83
Item25	1	1	1	1	1	0	5	0.83
Item26	1	1	1	1	1	0	5	0.83
Item27	1	1	1	1	1	0	5	0.83

2.9.2 Reliability

2.9.2.2 Internal Consistency of Scale. Reliability analyses yielded a Cronbach's α of .91 for the SR-PA. The SR-HE yielded a Cronbach's α of .84. Reliability analysis was conducted for all sub-scale for both SR-PA and SR-HE (see Table 10 for more details).

2.9.2.3 Internal Consistency of Individual Items. Tables 8 and 9 represents the various corrected item total correlation and the subsequent Cronbach's α if the item was deleted from the scale. Deleting any of the items for both scales did not significantly increase Cronbach's α above a significant value. Therefore, all items were retained for subsequent analysis.

Table 8. Reliability and Item Analysis Results for Self-Regulation Strategies of Physical Activity

Deleted Variable	*Corrected Item Total Correlation*	*Cronbach's Alpha if Item Deleted*	Label
SRPA1	.849	.898	How committed are you to achieve the goal of being physically fit?
SRPA2	.809	.900	How committed are you to exercising weekly?
SRPA3	.613	.903	I selected the goal of being physically fit on my own.
SRPA4_R	-.301	.918	I selected the goal of being physically fit because of the influence of others.
SRPA5	.694	.902	I find pleasure in being physically fit in and of itself as my overall goal.
SRPA6	.633	.903	I find that being physically fit helps me achieve other goals
SRPA7	.775	.899	I have set specific physical exercising goals to achieve each week.
SRPA8_R	-.604	.923	I have set difficult physical exercising goals to meet each week.
SRPA9	.789	.899	"I have already planned precisely when to exercise"
SRPA10	.738	.900	"I have already planned precisely where to exercise"
SRPA11	.449	.906	In the past 7 days I have set up a system that automatically reminds me to exercise (e.g., alarm clock, putting jogging shoes in front of door, having people to remind you, purposely parking in the gym parking lot, daily checklist, etc…)
SRPA12	.740	.900	I watch myself carefully to see if exercise is working to make me physically fit.
SRPA13	.755	.900	I evaluate the benefit of exercise to see if it has an impact on my physical fitness.
SRPA14	.679	.902	I use criteria for making a decision on my own to change the type, frequency, or intensity of exercise in response to changes in my physical fitness
SRPA15	.698	.901	I have a plan to adjust my exercise if the pattern of physical fitness gets better or worse.
SRPA16	.733	.901	I can easily switch exercise techniques in order to achieve my goal of being physically fit.
SRPA17_R	.628	.902	In general, in the past 7 days, I got lazy and did not exercise.
SRPA18	.602	.903	In the past 7 days, I exercised even when I did not feel like it.
SRPA19_R	.291	.909	Pleasure and fun got in the way of exercising in the past 7 days.
SRPA20	.299	.908	How often do you find yourself in the past 7 days, automatically without thinking, walking fast between any two locations in your daily errands?
SRPA21	.403	.907	How often do you find yourself in the past 7 days, automatically without thinking, taking the stairs instead of the elevators?
SRPA22	.463	.905	In the past 7 days I have rewarded myself ("treated myself") when I accomplished my weekly goal of exercising.
SRPA23	.316	.908	In the past 7 days I have punished myself when I did not accomplish my weekly goal of exercising.
SRPA24	.737	.901	How confident are you in your ability to manage your overall physical fitness?
SRPA25	.248	.910	During my weekly exercise, I go with a workout buddy.
SRPA26	.233	.908	During my weekly exercise, I go with a professional trainer.
SRPA27	.099	.909	During my weekly exercise, I attend motivational informational groups. (e.g., weight watchers)
SRPA28	.289	.908	During my weekly exercise, I attend group fitness (aerobics, aqua sports, boot camp conditioning, club boxing, cycling, etc...).

Table 9. Reliability and Item Analysis Results for Self-Regulation Strategies of Healthy Eating

Deleted Variable	*Corrected Item Total Correlation*	*Cronbach's Alpha if Item Deleted*	Label
SRHE1	.673	.833	How committed are you to achieve the goal of eating healthy?
SRHE2	.742	.830	How committed are you to eating healthy *every week*?
SRHE3	.499	.837	I selected the goal of eating healthy on my own.
SRHE4_R	-.053	.854	I selected the goal of eating healthy because of the influence of others.
SRHE5	.688	.831	I find pleasure in eating healthy in and of itself as my overall goal.
SRHE6	.679	.832	I find that eating healthy helps me achieve other goals
SRHE7	.705	.829	I have set specific healthy eating goals each week to achieve
SRHE8_R	-.445	.865	I have set difficult healthy eating goals to meet each week.
SRHE9	.646	.831	I have already planned precisely when to eat my healthy diet.
SRHE10	.641	.831	I have already planned precisely where to eat my healthy diet.
SRHE11	.366	.842	In the past 7 days I have set up a system that automatically reminds me to eat healthy (e.g., alarm clock, having people to remind me, daily checklist, etc…)
SRHE12	.642	.832	I watch myself carefully to see if eating healthy is working to make me healthy.
SRHE13	.696	.830	I evaluate the benefit of healthy eating to see if it had an impact on my health goals.
SRHE14	.648	.832	I use criteria for making a decision on my own to change the type of food in response to changes in my health.
SRHE15	.441	.839	I have a plan to adjust my eating habits if my health gets better or worse.
SRHE16	.543	.836	I can easily switch eating regimens in order to achieve my goal of being healthy.
SRHE17_R	.307	.844	In general, in the past 7 days, I got lazy and decided not to eat healthy.
SRHE18	.431	.839	In the past 7 days, I resisted the temptation to eat junk food.
SRHE19_R	.214	.848	Pleasure and fun got in the way of eating healthy in the past 7 days.
SRHE20	-.212	.863	How often do you find yourself in the past 7 days, automatically without thinking, eating everything on your plate, even if it be unhealthy food?
SRHE21	-.369	.868	How often do you find yourself in the past 7 days, automatically without thinking, buying some unhealthy food while shopping for groceries?
SRHE22	.415	.840	In the past 7 days I have rewarded myself ("treated myself") when I accomplished my weekly goal of healthy eating.
SRHE23	.223	.845	In the past 7 days I have punished myself when I did not accomplish my weekly goal of healthy eating.
SRHE24	.613	.834	Overall, how confident are you in your ability to manage your health via healthy eating?
SRHE25	.315	.843	During the week, I eat with individuals who share my healthy eating goals.
SRHE26	.419	.840	During the week, I check my weekly recipes and foods with someone who knows a lot about nutrition.
SRHE27	.223	.845	During the week, I attend motivational informational groups. (e.g., weight watchers, neighborhood food clubs, etc…)

Table 10. Reliability Analysis for Individual SR Sub-Scales.

Sub-Scale Name	Cronbach's alpha	N of Items
SR-PA.Goal Selection	**0.78***	6
SR-PA.Goal Setting	**0.80***	2
SR-PA.Implementation Intentions	**0.86***	2
SR-PA.Goal Reminders	NA**	1
SR-PA.Self-Monitoring	**0.91***	5
SR-PA.Self-Control	0.62	3
SR-PA.Automaticity	**0.77***	2
SR-PA.Self-Consequating	0.54	2
SR-PA.Self Efficacy	NA**	1
SR-PA.Social Influence	0.47	4
SR-HE.Goal Selection	**0.81***	6
SR-HE.Goal Setting	0.67	2
SR-HE.Implementation Intentions	**0.87***	2
SR-HE.Goal Reminders	NA**	1
SR-HE.Self-Monitoring	**0.83***	5
SR-HE.Self Control	0.58	3
SR-HE.Automaticity	**0.76***	2
SR-HE.Self Consequating	0.56	2
SR-HE.Self Efficacy	NA**	1
SR-HE.Social Influence	0.63	3

*All recommended values above 0.7 (DeVellis, 2003).
**Not applicable due to having only one item for the sub-scale.

Chapter 3

Results

3.1 Data Screening

Prior to analysis, the dependent variables of PA and HE were both examined through SPSS descriptive statistics by using *frequencies* and the *explore* option in order to examine the scores for correct data entry, missing values, outliers, and checking if any of the variables met the necessary assumptions to run parametric statistical analyses for univariate models. Both dependent variables displayed a violation of normality. This was expected due to the fact that these health behaviors are seldom practiced as previously mentioned.

The dependent variable of PA was not normally distributed with a skewness of 2.71 (*SE* = .19), *z*-score = 14.19; and a kurtosis of 11.96 (*SE* = .38), *z*-score = 31.57. This variable was transformed using a logarithm transformation due to the substantial positive skewness (Tabachnick & Fidell, 2007). After transformation visual inspection of the histogram as well as the normal Q-Q plot revealed a normal distribution with a skewness of -.505 (*SE* = .22), *z*-score = -2.32; and a kurtosis of .50 (*SE* = .43), *z*-score = 1.15.

The dependent variable of HE was not normally distributed with a skewness of 0.50 (*SE* = .19), *z*-score = 2.59; and a kurtosis of .48 (*SE* = .38), *z*-score = 1.27. This variable was transformed using a square root transformation due to the moderate positive skewness according to the visual inspection of the distribution (Tabachnick & Fidell, 2007). After transformation visual inspection of the histogram as well as the normal Q-Q plot revealed a normal distribution, however, the skewness of -1.22 (*SE* = .19), *z*-score = -6.40; and a kurtosis of 3.66 (*SE* = .38), *z*-score = 9.67, are still out of range. Therefore, the original variable was used for the subsequent analyses.

3.2 Descriptive Statistics

3.2.1 Demographics. The majority of the sample (75.9%) consisted of females. Out of the 123 females in the sample, none were pregnant or in postpartum. The mean and median age of the sample is 21.64 and 19 years of age, respectively. This sample did not include participants with heart disease or diabetes. Twenty-one percent of the sample was of Hispanic ethnicity. In regards to race, 3.1% were

American Indian, 30.9% Asian, 12.3% Black, 42% White, and 11.7% as mixed or other. The majority (66.7%) of the sample was in the *normal* BMI category. The median credit hours taken during the enrolled semester was 13, indicating full-time status as students. The median number of hours worked per week was 5.5. Additionally, the sample rated themselves as having a positive outlook on life (*M* = 4.99, *SD* = 0.90) and being satisfied with their lives (*M* = 4.72, *SD* = 1.14). For more information please see Appendix E for the list of questions and Appendix G for descriptive tables.

3.2.2 Dependent Variables. Descriptive statistics of the dependent variables are located in Table 11. For this sample, the average number of minutes spent in exercise was 156 minutes (2 hours and 36 minutes) per week. However, the standard deviation for this variable is 195 minutes (3 hours and 15 minutes), indicating a substantial variation amongst participants. For the HE variable, the average cup equivalents of fruits and vegetables consumed per day was 2.59 (*SD* = 1.20). Both variables were transformed due to non-normality of the distribution; however, the original HE variable was used for the subsequent analyses.

Table 11. Dependent Variables: Before and After Transformation

		PA	PA Logarithm Transformation	HE	HE Square Root Transformation
N	Valid	162	123	162	162
	Missing	0	39	0	0
Mean		156.68	2.14	2.59	1.55
Median		120	2.18	2.42	1.56
Std. Deviation		195.21	0.42	1.20	0.44
Range		1440	2.46	6.31	2.51

3.2.3 Independent Variables/Predictors. Descriptive statistics of the performance based and self-report based measures of EF are in Table 12 and Table 13, respectively. All the performance based measures of EF were considered above average compared to a normed sample. The self-report based measures also showed high levels of initiation (*M* = 19.42, *SD* = 3.01), inhibition (*M* = 18.88, *SD* = 2.99), working memory (*M* = 18.99, *SD* = 3.05), and shifting (*M* = 14.59, *SD* = 2.19). All four self-report based EF measures had adequate reliability except for Shifting-S (Cronbach's $\alpha = .65$).

Tables 14 and 15 provide more information about the specific sub-scales of SR-PA and SR-HE. In general, all sub-scales had adequate reliability ($\geq$ .70) except for the SR-HE goal setting sub-scale (Cronbach's $\alpha = .67$) and the self-control sub-scale for both PA (Cronbach's $\alpha = .62$) and HE (Cronbach's $\alpha = .58$).

Finally, Table 16 provides the overall correlation matrix for all dependent and predictor variables. It was found that Initiation-P correlated with PA ($r = .20$, $p < .05$) as well as the relationship between WM-P and PA ($r = .18$, $p < .05$). Amongst the self-report EF measures, only Initiation-S and Shifting-S correlated with PA ($r = .21$, $p < .05$; $r = .29$, $p < .05$; respectively). None of the EF measures, both performance and self-report, correlated with HE. On the other hand, HE did correlate with PA ($r = .20$, $p < .05$).

Table 12. Performance Based Measures of EF

		Initiation-P	Inhibition-P	WM-P	Shifting-P
N	Valid	162	160	160	160
	Missing	0	2	2	2
Mean		10.65	107.82	107.05	106.45
Median		11.00	108.83	105.99	108.79
Std. Deviation		1.45	7.36	15.39	9.01
Range		6.00	35.74	66.02	52.94

Table 13. Self-Report Based Measures of EF

		Initiation-S	Inhibition-S	WM-S	Shifting-S
N	Valid	162	162	162	162
	Missing	0	0	0	0
Mean		19.42	18.88	18.99	14.59
Median		20.00	19.00	19.00	15.00
Std. Deviation		3.01	2.99	3.05	2.19
Range		14.00	14.00	14.00	10.00
Cronbach's α		.73	.73	.77	.65

Note: An overall Cronbach's alpha of .95 was found for the BRIEF-A.

Table 14. SR-PA: Specific Sub-Scales

		Goal Setting	Implementation Intentions	Goal Reminders	Self-Monitoring	Self-Control
N	Valid	161	161	161	161	161
	Missing	1	1	1	1	1
Mean		3.76	3.71	2.62	3.83	3.52
Median		3.50	4.00	2.00	3.80	3.33
Std. Deviation		0.63	1.66	1.76	1.26	1.33
Range		5.00	5.00	5.00	5.00	5.00
Cronbach's α		.80	.86	NA	.91	.62

Table 15. SR-HA: Specific Sub-Scales

		Goal Setting	Implementation Intentions	Goal Reminders	Self-Monitoring	Self-Control
N	Valid	162	162	162	162	162
	Missing	0	0	0	0	0
Mean		3.89	2.71	1.78	3.69	3.44
Median		3.50	2.50	1.00	3.60	3.67
Std. Deviation		0.71	1.47	1.15	1.06	1.20
Range		3.50	5.00	5.00	4.80	5.00
Cronbach's α		.67	.87	NA	.83	.58

Table 16. Correlation Matrix for Hypotheses1-16

		Initiation-P	Inhibition-P	WM-P	Shifting-P	Initiation-S	Inhibition-S	WM-S	Shifting-S	PA	HE
Initiation-P	Pearson Correlation	1	.142	**.239****	.082	.046	.150	.036	.064	**.196***	.113
	Sig. (2-tailed)		.074	.002	.305	.559	.058	.649	.416	.030	.152
	N		160	160	160	162	162	162	162	123	162
Inhibition-P	Pearson Correlation		1	**.232****	**.400****	.078	.095	.083	.083	.005	.002
	Sig. (2-tailed)			.003	.000	.327	.233	.299	.299	.958	.977
	N			160	160	160	160	160	160	122	160
WM-P	Pearson Correlation			1	.097	**-.159***	-.099	.012	.104	**.183***	.052
	Sig. (2-tailed)				.221	.045	.213	.882	.192	.043	.518
	N				160	160	160	160	160	122	160
Shifting-P	Pearson Correlation				1	-.075	-.060	-.108	.063	-.015	-.041
	Sig. (2-tailed)					.347	.452	.175	.431	.871	.610
	N					160	160	160	160	122	160
Initiation-S	Pearson Correlation					1	**.563****	**.584****	**.419****	**.206***	-.075
	Sig. (2-tailed)						.000	.000	.000	.022	.341
	N						162	162	162	123	162
Inhibition-S	Pearson Correlation						1	**.647****	**.315****	.082	-.040
	Sig. (2-tailed)							.000	.000	.368	.615
	N							162	162	123	162
WM-S	Pearson Correlation							1	**.506****	.139	-.025
	Sig. (2-tailed)								.000	.124	.753
	N								162	123	162
Shifting-S	Pearson Correlation								1	**.288****	.025
	Sig. (2-tailed)									.001	.748
	N									123	162
PA	Pearson Correlation									1	**.200***
	Sig. (2-tailed)										.027
	N										123
HE	Pearson Correlation										1
	Sig. (2-tailed)										
	N										

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.3 Statistical Test of Hypotheses 1-16

3.3.1 Model 1 (Hypotheses 1-4). PA was regressed on Initiation-P, WM-P, Shifting-P, and Inhibition-P. The first assumption of multiple regression is determining the independence of residuals. This assumption was met as assessed by the Durbin-Watson statistic of 2.33. Next, the assumption of determining a linear relationship between the predictors and the dependent variable was visually inspected by plotting the studentized residuals against the unstandardized predicted values. The residuals formed a horizontal band, indicating that the relationship between the predictors and the dependent variable is linear. Additionally, all partial regression plots showed a linear relationship between the independent predictors and the dependent variable. Finally, the spread of the residuals did not increase or decrease across the predicted values demonstrating homoscedasticity of the residuals. All variables had correlations less than 0.7. Furthermore, Tolerance values were greater than 0.1, or by looking at Variance Inflation Factor (VIF) values all predictors were less than 10. One case had a standardized residual that was $\pm$3 standard deviations. One case had a marginal leverage value above 0.2, but all others were less than 0.2. Finally, Cook's distance values were all below 1 (Cook & Weisberg, 1982). The last assumption of a normal distribution of the residuals was met by visually inspecting the histogram and P-P plots.

Initiation-P, WM-P, Shifting-P, and Inhibition-P did not significantly predict PA, $F(4, 117) = 1.92$, $p = .11$. A post-hoc power analysis was conducted based on having four predictors, $R^2 = .06$, α level = .05, $n = 122$. The observed statistical power for this model is 0.58. In reference to the low degrees of freedom, note that after the PA variable was transformed 39 cases were dropped due to having zero minutes of exercise in the past seven days (the logarithm of zero is undefined). Therefore the sample size for the transformed PA variable is now set at 123. Additionally, the predictors also had two missing cases.

3.3.2 Model 2 (Hypotheses 9-12). PA was regressed on Initiation-S, WM-S, Shifting-S, and Inhibition-S. All assumptions of running the multiple regression analysis were met. Initiation-S, WM-S, Shifting-S, and Inhibition-S significantly predicted PA, $F(4, 118) = 3.22$, $p < .05$. Only Shifting-S added significantly to the prediction. Thus, for each 1 unit increase of shifting capacity, there is an increase of .05 unit of total PA minutes per week. A post-hoc power analysis was conducted based on having four

predictors, R^2 = .098, α level = .05, *n* = 123. The observed statistical power for this model is 0.83. See Table 17 for more information.

Table 17. Model 2 Summary of Multiple Regression Analysis Predicting PA.

Variable	*B*	SE_B	β
Intercept	1.30	.30	
Initiation	.02	.02	.16
Working Memory	-.01	.02	-.05
Inhibition	-.01	.02	-.07
Shifting	.05	.02	**.27***

Note: * p < .05
B = unstandardized regression coefficient
SE_B = standard error of unstandardized regression coefficient
β = standardized coefficient

3.3.3 Model 3 (Hypotheses 5-8). HE was regressed on Initiation-P, WM-P, Shifting-P, and Inhibition-P. All assumptions of multiple regression were met. Initiation-P, WM-P, Shifting-P, and Inhibition-P did not significantly predict HE, *F*(4, 155) = 1.02, *p* = .40. A post-hoc power analysis was conducted based on the parameters of having four predictors, R^2 = .026, α level = .05, and *n* = 160. The observed statistical power is 0.34.

3.3.4 Model 4 (Hypotheses 13-16). HE was regressed on Initiation-S, WM-S, Shifting-S, and Inhibition-S. As with model 3 all assumptions were met. Initiation-S, WM-S, Shifting-S, and Inhibition-S did not statistically significantly predict HE, *F*(4, 157) = 0.60, *p* = .66. Using the parameters of four predictors, R^2 = .015, α level = .05, and *n* = 162, the observed statistical power is .20.

3.4 Statistical Test of Hypotheses 17-26

3.4.1 Hypothesis 17 and 22. Initiation-P did not show a significant relationship with either the SR-PA or SR-HE strategies of Goal Setting and Implementation Intentions; r = .08, *ns*; r = .10, *ns*; r = -.002, *ns*; r = -.09, *ns*; respectively.

3.4.2 Hypothesis 18 and 23. WM-P and the SR-PA (r = .11, *ns*) and SR-HE (r = -.15, *ns)* strategy of Goal Reminders did not show a statistically significant association.

3.4.3 Hypothesis 19 and 24. WM-P and the SR-PA (r = .06, *ns*) and SR-HE (r = .05, *ns*) strategy of Self-Monitoring did not yield any significant association.

3.4.4 Hypothesis 20 and 25. Shifting-P and the SR-PA (r = .08, *ns*) and SR-HE (r = .12, *ns*) strategy of Self-Monitoring did not show a statistically significant correlation.

3.4.5 Hypothesis 21 and 26. Inhibition-P and the SR-PA (r = .001, *ns*) and SR-HE (r = .-.04, *ns*) strategy of Self-Control were not statistically significant.

3.4.6 Posthoc Analyses. Refer to Table 18 for the correlation matrix for hypotheses 17-26. Despite finding non-significant relationships for hypotheses 17-26, several other interesting correlations were detected that were not previously proposed. First, Shifting-P was correlated with SR-HE Goal Setting sub-scale (r = .19, p < .05). Between the two health behaviors, several identical sub-scales showed statistically significant relationships. For example, SR-PA Goal Setting and SR-HE Goal Setting sub-scales were correlated (r = .22, p < .05). Additionally, SR-PA and SR-HE Implementation Intentions sub-scale were moderately correlated (r = .33, p < .001). SR-PA and SR-HE Goal Reminder sub-scale revealed a moderate correlation (r = .37, p < .001). SR-PA and SR-HE Self-Monitoring sub-scale showed a strong correlation (r = .51, p < .05). Finally, SR-PA and SR-HE Self-Control sub-scale were moderately related (r = .34, p < .001).

Additionally, several correlational analyses were conducted between the BDS and Health Behaviors. The BDS-Total was correlated with PA (r = .17, p < .05) and HE (r = .20, p < .05). Concerning the three factor scores, only BDS-EI correlated with PA (r = .15, p < .05), while the BDS-MP (the Initiation-P variable) negatively correlated with unhealthy consumption of sugar (r = -.16, p < .05).

Table 18. Correlation Matrix for Hypotheses 17-26.

		Initiation-P	WM-P	Shifting-P	Inhibition-P	PA. Goal Setting	PA. Implementation Intentions	HE. Goal Setting	HE. Implementation Intentions	PA. Goal Reminders	PA. Self-Monitoring	HE. Goal Reminders	HE. Self-Monitoring	PA. Self-Control	HE. Self-Control
Initiation-P	Pearson Correlation	1	**.239****	.082	.142	.079	.095	-.002	-.093	.082	.102	-.058	.017	.100	**-.157***
	Sig. (2-tailed)		.002	.305	.074	.320	.230	.976	.238	.302	.197	.466	.828	.206	.046
	N		160	160	160	161	161	162	162	161	161	162	162	161	162
WM-P	Pearson Correlation		1	.097	**.232****	-.006	.126	.018	.005	.114	.063	-.146	.049	.116	.014
	Sig. (2-tailed)			.221	.003	.938	.112	.824	.951	.154	.427	.066	.541	.144	.857
	N			160	160	159	159	160	160	159	159	160	160	159	160
Shifting-P	Pearson Correlation			1	**.400****	.103	.007	**.185***	-.016	.032	.080	-.071	.117	-.018	-.080
	Sig. (2-tailed)				.000	.198	.931	.019	.842	.686	.316	.369	.140	.817	.312
	N				160	159	159	160	160	159	159	160	160	159	160
Inhibition-P	Pearson Correlation				1	.014	-.007	.060	-.098	-.016	-.023	-.099	.074	.001	-.042
	Sig. (2-tailed)					.860	.927	.450	.218	.843	.773	.211	.352	.990	.595
	N					159	159	160	160	159	159	160	160	159	160
PA.Goal Setting	Pearson Correlation					1	**.312****	**.222****	.086	**.201***	**.248****	.028	.145	**.338****	.097
	Sig. (2-tailed)						.000	.005	.277	.011	.002	.729	.066	.000	.220
	N						161	161	161	161	161	161	161	161	161
PA.Implementation Intentions	Pearson Correlation						1	.093	**.326****	**.547****	**.731****	.134	**.292****	**.679****	**.161***
	Sig. (2-tailed)							.238	.000	.000	.000	.091	.000	.000	.041
	N							161	161	161	161	161	161	161	161
HE.Goal Setting	Pearson Correlation							1	**.411****	-.037	**.192***	.037	**.347****	**.216****	**.366****
	Sig. (2-tailed)								.000	.637	.014	.637	.000	.006	.000
	N								162	161	161	162	162	161	162
HE.Implementation Intentions	Pearson Correlation								1	**.198***	**.315****	**.372****	**.551****	**.261****	**.353****
	Sig. (2-tailed)									.012	.000	.000	.000	.001	.000
	N									161	161	162	162	161	162

Table 18 - continued

		Initiation-P	WM-P	Shifting-P	Inhibition-P	PA. Goal Setting	PA. Implementation Intentions	HE. Goal Setting	HE. Implementation Intentions	PA. Goal Reminders	PA. Self-Monitoring	HE. Goal Reminders	HE. Self-Monitoring	PA. Self-Control	HE. Self-Control
PA.Goal Reminders	Pearson Correlation									1	**.447****	**.368****	**.176***	**.317****	-.030
	Sig. (2-tailed)										.000	.000	.025	.000	.709
	N										161	161	161	161	161
PA.Self-Monitoring	Pearson Correlation										1	.155	**.513****	**.536****	.136
	Sig. (2-tailed)											.050	.000	.000	.084
	N											161	161	161	161
HE.Goal Reminders	Pearson Correlation											1	**.311****	.050	.141
	Sig. (2-tailed)												.000	.528	.073
	N												162	161	162
HE.Self-Monitoring	Pearson Correlation												1	**.216****	**.366****
	Sig. (2-tailed)													.006	.000
	N													161	162
PA.Self-Control	Pearson Correlation													1	**.342****
	Sig. (2-tailed)														.000
	N														161
HE.Self-Control	Pearson Correlation														1
	Sig. (2-tailed)														
	N														

Table 19. Posthoc Analysis between BDS and Health Behaviors.

		BDS Total	BDS EI	BDS FI	BDS MP	PA	HE	UH
BDS Total	Pearson Correlation	1	**.688****	**.629****	**.817****	**.173***	**.197***	-.109
	Sig. (2-tailed)		.000	.000	.000	.028	.012	.167
	N		162	162	162	162	162	162
BDS EI	Pearson Correlation		1	**.221****	**.306****	.144	**.155***	-.040
	Sig. (2-tailed)			.005	.000	.067	.049	.615
	N			162	162	162	162	162
BDS FI	Pearson Correlation			1	**.288****	.134	.121	.011
	Sig. (2-tailed)				.000	.088	.126	.887
	N				162	162	162	162
BDS MP	Pearson Correlation				1	.107	.148	**-.166***
	Sig. (2-tailed)					.177	.060	.035
	N					162	162	162
PA	Pearson Correlation					1	**.177***	-.031
	Sig. (2-tailed)						.024	.698
	N						162	162
HE	Pearson Correlation						1	.088
	Sig. (2-tailed)							.263
	N							162
Unhealthy Eating (UE)	Pearson Correlation							1
	Sig. (2-tailed)							
	N							

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Chapter 4

Discussion

The purpose of this study was to establish answers to several theoretical questions involved with neuropsychological functioning, self-regulatory strategies, and protective health behaviors. Although there is a lack of research investigating the multiple facets of EF and SR strategies, an attempt was made through this study to find a robust prediction of health behavior.

This study found several lines of evidence that show the overall relationship between EF and health behavior. For example, performance-based EF measure of Initiation and Working Memory were correlated with PA. Additionally, self-report based EF measure of Initiation and Shifting were correlated with PA. Despite the fact that none of the EF measures were correlated with HE, the HE variable was correlated with PA. This indicates that individuals who engage in PA are also more likely to maintain a healthy diet. This provides sufficient preliminary evidence that the relationships proposed do exist which is consistent with literature that was previously cited.

A questionnaire was constructed specific to the SR of PA and HE. Several of the same sub-scales from PA and HE were correlated together. For example, the sub-scales of Goal Setting from PA and HE were correlated. Additionally, the sub-scales from both PA and HE concerning implementation intentions, goal reminders, and self-control all revealed moderate correlations. A strong correlation was detected for the sub-scale of self-monitoring between the PA and HE versions. These analyses confirm that the SR questionnaires are consistent and that individuals use the same strategies for initiating and maintaining different forms of health behavior.

It was hypothesized that initiation, working memory, inhibition, and flexible switching would predict health behavior. However, all four facets of EF (both performance-based and self-report) did not predict health behaviors of PA and HE except for Shifting-S predicting PA (which was an extremely small effect). Additionally, a SR context-specific questionnaire was created for the purpose of finding associations with EF. None of the four performance-based EF facets were found to be significantly associated with the SR strategies proposed in Figure 3. Although the results may indicate that these variables are clearly not associated, all of the models had very low statistical power except for Model 2.

Therefore, by increasing the sample size to 500 for the other models, there was a chance a small effect size between EF and health behavior could have been detected. These analyses may indicate that the EF-Health Behavior association is a small effect of practical significance.

It appears that by not using an overall EF composite, the hypothesized relationship was attenuated. Due to the fact that the individual performance based measures of EF cannot give an overall composite score of EF, another measure that gave sufficient coverage of EF (inhibition, initiation, working memory, shifting, etc…) was used as a composite. Hence, a posthoc analysis was conducted using the BDS as a composite score in addition to the three individual factor scores. The BDS is a measure assessing the "integrity of the capacity for behavioral self-regulation" (Grigsby & Kaye, 1996, p.2) using the neuropsychological methods devised by Luria (1966). The overall composite score correlated positively with PA and HE. Of the three factor scores, only two showed associations with health behavior. The BDS-EI correlated positively with PA, while the BDS-MP correlated negatively with unhealthy eating (sugar consumption). That is, the higher the capacity for initiation, the lower intake of sugar. Therefore, more insight may be provided by looking at unhealthy health habits (e.g., physical inactivity, unhealthy eating) in addition to using other neuropsychological measures.

There are numerous issues to grapple with when approaching the study of EF. One of the main concerns is that it is challenging to discriminate between EF tasks and non-EF tasks (Rabbitt, 1997). This is because the foremost requirement of a task measuring EF is to be novel to the individual. However, individuals cease to use EF as soon as a task is encountered more than once. Additionally, EF tasks must be novel not only in their content, but also in their form (Denckla, 1994). Consequently, how much practice is required in order to differentiate between EF and non-EF behavior? Some participants in this study indicated that they subscribe to "Lumosity" which is a brain training website. Therefore, the novelty of some tasks presented in the study was potentially compromised as several participants indicated that they were familiar with the task; however, these participants were not coded because this issue was unexpected. Based on this fact, would their scores on the various tests of "EF" actually qualify as measures of EF? Or would it be more appropriate to say it was a measure of practiced automatic behavior? Due to the fact that something can only be novel once, EF tasks tend to have very poor

test/retest reliability, which contributes greatly to measurement error leading to very weak correlations with other logically-known closely related factors (Rabbitt, 1997).

An additional problem with EF tests is the uncertainty surrounding their validity. For example, according to Rabbitt (1997), no single task has gone unchallenged as the standard test of EF. The reason for this problem stems from the lack of task purity. This means the task not only makes demands, for example, on inhibition, but also on other cognitive processes that are not related to what is being measured. However, Rabbitt argues that there is a problem with “process impurity” rather than “task impurity” because of the difficult nature of measuring EF (Rabbitt, 1997, p.14).

Furthermore, the overall construct validity of using individual components of EF is problematic. These hypothetical components are actually the simple descriptions of what the task demands and may not represent the actual construct (Rabbitt, 1997). For example, what is the difference between inhibition and switching? Are they two distinct processes or are they two sub-components of a single process?

Finally, there is no definitive demonstration that these hypothetical processes are actually distinct functional processes. Many researchers give absolute precedence to statistical constructs, as given by factor analysis, and completely ignore the theoretical functional process that might be involved. In the end, the term EF and its definition is largely a theoretical definition, and not an operational definition (Burgess, 1997). However, once we create an operational definition is formulated, it will be used as the hypothetical construct definition, which contributes to the overall problem of construct validity.

It was stated previously that the EF-Health Behavior relationship may be in the end a small effect of practical significance. This conclusion may come as a surprise due to the fact that research has already shown clear effects between EF and health behavior (Allan, Johnston, & Campbell, 2011; Hall et al., 2006; Hall et al., 2008; Hall, 2012; Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008). However, according to Suchy (2009), when utilizing EF to study health behavior, researchers are strongly encouraged to use *experimental* measures of EF instead of *clinical* measures. Clinical measures of EF include the common tests such as Wisconsin Card Sorting Task, Trail Making Test, Tower of Hanoi, Tower of London, Stroop color and word test, Go/No Go commissions and omissions test, amongst others. This is due to the fact that clinical measures have limited range of score with low ceilings for

normal individuals and using behavioral skills which might confound EF ability with over-practiced, over-learned, and prepotent responses (Suchy, 2009). When looking back at the above-mentioned research showing associations between EF and health behavior, one finds that the researchers used *clinical* measures of EF such as the Stroop task and Go/No Go task which might have inflated the overall effect found in these studies.

Concerning PA and HE, a self-report measure was used. However, the tradeoffs between accuracy and non-biased data for convenience and time efficiency are always a difficult decision for all researchers. Specifically for diet, there are several main methods of assessment (Thompson & Subar, 2008). One way of assessing diet is to use a food frequency questionnaire that asks about usual intake. However, respondents may have a difficult time remembering what they ate in the past month and may even misreport intake. As a result, the data from such questionnaires are not precise due to measurement error. Due to limited resources, the food frequency questionnaire method was chosen. Despite the DSQ's validity with the gold standard 24-hour recall (National Cancer Institute - Applied Research Program, n.d.), these questionnaires have unpredictable performance with different samples (Thompson & Subar, 2008).

The proposed study is not without limitations. The sampling method was not randomized, thus limiting our ability to infer causation with the associated variables. The study was limited to only a seven day period for PA or one month period for HE. In the future, studies looking at longer time periods as well as experimental conditions can provide much needed information concerning the theoretical relationships previously discussed.

One important limitation of our study was the inability to assess participants' knowledge of health behavior. Chang (1994) suggested that respondent knowledge is very important in affecting the responses. However, low content validity values of items assessing respondent knowledge resulted in excluding these items from the study. Therefore, future research will be conducted to modify these items or increase the number of SMEs evaluating the questionnaire, in addition to assessing construct and criterion validity.

Another limitation was that a cross-sectional correlational design was chosen for this study. This design gave the researcher ample flexibility as well as reduced costs in time and resources to assess relationships between variables. If evidence revealed a strong prediction, then this may be indicative of a causal relationship proposed a priori, despite the evidence being indefinite. However, this type of design offers no conclusive insight on proof of mechanisms or processes. That is, the main weakness of this design is the lack of control over extraneous variables. However, this study employed various strategies to reduce the influence of such extraneous variables. For example, Ogden (2003) flagged an important confound detailing whether health researchers are assessing cognitions or actually creating it. During the PA interview, some participants felt guilty and embarrassed for the near total absence of exercise behavior in the past week. This could have easily manipulated their commitment to physical activity when filling out the SR questionnaire by shifting their attitudes towards more socially desirable responses. Therefore, to control for such influences the research design incorporated counterbalancing by varying the order of presenting experimental tasks and completing questionnaires. Moreover, moderator variables of both EF and SR were collected. Because the main focus of this study was EF, participants were excluded who showed significant influences from these moderators. For example, older adults past the age of 50 were excluded due to the fact that EF functions naturally decline with age. Additionally, individuals who considered themselves athletes were excluded because consistent exercise actually improves EF. Due to the near absence of EF-Health Behavior effect, it is strongly suspected that other moderators may be masking this effect. For example, four items assessing social influence on engaging in PA were collected. A variable was created by averaging these items. It was shown that SR-PA sub-scale of social influence was positively correlated with PA ($r = .20$, $p < .05$). Similarly, three items assessing the social influence on healthy eating was averaged. This sub-scale of social influence on SR-HE was correlated with consumption of healthy foods ($r = .20$, $p < .05$). Therefore, it strongly recommended in the future for researchers to assess and model these moderators as part of a larger exploration of the relationship between EF and health behavior.

It is recommended that future research should also focus on unhealthy behavior (i.e., physical inactivity, fatty food consumption, sugar consumption, etc...). Additionally, using composite scores of EF

as well as using more accurate measures to assess food consumption is recommended. Additional research is required to accurately assess the theoretical relationship between EF and SR using mediation analysis.

The results from this study have both practical and theoretical implications. From a practical standpoint, the results demonstrate that when using EF performance-based measures, strict protocol should be followed. The most important condition for using EF measures must be strictly enforced. The task must be novel to the participant, otherwise, research conclusions may be questionable (Rabbitt, 1997). Also, experimental tasks of EF rather than clinical measures should be used (Suchy, 2009). From a theoretical point of view it seems that using EF as a predictor is adequate but not ideal. Continued research is always needed to understand complex behavior such as health behavior in relation to these predictors.

In summary, investigating the determinants of health behavior can help researchers to both improve measurement tools as well as better understand the nature of the theoretical relationships between variables related to physical activity and healthy eating. Assessing and establishing empirical support for the relationships between EF, SR, and protective health behavior is critical for forming better models of health behavior.

Appendix A

Institutional Review Board Approval Letter

THE UNIVERSITY
OF TEXAS
AT ARLINGTON

Office of Research
Administration
Box 19188
202 E. Border St., Suite 214
Arlington, Texas
76019-0188

T 817.272.3723
F 817.272.1111

http://www.uta.edu/research
Expertise at UT Arlington
http://www.uta.edu/expertise

February 13, 2013

Tamer f Desouky
Dr. Mary a Cazzell
Psychology
The University of Texas at Arlington
Box 19528

EXPEDITED APPROVAL OF HUMAN SUBJECT RESEARCH

IRB No.: 2013-0342
TITLE: Brain Functioning and Health Behavior
Effective Date: February 13, 2013
Expiration Date: February 13, 2014

Approved Number of Participants: 600 **(Do not exceed without prior IRB approval).**

The University of Texas Arlington Institutional Review Board (UTA IRB) has made the determination that this research protocol involving human subjects is eligible for expedited review in accordance with Title 45 CFR 46.110(a)-(b)(1), 63 FR 60364 and 63 FR 60353, category(7). The IRB Chairman (or designee) approved this protocol effective February 13, 2013. IRB approval for the research shall continue until February 13, 2014.

APPROVED NUMBER OF PARTICIPANTS:

This protocol has been approved for enrollment of a maximum of 600 participants and is not to exceed this number. If additional data are needed, the researcher must submit a modification request to increase the number of approved participants **before** the additional data are collected. Exceeding the number of approved participants is considered an issue of non-compliance and will result in the destruction of the data collected beyond the approval number and will be subject to deliberation set forth by the IRB.

INFORMED CONSENT DOCUMENT:

The IRB approved and stamped informed consent document (ICD) showing the approval and expiration date must be used when prospectively enrolling volunteer participants into the study. The use of a copy of any consent form on which the IRB-stamped approval and expiration dates are not visible, or are replaced by typescript or handwriting, is prohibited. The signed consent forms must be securely maintained on the UT Arlington campus for the duration of the study plus a minimum of three years after the completion of all study procedures (including data analysis). The complete study record is subject to inspection and/or audit during this time period by entities including but not limited to the UT Arlington IRB, Regulatory Services staff, OHRP, and by study sponsors (if the study is funded).

MODIFICATION TO AN APPROVED PROTOCOL:

Pursuant to Title 45 CFR 46.103(b)(4)(iii), investigators are required to, "promptly report to the IRB ***any*** proposed changes in the research activity, and to ensure that such changes in approved research, during the period for which IRB approval has already been given, are **not initiated without prior IRB review and approval** except when necessary to eliminate apparent immediate hazards to the subject." Modifications include but are not limited to: Changes in protocol personnel, number of approved participants, and/or updates to the protocol procedures or instruments and must be submitted via the electronic submission system. Failure to obtain approval for modifications is considered an issue of non-compliance and will be subject to review and deliberation by the IRB which could result in the

suspension/termination of the protocol.

ANNUAL CONTINUING REVIEW:
In order for the research to continue beyond the first year, a Continuing Review must be completed via the online submission system within 30 days preceding the date of expiration indicated above. A reminder notice will be forwarded to the attention of the Principal Investigator (PI) 30 days prior to the expiration date. Continuing review of the protocol serves as a progress report and provides the researcher with an opportunity to make updates to the originally approved protocol. Failure to obtain approval for a continuing review will result in automatic ***expiration of the protocol*** all activities involving human subjects must cease immediately. The research will not be allowed to commence by any protocol personnel until a new protocol has been submitted, reviewed, and approved by the IRB. Per federal regulations and UTA's Federalwide Assurance (FWA), there are no exceptions and no extensions of approval granted by the IRB. The continuation of study procedures after the expiration of a protocol is considered to be an issue of non-compliance and a violation of federal regulations. Such violations could result in termination of external and University funding and/or disciplinary action.

ADVERSE EVENTS:
Please be advised that as the principal investigator, you are required to report local adverse (unanticipated) events to The UT Arlington Office of Research Administration; Regulatory Services within 24 hours of the occurrence or upon acknowledgement of the occurrence.

HUMAN SUBJECTS TRAINING:
All investigators and key personnel identified in the protocol must have documented Human Subjects Protection (HSP) training or CITI Training on file with The UT Arlington Office of Research Administration; Regulatory Services. Completion certificates are valid for 2 years from completion date.

COLLABORATION:
If applicable, approval by the appropriate authority at a collaborating facility is required prior to subject enrollment. If the collaborating facility is *engaged in the research*, an OHRP approved Federalwide Assurance (FWA) may be required for the facility (prior to their participation in research-related activities). To determine whether the collaborating facility is engaged in research, go to: http://www.hhs.gov/ohrp/humansubjects/assurance/engage.htm

CONTACT FOR QUESTIONS:
The UT Arlington Office of Research Administration; Regulatory Services appreciates your continuing commitment to the protection of human research subjects. Should you have questions or require further assistance, please contact Robin Dickey at robind@uta.edu or you may contact the office of Regulatory Services at 817-272-3723.

Sincerely,

Maria Martinez-Cosio, Ph.D.
Associate Professor
UT Arlington IRB Chair

Appendix B

Consent Form

APPROVED

MAR 07 2013 FEB 13 2014

Institutional Review Board

Informed Consent - Prescreening (UTA Students)

Consent Form

PRINCIPAL INVESTIGATOR: Tamer F. Desouky, M.S.
FACULTY ADVISOR: Mary Cazzell, Ph.D.

TITLE OF PROJECT: Executive Functioning and Health Behavior

This Informed Consent will explain about being a participant in a research study. It is important that you read this material carefully and then decide if you wish to be a volunteer. This statement describes the purpose, procedures, benefits, risks, discomforts, and precautions of the program. Participation is voluntary.

PURPOSE:
You have been invited to participate in a research project investigating the relationship between cognitive measures and behavior. A total of 600 college students will be participating in this study.

DURATION
The study setup should take 1 hour and 30 minutes to complete.

PROCEDURES
To participate in the current study you must be 18 years of age or older. Subjects with neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with thinking, memory, concentration, sensation, perception, or motor behavior will be excluded from this study.

The first part of the study will be conducted on-line. Upon completion of the brief 5 minute survey you will be invited to participate in the second part of the study by the researcher.

The second part of the study will be conducted on campus in the Life Science building. You will complete 5 questionnaires on demographics as well as health behaviors. Additionally, you will take 4 cognitive tests assessing several areas of brain functioning. These cognitive measures include the use of a computer mouse, computer keyboard, and/or physical console, and some behavioral tests.

POSSIBLE RISKS/DISCOMFORTS
There are no risks associated with this research project other than your valuable time being spent in the research study.

POSSIBLE BENEFITS

The possible benefits of your participation are:

If you are taking a Psychology course then by participating in this study it will satisfy the requirements for required research credit within the Psychology department.

According to the participant pool information handbook, credit will be based on 30-minute increments.

A typical on-line 30-minute experiment will be worth 0.5 credit; a typical on-line 60-minute experiment is worth 1 credit.

A typical in-lab 30-minute experiment will be worth 0.75 credit; a typical in-lab 60-minute experiment is worth 1.5 credits.

In a scientific sense, there will be a societal benefit of increased understanding of health behavior.

You may contact the Researchers at a later time for a summary of the research results.

ALTERNATIVE PROCEDURES / TREATMENTS

The alternative procedures / treatments available to you if you elect not to participate in this study are: Please talk with your course instructor about other options for research requirements or extra credit.

CONFIDENTIALITY

Every attempt will be made to see that your study results are kept confidential. A copy of the records from this study will be stored in Office 302 in the Life Sciences Building for at least three (3) years after the end of this research. The results of this study may be published and/or presented at meetings without naming you as a subject. Although your rights and privacy will be maintained, the Secretary of the Department of Health and Human Services, the UTA IRB, the FDA (if applicable), and personnel particular to this research (individual or department) have access to the study records. Your data records will be kept completely confidential according to current legal requirements. They will not be revealed unless required by law, or as noted above.

FINANCIAL COSTS

The possible financial costs to you as a participant in this research study are: None.

CONTACT FOR QUESTIONS

If you have any comments, problems or research-related questions at any time, you may call Tamer Desouky at 682-553-7614. You may call the Chairperson of the Institutional Review Board at 817/272-3723 for any questions you may have about your rights as a research subject.

VOLUNTARY PARTICIPATION

Participation in this research experiment is voluntary. You must be 18 years of age or older, or have parental consent on file through SONA in order to participate. You may refuse to participate or quit at any time. If you quit or refuse to participate, the benefits (or treatment) to which you are otherwise entitled will not be affected. You may quit by calling Tamer Desouky, whose phone number is (682-553-7614). You will be told immediately if any of the results of the study should reasonably be expected to make you change your mind about staying in the study.

By electronically signing below, you confirm that you have read this document and that you freely and voluntarily choose to be in this research project.

1. SUBJECT'S PERMISSION

I have read the Consent Form and conditions of this project.

I have asked any questions that I had and agree to participate in this study.

I understand that I may withdraw from participation at any time without penalty.

I hereby acknowledge the above and give my voluntary consent:

*

- ○ Yes - I hereby acknowledge the above and give my voluntary consent.
- ○ No - I do not acknowledge the above and do not give my voluntary consent.

Prescreening

Last Name: *

First Name: *

UTA ID Number (starts with 1000): *

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MAR 0 5 2013 FEB 1 3 2014
Institutional Review Board

2. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *thinking*? *

- ○ Yes
- ○ No

3. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *memory*? *

- ○ Yes
- ○ No

4. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *concentration* (i.e., paying attention)? *

- ○ Yes
- ○ No

5. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *sensation*? *

- ○ Yes
- ○ No

6. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *perception*? *

- ○ Yes
- ○ No

7. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *motor behavior (e.g., walking, running, grasping, etc..)*? *

- ○ Yes
- ○ No

Thank You!

Thank you for your responses! You are eligible to participate in the study.

You will invited to participate in the second part of this study. If you do not hear back from the researcher please contact Tamer Desouky to schedule a meeting time.

E-mail: tamer.desouky@mavs.uta.edu

APPROVED
MAR 0 5 2013 FEB 1 3 2014
Institutional Review Board

APPROVED
MAR 0 5 2013 FEB 1 3 2014
Institutional Review Board

Informed Consent - Prescreening (Adults)

Consent Form

PRINCIPAL INVESTIGATOR: Tamer F. Desouky, M.S.
FACULTY ADVISOR: Mary Cazzell, Ph.D.

TITLE OF PROJECT: Executive Functioning and Health Behavior

This Informed Consent will explain about being a participant in a research study. It is important that you read this material carefully and then decide if you wish to be a volunteer. This statement describes the purpose, procedures, benefits, risks, discomforts, and precautions of the program. Participation is voluntary.

PURPOSE:
You have been invited to participate in a research project investigating the relationship between cognitive measures and behavior. A total of 600 adults will be participating in this study.

DURATION
The study setup should take 1 hour and 30 minutes to complete.

PROCEDURES
To participate in the current study you must be 18 years of age or older. Subjects with neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with thinking, memory, concentration, sensation, perception, or motor behavior will be excluded from this study.

The first part of the study will be conducted on-line. Upon completion of the brief 5 minute survey you will be invited to participate in the second part of the study by the researcher.

The second part of the study will be conducted on campus in the Life Science building. You will complete 5 questionnaires on demographics as well as health behaviors. Additionally, you will take 4 cognitive tests assessing several areas of brain functioning. These cognitive measures include the use of a computer mouse, computer keyboard, and/or physical console, and some behavioral tests.

POSSIBLE RISKS/DISCOMFORTS
There are no risks associated with this research project other than your valuable time being spent in the research study.

POSSIBLE BENEFITS
You will be compensated with a $5 dollar gift card to Starbucks.

In a scientific sense, there will be a societal benefit of increased understanding of health behavior.

You may contact the Researchers at a later time for a summary of the research results.

ALTERNATIVE PROCEDURES / TREATMENTS

The alternative procedures / treatments available to you if you elect not to participate in this study are: Please talk with your course instructor about other options for research requirements or extra credit.

CONFIDENTIALITY

Every attempt will be made to see that your study results are kept confidential. A copy of the records from this study will be stored in Office 302 in the Life Sciences Building for at least three (3) years after the end of this research. The results of this study may be published and/or presented at meetings without naming you as a subject. Although your rights and privacy will be maintained, the Secretary of the Department of Health and Human Services, the UTA IRB, the FDA (if applicable), and personnel particular to this research (individual or department) have access to the study records. Your data records will be kept completely confidential according to current legal requirements. They will not be revealed unless required by law, or as noted above.

FINANCIAL COSTS

The possible financial costs to you as a participant in this research study are: None.

CONTACT FOR QUESTIONS

If you have any comments, problems or research-related questions at any time, you may call Tamer Desouky at 682-553-7614. You may call the Chairperson of the Institutional Review Board at 817/272-3723 for any questions you may have about your rights as a research subject.

VOLUNTARY PARTICIPATION

Participation in this research experiment is voluntary. You must be 18 years of age or older, or have parental consent on file through SONA in order to participate. You may refuse to participate or quit at any time. If you quit or refuse to participate, the benefits (or treatment) to which you are otherwise entitled will not be affected. You may quit by calling Tamer Desouky, whose phone number is (682-553-7614). You will be told immediately if any of the results of the study should reasonably be expected to make you change your mind about staying in the study.

By electronically signing below, you confirm that you have read this document and that you freely and voluntarily choose to be in this research project.

1. **SUBJECT'S PERMISSION**

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MAR 0 5 2013 FEB 1 3 2014
Institutional Review Board

I have read the Consent Form and conditions of this project.

I have asked any questions that I had and agree to participate in this study.

I understand that I may withdraw from participation at any time without penalty.

I hereby acknowledge the above and give my voluntary consent:

*

- ○ Yes - I hereby acknowledge the above and give my voluntary consent.
- ○ No - I do not acknowledge the above and do not give my voluntary consent.

Prescreening

Last Name: *

First Name: *

UTA ID Number (starts with 1000): *

2. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *thinking*? *

- ○ Yes
- ○ No

3. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *memory*? *

- ○ Yes
- ○ No

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MAR 05 2013
FEB 13 2014
Institutional Review Board

4. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *concentration* (i.e., paying attention)? *

- ○ Yes
- ○ No

5. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *sensation*? *

- ○ Yes
- ○ No

6. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *perception*? *

- ○ Yes
- ○ No

7. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *motor behavior (e.g., walking, running, grasping, etc..)*? *

- ○ Yes
- ○ No

Thank You!

Thank you for your responses! You are eligible to participate in the study.

You will invited to participate in the second part of this study. If you do not hear back from the researcher please contact Tamer Desouky to schedule a meeting time.

E-mail: tamer.desouky@mavs.uta.edu

APPROVED

MAR 0 5 2013 FEB 1 3 2014

Institutional Review Board

Appendix C

License Agreement for BRIEF®-A

PAR
Creating Connections. Changing Lives.

16204 N. FLORIDA AVENUE • LUTZ, FLORIDA 33549
Telephone: 813.968.3003 • Fax: 813.968.2598 • Web: www.parinc.com

LICENSE AGREEMENT

THIS AGREEMENT, made this December 18, 2012, by and between Psychological Assessment Resources, Inc., a Florida Corporation, with its principal offices located at 16204 North Florida Avenue, Lutz, Florida 33549, hereinafter referred to as PAR, and Tamer F. Desouky, M.S., with his principal offices located at The University of Texas at Arlington, Department of Psychology, 501 S. Nedderman, Suite 313, Arlington, TX 76019, hereinafter referred to as Licensee.

1) RECITALS

PAR has developed and holds all copyrights and distribution rights to certain psychological tests and related materials as listed in Schedule A, hereinafter called "Test". The Test consists of PAR's items, scoring keys, scales, profiles, standard-score conversion tables, norms tables, interpretive information, and related materials created, prepared, devised, and combined by PAR for the administration, scoring, reporting, and analysis of the Test, and includes the words, symbols, numbers, and letters used to represent the Test. Licensee desires to develop automated procedures for the secure and encrypted administration of the Test through Licensee's secure internet assessment website. The access to Licensee's website will be by invitation only in connection with Licensee's research study titled, *Is Executive Functioning Associated with Protective Health Behaviors of Physical Activity and Healthy Dieting?* and to subjects for this research purpose only (the "Limited Purpose(s)"). Unless permitted to do so by a separate license agreement, Licensee only has the right to use the Test for the Limited Purpose described above.

In consideration of the mutual covenants and promises expressed herein and other good and valuable considerations, it is agreed as follows:

2) LICENSE

PAR hereby grants to Licensee, subject to the terms of this Agreement, a non-transferable, non-exclusive license to place the Test on Licensee's Website for the Limited Purpose described in Section 1 above. Licensee agrees to hold secure and treat as proprietary all information transferred to it from PAR. Licensee shall carefully control the use of the Test for the

Limited Purpose described in this Agreement. Licensee's use of the Test will be under the supervision or in consultation with a qualified psychologist or other qualified individual and consistent with the then current edition of the Standards for Educational and Psychological Testing published by the American Psychological Association.

3) TERMS AND TERMINATION

The initial term of this Agreement shall extend from January 1, 2013 through September 30, 2013, and may be extended only by mutual agreement of the parties. Not withstanding any other provision of this Agreement, this Agreement may be terminated if any of the following events occur:

(a) Termination is mutually agreed to by the parties.

(b) Licensee defaults in the performance of any of its duties hereunder.

On the effective date of expiration or termination of this Agreement pursuant to subsections (a) and (b) above, all rights in this Agreement revert to PAR. Computer software programs written by or for Licensee remain the property of Licensee. Licensee warrants that upon expiration or termination of this Agreement under subsections (a) and (b) above, and except as set forth in any separate license agreement relating thereto, all portions of the Test licensed hereunder shall be removed from Licensee's Website. Failure to cease all uses of the Test shall constitute copyright infringement.

4) TERMINATION RIGHTS

In the event of termination pursuant to paragraph 3 above for any reason, PAR shall not be liable to Licensee for compensation, reimbursement or damages for any purpose, on account of any expenditures, investments, leases or commitments made or for any other reason whatsoever based upon or growing out of this Agreement.

5) CONDITIONS OF USE

PAR shall have the right to review, test, and approve that portion of Licensee's Website which includes the Test. Following PAR's approval of that portion of Licensee's Website containing the Test, the manner in which the Test appears on such Website shall not be changed in any material way without prior approval of PAR.

The computer programs developed by Licensee and used in any phase of administration and scoring of the Test shall be fully tested by Licensee and shall be encrypted and reasonably protected from access, intrusion and changes by persons who are not authorized agents of Licensee. In addition to the foregoing, Licensee shall exert all reasonable commercial efforts to prevent the Programs, and any accompanying code for the administration of the Test from being accessed, viewed or copied by others. Licensee warrants the accuracy of such scoring and reporting.

6) PROPRIETARY RIGHTS

PAR is the owner of all right, title and interest in the Test. Licensee shall acquire no right or interest in the Test, by virtue of this Agreement or by virtue of the use of the Test, except the right to use the Test in accordance with the provisions of this Agreement. Licensee shall not modify or revise the Test in any manner without written approval by PAR. All uses of the Test by Licensee shall inure to the benefit of PAR. Licensee agrees not to challenge or otherwise interfere with the validity of the Test or PAR's ownership of them.

7) ROYALTIES

Licensee agrees to pay PAR a royalty fee for use of the Test and copyrighted materials contained therein, at the rate of $1.25 per each test administration of the Test. Licensee will also provide PAR with an itemized accounting of all administrations of each Test administered by Licensee during the term of this agreement. Licensee shall pay to PAR Two Hundred and Fifty Dollars ($250.00) as an initial license fee ($1.25 per administration for 200 administrations), which is due and payable upon the signing of this License Agreement. Licensee shall also pay PAR $1.25

per each test administered for any tests administered above 200 by October 15, 2013.

8) ACCOUNTING

Licensee shall develop secure computerized accounting methods acceptable to PAR. Such accounting methods must include an electronic counting mechanism which will accurately record the number of administrations of each Test used. Licensee will keep accurate financial records of all transactions relating to the use of the Test, and PAR shall have the right to examine the software and records of Licensee pertaining to the use of the Test. Licensee will make such software and records accessible to PAR or its nominee during normal working hours upon not less than five (5) business days' prior written notice. Licensee shall retain such software and records for at least one year from the date this Agreement expires or the effective termination date.

The Website shall contain the following copyright notice:

> "Adapted and reproduced by special permission of the Publisher, Psychological Assessment Resources, Inc., 16204 North Florida Avenue, Lutz, Florida 33549, from the Behavior Rating Inventory of Executive Function-Adult Version by Robert M. Roth, Ph.D., Peter K. Isquith, Ph.D. and Gerard A. Gioia, Ph.D., Copyright 1996, 1998, 2001, 2003, 2004, 2005 by PAR, Inc. Further reproduction is prohibited without permission from PAR, Inc."

9) INDEMNITY

Licensee agrees to indemnify PAR and hold PAR harmless against any claim or demand or against any recovery in any suit (including taxes of any kind, reasonable attorney's fees, litigation costs, and other related expenses) that may be:

(a) brought by or against PAR, arising or alleged to have arisen out of the use of the Test by Licensee;

(b) sustained or incurred by PAR, arising or alleged to have arisen in any way from the breach of any of Licensee's obligations hereunder; or

(c) incurred by PAR in any litigation to enforce this Agreement, including litigation against Licensee.

10) ASSIGNMENT

Licensee shall not assign this Agreement or any license, power, privilege, right, or immunity, or delegate any duty, responsibility, or obligation hereunder, without the prior written consent of PAR. Any assignment by PAR of its rights in the Test shall be made subject to this Agreement.

11) GOVERNING LAW

This Agreement shall be construed according to the laws of the State of Florida of the United States of America. Venue for any legal action relative to this Agreement shall be in the appropriate state court in Hillsborough County, Florida, or in the United States District Court for the Middle District of Florida, Tampa division. Licensee agrees that, in any action relating to this Agreement, the Circuit Court in Hillsborough County, Florida or the United States District Court for the Middle District of Florida, Tampa Division, has personal jurisdiction over Licensee, and that Licensee waives any argument it may otherwise have against the exercise of those courts' personal jurisdiction over Licensee.

12) SEVERABILITY

If any provision of this Agreement shall, to any extent, be invalid and unenforceable such provision shall be deemed not to be part of this Agreement, and the parties agree to remain bound by all remaining provisions.

13) EQUITABLE RELIEF

Licensee acknowledges that irreparable damage would result from unauthorized use of the Test and further agrees that PAR would have no adequate remedy at law to redress such a breach. Therefore, Licensee agrees that, in the event of such a breach, specific performance and/or

injunctive relief, without the necessity of a bond, shall be awarded by a Court of competent jurisdiction.

14) ENTIRE AGREEMENT OF THE PARTIES

This instrument embodies the whole Agreement of the parties. There are no promises, terms, conditions, or obligations for the Test licensed hereunder other than those contained herein; and this Agreement shall supersede all previous communications, representations, or agreements, either written or verbal, between the parties hereto, with the exception of any prior agreements that have not previously been terminated by written consent of both parties or by one party if the terms of the agreement allow. This Agreement may be changed only by an agreement in writing signed by both parties.

15) NOTICES AND MODIFICATIONS

Any notice required or permitted to be given under this Agreement shall be sufficient if in writing and if sent by certified or registered mail postage prepaid to the addresses first herein above written or to such addresses as either party may from time to time amend in writing. No letter, telegram, or communication passing between the parties hereto covering any matter during this contract, or periods thereafter, shall be deemed a part of this Agreement unless it is distinctly stated in such letter, telegram, or communication that it is to constitute a part of this Agreement and is to be attached as a right to this Agreement and is signed by both parties hereto.

16) SUCCESSORS AND ASSIGNS

Subject to the limitations on assignments as provided in Section 10, this Agreement shall be binding on the successors and assigns of the parties hereto.

17) PARAGRAPH HEADINGS

The paragraph headings contained in this Agreement are inserted only for convenience and they are not to be construed as part of this Agreement.

18) AUTHORIZATION AND REPRESENTATION

Each party represents to the others that it has been authorized to execute and deliver this Agreement through the persons signing on its behalf.

IN WITNESS WHEREOF, the parties have executed this Agreement in duplicate on the date first herein above written.

ACCEPTED AND AGREED:

BY: [redacted]

TAMER F. DESOUKY, M.S.

Title: [redacted]

DATE: 12/20/2012

ACCEPTED AND AGREED:

BY: [redacted]

R. BOB SMITH III, PH.D.

Title: CHAIRMAN AND CEO

DATE: 12-27-12

PAYMENT RECEIVED: [redacted]
PAR CUSTOMER No.: [redacted]

SIGNATURE OF PROFESSOR REQUIRED:

I hereby agree to supervise this student's use of these materials. I also certify that I am qualified ~~to~~ use and interpret the results of these tests as recommended in the *Standards for Educational and Psychological Testing*, and I assume full responsibility for the proper use of all materials used per this Agreement.

BY: [redacted]

Printed Name: [redacted]

SCHEDULE A

The Test licensed to Licensee pursuant to the above license consist of PAR's items, scoring keys, scales, profiles, standard-score conversion tables, norms tables, and related materials created, prepared, devised, and combined by PAR for the administration, scoring, reporting, and analysis of the Test, and include the words, symbols, numbers, and letters used to represent the Test. However, PAR and Licensee acknowledge and agree that Licensee may use only the PAR items and scoring information for the Test as appropriate for the Limited Purpose. The Test referred to in the body of this Agreement is defined as follows:

1) Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A) Self-Report Form Only

Added 1/30/2013: Permission is also granted for you to include up to a total of three (3) sample items from the BRIEF-A in the appendix of your dissertation.

Appendix D

Latin Square Study Setup

The 6x6 Balanced Latin Square is made as follows (Bradley, 1958):

1	2	*n*	3	*n*-1	4
2	3				
3	4				
4	5				
5	6				
6	1				

The Complete 6x6 Balanced Latin Square.

1	2	6	3	5	4
2	3	1	4	6	5
3	4	2	5	1	6
4	5	3	6	2	1
5	6	4	1	3	2
6	1	5	2	4	3

Legend
1=EF Experimental Tasks
2=BRIEF-A
3=Physical Activity Recall
4=Dietary Questionnaire
5=SR Physical Activity
6=SR Healthy Eating

Subject Number	Condition Order					
1	EF Experimental Tasks	BREIF-A	SR Healthy Eating	Physical Activity	SR Physical Activity	Dietary Questionnaire
2	BREIF-A	Physical Activity	EF Experimental Tasks	Dietary Questionnaire	SR Healthy Eating	SR Physical Activity
3	Physical Activity	Dietary Questionnaire	BREIF-A	SR Physical Activity	EF Experimental Tasks	SR Healthy Eating
4	Dietary Questionnaire	SR Physical Activity	Physical Activity	SR Healthy Eating	BREIF-A	EF Experimental Tasks
5	SR Physical Activity	SR Healthy Eating	Dietary Questionnaire	EF Experimental Tasks	Physical Activity	BREIF-A
6	SR Healthy Eating	EF Experimental Tasks	SR Physical Activity	BREIF-A	Dietary Questionnaire	Physical Activity
5	*Repeat Sequence*					

The 4x4 Balanced Latin Square is made as follows (Bradley, 1958):

1	2	*n*	3
2	3		
3	4		
4	1		

The Complete 4x4 Balanced Latin Square.

1	2	4	3
2	3	1	4
3	4	2	1
4	1	3	2

Legend
1=Initiation
2=Working Memory
3=Switching
4=Inhibition

Subject Number	Condition Order			
1	Initiation	Working Memory	Inhibition	Switching
2	Working Memory	Switching	Initiation	Inhibition
3	Switching	Inhibition	Working Memory	Initiation
4	Inhibition	Initiation	Switching	Working Memory
5	*Repeat Sequence*			

Appendix E

Questionnaires

Prescreening

1. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *thinking*? (yes/no)
2. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *memory*? (yes/no)
3. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *concentration* (i.e., paying attention)? (yes/no)
4. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *sensation*? (yes/no)
5. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *perception*? (yes/no)
6. Do you have any neurocognitive, neuropsychological, neurological, psychiatric, medical, or developmental conditions that interfere with *motor behavior*? (yes/no)

Control Variables

7. Do you have heart disease? (yes/no)
8. Do you have diabetes? (yes/no)
9. What is your height and weight? [to measure obesity] (yes/no)
10. Are you currently pregnant? (yes/no)
11. Have you given birth in the previous six months? (yes/no)
12. Are you a student athlete? (yes/no)
13. How many credit hours are you taking this semester? _____.
14. How many hours do you work per week this semester? _____.

15. I tend to have a positive outlook on life.

Strongly disagree					Strongly agree
1	2	3	4	5	6

16. I am satisfied with the way my life is going right now.

Strongly disagree					Strongly agree
1	2	3	4	5	6

The Self-Regulation Scale of Physical Activity

Goal Selection

Please rate your agreement with the statements below:

1. How committed are you to achieve the goal of being physically fit? [commitment]

Not at all committed					Very committed
1	2	3	4	5	6

2. How committed are you to exercising weekly? [commitment]

Not at all committed					Very committed
1	2	3	4	5	6

3. I selected the goal of being physically fit on my own. [self set]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

4. I selected the goal of being physically fit because of the influence of others. [other set]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

5. I find pleasure in being physically fit in and of itself as my overall goal. [intrinsic]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

6. I find that being physically fit helps me achieve other goals [extrinsic]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Goal setting

7. I have set specific physical exercising goals to achieve each week. [Specificity]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

8. I have set difficult physical exercising goals to meet each week. [Difficulty]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Implementation Intentions (Ziegelmann et al., 2007)

9. "I have already planned precisely when to exercise"

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

10. "I have already planned precisely where to exercise"

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Goal Reminders

11. In the past 7 days I have set up a system that automatically reminds me to exercise (e.g., alarm clock, putting jogging shoes in front of door, having people to remind you, purposely parking in the gym parking lot, daily checklist, etc…)

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Self-Monitoring (Modified from Clark et al. 2001)

12. I watch myself carefully to see if exercise is working to make me physically fit.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

13. I evaluate the benefit of exercise to see if it has an impact on my physical fitness.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

14. I use criteria for making a decision on my own to change the type, frequency, or intensity of exercise in response to changes in my physical fitness

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

15. I have a plan to adjust my exercise if the pattern of physical fitness gets better or worse.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

16. I can easily switch exercise techniques in order to achieve my goal of being physically fit.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Self-Control

17. In general, in the past 7 days, I got lazy and did not exercise.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

18. In the past 7 days, I exercised even when I did not feel like it.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

19. Pleasure and fun got in the way of exercising in the past 7 days.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Automaticity

20. How often do you find yourself in the past 7 days, automatically without thinking, walking fast between any two locations in your daily errands.

Not at all					Very often
1	2	3	4	5	6

21. How often do you find yourself in the past 7 days, automatically without thinking, taking the stairs instead of the elevators.

Not at all					Very often
1	2	3	4	5	6

Self-Consequating

22. In the past 7 days I have rewarded myself (“treated myself”) when I accomplished my weekly goal of exercising.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

23. In the past 7 days I have punished myself when I did not accomplish my weekly goal of exercising.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Self-Efficacy

24. How confident are you in your ability to manage your overall physical fitness?

Not at all confident					Very confident
1	2	3	4	5	6

Controlling for Social Facilitation Items

25. During my weekly exercise, I go with a workout buddy.

Strongly disagree					Strongly agree
1	2	3	4	5	6

26. During my weekly exercise, I go with a professional trainer.

Strongly disagree					Strongly agree
1	2	3	4	5	6

27. During my weekly exercise, I attend motivational informational groups. (e.g., weight watchers)

Strongly disagree					Strongly agree
1	2	3	4	5	6

28. During my weekly exercise, I attend group fitness (aerobics, aqua sports, boot camp conditioning, club boxing, cycling, etc...).

Strongly disagree					Strongly agree
1	2	3	4	5	6

The Self-Regulation Scale of Healthy Eating

Goal Selection

1. How committed are you to achieve the goal of eating healthy? [commitment]

Not at all committed					Very committed
1	2	3	4	5	6

2. How committed are you to eating healthy *every week*? [commitment]

Not at all committed					Very committed
1	2	3	4	5	6

3. I selected the goal of eating healthy on my own. [self set]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

4. I selected the goal of eating healthy because of the influence of others. [other set]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

5. I find pleasure in eating healthy in and of itself as my overall goal. [intrinsic]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

6. I find that eating healthy helps me achieve other goals [extrinsic]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Goal setting

7. I have set specific healthy eating goals each week to achieve. [Specificity]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

8. I have set difficult healthy eating goals to meet each week. [Difficulty]

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Implementation Intentions (Ziegelmann et al., 2007)

9. I have already planned precisely when to eat my healthy diet.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

10. I have already planned precisely where to eat my healthy diet.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Goal Reminders

11. In the past 7 days I have set up a system that automatically reminds me to eat healthy (e.g., alarm clock, having people to remind me, daily checklist, etc…)

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Self-Monitoring (Modified from Clark et al. 2001)

12. I watch myself carefully to see if eating healthy is working to make me healthy.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

13. I evaluate the benefit of healthy eating to see if it had an impact on my health goals.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

14. I use criteria for making a decision on my own to change the type of food in response to changes in my health.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

15. I have a plan to adjust my eating habits if my health gets better or worse.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

16. I can easily switch eating regimens in order to achieve my goal of being healthy.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Self-Control

17. In general, in the past 7 days, I got lazy and decided not to eat healthy.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

18. In the past 7 days, I resisted the temptation to eat junk food.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

19. Pleasure and fun got in the way of eating healthy in the past 7 days.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Automaticity

20. How often do you find yourself in the past 7 days, automatically without thinking, eating everything on your plate, even if it be unhealthy food?

Not at all					Very often
1	2	3	4	5	6

21. How often do you find yourself in the past 7 days, automatically without thinking, buying some unhealthy food while shopping for groceries?

Not at all					Very often
1	2	3	4	5	6

Self-Consequating

22. In the past 7 days I have rewarded myself (“treated myself”) when I accomplished my weekly goal of healthy eating.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

23. In the past 7 days I have punished myself when I did not accomplish my weekly goal of healthy eating.

Strongly Disagree					Strongly Agree
1	2	3	4	5	6

Self-Efficacy

24. Overall, how confident are you in your ability to manage your health via healthy eating?

Not at all confident					Very confident
1	2	3	4	5	6

Controlling for Social Facilitation Items

25. During the week, I eat with individuals who share my healthy eating goals.

Strongly disagree					Strongly agree
1	2	3	4	5	6

26. During the week, I check my weekly recipes and foods with someone who knows a lot about nutrition.

Strongly disagree					Strongly agree
1	2	3	4	5	6

27. During the week, I attend motivational informational groups. (e.g., weight watchers, neighborhood food clubs, etc…)

Strongly disagree					Strongly agree
1	2	3	4	5	6

Appendix F

Sample Items from BRIEF®-A

Inhibit	58. I rush through things.
Shift	22. I have trouble accepting different ways to solve problems with work, friends, or tasks.
Working Memory	26. I have trouble staying on the same topic when talking.

Appendix G

Descriptive Statistics - Tables

Gender

	Frequency	Percent
Male	39	24.1
Female	123	75.9
Total	162	100.0

Ethnicity

	Frequency	Percent
Hispanic	34	21.0
Non-Hispanic	128	79.0
Total	162	100.0

Race

	Frequency	Percent
American Indian	5	3.1
Asian	50	30.9
Black	20	12.3
White	68	42.0
Other Race	19	11.7
Total	162	100.0

Education

	Frequency	Percent
HS/GED	27	16.7
Two Year College	6	3.7
Working Towards BS	109	67.3
Four Year Degree	16	9.9
Master's Degree	4	2.5
Total	162	100.0

Academic Status

	Frequency	Percent
Freshmen	61	37.7
Sophomore	44	27.2
Junior	29	17.9
Senior	19	11.7
Not Applicable	9	5.6
Total	162	100.0

Income

	Frequency	Percent
$0-19,999	31	19.1
$20,000-$39,999	45	27.8
$40,000-$59,999	33	20.4
$60,000-$79,999	20	12.3
$80,000-$99,999	11	6.8
$100,000 +	22	13.6
Total	162	100.0

Relationship

	Frequency	Percent
Single	140	86.4
Cohabitating	10	6.2
Married	10	6.2
Separated	0	0
Divorced	2	1.2
Total	162	100.0

BMI Status

	Frequency	Percent
Underweight	23	14.2
Normal	108	66.7
Marginally Overweight	11	6.8
Overweight	20	12.3
Obese	0	0
Total	162	100

Age

N	Valid	162
	Missing	0
Mean		21.64
Median		19.00
Std. Deviation		5.71
Range		31.00

BMI

N	Valid	162
	Missing	0
Mean		22.92
Median		22.48
Std. Deviation		3.52
Range		15.17

School and Work Obligations

		Credit Hours	Work Hours
N	Valid	162	162
	Missing	0	0
Mean		12.21	11.63
Median		13.00	5.50
Std. Deviation		4.22	13.39
Range		21.00	45.00

General Well-Being

		Positive Outlook	Life Satisfaction
N	Valid	162	162
	Missing	0	0
Mean		4.99	4.72
Median		5.00	5.00
Std. Deviation		0.90	1.14
Range		4.00	5.00

References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology, 78*(1), 53-63.

Ajzen, I. (1985). From intentions to actins: A theory of planned behavior. In J. Kuhl, & J. Beckmann (Eds.), *Action-control: From cognition to behavior.* (pp. 11-39). Heidelberg, Germany: Springer-Verlag.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewood Cliffs, NJ: Prentice-Hall.

Allan, J. L., Johnston, M., & Campbell, N. (2011). Missed by an inch or a mile? predicting the size of intention–behaviour gap from measures of executive control. *Psychology & Health, 26*(6), 635-650.

Anderson, E. S., Wojcik, J. R., Winett, R. A., & Williams, D. M. (2006). Social-cognitive determinants of physical activity: The influence of social support, self-efficacy, outcome expectations, and self-regulation among participants in a church-based health promotion study. *Health Psychology, 25*(4), 510-20.

Angevaren, M., Aufdemkampe, G., Verhaar, H. J., Aleman, A., & Vanhees, L. (2008). Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment. *Cochrane Database of Systematic Reviews, 16*(3), CD005381.

Arnsten, A. F., & Goldman-Rakic, P. S. (1998). Noise stress impairs prefrontal cortical cognitive function in monkeys: Evidence for a hyperdopaminergic mechanism. *Archives of General Psychiatry, 55*(4), 362-8.

Baddeley, A. (2003). Working memory: Looking back and looking forward. *Nature Reviews Neuroscience, 4*, 829-839.

Baddeley, A. & Hitch, G. (1974). Working memory. *Psychology of Learning and Motivation, 8*, 47-89.

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology & Health, 13*(4), 623-649.

Banfield, J. F., Wyland, C. L., Macrae, C. N., Munte, T. F., & Heatherton, T. F. (2004). The cognitive neuroscience of self-regulation. In R. F. Baumeister, & K. D. Vohs (Eds.), *Handbook of self-regulation: Research, theory, and applications* (pp. 62-83). New York: Guilford Press.

Barenberg, J., Berse, T., & Dutke, S. (2011). Executive functions in learning processes: Do they benefit from physical activity? *Educational Research Review, 6*, 208-222.

Barkley, R. A. (2001). The executive functions and self-regulation: An evolutionary neuropsychological perspective. *Neuropsychology Review, 11*(1)

Baumeister, R. F., & Heatherton, T. F. (1996). Self-regulation failure: An overview. *Psychological Inquiry, 7*, 1-15.

Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. *Social and Personality Psychology Compass, 1*(10), 1-14.

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science, 16*, 351–355.

Beaumont, J. L., Havlik, R., Cook, K. F., Hays, R. D., Wallner-Allen, K., Korper, S. P., et al. (2013). Norming plans for the NIH toolbox. *Neurology, 80*(11 Supplement 3), S87-S92.

Becker, M. H. (1974). The health belief model and sick role behavior. *Health Education & Behavior, 2*(4), 409-419.

Biddle, S. J., Wang, C. K., Chatzisarantis, N. L., & Spray, C. M. (2003). Motivation for physical activity in young people: Entity and incremental beliefs about athletic ability. *Journal of Sports Science, 21*(12), 973-989.

Boekaerts, M., Pintrich, P. R., & Zeidner, M. (Eds.). (2000). *Handbook of self-regulation.* . San Diego: Academic Press.

Bradley, J. V. (1958). Complete counterbalancing of immediate sequential effects in a latin square design. *Journal of the American Statistical Association, 53*(282), 525-528.

Brannon, L., & Feist, J. (2010). *Health psychology: An introduction to behavior and health* (7th ed.). Belmont, CA: Wadsworth Cengage Learning.

Brooks, D. J. (1995). The role of the basal ganglia in motor control: Contributions from PET. *Journal of Neurological Science, 128*, 1-13.

Brown, J. M., Miller, W. R., & Lawendowski, L. A. (1999). The self-regulation questionnaire. In L. VandeCreek, & T. L. Jackson (Eds.), *Innovations in clinical practice: A source book* (Volume 17 ed., pp. 281-289). Sarasota, FL: Professional Resource Press.

Bunge, M. (1996). Mechanism and explanation. *Philosophy of the Social Sciences, 27*(4), 410-465.

Burgess, P. W. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 81-116). East Sussex, U.K.: Psychology Press.

Burnette, J. L. (2010). Implicit theories of body weight: Entity beliefs can weigh you down. *Personality and Social Psychology Bulletin, 36*(3), 410-422.

Carver, C. S. (1979). A cybernetic model of self-attention processes. *Journal of Personality and Social Psychology, 37*(8), 1251.

Carver, C. S., & Scheier, M. F. (1998). *On the self-regulation of behavior*. New York: Cambridge University Press.

Centers for Disease Control and Prevention. (2011). *U.S. physical activity Statistics* . Retrieved November 7, 2011, from http://apps.nccd.cdc.gov/PASurveillance/StateSumResultV.asp?CI=&Year=2007&State=1#data

Chang, L. (1994). A psychometric evaluation of 4-point and 6-point likert-type scales in relation to reliability and validity. *Applied Psychological Measurement, 18*(3), 205-215.

Chomeya, R. (2010). Quality of psychology test between likert scale 5 and 6 points. *Journal of Social Sciences, 6*(3), 399-403.

Clark, N. M., Gong, M., & Kaciroti, N. (2001). A model of self-regulation for control of chronic disease. *Health Education & Behavior, 28*(6), 769-782.

Colcombe, S. J., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science, 14*, 125–130.

Collette, F., Van der Linden, M., Laureys, S., Delfiore, G., Degueldre, C., Luxen, A., et al. (2005). Exploring the unity and diversity of the neural substrates of executive functioning. *Human Brain Mapping, 25*, 409-423.

Colman, A. M. (2001). *A dictionary of psychology*. Oxford: Oxford University Press.

Cook, R. D., & Weisberg, S. (1982). *Residuals and influence in regression*. New York: Chapman and Hall.

Cox III, E. P. (1980). The optimal number of response alternatives for a scale: A review. *Journal of Marketing Research,* , 407-422.

Crews, F. T., & Boettiger, C. A. (2009). Impulsivity, frontal lobes and risk for addiction. *Pharmacology, Biochemistry and Behavior, 93*, 237–247.

Cummins, R. A., & Gullone, E. (2000). Why we should not use 5-point likert scales: The case for subjective quality of life measurement. Paper presented at the *Proceedings of the Second International Conference on Quality of Life in Cities,* Singapore. pp. 74-93.

Dalsgaard, M. K. (2006). Fuelling cerebral activity in exercising man. *Journal of Cerebral Blood Flow & Metabolism, 26*(6), 731-50.

De Luca, C. R., Wood, S. J., Anderson, V., Buchanan, J. A., Proffitt, T. M., Mahony, K., et al. (2003). Normative data from the cantab. I: Development of executive function over the lifespan. *Journal of Clinical and Experimental Neuropsychology, 25*(2), 242-254.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum Press.

Denckla, M. B. (1994). Measurement of executive function. In G. R. Lyon (Ed.), *Frames of reference for the assessment of learning disabilities. new views on measurement issues.* (pp. 117-142). Baltimore, MD: Paul H Brookes Publishing.

Desouky, T. F. (2012). *Is executive functioning associated with protective health behaviors of physical activity and healthy dieting? A meta-analytic study with a narrative review of literature.* Unpublished manuscript.

DeVellis, R. F. (2003). *Scale development: Theory and applications* (2nd ed.). Thousand Oaks, CA: Sage Publications.

DeVon, H. A., Block, M. E., Moyle-Wright, P., Ernst, D. M., Hayden, S. J., Lazzara, D. J., et al. (2007). A psychometric toolbox for testing validity and reliability. *Journal of Nursing Scholarship, 39*(2), 155-164.

Duckworth, A. L., & Kern, M. I. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality, 45*, 259-268.

Durstine, J. L., Grandjean, P. W., Cox, C. A., & Thompson, P. D. (2002). Lipids, lipoproteins, and exercise. *Journal of Cardiopulmonary Rehabilitation, 22*(6), 385-398.

Ecklund-Johnson, E., Miller, S. A., & Sweet, J. J. (2004). Confirmatory factor analysis of the behavioral dyscontrol scale in a mixed clinical sample. *The Clinical Neuropsychologist, 18*(3), 395-410.

Edwards, W. (1954). The theory of decision making. *Psychological Bulletin, 51*(4), 380.

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behavior Research Methods, Instruments, & Computers, 28*, 1-11.

Etnier, J. L., & Chang, Y. (2009). The effect of physical activity on executive function: A brief commentary on definitions, measurement issues, and the current state of the literature. *Journal of Sport and Exercise Psychology, 31*, 469-483.

Friese, M., & Hofmann, W. (2008). What would you have as a last supper? thoughts about death influence evaluation and consumption of food products. *Journal of Experimental Social Psychology, 44*(5), 1388–1394.

Friese, M., Hofmann, W., & Wänke, M. (2008). When impulses take over: Moderated predictive validity of implicit and explicit attitude measures in predicting food choice and consumption behaviour. *British Journal of Social Psychology, 47*(3), 397–419.

Fuster, J. (1993). Frontal lobes. *Current Opinion in Neurobiology, 3*, 160-165.

Gailliot, M. T., Schmeichel, B. J., & Baumeister, R. F. (2006). Self-regulatory processes defend against the threat of death: Effects of self-control depletion and trait self-control on thoughts and fears of dying. *Journal of Personality and Social Psychology, 91*, 49-62.

Gerloff, C., Corwell, B., Chen, R., Hallett, M., & Cohen, L. G. (1998). The role of the human motor cortex in the control of complex and simple finger movement sequences. *Brain,121(9)*, 1695-1709.

Gershon, R. C., Cella, D., Fox, N. A., Havlik, R. J., Hendrie, H. C., & Wagster, M. V. (2010). Assessment of neurological and behavioural function: The NIH toolbox. *The Lancet Neurology, 9*(2), 138-139.

Gershon, R. C., Wagster, M. V., Hendrie, H. C., Fox, N. A., Cook, K. F., & Nowinski, C. J. (2013). NIH toolbox for assessment of neurological and behavioral function. *Neurology, 80*(11 Supplement 3), S2-S6.

Gioia, G. A., Guy, S. C., & Isquith, P. K. (2001). Assessment of executive functions in children with neurologic impairment. In G. A. Gioia, S. C. Guy & P. K. Isquith (Eds.), *Psychological and development assessment* (pp. 317-356). New York, NY: Guilford Press.

Gold, S. M., Schulz, K. H., Hartmann, S., Mladek, M., Lang, U. E., Hellweg, R., et al. (2003). Basal serum levels and reactivity of nerve growth factor and brain-derived neurotrophic factor to standardized acute exercise in multiple sclerosis and controls. *Journal of Neuroimmunology, 138*(1-2), 99-105.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*, 493-503.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why? *Current Directions in Psychological Science, 13*(1), 1-4.

Grigsby, J., & Kaye, K. (1996). *The behavioral dyscontrol scale: Manual*. Denver, CO: Authors.

Grigsby, J., Kaye, K., Eilertsen, T. B., & Kramer, A. M. (2000). The behavioral dyscontrol scale and functional status among elderly medical and surgical rehabilitation patients. *Journal of Clinical Geropsychology, 6*(4), 259-268.

Grigsby, J., Kaye, K., & Robbins, L. J. (1992). Reliabilities, norms and factor structure of the behavioral dyscontrol scale. *Perceptual and Motor Skills, 74*(3), 883-892.

Grodstein, F., Chen, J., & Wilson, R. S. (2001). Type 2 diabetes and cognitive function, I: Community-dwelling elderly women. *Diabetes Care, 24*, 1060–1065.

Hagger, M. S. (2009). Theoretical integration in health psychology: Unifying ideas and complimentary explanations. *British Journal of Health Psychology, 14*, 189-194.

Hagger, M. S., Chatzisarantis, N. L. D., & Biddle, S. J. H. (2002). A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport and Exercise Psychology, 24*, 3-32.

Hagger, M. S., Chatzisarantis, N. L. D., & Harris, J. (2006). The process by which relative autonomous motivation affects intentional behavior: Comparing effects across dieting and exercise behaviors. *Motivation and Emotion, 30*, 306-320.

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2009). The strength model of self-regulation failure and health-related behavior. *Health Psychology Review, 3*(2), 208-238.

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin, 136*(4), 495–525.

Hall, P. A. (2006). *Associations between accelerometer-assessed and self-reported measures of physical activity.* Unpublished manuscript.

Hall, P. A. (2012). Executive control resources and frequency of fatty food consumption: Findings from an age-stratified community sample. *Health Psychology, 31*(2), 235.

Hall, P. A., Crossley, M., & D'Arcy, C. (2010). Executive function and survival in the context of chronic illness. *Annals of Behavioral Medicine, 39*(2), 119-27.

Hall, P. A., Elias, L. J., & Crossley, M. (2006). Neurocognitive influences on health behavior in a community sample. *Health Psychology, 25*(6), 778-782.

Hall, P. A., & Fong, G. T. (2007). Temporal self-regulation theory: A model for individual health behavior. *Health Psychology Review, 1*, 6-52.

Hall, P. A., Fong, G. T., Epp, L., & Elias, L. (2008). Executive function moderates the intention-behavior link for physical activity and dietary behavior. *Psychology and Health, 23*(3), 309-326.

Heatherton, T. F., & Wagner, D. D. (2011). Cognitive neuroscience of self-regulation failure. *Trends in Cognitive Sciences, 15*(3), 132-139.

Hodes, R. J., Insel, T. R., & Landis, S. C. (2013). The NIH toolbox: Setting A standard for biomedical research. *Neurology, 80*(11 Supplement 3), S1-S1.

Hofmann, W., Gschwendner, T., Castelli, L., & Schmitt, M. (2008). Implicit and explicit attitudes and interracial interaction: The moderating role of situationally available control resources. *Group Process & Intergroup Relations, 11*, 69-87.

Hofmann, W., Gschwendner, T., Friese, M., Wiers, R. W., & Schmitt, M. (2008). Working memory capacity and self-regulatory behavior: Toward an individual differences perspective on behavior determination by automatic versus controlled processes. *Journal of Personality and Social Psychology, 95*(4), 962.

Hofmann, W., Rauch, W., & Gawronski, B. (2007). And deplete us not into temptation: Automatic attitudes, dietary restraint, and self-regulatory resources as determinants of eating behavior. *Journal of Experimental Social Psychology, 43*, 497–504-10.1016/j.jesp.2006.05.004.

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences, 3*, 174-180.

Horn, J. L., & Cattell, R. B. (1967). Age differences in fluid and crystallized intelligence. *Acta Psychologica, 26*, 107-129.

Inzlicht, M., McKay, L., & Aronson, J. (2006). Stigma as ego depletion: How being the target of prejudice affects self-control. *Psychological Science, 17*, 262–269.

Kahn, J., & Dietzel, L. C. (2008). *Late, lost and unprepared: A parents' guide to helping children with executive functioning*. Bethesda: Woodbine House.

Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self regulation. *Perspectives on Psychological Science, 5*(1), 43-57.

Karoly, P. (1993). Mechanisms of self-regulation: A systems view. *Annual Review of Psychology, 44*, 23-52.

Kasimatis, M., Miller, M., & Marcussen, L. (1996). The effects of implicit theories on exercise motivation. *Journal of Research in Personality, 30*(4), 510-516.

Kawakita, E., Hashimoto, M., & Shido, O. (2006). Docosahexaenoic acid promotes neurogenesis *in vitro* and *in vivo*. *Neuroscience, 139*(3), 991-997.

Kim, H. (2007). Novel metabolism of docosahexaenoic acid in neural cells. *Journal of Biological Chemistry, 282*(26), 18661-18665.

Kimmons, J., Gillespie, C., Seymour, J., Serdula, M., & Blanck, H. M. (2009). Fruit and vegetable intake among adolescents and adults in the united states: Percentage meeting individualized recommendations. *Medscape Journal of Medicine, 11*(1): 26.

Knudsen, E. L. (2007). Fundamental components of attention. *Annual Review of Neuroscience, 30*, 57-78.

Leventhal, H., Leventhal, E. A., & Contrada, R. J. (1998). Self-regulation, health, and behavior: A perceptual-cognitive approach. *Psychology and Health, 13*(4), 717-733.

Leventhal, H., Meyer, D., & Nerenz, D. (1980). The common sense representation of illness danger. In S. Rachman (Ed.), *Medical psychology* (Vol II ed., pp. 7-30). New York: Pergamon Press.

Levy, W. C., Cerqueira, M. D., Harp, G. D., Johannessen, K. A., Abrass, I. B., Schwartz, R. S., et al. (1998). Effect of endurance exercise training on heart rate variability at rest in healthy young and older men. *The American Journal of Cardiology, 82*(10), 1236-41.

Libet, B., Gleason, C. A., Wright, E. W., & Pearl, D. K. (1983). Time of conscious intention to act in relation to onset of cerebral activity (readiness potential). the unconscious initiation of a freely voluntary act. *Brain, 106*, 623–642.

Lukiw, W. J., Cui, J. G., Marcheselli, V. L., Bodker, M., Botkjaer, A., Gotlinger, K., et al. (2005). A role for docosahexaenoic acid–derived neuroprotectin D1 in neural cell survival and alzheimer disease. *Journal of Clinical Investigation, 115*(10), 2774-2783.

Luria, A. R. (1966). *Higher cortical functions in man.* New York: Basic Books.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex “Frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49-100.

Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual causes of death in the united states, 2000. *The Journal of the American Medical Association, 291*(10), 1238-1245.

Mora, P. A., & Ozakinci, G. (2012). Self-regulation model. In M. Gellman, & T. J. Rick (Eds.), *Encyclopedia of behavioral medicine*. New York: Springer Science Business Media.

National Cancer Institute - Applied Research Program. *Dietary factors, food items asked, and testing status for dietary screener questions for NHANES 2009-10.* Retrieved September 29, 2013, from http://appliedresearch.cancer.gov/studies/nhanes/dietscreen/evaluation.html

NIH toolbox Administration Manual – English Version. (2012). Unpublished manuscript.

NIH toolbox Training Manual – English Version. (2012). Unpublished manuscript.

Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. J. Davidson (Ed.), *Consciousness and self-regulation: Advances in research and theory (volume 4)* (pp. 1-18). New York: Plenum.

Nowinski, C. J., Victorson, D., Debb, S. M., & Gershon, R. C. (2013). Input on NIH toolbox inclusion criteria surveying the end-user community. *Neurology, 80*(11 Supplement 3), S7-S12.

Ogden, J. (2003). Some problems with social cognition models: A pragmatic and conceptual analysis. *Health Psychology, 22*(4), 424.

Ommundsen, Y. (2003). Implicit theories of ability and self-regulation strategies in physical education classes. *Educational Psychology, 23*(2), 141-157.

Omondi, O. D., Othoun, A. O. L., & Mbagaya, M. G. (2012). Can physical activity and dietary fat intake influence body mass index in a cross-sectional correlation design? *International Journal of Biological and Life Sciences, 8*(3), 163-166.

Pavlov, I. P. (1927). *Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex*. London: Oxford University Press.

Phan, K. L., & Tucker, D. M. (2003). Self-regulation and the executive functions: Electrophysiological clues. In A. Zani, & A. Mado Proverbio (Eds.), *The cognitive electrophysiology of mind and brain* (pp. 199– 223). California: Elsevier.

Pinto, A., Di, R., D., Tuttolomondo, A., Buttà, C., Milio, G., & Licata, G. (2012). Effects of physical exercise on inflammatory markers of atherosclerosis. *Current Pharmaceutical Design, ePublication ahead of print.*

Prochaska, J. O., & DiClemente, C. C. (1982). Transtheoretical therapy: Toward a more integrative model of change. *Psychotherapy: Theory, Research & Practice, 19*(3), 276.

Rabbitt, P. (1997). Introduction: Methodologies and models in the study of executive function. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 1-38). East Sussex, U.K.: Psychology Press.

Richeson, J. A., & Shelton, J. N. (2003). When prejudice does not pay: Effects of interracial contact on executive function. *Psychological Science, 14*, 287–290.

Roberts, B. W., Kuncel, N. R., Shiner, R., Caspi, A., & Goldberg, L. R. (2007). The power of personality: The comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. *Perspectives on Psychological Science, 2*(4), 313-345.

Rogers, P. J. (2001). A healthy body, a healthy mind: Long-term impact of diet on mood and cognitive function. *Proceedings-Nutrition Society of London, 60*(1), 135-143.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude Change1. *The Journal of Psychology, 91*(1), 93-114.

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *BRIEF-A: Behavioral rating inventory of executive Function—Adult version.* Lutz, FL: Psychological Assessment Resources, Inc.

Sallis, J. F., Haskell, W. L., Wood, P. D., Fortmann, S. P., Rogers, T., Blair, S. N., et al. (1985). Physical activity assessment methodology in the five-city project. *American Journal of Epidemiology, 121*(1), 91-106.

Sansone, C., & Smith, J. L. (2000). The "how" of goal pursuit: Interest and self-regulation. *Psychological Inquiry, 11*, 306-309.

Sarsour, K., Sheridan, M., Jutte, D., Nuru-Jeter, A., Hinshaw, S., & Boyce, W. T. (2011). Family socioeconomic status and child executive functions: The roles of language, home environment, and single parenthood. *Journal of the International Neuropsychological Society, 17*(1), 120-32.

Schaie, K. W. (1994). The life course of adult intellectual abilities. *American Psychologist, 49*, 304-313.

Schneiderman, N. (2004). Psychosocial, behavioral, and biological aspects of chronic diseases. *Current Directions in Psychological Science, 318*, 247-252.

Schneiderman, N., Antoni, M. H., Saab, P. G., & Ironson, G. (2001). Health psychology: Psychosocial and biobehavioral aspects of chronic disease management. *Annual Review of Psychology, 52*(1), 555-580.

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In R. Schwarzer (Ed.), *Self-efficacy: Thought control of action* (pp. 217-243). Washington, D.C.: Hemisphere Publishing.

Sims, R. C., Levy, S. A., Mwendwa, D. T., Callender, C. O., & Campbell, A. L. J. (2011). The influence of functional social support on executive functioning in middle-aged african americans.

Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition, 18(4), 414-31.

Slotkin, J., Nowinski, C., Hays, R., Beaumont, J., Griffith, J., Magasi, S., et al. (2012). *NIH Toolbox Scoring and Interpretation Guide - English Version.* Unpublished manuscript.

Soon, C. S., Brass, M., Heinze, H. J., & Haynes, J. D. (2008). Unconscious determinants of free decisions in the human brain. *Nature Neuroscience, 11*, 543 - 545.

Soper, D. S. (2013). *A-priori sample size calculator for multiple regression [software].* Retrieved December/2, 2012, from http://www.danielsoper.com/statcalc

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test-performance of african-americans. *Journal of Personality & Social Psychology, 69*, 797–811.

Stern, Y., Liu, X., Marder, K., Todak, G., Sano, M., Ehrhardt, A., et al. (1995). Neuropsychological changes in a prospectively followed cohort of homosexual and bisexual men with and without HIV infection. *Neurology, 45*, 467–472.

Stevenson, S. J., & Lochbaum, M. R. (2008). Understanding exercise motivation: Examining the revised social-cognitive model of achievement motivation. *Journal of Sport Behavior, 31*(4), 389-412.

Stuss, D. T. (1992). Biological and psychological development of executive functions. *Brain and Cognition, 20*, 8-23.

Suchy, Y. (2009). Executive functioning: Overview, assessment, and research issues for non-neuropsychologists. *Annals of Behavioral Medicine, 37*(2), 106-116.

Suchy, Y., Blint, A., & Osmon, D. C. (1997). Behavioral dyscontrol scale: Criterion and predictive validity in an inpatient rehabilitation unit population. *The Clinical Neuropsychologist, 11*(3), 258-265.

Suchy, Y., Derbidge, C., & Cope, C. (2005). Behavioral dyscontrol scale-electronic version: First examination of reliability, validity, and incremental utility. *The Clinical Neuropsychologist, 19*, 4-26.

Suchy, Y., & Kraybill, M. L. (2007). The relationship between motor programming and executive abilities: Constructs measured by the push-turn-taptap task from the BDS-EV. *Journal of Clinical and Experimental Neuropsychology, 29*(6), 648-659.

Sutton, S. (1998). Predicting and explaining intentions and behavior: How well are we doing? *Journal of Applied Social Psychology, 28*(15), 1317-1338.

Suzuki, M., Miyai, I., Ono, T., Oda, I., Konishi, I., Kochiyama, T., et al. (2004). Prefrontal and premotor cortices are involved in adapting walking and running speed on the treadmill: An optical imaging study. *Neuroimage, 23*(3), 1020-6.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics*. Boston: Allyn and Bacon.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*, 271-322.

Thayer, J. F., Hansen, A. L., Saus-Rose, E., & Johnsen, B. H. (2009). Heart rate variability, prefrontal neural function, and cognitive performance: The neurovisceral integration perspective on self-regulation, adaptation, and health. *Annals of Behavioral Medicine, 37*(2), 141-53.

Thompson, F. E., & Subar, A. F. (2008). Dietary assessment methodology. *Nutrition in the Prevention and Treatment of Disease, 2*, 3-39.

Tice, D. M., Baumeister, R. F., Shmueli, D., & Muraven, M. (2007). Restoring the self: Positive affect helps improve self-regulation following ego depletion. *Journal of Experimental Social Psychology, 43*, 379–384.

Triandis, H. C. (1977). Subjective culture and interpersonal relations across cultures. *Annals of the New York Academy of Sciences, 285*(1), 418-434.

United States Department of Agriculture. (2013). *USDA's MyPlate.* Retrieved October 30, 2011, from http://www.ChooseMyPlate.gov

United States Department of Health and Human Services. (2008). *2008 physical activity guidelines for americans*. Washington, D.C.: Department of Health and Human Services.

Van Duyn, M. A. S., & Pivonka, E. (2000). Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: Selected literature. *Journal of the American Dietetic Association, 100*(12), 1511-1521.

VandenBos, G. R. (2007). *APA dictionary of psychology*. Washington, D.C.: American Psychological Association,.

Vohs, K. D., & Heatherton, T. F. (2000). Self-regulatory failure: A resource-depletion approach. *Psychological Science, 11*, 249–254.

Waldstein, S. R., Jennings, J. R., Ryan, C. M., Muldoon, M. F., Shapiro, A. P., Polefrone, J. M., et al. (1996). Hypertension and neuropsychological performance in men: Interactive effects of age. *Health Psychology, 15*, 102–109.

Ward, A., & Mann, T. (2000). Don't mind if I do: Disinhibited eating under cognitive load. *Journal of Personality and Social Psychology, 78*, 753–763.

Weinstein, N. D. (2007). Misleading tests of health behavior theories. *Annals of Behavioral Medicine, 33*(1), 1-10.

Weintraub, S., Dikmen, S. S., Heaton, R. K., Tulsky, D. S., Zelazo, P. D., Bauer, P. J., et al. (2013). Cognition assessment using the NIH toolbox. *Neurology, 80*(11 Supplement 3), S54-S64.

Williams, P. G., & Thayer, J. F. (2009). Executive functioning and health: Introduction to the special series. *Annals of Behavioral Medicine, 37*(2), 101-105.

Wilund, K. R. (2007). Is the anti-inflammatory effect of regular exercise responsible for reduced cardiovascular disease? *Clinical Science, 112*(11), 543-55.

Winter, B., Breitenstein, C., Mooren, F. C., Voelker, K., Fobker, M., Lechtermann, A., et al. (2007). High impact running improves learning. *Neurobiology of Learning and Memory, 87*(4), 597-609.

Wu, S. Y., Wang, T. F., Yu, L., Jen, C. J., Chuang, J. I., Wu, F. S., et al. (2011). Running exercise protects the substantia nigra dopaminergic neurons against inflammation-induced degeneration via the activation of BDNF signaling pathway. *Brain, Behavior, and Immunity, 25*(1), 135-46.

Yehuda, S. (2003). Omega-6/Omega-3 ratio and brain-related functions. In A. P. Simopoulos, & L. G. Cleland (Eds.), *Ome-6/Omega-3 essential fatty acid ratio: The scientific evidence* (pp. 37-56). Basel, Switzerland: Karger Publishers.

Zelazo, P. D., Carter, A., Reznick, J., & Frye, D. (1997). Early development of executive functions: A problem-solving framework. *Review of General Psychology, 1*, 198-226.

Ziegelmann, J. P., Luszczynska, A., Lippke, S., & Schwarzer, R. (2007). Are goal intentions or implementation intentions better predictors of health behavior? A longitudinal study in orthopedic rehabilitation. *Rehabilitation Psychology, 52*(1), 97.

Biographical Information

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