ABSTRACT

Sleep Quality as a Moderator between Self-Control and the
Intention-Behavior Gap of Diet and Physical Activity

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Meta-analyses and weight regulation treatment studies found inconsistent direct relationships between cognitive self-control and complicated behaviors such as healthy diet and engagement in physical activity. Variability in relationships may be due to challenging conditions such as sleep restriction the night before assessment, which has been shown to impact self-regulatory capacity the following day. In fact, varying levels of sleep quality complaints are independently associated with execution of health behaviors such as diet and physical activity. Although studies assess direct relationships between sleep, self-control and health behaviors, no study to date has examined how sleep quality complaints moderate the relationship between cognitive self-control and health behaviors while accounting for individual differences in intention. Barber and Munz (2011) found college students who self-reported consistent, good-quality sleep throughout a 5-day period experienced greater self-regulatory task strength (handgrip task) and lower perceived psychological strain compared to baselines measurements. These results indicate sleep complaints are associated with performance on a simple self-regulatory task, but findings may not apply to complicated self-control tasks such as weight regulating behaviors. The present study was designed to measure whether the interaction between objective measures of self-control (working memory or inhibition) and sleep quality complaints predict successful execution of diet and physical activity goals. Multiple hierarchical linear regression models were used to analyze the interaction effects of sleep quality complaints and self-control on health behavior. Results indicate sleep latency moderates the relationship between working memory and the intention-behavior gap of vegetable consumption, but not intention-behavior gaps of fruit consumption or engagement in physical activity. Findings can inform future interventions aimed at increasing control over weight gain among students during their transition from high school to college.

Keywords: self-control, intention-behavior gap, fruits and vegetables, physical activity, executive control

Sleep Quality as a Moderator between Self-Control and the Intention-Behavior Gap of Diet and Physical Activity

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CHAPTER ONE

Introduction

Weight gain often occurs during critical periods of lifestyle change such as beginning college student (Anderson, Shapiro, & Lundgren, 2003; Holm-Denoma, Joiner & Vohs, 2008). The average weight gain in the first semester of college has ranged from 3.5 (Holm-Denoma, Joiner & Vohs, 2008) to 7.8 pounds (Lloyd-Richardson, Bailey, Fava & Wing, 2006). Approximately 11% of 1st semester college students transition from normal weight to overweight status following the first semester of freshman year (Anderson et al., 2003). Lloyd-Richarson and colleagues (2009) suggest approximately 70% of undergraduate students experience some weight gain in their first two years in college. Because weight gain or being overweight are associated with numerous risks such as asthma, diabetes, cardiovascular disease, low self-esteem and depression (Beuther & Sutherland, 2007; Cooley & Toray, 2001; Gomez-Ambrosi et al., 2011Lowery et al., 2005; Neumark-Sztainer & Haines, 2004; Romero-Corral et al., 2010), identification of modifiable factors for weight gain during early college is important (Finlayson, Cecil, Highs, Hill & Hetherington, 2012).

Weight gain in early college can result from engaging in patterns of unhealthy behavior including reduced physical activity and a poor diet (Robinson, Otten & Hermans, 2015). Social influence in this population impacts healthfulness of behavior, in that college students (UK and Australia) and adults (USA) with peers who frequently eat energy dense snack food are more likely to consume snack foods themselves and gain weight (de la Haye, Robins, Mohr, & Wilson, 2013; Robinson, Otten & Hermans, 2016). Most college students do not meet dietary or physical activity guidelines set forth by the World Health Organization (WHO; Nishida, Uauy, Kumanyika & Shetty, 2004). In a study of college students at University of Kansas approximately 69% of students reported eating < 5 servings of fruits and vegetables per day and 67% indicated eating < 20 grams of fiber per day (Huang et al., 2003). In another study examining students enrolled at a large midwestern university, 57% of male and 61% of female university students reported exercising < 3 days per week (Buckworth & Nigg, 2004). Incidence of poor diet and physical activity is troublesome in this population as the transition from adolescence to young adulthood can be a critical period in which diet and physical activity habits are established (Poobalan et al., 2010). Consequently, there is a need for weight gain prevention interventions and increased understanding of the negative impact of gaining weight in this population (Anding, Suminski & Boss, 2010; Racette et al., 2005a; 2008).

Weight gain prevention programs employ various techniques to decrease energy intake and increase energy expenditure, which include planning and inhibition training in combination with nutrition education (Boyle, Mattern, Lassiter & Ritzler, 2011; Larson, Perry, Story & Neumark-Sztainer, 2006; Laska, Graham, Moe, Lytle, & Fulkerson, 2011). Programs that aim to prevent weight-gain in college focus on decreasing need for self-control (or self-regulation) resource use and increasing available resources (Mauraven, 2010). Self-control is generally defined as cognitive restraint of conscious mental processes (mental acts that require effort, intention, and can be controlled; Logan & Cowan, 1984) that would otherwise interfere with intended behavior (Bargh & Chartrand, 1999). Failure to self-regulate (increased cognitive control necessary to overcome temptation; Baumeister & Heatherton, 1996; Carver & Scheier, 1996; Heatherton, 2011) is negatively associated with engagement in physical activity (Hagger, Chatzisarantis, & Biddle, 2002a, 2002b) and healthfulness of diet (Hagger, Chatzisarantis, & Harris, 2006a, 2006b). Those with greater self-control are more effective overriding automatic behavior patterns as well as structuring realistic health goals. To structure realistic health goals one must recognize potential obstacles and consequences of their behavior (de Ridder et al., 2012; Gottfredson & Hirschi, 1990; Muraven, Pogarsky, & Shmueli, 2006). For example, self-regulatory success moderates the effect of food cues on restrained eaters such that food cues activate the dieting goal in effective restrained eaters and inhibit the dieting goal in ineffective restrained eaters (Papies, Stroebe, & Aarts, 2008). Consequently, individuals with high self-control are more likely to execute complicated health tasks, including a healthy diet and physical activity that require complex negotiation of cost and benefit (Muraven & Baumeister, 2000; Peneau et al., 2011; Verburgh et al., 2013).

Individuals are more likely to attain self-regulatory goals if they are able to cognitively maintain and update goal congruent information and simultaneously inhibit interference of goal-incongruent information (Hofmann, 2008; Hoffman & Friese, 2009; Hofmann & Gschwendner, 2008). For example, Fishbach and colleagues (2003) found participants with greater accessibility of a dieting goal, as measured by a lexical decision task, were more likely to choose healthy, diet-congruent (apple) snacks as opposed to diet incongruent (chocolate bar) snacks. The biased-competition model of selective attention by Desimone and Duncan (1995) suggests attention is the first "battlefield" of self-regulation: whatever catches our attention has the opportunity to access privileged space in active memory stores and impact future behavior (Vohs & Baumeister, 2011). This model of controlled behavior assumes that when presented with a stimulus, multiple response pathways are activated (Gabenhorst & Rolls, 2010). To strengthen a certain pathway, a goal must be represented and internally maintained thus fortifying the goal-congruent pathway (Rolls, 2008). These pathways compete for expression by mutually inhibiting one another until the strongest pathway wins and influences behavior (Rolls, Grabenhorst, & Deco, 2010).

Working memory describes the cognitive storage and control mechanisms that internally maintain goals relevant to engagement in goal appropriate behavior (Kane et al., 2003). Intention stored in working memory along with "adaptive gating," or the hindering force that rejects goal irrelevant information (inhibition) from entering working memory, are needed to maintain and manipulate information and subsequently control behavior (Chelazzi, 1998; Reynolds & Desimone, 1999). Working memory and inhibition selectively attend to health-promoting information, hinder competing information from entering working memory, and encourage adherence to health goals (Braver & Cohen, 2000; O'Reilly, Braver, & Cohen, 1999). Adults with high working memory abilities are better at inhibiting attention toward goal-competing information (Unsworth, Schrock, & Engle, 2004). These top-down processes are consistent with traditional theories of working memory which distinguish between the storage and executive components of working memory and executive functions responsible for manipulating information held in working memory (i.e., the execution of control; Baddeley, 1992). However, when working memory strength is weak after use in other self-control tasks, goals are insufficiently active in working memory, interference effects are observed, and the individual is likely to succumb to temptation (Hofmann et al., 2007; Schmeichel, Vohs, & Baumeister, 2003).

Although working memory, inhibition and subsequent self-control performance are associated with each other (Hofmann et al., 2008), this relationship is complicated by depletion of resources the individual's motivation to use self-control (Muraven, Shmueli, & Burkley, 2006). According to the self-regulatory strength model (Heatherton & Baumeister, 1996), cognitive resources used to engage in self-regulating behaviors are limited and prior exertion of self-control depletes energy stores (Baumeister et al., 1998). Relationships between executive functioning and execution of goal directed behavior are unreliable (Hall, Fong, Epp, & Elias, 2008). Self-regulatory resources are used by a host of different self-control activities (Hagger & Chatzisarantis, 2014). Thus, after self-control resources are exerted in one behavioral sphere less energy remains for use by other disparate areas (Baumeister, 2000, 2002). A core premise of the self-regulatory strength model is successful self-control over impulses hinges on the momentary availability of self-control resources. Self-control resources are depleted immediately after use and regain strength slowly or following rest (e.g., cognitive rest, physical rest, or sleep; Baumeister, 2000; Tyler & Burns, 2008). Tyler and Burns (2008) conducted a study to explore the extent to which short periods of cognitive relaxation between self-control tasks impacts self-control resource depletion in a sample of undergraduates at a university in the Midwest United States. Authors used a handgrip task to assess their dependent variable: Self-control resource depletion. The handgrip task requires participants to continually squeeze the apparatus despite the impulse to relax their grip and discontinue effort (Vohs, Baumeister, & Ciarocco, 2005). Authors found participants who relaxed both physically and cognitively between self-control tasks scored higher on the handgrip self-control task than undergraduates in the comparison group that was instructed to relax physically, but not cognitively, between self-control tasks. These findings suggest that replenishment of self-control resources occurs following rest and may increase ability to plan effectively (Mullan, Wong, Allom, & Pack, 2011). Similar findings in weight-regulation literature indicate dieters are at higher risk of overeating simply because they already exerted self-control throughout the day, thus leaving few available resources for subsequent self-control efforts (Vohs & Heatherton, 2000).

Relationship between Self-Control, Diet and Physical Activity

Resource depletion has a pervasive impact on health behaviors (Hagger, Leaver, Esser et al., 2015; Smith et al., 2011) including healthy diet (Gerrits, O'Hara, Piko et al., 2010; Hagger, Panetta, Leung et al., 2013) and physical activity (Buckley, Cohen, Kramer, McAuley, & Mullen, 2014). Riggs et al. (2010) proposed the association between unhealthy behaviors (diet and physical activity) and resource depletion is bidirectional, in that (1) reduced working memory and inhibition are attributable to central effects of excess adiposity such as inflammation, insulin resistance, and lipid dysregulation (Smith et al., 2011; van der Akker, 2014), and (2) reduced working memory and inhibition can promote unhealthy diet behaviors (Kanoski & Ted, 2014).

Reduced working memory and inhibition are associated with physiological consequences of obesity as indicated by a study by Gonzales and colleagues (2012) on normal, overweight and obese cognitively healthy adults. Inclusion of insulin sensitivity, commonly found in obese adults, in the predictive model of working memory performance abolished the significant relationships between BMI and right prefrontal cortex activation (measured using fMRI), an area of the brain associated with higher cognitive load (Braver, Cohen, & Nystrom, 1997). Thus, insulin sensitivity successfully mediated the relationship between BMI and working memory performance. Results underscore the influence of insulin dysregulation in working memory performance and subsequent self-regulation (Gonzales, Tarumi, Miles, & Tanaka et al., 2012). On the other hand, lower working memory and inhibition can lead the individual to engage in unhealthy behaviors (Hofmann, Friese, & Roefs, 2009). Jasinska and colleagues (2013) found inhibitory control, as assessed by both self-report and task performance measures, was positively associated with stronger tendency to overeat in response to external food cues and negative mood states in a sample of predominantly normal weight and overweight undergraduate students at a university in the Midwest United States. Therefore, results indicate impulsive young adults may be more likely to make impulsive and unhealthy food choices in the midst of stress than same aged peers. Results from a study examining a non-US sample of undergraduates by Hoffman and colleagues (2007) support the relationship between diminished cognitive self-control resources and dietary restraint. They found participants with low working memory and inhibition resources were unable to inhibit automatic attitudes and ate more candy than those whose resources were not depleted (Hofmann et al., 2008). The present literature review will examine working memory and inhibition separately in regard to their relationships with diet and physical activity.

Working Memory

According to the biased-competition model of selective attention (Desimone & Duncan, 1995), working memory is related to diet and healthfulness of food choice because it supports protective attention to goal-congruent information and resists the attentional capture of tempting stimuli during early stages of processing (Hofmann, Schmeichel & Baddeley, 2012). Similarly, the strength model of self-control implies momentarily-available working memory resources should predict the extent to which the individual can control impulsive reactions to tasty energy dense foods. Since perception of cues for high calorie foods deplete visuo-spatial working memory (Meulea, Skirdea, Vögeleb & Küblera, 2012), and food cues are omnipresent in the college environment, working memory will be depleted by the end of the day and contribute to consumption of dietary fat in the evening hours (Baumeister, 2002). For example, McMillan and colleagues (2013) found adults who engaged in rigid "all-or-nothing" diets weighed more and were less likely to lose weight after 6 months of attempted weight loss than individuals with flexible diet plans irrespective of baseline working memory scores. Therefore, strict diets force the individual to depletes working memory resources earlier in the day resulting in greater likelihood they will succumb to temptation during late hours as compared to those who applied self-control judiciously (McMillan et al., 2013).

The biased competition model of selective attention indicates higher working memory capacity should be associated with attentional bias towards cues that reinforce attitudes about physical activity (e.g., pictures of footballs, stretching bands and field hockey sticks; Berry, Spense, & Stolp, 2011) thus increasing the strength of goal-congruent physical activity pathways (Calitri, Lowe, Eves, & Bennett, 2009). Calitri and colleagues (2009) examined associations between implicit motivation to engage in physical activity, attention to physical activity related cues, and recent physical activity in a sample of college students. They found a positive association between recent engagement in physical activity and attentional bias only for those who held a strong positive explicit attitude. Results suggested physically active people holding strong affective attitudes are more likely to notice exercise related cues in their environment (Conroy, Hyde, Doerksen, & Riberiero, 2010). On the contrary, when an individual has low working memory capacity, as a result of prior use or poor sleep, the individual has difficulty maintaining selective attention to physical activity promoting cues which leaves them vulnerable to temptation. Repeated selective attention to stimuli that promote engagement in physical activity and inhibit activation of the "sedentary behavior" pathway strengthen the *mere selection effect*. The mere selection effect indicates attention to one pathway increases future preference of that same pathway (Janiszewski, Kuo & Tavassoli, 2012). For example, an individual's diet program instructs them to go for walks rather and avoid video game play. The individual attends to stimuli in their environment that promote engagement in low intensity physical activity and ignore cues for sedentary behavior. After repeated behavior the person is more likely to choose walking activities (the neutral familiar option) over video game play (the neglected alternative). Therefore repeated choice of healthy behavior reinforces the healthy behavior decision making pathway and increases the likelihood the individual will attend to health behavior promoting stimuli in the future.

As physical activity habits develop so does the mere selection effect (Krauzlis, Bollimunta, Arcizet, & Wang, 2015); therefore, habitual behaviors, such as chronic physical activity, require minimal self-control to execute, thus leaving self-control resources for other activities (Sniehotta, Scholz & Schwarzer, 2004). For example, in early stages of adopting physical activity regiment engagement in behavior is initially regulated through conscious controlled and deliberative pathways (Orbell & Verplanken, 2010). Following repeated physical activity and the associated reward responses, the behavior is reinforced and the pathways compel an individual to return to the activity (Dimmock & Banting, 2009; Sheeran et al., 2013). After sufficient repetition, the decision making pathways are reinforced, self-control processes becomes less deliberative, and pathways determining initiation of physical activity in response to salient cues are met with stronger neural activation relative to competing processes leading to strengthened action (Healtherton & Wagner, 2011; Labrecque & Wood; Miller & Cohen, 2001; Rebar, Loftus, & Hagger, 2015). People are more effective at maintaining physical activity regimen if they shift more behavior regulation over to non-conscious processes thereby reducing use of self-control resources (De Ridder et al., 2012). This highlights the potential for the usefulness of self-control training as a means to enhance non-conscious regulation of physical activity via the formation and maintenance of strong habits (Hagger & Luszczynska, 2014). Habitual inhibition, attention and behavior may also alter self-control capacity (McVay & Kane, 2009).

Working memory is related to physical activity in that higher working memory is associated with adherence to chronic physical activity regimen (≥ *5 months of physical activity at least 2 times per week*; Erickson et al., 2013; Verburgh et al., 2013), while physical arousal from physical activity temporarily increases working memory in certain subsamples of young adults (Kane & Engle, 2002; Lambourne, 2006). Sibley and Beilock

(2007) found individuals with low pre-treatment working memory experienced greater increases in working memory immediately following acute physical activity (working memory assessed after 30 minutes treadmill running in 60-80% maximum heart rate) than individuals with greater pre-treatment working memory (Sibley & Beilock, 2007; Conway et al., 2001; Redick & Engle, 2006; Unsworth et al., 2004; Vogel et al., 2005). Therefore the arousing effect of physical activity improves working memory performance in those with low initial working memory scores while adults with normal and high working memory benefit from selective attention facilitated by habitual physical activity.

Inhibition

Self-report (Barratt Impulsiveness Scale-11 and Behavioral Inhibition Scale), task performance (Stop Signal Task and Go/NoGo task) and neuroimaging (fMRI) measures similarly indicate inhibition has a key role in determining which and how much food is consumed in healthy, overweight and obese young adults (Beaver et al., 2006; Bekker, van de Meerondonk, & Mollerus, 2003; Copping & Campbell, 2011; Guerrieri, Nederkoorn, & Jansen, 2008; Jasinska, 2012; Nederkoorn, et al., 2009; Racine, Culbert, Larson, & Klump, 2009; Verburgh et al., 2013). Young adults with lower trait inhibition (also called an impulsive personality or trait, Nigg, 1999) often have difficulty managing their weight (Verburgh et al., 2013) as these individuals consume more calories per day (kcal/d) and fewer healthy foods than those with higher trait inhibition (Limbers & Young, 2015). From the perspective of the strength model of self-control, cognitive resources are needed to inhibit unhealthy automatic responses to internal or external cues (e.g., eating a piece of cake when it is presented to you or sitting on the couch after a tiring day of work; Hagger, Wong, & Daveyl, 2015). After an individual drains self-control resources by inhibiting attention in the face of food cues, self-control resources are fatigued, which leave the person vulnerable to subsequent food temptation (Vohs & Healtherton, 2000).

Individuals who diet for extended periods of time have greater difficulty inhibiting conditioned responses to unhealthy food cues and adhering to their diet plan (Akkermann et al., 2011). Hagger and colleagues (2013) found individuals who self-report chronically inhibiting food related responses are likely to have, greater sensitivity to resource depletion and more frequent subsequent inhibition failure when presented with food temptation (Hagger et al., 2013). As a consequence of inhibition failure, chronic dieters (defined as individuals who exhibit a generalized, long-term tendency to restrict eating behavior; Vohs & Heatherton, 2000) have been shown to eat more unhealthy food than those who diet more flexibly (Hagger et al., 2013). Akkermann and colleagues (2011) found self-report inhibition performance of restrictive eaters, assessed using a self-report eating restraint scale, was positively associated with kcal/d, in that those with higher inhibition consumed more calories (Jansen et al., 2009). Successful dieters may have higher inhibition abilities but exert more food-related self-control before they arrive at the laboratory as indicated by a self-report food diary (Akkermann et al., 2011). Thus, they deplete their once-high self-control resources and are no longer able to inhibit lower-level responses to food cues during laboratory tasks (Friese, 2015). Chronic dieting was related to inhibition of impulse to eat unhealthy food independent of trait self-control. Theoretically, persons with dispositionally lower working memory and inhibition capacity have increased difficulty inhibiting response to food temptation particularly if they had been involved in the chronic restraint of eating behavior (e.g., adults with high BMI; Baumeister, Gailliot, DeWall, & Oaten, 2006; Hagger et al., 2013; Schmeichel & Zell, 2007).

Scores on neuropsychological measures of response inhibition are related to acute, short term and chronic physical activity in young adults (Kubesch et al., 2003; Tomporowski et al., 2003; Verburgh et al., 2013). A meta-analysis by Tomporowski and colleagues (2003) indicate that single bouts of submaximal aerobic exercise performed for durations between 20 and 60 minutes improves response inhibition performance in healthy young adults and highly active adults, reflecting the immediate benefit of moderate intensity aerobic activity on decision making (Hogervorst et al., 1996; Lichtman & Poser, 1983; Tomporowski et al., 2003). In support of the relationship between acute physical activity and inhibition performance another meta-analysis found a moderate positive association between acute physical activity and state inhibition control (d=.46; Verburgh et al., 2013).

Consistent with the biased competition model of selective attention, greater inhibition of attention to unhealthy cues allows focus on healthy cues. Repeated choice of physical activity over the competing sedentary behavior pathways increases future attention to stimuli congruent with health goals and physical activity. Thus, the individual is more likely to choose physical activity over sedentary behavior in the future, which in turn reduces cognitive resources used in decision making for this health behavior. Acute bouts of physical activity are related to some, but not all, facets of executive functioning. Single bouts of physical activity are related to performance on neuropsychological measures of response inhibition, but are not associated with changes in working memory performance (Kubesch et al., 2003; Lichtman & Poser, 1983; Hogervorst et al., 1996).

Coles and Tomporowski (2007) postulate the distributed-learning model (Pelligrini & Bjorklund, 1997) explains how physical activity arousal selectively improves inhibition performance. Any break in a mentally effortful activity will lead to short-term improvements in cognitive performance (Coles & Tomporowski, 2007; Pelligrini & Bjourklund, 1997). Therefore, while engaging in physical activity, the individual rests the self-control system allowing minimal healing of simple inhibition processes but not complex working memory (Coles & Tomporowski, 2007).

Health Behavior Intention

Intention to be healthy and availability of self-control resources do not directly predict health behavior success (Webb & Sheeran, 2006). A meta-analysis found intent to engage in physical activity weakly correlated with physical activity behavior ($r = .47$; Hausenblah, Carron & Mack, 1997). Even if the individual has high intention to lose weight, a healthy diet is typically seen as a complex task that is vulnerable to self-regulatory failures despite the presence of strong intentions (Kumanyika et al., 2000). Whether or not the intentions are translated into action is generally called the "intention behavior gap" (Schwarzer, 2008). This intention behavior gap reflects that intention alone is generally insufficient to ensure compliance with a healthy diet (Webb & Sheeran, 2006). Intention to lose weight is related to engagement in physical activity (Milne, Orbell, & Sheeran, 2002; Prestwich, Lawton, & Conner, 2003; Rise, Thompson, & Verplanken, 2003), and accounts for 20-35% of variance in goal achievement (Hagger, Chatzisarantis, & Biddle, 2002). Results alludes to the possibility that engagement in physical activity requires more cognitive manipulation than achieved by intention alone (Norman & Conner, 2005; Sniehotta, Scholz, & Schwarzer, 2004; 2006).

The relationship between self-control resource depletion and execution of health behaviors is moderated by intention (Muraven & Slessareva, 2003). People express low intent to allocate sufficient self-control resources to health behavior because self-regulation requires effort, perceived cost exceeds perceived gain (Maes & Karoly, 2005), or the individual is concerned with conserving strength for use elsewhere (Muraven, & Slessareva, 2003). Therefore, the self-regulatory strength model may explain the relationship between self-control resources and execution of self-regulating behavior only when the individual has the strong intention to allocate precious resources (Muraven, Shmueli, & Burkley, 2006). Similarly, failure of health-related self-control may occur because the individual is unwilling or unable to allocate working memory and inhibition resources to the task. The association between intention and action is further complicated by insufficient recuperation from resource depletion the previous day (Hagger et al., 2009). Although researchers explored relationships between executive functioning and engagement in health behaviors, few accounted for the potential effects of variables such as motivation and sleep consistency.

Sleep

Insufficient sleep quality, quantity and negatively impacts self-regulatory capacity (Altena, Van Der Werf, Strijers, & Van Someren, 2008) and cognitive functioning (Walker, 2008). Insufficient sleep can reduce self-regulatory energy for managing stressors, with individuals showing increased emotional reactivity to stressful events immediately following acute sleep loss (Hamilton et al., 2007; Zohar et al., 2005). Galla and Duckworth (2015) indicated consistency of self-report sleep onset and wake times were related to greater self-report self-control ability (Brief Self-Control Scale; Tangney et al., 2004) and less effort required to initiate healthy snack (r = .28 to .29, p < .01) and physical activity behaviors (r = .22 to .27, p < .01). Therefore, individuals who report poor sleep habits also self-report less self-control and greater need/use of self-control to engage in weight regulating behaviors (Galla & Duckworth, 2015). Specifically sleep is necessary for the restoration of self-control resources of complex behaviors such as dieting, physical activity, quitting smoking, and limiting alcohol intake (Hagger et al., 2009). Reduced sleep negatively impacts health-related decision making and physiological outcomes (Chaput et al., 2007) via multiple pathways according to the strength model of self-control: Poor sleep hinders restoration of working memory and inhibition resources while simultaneously inducing physiological symptoms that demand use of even greater resources from an already depleted system (Daviaux, Mignardot, Cornu, & Deschamps, 2014; Roth, Silva, & Chase, 2001).

Young adults who experience sleep restriction consume more kcal/d than those who sleep normally (Markwald, Melanson, Smith, & Higgins, et al., 2013; McNeil, Doucet, Brunet, & Hintze et al., 2016). Brondel and colleagues (2010) found college aged adults who experienced a single night of sleep restriction (4 hours of sleep from 2:00am to 6:00am) consumed 559 ± 617 (22%) more kcal and greater self-report hunger before breakfast and dinner on the day after sleep restriction compared to those who experienced normal sleep (8 hours from 12:00am to 8:00am). In addition, changes in appetite regulating hormones connected with sleep loss exacerbate the effects of already diminished self-control resources (Greer, Goldstein, & Walker, 2013). Poor sleep (less than 7 hours of sleep per night; Ekstedt et al., 2006) can influence production of appetite-related hormones leptin and grehlin which then increase food intake (Broussard, Kilkus, Delebecque, & Abraham et al., 2016; Cadernaes, 2015; Kim, Jeong, & Hong, 2015; Landis, Parker, & Dunbar, 2009; Morselli, Leproult, Balbo & Spiegel, 2010). Literature is inconclusive about the relationship between a single night of reduced sleep (≤ 4 hours) and kcal/d (Brondel, Romer, Nougues, & Touyarou, et al., 2010; Collet, Romney, Larson, Clark, & Tucker, et al., 2015; van der Klaauw, Henning, & Keogh, et al., 2016; Wells & Cruess, 2006). However, authors agree that consecutive nights of reduced sleep increase food intake in college age adults (Kim et al., 2011).

Beginning with 2 consecutive nights of sleep reduction, kcal/d begins to negatively associate with sleep loss (Spiegel, Tasali, Penev, & Cauter, 2004). Following 4 nights of restricted sleep (4 hours of time in bed) adults consumed 552.9 ± 265.8 more calories than subjects in the control condition specifically between the hours of 22:00-03:59 (Calvin et al., 2013). After 8 nights of restricted sleep, Calvin and colleagues (2013) found healthy adults consumed 559 ± 706 more calories than their baseline measurements, and a net difference of +677 (95% CI 148-1,206 kcal/d) more calories than those randomized to the control group. Sleep and self-control create a feedback loop where repeated nights of poor sleep depletes energy resources, which contributes to poor planning and decision making about sleep hygiene (Barber et al., 2013). Consequently, sleep deficits are maintained and accumulate as a function of poor self-control (Pilcher, Morris, Donnelly, & Feigl, 2015). Although all humans are biologically propelled to over-compensate for repeated nights of sleep loss with increased intake of energy, young adults in college respond more strongly than middle-aged adults (Spaeth, Dinges, & Goel, 2013).

Late bed time and poor sleep increase weight gain in college-aged adults (Culnan, Kloss, & Grandner, 2013; Hart, LaRose, Fava, & James et al., 2014; Hasler, Buysse, & Klaghofer et al., 2004; Meyer, Wall, Larson, & Laska, 2012; Theorell-Haglöw, Berne, Janson, & Sahlin et al., 2010). For example, Spaeth and colleagues (2013) found sleep restricted healthy adults gained more weight over a 60 day period and consumed more calories (130 +/- 43% of daily caloric requirement) during days with delayed bedtime (4:00am) compared with control subjects who went to bed at 10:00pm. Similarly, Hursel and colleagues (2011) found healthy college age adults who underwent 2 consecutive nights of lab controlled fragmented sleep (accomplished with hourly wake up calls during the hours of 11:30pm and 7:30am) had lower total sleep time and sleep quality (amount of time spent in SWS and REM sleep) and reported more intense hunger sensations especially after dinner compared to participants allowed to sleep through the night (Hursel, Rutters, Gonnissen, & Martens et al., 2011). Cognitive resources necessary for diet control are restored during normal sleep and then become progressively diminished during the following day as the person engages in activities that require control over impulses (Muraven, Tice, & Baumeister, 1998). Hence failures of dietary self□control are more common in evening than morning hours (Baumeister, 2002). College students frequently consume more carbohydrate and fat rich food late at night (e.g., potato chips; Golley, Maher, Matricciani, & Olds, 2013; Schmid et al., 2009; Spiegel et al., 2004). Those who sleep poorly and are awake during the late hours of the night will have less access to self-control resources and greater exposure to unhealthy food (Golley et al., 2013). In support of the importance of bedtime in the model of self-control, Nedeltcheva and colleagues (2009) randomly assigned participants to either a 5.5 hour/night late bedtime (experimental) or 8.5 hour/night normal bedtime (control) conditions. Students in the experimental condition consumed more calories from snacks (1087 ± 541) and foods with high carbohydrate content (65% compared to 61%; p=0.04) than controls (866 ± 365) particularly during the period from 1900 to 0700 (Nedeltcheva et al., 2009). Given the relationship between total hours of sleep, bedtime and kcal/d (Owens et al., 2014; Quick et al., 2014; Van Cauter, Spiegel, Tasali, & Leproult, 2008), it is not surprising college freshman who habitually go to bed late and restrict sleep gain weight (Butler, Black, Blue, Gretebeck, & Randall, 2004; Orzech, Salafsky, & Hamilton, 2011; Vella-Zarb & Elgar, 2010).

Complaints about quality of sleep are negatively associated with working memory and inhibition (Benitez & Gunstad, 2012). Telzer and colleagues (2013) found older adolescents who reported sleep poorer quality sleep responded slower to go trials during a response inhibition task than same aged peers who slept normally. Working memory is associated with self-report of time awake after initial sleep onset (WASO) while inhibition is associated with total hours slept (TST). Differential effects of sleep complaints on working memory and response inhibition occur because working memory recovery occurs primarily during slow wave sleep (SWS), the third stage of sleep, while inhibition resources appear to be more easily replenished by physical and psychological rest in general. Because SWS replenishes working memory, and WASO reduces time spent in SWS, self-report WASO is negatively associated with working memory recovery (Diekelmann et al., 2013). SWS facilitates consolidation of memory and strengthens associations between intended behavior and the context in which the behavior is to be executed (Diekelmann et al., 2013; Durrant, Taylor, Cairney, & Lewis, 2011). These strong context behavior associations increase likelihood of health behavior execution (Scullin & McDaniel, 2010). Therefore waking in the middle of the night, which can reduce time spent in SWS, highly impacts ease of behavior execution and thus the intention behavior gap. Certain health behaviors can increase the likelihood the individual will fall asleep and sleep through the night.

Quality and quantity of sleep are positively related to engagement in physical activity (Awad, Drescher, Malhotra, & Quan, 2012; Cappuccio et al., 2008; Uchida et al., 2012; Yang, Ho, Chen, & Chien, 2012). Poor quality of sleep (Kubitz, Landers, Petruzzello, & Han, 1996; Youngstedt, O'Connor, & Dishman, 1997; Kredlow, Capozzoli, Hearon, Calkins, & Otto, 2015; Chennaoui et al., 2015), quantity of sleep (Temesi et al., 2013; Schmid et al., 2009), sleep latency (Lang, Brand, Feldmeth, & Holsboer-Trachsler, et al., 2013) and bed time are related to low objective (Loprinzi & Cardinal, 2011) and subjective (National Sleep Foundation, 2003) physical activity the next day (Lentino, Purvis, Murphy, & Deuster, 2013). Following this same pattern, Hublin and colleagues (2001) found adults in the upper three quartiles of self-report engagement in physical activity self-reported significantly higher quantity of sleep compared to those in the lowest quartile for physical activity (Hublin, Kaprio, Partinen, & Koskenvuo, 2001). Participants who have early bedtimes and wake up early are likely to meet National physical activity guidelines (Azarmanesh, 2014). Since sleep influences engagement in physical activity, examination of sleep complaints alongside state self-control and health behavior may increase our understanding of mechanisms behind weight regulation (Fillatrault et al., 2014).

Sleep in the Model of Self-Control

Understanding of mechanisms behind weight maintenance in college students increases if sleep complaints are included in the model of self-control. The role of sleep is pertinent given independent links between self-control resources (Daviaux, Mignardot, Cornu, & Deschamps, 2014; Roth, Silva, & Chase, 2001), health behaviors (Benitez & Gunstad, 2012; Hogenkamp et al., 2013; Nedeltcheva et al., 2010), and sleep (Foti et al., 2011; Schmid et al., 2009; Wells & Cruess, 2006). Poor sleep exacerbates health-related self-regulation failure by depleting cognitive resources (Barber & Munz, 2011; Barber et al., 2010; Hagger, 2015). Fillatrault and colleagues (2014) found self-report sleep complaints were associated with both short and long term weight-loss success, and speculated that decision making associated with weight control may be dominated by the influence of sleeping habits.

Quality of sleep allows self-control resources to recover from previous use and transition intentions into health behavior (Mullan et al., 2011). Preliminary evidence examining complex outcome behaviors supports the moderating effect of sleep on state self-control and impulsive behavior (Hagger, 2015). Interaction between state self-control and impulsive behavior is confirmed in models of smoking cessation (Hamidovic & de Wit, 2009), gambling (Loft & Loo, 2014), social interaction (Bates et al., 2002), psychological strain (Barber & Munz, 2011), and delinquency (Meldrum, Barnes, & Hay, 2013). Although most research utilizes laboratory regulated sleep deprivation and trait impulsivity measurements, these studies provide evidence for the relationship between sleep, cognitive self-control resources and impulsive behavior (Hamidovic & de Wit, 2009). Only one study in the present literature review examined relationships between different levels of sleep complaints, state inhibition and psychological functioning. Barber and Munz (2011) found undergraduate students who self-reported good quality and consistently of sleep throughout a 5 day period reported greater self-regulatory strength (handgrip task) and lower perceived psychological strain than subjects whose sleep varied in quality or was consistently poor. Sleep consistency complaints moderated relationships between sleep quality complaints and psychological strain (Barber & Munz, 2011). These relationships occurred only in the group of participants who reported good quality and consistency of sleep. In this group, sleep predicted self-control, and self-control in turn predicted psychological strain. However, relationships between sleep, self-control, and psychological strain were not present in other sleep groups. Without inclusion of sleep complaints in the model, the relationship between self-regulatory strength and psychological strain reached only marginal significance.

Interaction between perceived sleep deficits and self-control will influence outcome behaviors especially when these behaviors are complex (Kamphuis et al., 2012; Loft & Loo, 2014; Meldrum & Hay, 2015). Depletion of self-regulatory resources impairs performance on tasks that require active and controlled processing (e.g., complex reading comprehension problems or weight-regulating behaviors; Gailliot et al., 2007). However, depletion should not influence to the same degree simpler, more basic forms of information processing (e.g., rote memory, reaction time, or driving simulation tests; Owens & Benton, 1994), insofar as these can proceed by well-practiced procedures that involve retrieving information from memory, applying simple rules, or performing a well-practiced behavior. Therefore the impact of resource depletion on health behavior self-control is likely to be greater than perceived stress or subjective personal health (Steptoe, Peacey, & Wardle, 2006).

Direct associations between poor sleep, motivation, physical activity, and diet have been demonstrated in the empirical literature (Appelhans, 2009; Beaver et al., 2006; Benitez & Gunstad, 2012; Curcio Ferrara & De Gennaro, 2006; Hamidovic & de Wit, 2009; Levine, 2013; Strack & Deutsch, 2004; Wilckens et al., 2014), but to the best of my knowledge, no studies to date have specifically examined if sleep moderates the relationship between the intention and behavior of diet and physical activity in a university student population. Barber and Munz (2011) examined differences in self-control between groups of young adults who reported different patterns of sleep (ANOVA). They found only those college students who self-reported consistent good quality sleep throughout a 5 day period experienced greater self-regulatory strength (handgrip task) and lower perceived psychological strain compared to baselines measurements. Without inclusion of sleep complaints in the model the relationship between self-regulatory strength and psychological strength reached only marginal significance. In the present study I evaluated if sleep quality complaints moderate the relationship between objective measures of self-control (working memory and inhibition) and the intention behavior gap of health behaviors (diet and physical activity). This research attempted to provide initial evidence to support a model of health behavior that includes both quality of sleep and degree of intention as predictive variables of success. Researchers aimed to inform future interventions aimed at increasing control over weight gain among students during their transition from high school to college.

Hypotheses

In sum, the following hypotheses were explored in the current project: It was hypothesized that sleep quality complaints would moderate the relationship between working memory and the intention-behavior gap of (a) fruit consumption, (b) vegetable consumption, and (c) physical activity on day of assessment. In addition, inclusion of intention in the calculation of health behavior dependent variables would increase the amount of variance explained by the model.

Purpose

Only one study in the present literature review examined the effects of different levels of sleep complaints on state self-control and self-report physical or psychological functioning. Barber and Munz (2011) found undergraduate students who self-reported good quality and consistency of sleep throughout a 5-day period reported lower perceived psychological strain and higher self-regulatory strength than participants who experienced poor quality sleep. In the group of consistently good quality sleepers, the authors found sleep predicted self-control, and self-control predicted psychological strain. Without inclusion of sleep complaints in the model, the relationship between self-regulatory strength and psychological strain reached only marginal significance (Barber & Munz, 2011). The present study aimed to apply findings from Barber & Munz to weight regulating health behaviors which have been directly linked to both state self-control, diet and physical activity. This new model of health behavior engagement includes both sleep quality complaints and degree of intention as predictive variables of success. Due to the great variability of measurement of sleep, self-control, and health behaviors in current literature, more evidence of relationships between objectively measured cognitive self-control, self-report diet and sleep complaints is needed. Results may inform future interventions aimed at increasing control over weight gain among students during their transition from high school to college.

CHAPTER TWO

Materials and Measures

Participants

Participants for the proposed study were 272 undergraduate students. Students were enrolled in an introductory psychology course at the time of assessment and recruited to participate in this study in exchange for course credit. The sample size of the present study exceeded the proposed sample size. The original target sample size of 172 was based on an a-priori power analysis using G-Power 3 (Faul, Erdfelder, Buchner & Lang, 2009). This analysis indicated 172 participants would be adequate to detect a medium effect in a model testing 10 predictors with an alpha of .05 and power of .95. Sample sizes of similar research in current literature range from 115 (Allom & Mullan, 2014) to 210 (Janiska et al., 2012). The sample size of 172 calculated by G-Power 3 lies within the range set by these precedents.

Inclusion criteria for the current study included enrollment as a student at Baylor University, female gender, and fluency in the English language. Participants were not invited to partake in the study if they had a history of any of the following disorders as diagnosed by a medical professional: attention deficit hyperactive disorder (ADHD), traumatic brain injury, schizophrenia, bipolar disorder or an eating disorder (Allom, 2014; Sapeth, Dinges & Goel, 2013).

Procedures

Information for the study was posted through the Baylor Research SONA system. Interested participants signed up for the study through the SONA website. Participants registered for one administration appointment between the hours of 1:30pm and 4:30pm on Mondays and Wednesdays during the Spring 2016 semester. Administration of the study occurred in a computer room in the Baylor Science Building in Waco, TX. Upon arriving at the room, trained research staff asked participants to read the Baylor University IRB approved consent form and determine if they would like to participate. Research staff made themselves available to answer questions. If participants chose to sign the consent form, research staff instructed them to sit at computers, sign into their Baylor email accounts, and open an email titled "Sleep and Self-Control Study." This link directed participants to a questionnaire and set of 2 different cognitive tasks.

After completing computer activities, research staff instructed participants to check their email again either on their internet ready phones or on the desktop computers in order to complete another short questionnaire titled "Day 1 Survey." This survey asked about the participant's health behaviors and sleep the day/night before. Research staff indicated the same questionnaire would be emailed to each participant at 4:00 am each morning for the next 2 days. Participants could complete the survey at any location and time over the next 24 hours. Each participant was notified they would receive 1 research credit for the in person administration of the study. They could receive a second research credit if they completed both of the at-home surveys. Finally, research staff measured weight (pounds) and height (inches) of each participant. Measurement occurred behind a room divider to ensure participant privacy. Research staff thanked participants for their participation and indicated the PI (Rachel Kantor) could be contacted at any time with questions about the content or process of the study. Deidentified data were stored on a PGP encrypted thumb drive accessible only in the lab of Christine Limbers at 801 Washington Avenue in Waco, TX.

Measures

Demographic Information

The demographic questionnaire included questions about age (years, months), class (1st semester freshman, 2nd semester freshman, 1st semester sophomore, 2nd semester sophomore, other), and race/ethnicity (*Hispanic, non-Hispanic white, non-Hispanic black, Asian, Native American, Bi-racial, Other, I prefer not to answer*). Finally participants were asked to identify the highest level of education accomplished by their primary caregiver (mother, father, grandparent, or legal guardian). Response options included: *grade 7, grade 8, grade 9, grade 10, grade 11, graduated high school, GED, Some college, Associate's Degree, Bachelor's Degree, Master's Degree, Doctorate (e.g., Ph.D., J.D., M.D.), I don't know,* and *I prefer not to answer.*

Dieting and Weight

Current dieting status was measured with the following questions used by Butler and colleagues (2004): "Are you currently dieting to lose weight?" Restrained eaters who report they are currently on a diet often show different patterns of eating behavior than those who report they are not on a diet (Butler et al., 2004; Lowe, 1995) making this an important variable to control for in the analysis. To assess BMI, trained research assistants measured participant height and weight after completion of in person assessment measures. BMI was calculated by dividing weight in pounds (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703 (Centers for Disease Control and Prevention, 2014). Based on similar literature (Hall, 2012), BMI was used as a control variable in the present study.

Inhibition

The inhibition measure was administered using Inquisit Millisecond software (Inquisit 4.0.9.0, 2016), an online administration system for behavioral studies. The Parametric Go/No-Go task (PGNG) was used in the current experiment as a measure of context based response inhibition (Langenecker et al., 2007). Context based tasks include a rule for shifting the target or distractor stimulus during the task. Participants determined which distractor should be inhibited based on the context. By assessing context based inhibition, literature indicates PGNG scores accurately measure multiple facets of inhibitory control in college students (Votruba & Langenecker, 2013). This task presented participants with 3 levels of difficult tasks administered in order of ascending complexity. For all 3 levels a serial stream of black letters were flashed on a white background for 500ms with 0ms interstimulus intervals. Participants responded to the stimulus according to the rules of the task as quickly as possible by pressing the spacebar.

Level 1, the 3 target static inhibition level, is designed to build prepotent responses to target letters. Since this level measures static (the distractor stimulus remains constant throughout the task) and not context based response inhibition, scores from level 1 were not included in the scale scores. Level 2, a 2 context level, required participants respond to certain letters only when they appear in a non-repeating order. In level 3, the 3-target context based task, the increased complexity reduces the participant’s ability to correctly anticipate the next response. This has been shown to remove the ceiling effects of performance of young healthy adults (Langenecker et al., 2005; Neilson et al., 2002). Following completion of the measure, scores of sustained attention (PCTT), response inhibition (PCIT) and complex processing speed (RTT) were obtained. Domain scores have been shown to have adequate test-retest reliability and good convergent validity in student populations (Langenecker et al., 2007).

Working Memory

The single adaptive n-back (Jaeggi et al., 2010) task was administered in the present study using Inquisit Millisecond software. Participants were shown a series of abstract yellow shapes on black background for 500ms followed by a 2500ms interstimulus interval. The program instructed participants to identify which shapes matched target shape “n” steps earlier in the sequence. Updating was required with each new stimulus presentation in order to properly recognize whether the present stimulus matches the target shape. First, participants completed the 1-back level. Following completion the level of “n” was adjusted according to performance. If less than 3 errors were made during the preceding level, “n” increased by 1. If participants made between 3 and 5 errors, the “n” stayed the same. However, if more than 5 errors were made, the program decreased “n” by 1, thus decreasing the difficulty of the task. In total, the task consisted of 15 blocks of 24 trials. The final score reflected the proportion of hits minus false alarms averaged over all levels of the N-back task, such that higher scores indicated greater working memory. This measure was used to assess working memory and updating in several similar studies of EF (Au, Sheehan, Tsai et al., 2015; Redick, Shipstead & Fried, 2013; Schneiders, Opiz, Tang et al., 2012) and eating behavior in college students (Allom & Mullan, 2014).

Health Behavior: Intention

Intention to consume fruits and vegetables (assessed in servings) was measured by the questions, "*On a regular weekday, how many servings of fruit do you intend to eat*," and, "*On a regular weekday, how many servings of vegetables do you intend to eat*." Examples of serving sizes of fruits and vegetables were printed below each question. Response options included: 0 servings, 1 serving, 2 servings, 3 servings, and 4 or more servings. Intention to engage in physical activity on each of the 3 days of the study (the day before assessment, the day of assessment, and the day after assessment) was assessed by the questions, "*How many minutes did you intend to exercise yesterday,*" "*How many minutes do you intend to exercise today,*" and, "*How many minutes do you intend to exercise tomorrow?*" Included in the question participants are reminded "*Exercise = any activity that causes a noticeable increase in your heart rate*." Responses ranged from 0 min to 180 minutes (or more) at 15 minute increments. This measure was adapted for use in the present study from Mullan and colleagues (2014).

Health Behavior: Action

Daily consumption of fruits and vegetables was measured using the questions, "*How many servings of fruits and vegetables did you eat*" on the day in question. Responses to fruit and vegetables were assessed separately using a matrix table response format. Immediately following the question participants were reminded "*1 serving of fruit = cup/piece of fruit the size of a baseball*" and "*1 serving of vegetable = cup of* *vegetables (not including potatoes) the size of a fist*." Response options included: 0 servings, 1 serving, 2 servings, 3 servings, and 4 or more servings. Daily physical activity was assessed by the questions, "*How many minutes did you exercise*" on the day in question. Included in the question participants are reminded "*Exercise = any activity that causes a noticeable increase in your heart rate*." Responses ranged from 0 min to 180 minutes (or more) at 15 minute increments.

Overall Daytime Sleepiness

The Epworth Sleepiness Scale (ESS) is an 8 item measure used to identify excessive sleepiness associated with accumulated sleep debt and clinical sleep disorders (Johns et al., 1993). Items ask how sleepy the participants feel on a regular basis. Participants report the likelihood that they would fall asleep while doing certain activities including watching TV, sitting and talking to someone, and stopped at a traffic light. Response options range from 0 (would never doze) to 3 (high chance of dozing). Total scores range from 0 to 24 with scores of 10 and above indicating significant levels of daytime sleepiness.

The ESS has been shown to be sensitive to changes in levels of sleep difficulty, as evidenced by decreased scores following sleep related treatment (Johns, 1993). Psychometric analyses of the ESS indicate the measure has adequate internal consistency and divergent validity (Buysse et al., 2008), although factor analyses indicated numbers of identifiable factors may vary (Hagell & Broman, 2007; Nguyen, Baltzan & Small et al., 2006; Violani et al., 2003). The measure has been used extensively with undergraduate populations (Breslau, Roth & Rosenthal et al., 1997; Howell, Digdon & Buro, 2010; Oginska & Pokorski, 2006; Singleton & Wolfson, 2009; Wong, Lau & Wan et al., 2013). Research indicates the ESS has strong test-retest reliability (r = .82) and high internal consistency (Chronbach's alpha = .88; Johns, 1992).

Sleep Complaints

Sleep complaints were measured using the Consensus Sleep Diary-Core, a standardized nightly sleep self-monitoring survey developed by the American Academy of Sleep Medicine (Carney, Buysse, Ancoli-Israel, & Edinger et al., 2012). The Consensus Sleep Diary is currently a live document that is regarded as the "gold standard" for subjective sleep assessment (Carney et al., 2012). Although the measure requires validation, testing, and refinement, no standardized measure of nightly sleep complaints has been routinely used in sleep research thus far (Carney et al., 2012). Questions on are consistent with nightly sleep diaries used similar research of sleep complaints (Lichstein, Riedel, & Means, 1999; McCrae et al., 2005; Taylor, Mallory, Lichstein, et al., 2007; Scullin, Harrison, Factor & Bliwise) in college student samples (Carney & Waters, 2006; Monk et al., 1990; Means, Lichstein, Epperson, & Johnson, 2000; Taylor, Bramoweth, Grieser, & Roane, 2013). Item language is appropriate for individuals with a third grade reading level (Carney et al., 2012). The 7 item measure used in the present study assessed participant complaints of various sleep timing (e.g., "what time did you try to go to sleep") and quality issues (e.g., "how many times did you wake up that night") of their sleep the previous night. Total sleep time complaints were measured by subtracting total wake time from time in bed (McCrae et al., 2005). Sleep efficiency was calculated using the ratio of total sleep time to total time spent in bed multiplied by 100 (e.g., [total sleep time/total time spent in bed] X 100; McCrae et al., 2005). Daytime sleepiness ("How sleepy do you feel today") and sleep quality ("How would you rate the quality of your sleep last night") items were added to the measure to assess facets of sleep quality complaints shown to be associated with cognitive functioning in college student samples (García, Ramírez, Martínez, & Valdez, 2011; Langberg, Becker, Dvorsky, & Luebbe, 2014).

Nightly sleep diaries are more accurate estimations of sleep dysfunction than single time point retrospective estimates of typical sleep (Lichstein, Stone, Donaldson, & Nau, et al., 2006; Maes et al., 2014). When compared to polysomnography, the gold standard for objective measurement of sleep quality, healthy participants tend to overestimate sleep latency and total sleep time, whereas patients with insomnia underestimate total sleep time (Fichtenberg, Putnam, Mann, & Zafonte, et al., 2001; Lichstein et al., 2006; Lockley, Skene, & Arendt, 1998; Monk et al., 1994; Schwarz, 2007; Valliéres & Morin, 2003). Unlike single time-point retrospective measures of sleep, patients are likely able to recall specific details or more irregular sleep behaviors (Schwarz, 2007). Sleep diaries have shown adequate agreement with polysomnography, the gold standard objective measure of sleep, on estimates of times woken after sleep onset (r = .46), total sleep time (r = .59) and sleep efficiency (r = .48) for adults with insomnia (Lichstein, Stone, Donaldson, & Nau et al., 2006).

CHAPTER THREE

Results

The 272 participants in the present study (Table 1.1) ranged in age from 18–30 (*M* = 18.75, *SD* = .679). The majority of participants identified as freshmen in college (N=199; 73%). Participants predominantly identified as non-Hispanic white (N= 159; 59%), Hispanic (N= 34; 13%) or Asian (N=31; 12%). The majority of participants' primary caregivers received at least a college degree (N= 212, 78%). Participants were mostly in the normal BMI range (Table 1.2) (normal BMI= 18-24.9; N= 186, 68.4%), while some were underweight (underweight BMI < 18; N= 5; 1.8%), overweight (overweight BMI=25-29.9; N=52; 19.1%), or obese (obese BMI > 30; N=27; 9.9%). Most participants reported they were not dieting at time of assessment (N=200; 73.5%). Among the 272 total participants, there were 226 who successfully completed all cognitive and self-report measures of the study. The remaining 46 students with some missing data were included in some but not all analyses.

Table 1.1

Sample demographics

Category	*Variable*	*Frequency*	*Percent of Sample*
Age			
	18	105	38.6%
	19	130	47.8%
	20	37	13.6%
	Data missing	*0*	-
	Total	*272*	*100%*

(continued)

Category	*Variable*	*Frequency*	*Percent of Sample*
Year in university			
	Freshman	200	73.5%
	Sophomore	72	26.5%
	Data missing		
	Total	*272*	*100%*
Ethnicity			
	Non-Hispanic White	160	58.8%
	Hispanic	36	12.2%
	Asian	33	12.1%
	Non-Hispanic Black	18	16.6%
	Bi-racial	14	5.1%
	Other	7	2.6%
	Prefer not to answer	2	.7%
	Data missing	*0*	-
	Total	*272*	*100%*
Highest level education of Primary Caregiver			
	≤ Grade 7	3	1.1%
	Grade 8	0	-
	Grade 9	1	.4%
	Grade 10	0	-
	Grade 11	1	.4%
	High school diploma	19	7%
	GED	1	.4%
	Some College	26	9.6%
	Associate's degree	8	2.9%
	Bachelor's degree	93	34.2%
	Master's degree	77	28.3%
	Doctoral degree	42	15.4%
	Data missing	*1*	*.4%*
	Total	*272*	*100%*
Current dieting status			
	Dieting	69	25.4%
	Not dieting	200	73.5%
	Data missing	*3*	*1.1%*
	Total	*272*	*100%*
BMI group			
	Underweight	5	1.8%
	Normal Weight	186	68.4%
	Overweight	52	19.1%
	Obese	27	9.9%
	Data missing	*2*	*.7%*
	Total	*272*	*100%*

Table 1.2

Sample demographics

Variable	*N*	*Mean*	*SD*	*Minimum*	*Maximum*
BMI	270	23.9	4.2	17.8	42
Data missing	*2*	-	-	-	-
Total	*272*	-	-	-	-

Descriptive and Correlation Analyses

Data analyses were performed using version 23 of SPSS. Descriptive analyses were conducted for the following variables: age, year in university, ethnicity, highest level education of primary caregiver, current dieting status, and BMI. Means and standard deviations for demographic, cognitive self-control and health behavior variables are presented in Table 2.

Diet and Physical Activity

On typical weekdays, participants intended to eat more fruits (M= 2.39; SD=1.09) than vegetables (M= 2.18; SD= 1.17). They consumed on average 1.50 servings of fruit (M= 1.50-1.60; SD= 1.10-1.21) and 1.57 servings of vegetables (M= 1.54-1.62; SD= 1.08-1.18) per day, which resulted in an intention-behavior gap of approximately 2.24 (M= .69-.79; SD=1.10-1.20). Participants in the present sample intended to engage in physical activity for 40 minutes (SD= 27.13) on day 1, 41 minutes (SD= 28.62) on day 2, and 44 minutes (SD= 28.23) on day 3, but completed only 32 minutes (SD= 26.19), 30 (SD= 26.51), and 27 minutes (SD= 26.10), respectively. This resulted in intention-behavior gaps of 8.70 minutes (SD= 23.60) on day 1, 10.88 minutes (SD= 24.74) on day 2 and 16.41 minutes (SD= 29.43) on day 3.

Sleep

Regarding timing of sleep the night before assessment, participants initially tried to fall asleep primarily between 11:00pm and 2:00am (N= 194; 39.7%). However, some participants tried to fall asleep before 11:00pm (N= 35; 11.9%) or after 2:00am (N=23, 9.1%). Most participants reported waking up from sleep in the morning between 7:00am and 8:00am (N=200; 79%), and some reported waking earlier than 7:00am (N=24; 9.5%) or after 8:00am (N=29; 11.4%). After participants initially woke from sleep they stayed in bed for an additional 18 minutes on average (N= 253; SD= .61). Participants woke up in the middle of night approximately 1 time on average (SD= 1.2) for 7.24 (SD= 21.53) minutes on average. In total, most participants slept 6.67 hours per night on average (SD= 1.89). Most participants reported their sleep quality was fair (N= 93; 34.2%) or good (N= 102; 37.5%), while some indicated their sleep was very good (N= 24; 8.8%), poor (N= 19; 7%), or very poor (N= 15; 5.5%). According to scores on the ESS, a general retrospective measure of daytime sleepiness, participants reported feeling normally sleepy (N= 64; 25.5%) or somewhat sleepy (N=115; 45.8%) in general. However some participants did not feel sleepy at all (N=62; 24.7%) or felt excessively sleepy (N= 10; 4%). Consistent with similar studies (McCrae et al., 2005) compliance with diary completion was exceptionally high. Out of 3,205 possible data cells (8 sleep diary variables X 272 participants) used to assess sleep the night before assessment, only 155 data cells were missing (4.84%).

Cognitive Self-Control

Regarding response inhibition, participants received an average score of 50.34 (SD= 8.38; range= 21.48 to 71.83). On average participants scored 1.79 on the working memory measure (SD= .913; range= -3 to 4). Working memory was associated with sleepiness on day 1 (*r*= -.15) but not day 2 (*r*= -.04) nor day 3 (*r*= -.12).

Table 2

Means, standard deviations, and Pearson's correlations of sleep quality complaints, the intention-behavior gaps of diet and physical activity, and executive functioning (response inhibition and working memory)

Variable	Latency	WASO (#)	WASO (min)	Quality	Fruit	Veg.	Physical Activity	Response Inhibition	Working Memory
Sleep latency	-	.210**	.163*	-.258**	.023	-.001	.003	.036	-.008
WASO (#)	-	-	.330**	-.133*	-.074	-.067	-.079	.032	.022
WASO (min)	-	-	-	-.261**	.034	.009	.000	-.049	.027
Quality	-	-	-	-	-.112	-.065	-.049	.063	.012
Fruit	-	-	-	-	-	.374**	-.068	.045	.003
Vegetable	-	-	-	-	-	-	.034	.020	.102
Physical Activity	-	-	-	-	-	-	-	-.158*	.057
Response Inhibition	-	-	-	-	-	-	-	-	.105
Working Memory	-	-	-	-	-	-	-	-	-
N	239	248	248	239	250	250	249	256	243
Mean	31.88	.90	7.21	3.41	.792	.692	10.98	52.92	1.88
SD	34.544	1.155	21.79	.944	1.12	1.13	24.65	8.11	.729

** indicates correlation is significant at the 0.01 level (2 tailed)
* indicates correlation is significant at the 0.05 level (2 tailed)
Veg.=Vegetable

Statistical Analyses

Multiple hierarchical linear regressions were used to determine whether cognitive self-control (response inhibition or working memory), sleep quality complaints, or cognitive self-control-sleep quality complaint interactions were associated with intention-behavior gaps of health behaviors. It was hypothesized that the inclusion of sleep quality complaints the night before assessment would improve the prediction of the intention-behavior (IB) gaps after controlling for demographic variables. Selection of the independent variables comprising each block was based on a priori hypotheses about associations these variables would have with the dependent variables. Predictor variables were centered (subtracting the variable's arithmetic mean from each variable) to reduce multicollinearity in the squared terms and facilitate interpretation of regression coefficients (Aiken & West, 1991). For each analysis, the assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals were evaluated. Centered sleep quality complaint variables were highly correlated (r = .009 to .390). Sleep latency complaint was a stronger predictor of outcome variables (intention-behavior gaps of fruit consumption, vegetable consumption, and engagement in physical activity) than all other sleep quality variables. Consequently, sleep latency was included in the final regression analyses while all other sleep quality complaint variables were excluded. Dichotomous demographic variables consisting of BMI group (normal weight or overweight/obese), ethnicity group (Caucasian or not Caucasian), academic year in university (freshman or sophomore), and current dieting status (currently dieting or not currently dieting) were entered simultaneously as predictors in Step 1. In Step 2, centered cognitive self-control variables consisting of working memory and response inhibition were entered as simultaneous predictors. In Step 3, the centered sleep latency complaint from the night before was entered. In Step 4, the interaction between response inhibition and sleep latency complaint as well as working memory and sleep latency complaint were entered as simultaneous predictors. Table 3 presents the standardized beta coefficients for each variable comprising the models used to calculate the index scores.

Table 3

Independent variables used in multiple hierarchical linear regression models to predict the intention-behavior gaps of fruit consumption, vegetable consumption, and engagement in physical activity on day of administration of cognitive measures

Block	*Category*	*Variables in Block*
1	Demographic	- BMI group (normal weight/overweight-obese)
		- Ethnicity group (Caucasian/not Caucasian)
		- Year at Baylor (freshman/sophomore)
		- Currently dieting (yes/no)
2	Self-Control	- Working memory (centered)
		- Response inhibition (centered)
3	Sleep Complaint	- Sleep latency (centered)
4	Interaction	- Working memory*sleep latency
		- Response inhibition*sleep latency

In order to determine if physical activity and diet are predicted by different cognitive characteristics, regression analyses were conducted separately using the intention-behavior gap for each health behavior (fruit consumption, vegetable consumption, and physical activity) as the dependent variable. Therefore, a total of 3 separate hierarchical regression analyses were conducted.

Intention-Behavior Gap of Fruit Consumption

It was hypothesized that sleep latency complaint would interact with working memory to predict the intention-behavior gap of fruit consumption. A hierarchical linear regression was used to determine whether cognitive self-control (response inhibition and working memory), sleep latency complaint, or the cognitive self-control-sleep latency complaint interactions were associated with the intention-behavior gap of fruit consumption while controlling for demographic variables. As illustrated in Table 4, neither demographic variables (R^2= .017, F (4, 221) = .93, $p > .05$), self-control variables (R^2= .018, F (6, 219) = .67, $p > .05$), sleep latency complaint (R^2= .019, F (7, 218) = .60, $p > .05$) nor the interaction terms (R^2= .032, F (9, 216) = .80, $p > .05$) predicted a significant proportion of the variance in the intention-behavior gap of fruit consumption.

Table 4

Hierarchical regression analysis for prediction of the intention-behavior gap of fruit consumption on the same day as administration of cognitive measures

Step	*Category*	*Predictor*	R^2	ΔF	*df*	β
1	Demographic Variables	Block 1	.017	.929	221	-
		BMI group	-	-	-	.018
		Ethnicity group	-	-	-	-.074
		Undergraduate year	-	-	-	-.065
		Dieting status	-	-	-	.074
2	EF	Block 2	.018	.167	219	-
		Working memory	-	-	-	-.030
		Response inhibition	-	-	-	.028
3	Sleep	Block 3	.019	.223	218	-
		Latency	-	-	-	.050
4	Interaction	Block 4	.032	1.488	216	-
		working memory*latency	-	-	-	-.076
		response inhibition*latency	-	-	-	.094

β= standardized regression co-efficient for the additional variable included. Overall R^2=.03, *= significant at <.05 level, ** significant at <.01 level

Intention-Behavior Gap of Vegetable Consumption

It was hypothesized that the interaction between working memory and sleep latency would predict the intention-behavior gap of vegetable consumption. A hierarchical linear regression was used to test whether cognitive self-control (response inhibition and working memory), sleep latency complaint, or the cognitive self-control-sleep latency complaint interactions were associated with the intention-behavior gap of vegetable consumption on day of assessment while controlling for demographic variables. As can be seen in Table 5, the hypothesis was supported such that the interaction of working memory and sleep latency complaint variables significantly predicted the intention-behavior gap of vegetable consumption, β= -.005, $t(216) = -2.23$, $p < .05$. The addition of the response inhibition and sleep latency complaint interaction term did not predict a significant proportion of the variance in the intention-behavior gap of vegetable consumption, β= -.000, $t(216) = 1.826$, $p > .05$.

Table 5

Hierarchical regression analysis for prediction of the intention-behavior gap of vegetable consumption on the same day as administration of cognitive measures

Step	*Category*	*Predictor*	R^2	ΔF	*df*	β
1	Demographic	Block 1	.009	.491	221	-
	Variables	BMI group	-	-	-	.015
		Ethnicity group	-	-	-	-.008
		Undergraduate year	-	-	-	-.056
		Dieting status	-	-	-	-.077
2	EF	Block 2	.014	.608	219	-
		Working memory	-	-	-	.039
		Response inhibition	-	-	-	.017

(continued)

Step	*Category*	*Predictor*	R^2	ΔF	*df*	β
3	Sleep	Block 3	.020	1.314	218	-
		Latency	-	-	-	.017
4	Interaction	Block 4	.055	4.031	216	-
		working memory*latency	-	-	-	-.156*
		response inhibition*latency	-	-	-	.141

β= standardized regression co-efficient for the additional variable included. Overall R^2= .057, *= significant at <.05 level, ** significant at <.01 level

Intention-Behavior Gap of Physical Activity

It was hypothesized that sleep latency complaint would interact with working memory to predict the intention-behavior gap of physical activity. A hierarchical linear regression analysis was used to determine whether cognitive self-control (response inhibition and working memory), sleep latency complaint, or cognitive self-control-sleep latency complaint interactions were associated with the intention-behavior gap of physical activity while controlling for demographic variables (Table 6). Demographic variables in Block 1 did not account for a significant proportion of variance in the intention-behavior gap of physical activity in the first step, R^2= .009, F (4, 221) = .009, p > .05. In Block 2, response inhibition, but not working memory, was associated with the intention-behavior gap of physical activity, β= -.488, t(219) = -2.519, p < .05. In Block 3, the addition of sleep latency complaint to the model did not predict the dependent variable β= -.026, t(219) = -.719, p > .05. Contrary to the hypothesis, additions of the interaction term for response inhibition and sleep latency complaint (β= -.001, t(216) = -.382, p > .05) nor the interaction term for working memory and sleep latency complaint (β= .036, t(216) = .689, p > .05) predicted significant portions of the variance in the intention-behavior gap of physical activity.

Table 6

Hierarchical regression analysis for prediction of the intention-behavior gap of physical activity on the same day as administration of cognitive measures

Step	*Category*	*Predictor*	R^2	ΔF	*df*	β
1.	Demographic	Block 1	.009	.530	221	-
	Variables	BMI group	-	-	-	-.012
		Ethnicity group	-	-	-	.017
		Undergraduate year	-	-	-	.008
		Dieting status	-	-	-	.087
2.	EF	Block 2	.045	4.116	219	-
		Working memory	-	-	-	.117
		Response inhibition	-	-	-	-.173*
3.	Sleep	Block 3	.048	.518	218	-
		Latency	-	-	-	-.073
4.	Interaction	Block 4	.050	.303	216	-
		working memory*latency	-	-	-	.048
		response inhibition*latency	-	-	-	-.032

β= standardized regression co-efficient for the additional variable included. Overall R^2=.05, *= significant at <.05 level, ** significant at <.01 level

Inclusion of Total Sleep Time in Model of Health-Behavior

Multiple hierarchical regression analyses were conducted to determine whether cognitive self-control (response inhibition and working memory), total sleep time (TST), or the cognitive self-control-TST complaint interactions were associated with intention-behavior gaps of fruit consumption, vegetable consumption, and engagement in physical activity while controlling for demographic variables. Since this analysis was not included in hypotheses, no prediction of results was made. As illustrated in Table 7, neither demographic variables (R^2= .018, F (4, 221) = .99, p > .05), self-control variables (R^2= .019, F (6, 219) = .70, p > .05), TST complaint (R^2= .026, F (7, 218) =.84, p > .05) nor the interaction terms (R^2= .049, F (9, 216) =1.25, p > .05) predicted a significant proportion of the variance in the intention-behavior gap of fruit consumption. As illustrated in Table 8, neither demographic variables (R^2= .010, F (4, 221) = .55 p > .05), self-control variables (R^2= .015, F (6, 219) =.56, p > .05), TST complaint (R^2= .015, F (7, 218) =.48, p > .05) nor the interaction terms (R^2= .016, F (9, 216) = .40, p > .05) predicted a significant proportion of the variance in the intention-behavior gap of vegetable consumption. As illustrated in Table 9, neither demographic variables (R^2= .009, F (4, 221) =.50, p > .05), self-control variables (R^2= .045, F (6, 219) =1.73, p > .05), TST complaint (R^2= .048, F (7, 218) =1.56, p > .05) nor the interaction terms (R^2= .064, F (9, 216) =1.65, p > .05) predicted a significant proportion of the variance in the intention-behavior gap of physical activity.

Table 7

Hierarchical regression analysis for prediction of the intention-behavior gap of fruit consumption on the same day as administration of cognitive measures

Step	*Category*	*Predictor*	R^2	Δ*F*	*df*	*β*
1	Demographic	Block 1	.017	.998	221	-
	Variables	BMI group	-	-	-	-.019
		Ethnicity group	-	-	-	-.056
		Undergraduate year	-	-	-	-.069
		Dieting status	-	-	-	.074
2	EF	Block 2	.019	.118	219	-
		Working memory	-	-	-	-.042
		Response inhibition	-	-	-	.032
3	Sleep	Block 3	.026	1.698	218	-
		TST	-	-	-	-.061.
4	Interaction	Block 4	.049	2.620	216	-
		working memory*TST	-	-	-	.090
		response inhibition*TST	-	-	-	.128

β= standardized regression co-efficient for the additional variable included. Overall R^2=.03, *= significant at <.05 level, ** significant at <.01 level

Table 8

Hierarchical regression analysis for prediction of the intention-behavior gap of vegetable consumption on the same day as administration of cognitive measures

Step	*Category*	*Predictor*	R^2	ΔF	*df*	β
1	Demographic Variables	Block 1	.101	.547	221	-
		BMI group	-	-	-	-.004
		Ethnicity group	-	-	-	-.010
		Undergraduate year	-	-	-	-.067
		Dieting status	-	-	-	-.068
2	EF	Block 2	.015	.589	219	-
		Working memory	-	-	-	.066
		Response inhibition	-	-	-	.023
3	Sleep	Block 3	.015	.005	218	-
		TST	-	-	-	-.010
4	Interaction	Block 4	.016	.130	216	-
		working memory*TST	-	-	-	-.037
		response inhibition*TST	-	-	-	.012

β= standardized regression co-efficient for the additional variable included. Overall R^2=.03, *= significant at <.05 level, ** significant at <.01 level

Table 9

Hierarchical regression analysis for prediction of the intention-behavior gap of physical activity on the same day as administration of cognitive measures

Step	*Category*	*Predictor*	R^2	ΔF	*df*	β
1	Demographic	Block 1	.009	.503	221	-
	Variables	BMI group	-	-	-	.003
		Ethnicity group	-	-	-	-.006
		Undergraduate year	-	-	-	.014
		Dieting status	-	-	-	-.066
2	EF	Block 2	.045	4.148	219	-
		Working memory	-	-	-	.126
		Response inhibition	-	-	-	-.163*
3	Sleep	Block 3	.048	.596	218	-
		TST	-	-	-	-.090
4	Interaction	Block 4	.064	1.923	216	-
		working memory*TST	-	-	-	-.111
		response inhibition*TST	-	-	-	-.079

β= standardized regression co-efficient for the additional variable included. Overall R^2=.03, *= significant at <.05 level, ** significant at <.01 level

CHAPTER FOUR

Discussion

There has been a dearth of literature examining the relationships between cognitive self-control and health behaviors while accounting for nightly sleep complaints, despite evidence of direct associations between poor sleep, physical activity, and diet in young adults (Kakinami, O'Loughlin, Brunet, & Dugas et al., 2017; Quick et al., 2014; 2016). The current project examined the relationships between these variables. Although multiple sleep quality complaints were originally assessed, only sleep latency was included in the moderator model because it showed the strongest association with cognitive self-control and health behaviors. As sleep quality complaint variables did not correlate highly with each other, it seems each sleep quality complaint variable may have captured a different facet of perceived sleep quality.

Hypotheses

Hypothesis #1: Intention-Behavior Gap of Fruit and Vegetable Consumption.

Consistent with my hypothesis, the interaction of sleep latency complaint and working memory, but not response inhibition, significantly predicted the intention-behavior gap of vegetable consumption. Neither the interaction between sleep latency complaint and working memory, nor sleep latency complaint and response inhibition, predicted the intention-behavior gap of fruit consumption.

The findings that additional behavioral variables (in this case sleep latency) moderates the relationship between working memory and vegetable consumption, is consistent with multiple studies in the extant literature (Allen et al., 2011; Mullen et al., 2014). Mullan and colleagues (2014) found cognitive self-control and intention alone do not significantly predict the intention-behavior gap of vegetable consumption, and that an additional variable, such as sleep, is needed in the model. Similarly, findings from Allen and colleagues (2011) support the lack of contribution of response inhibition to the model of vegetable consumption. In that study, response inhibition (measured using the Go/NoGo task) was unrelated to the intention-behavior gap of fruit and vegetable consumption.

In general, literature supports present findings that poor sleep is related to food choice. While present results show a relationship between consumption of healthy food (vegetables) and sleep (sleep latency complaint), findings are similar across studies that assess consumption of unhealthy foods. Grandner and colleagues (2010) found objectively measured average total sleep time across one full week (measured using actigraphy) was negatively associated with average daily intake of high-fat foods in a large sample of middle aged females. Results are also consistent with studies measuring sleep complaints. Adults who self-reported less than 7 hours of total sleep time per night also reported higher percentage of intake of energy from fat than those who reported sleeping between 7 and 9 hours per night (Zumin Shi et al., 2005).

Particularly, previous research supports the relationship between sleep complaints and vegetable consumption found in this study. For example, Stamatakis and Brownson (2008) reported an association between self-report short sleep duration (<7 hours) and the increased odds of low (1–2 servings per day) vegetable consumption in a cohort of adults residing in the Midwest United States. Similar results were found in samples of Japanese adults. In this study, Japanese adults who reported short sleep duration (< 6 hours per night) consumed fewer vegetables than those who reported normal sleep duration (6-9 hours per night; Imaki, Hatanaka, Ogawa, & Yoshida, et al., 2002). Likewise, Katagiri and colleagues (2014) found overall retrospective sleep quality (measured using PSQI) was associated with low intake of vegetables after controlling for potential confounding factors including age and BMI. Results from multiple studies point to positive associations between sleep onset latency and other aspects of diet, such as total caloric intake, protein intake, carbohydrate intake, fat intake, and time of last meal (Afaghi, O'Connor, & Chow, 2007; Crispim, Zimberg, Gomes dos Reis, & Diniz, et al., 2011).

In contrast to the present findings that sleep latency complaint was related to vegetable consumption, extant literature indicates sleep deficits may also be related to consumption of fruits. In a cross sectional analysis of 410 adult females, complaint of short sleep duration (< 6 hours per night) was associated with lower intake of fruit (Haghighatdoost, Karimi, Esmaillzadeh, & Azadbakht, 2012). Disparities between my results and those of Haghighatdoost and colleagues may be attributable to differential measurement of sleep latency and sampling bias. The present study examined sleep latency complaints, while the study by Haghinghatdoost and colleagues (2012) assessed total sleep time complaints. These two questions have been shown to measure different dimensions of perceived sleep quality which would explain conflicting findings (Vanable, Aikens, Tadimeti, & Caruana-Montaldo, et al., 2000). Additionally, the two studies measure sleep over different time periods, which has been shown to impact findings (Wolfson, Carskadon, Acebo, & Seifer, et al., 2003). Haghinghatdoost and colleagues (2012) measured sleep retrospectively, while the present study assessed night by night sleep complaints. Finally, Haghinghatdoost and colleagues (2012) surveyed a sample of young adult females enrolled at a University in Iran, while the present study examined females enrolled in a private university in Texas. These two populations may report different patterns of diet, as the Iranian diet typically includes a greater number of servings of fruits and vegetables than same aged adults in the United States (Pourfarzi, Whelan, Kaldor, & Malekzadeh, 2009). Consequently, culture-related norms or habits may impact the predictive model of fruit consumption.

Hypothesis #2: Intention-Behavior Gap of Physical Activity.

Inconsistent with my hypothesis, neither the interaction of sleep latency complaints and working memory nor the interaction of sleep latency complaints and response inhibition predicted the intention-behavior gap of physical activity. These results are not consistent with previous literature, which indicates working memory, but not response inhibition, is related to regular physical activity in young adults (Berchicci et al., 2013; Hillman, Motl, Pontifex, & Posthuma, et al., 2006; Erikson, Banducci, Weinstein, & MacDonald, et al., 2014; Padilla, Perez, & Andres, 2014; Wong & Mullan, 2009).

Results of the present study are inconsistent with some studies that examined the relationship between working memory and chronic physical activity. Hansen and colleagues (2004) demonstrated that fitter young adults performed better on working memory measures (assessed using the n-back task) than less fit peers. Similarly, Lambourne (2006) observed that undergraduate students who met the physical activity requirements specified by the Center for Disease Control and Prevention (CDC) performed better on the working memory task (assessed using the reading span task) than peers who did not meet these requirements. However, findings in the literature are mixed, and some studies found working memory was unrelated to engagement in chronic physical activity (Hillman et al., 2006; Kamijo et al., 2010). Kamijo and colleagues (2010) found fitter college students did not achieve higher scores on the working memory task (assessed using the Stenberg task) than more sedentary peers. Hillman and colleagues (2006) reported analogous findings in which working memory (assessed using the WAIS-III working memory scale) was unrelated to level of engagement in regular physical activity in a sample of community dwelling young adults.

Different results may be explained by different ways of measuring physical activity in the literature. In the existing research, physical activity measurement involves the time periods over the past week (Berchicci et al., 2013), the intention-behavior gap in minutes over the past week (Hall et al., 2008), and the intention-behavior gap of minutes in the past day (present study). Day by day measurement of physical activity was chosen for the present study because engagement in physical exercise has been shown to differ based on the day of the week (Racette, et al., 2005b). Additionally, the present study measured the intention-behavior gap of physical activity by day (allowing for direct comparison to the previous night's sleep), as opposed to retrospective physical activity habits. Use of this retrospective variable would hinder examination of physical activity related decision making immediately following a night of poor sleep.

Limitations and Strengths

Several methodological limitations impact interpretation of the present results. This study utilized nightly and daily self-report measures of sleep latency and health behaviors because these tools are inexpensive and feasible to use in studies of large samples. However, bias inherent to self-report measurement of sleep and diet hinder generalizability of findings. Subjective sleep quality (measured in the present study) has been shown to have low to moderate construct validity (Wolfson et al., 2003), and subjective diet (measured in the present study) has been shown to have a low to moderate relationship with lab measured food consumption (Lichstein, Stone, Donaldson, & Nau et al., 2006; Prince, Adamo, Hamel, & Hardt, 2008). Self-report diet may have a weak relationship with lab measured food intake because of the influence of social desirability and social approval biases. These biases have been shown to lead to misclassification of 24 hour dietary intake estimates and exposure to specific foods or nutrients in females (Herbert, Ma, Clemow, & Ockene, et al., 1997) and engagement in physical activity (Prince, Adamo, Hamel, & Hardt, 2008). Relationships between sleep latency, total sleep time, and engagement in physical activity may differ in the literature because individuals completing sleep diaries are inclined to overestimate sleep latency and underestimate total sleep time (Chambers, 1994; Sadeh, Sharkey, & Carskadon, 1994). Effect of this reporting bias is positively associated with sleep deficits, in that adults with insomnia are more likely to report greater sleep onset latency and less total sleep time (Carskadon, Dement, Mitler, & Guilleminault, et al, 1976; Sadeh, Hauri, Kripke, & Lavie, 1995).

Homogeneity of the present study sample limits generalizability of findings. For example, the present sample is limited to undergraduate students, which restricts extrapolation of findings to same-aged adults in the community. Within the undergraduate population, the study sample is limited to freshman and sophomore female undergraduate students between the ages of 18 and 20. Results may not be generalizable to older college students as well. In support of this distinction, students in their junior and senior years have been shown to report different diet and physical activity behaviors than younger undergraduates (Small, Bailey-Davis, Morgan, & Maggs, 2013). The present sample excluded male students, as male undergraduates have been shown to report consumption of more servings of fruits and vegetables than their female peers (Li, Concepcion, Lee, & Cardinal, et al., 2012). Homogeneity of race and socioeconomic status in the present sample limits generalizability of findings. The majority of participants were Caucasian (58.8%) and reported their parents graduated from college (78%). Socioeconomic position and race have been shown to shape many health behaviors, such as dietary patters and physical activity (Isaacs & Schroeder, 2004).

Most participants in the present study were normal weight (68.4%), which is inconsistent with samples assessed in similar literature (Allom & Mullan, 2014; Guerrieri, et al., 2009; Houben, Nederkoorn, & Jansen, 2012). The sample's limited weight status variability biases findings since weight status is associated with engagement in weight regulating health-behaviors (Xiao, Keadle, Hollenbeck, & Matthews, 2014). Selection bias may explain the lack of variability of weight status in the present sample. The study advertisement stated participants would be weighed, and assessment of weight and body fat measurement has been shown to deter overweight and obese participants from enrolling in research (Drake, Longacre, Dalton, & Langeloh, et al., 2014).

Interpretation of results is limited because this study is cross sectional and thus cannot support causality. Though results contributed to the understanding of sleep complaints in the model of health behavior decision making, causation and direction of relationships cannot be determined. For example, whether sleep latency contributes to specific health behavior outcomes, or if poor cognitive self-control is a consequence of extended sleep latency, is unknown. Further longitudinal or experimental research could answer this question thereby extending the findings of this study.

There are notable strengths of the present study. This is the first study to examine sleep complaints, cognitive self-control, and weight-regulating health behaviors. Although multiple studies examined relationships between two of these three variables, it had yet to be determined how sleep complaints contributed to the relationship between cognitive self-control and weight regulating behaviors (Hofmann et al., 2008; Muraven, Shmueli & Burkley, 2006). Another strength of the present study is the large sample size. The sample used in this study was large (N=272) compared to previous literature (Allom & Mullan, 2014; Janiska et al., 2012). A larger number of participants in the present research allowed for greater potential statistical power and subgroup analysis. The present study contributes to literature on sleep complaints because it utilizes detailed sleep, diet, and physical activity diaries to investigate behavior immediately following a night of poor sleep. Similar studies evaluated sleep, diet, or physical activity habits, which does not capture day to day variation in behavior and sleep patterns (Buysse, et al., 2008).

Clinical Implications

Current findings have several potential implications for interventions designed to increase healthy behaviors in undergraduate females. Namely, it appears working memory, but not response inhibition, is associated with achieving vegetable consumption goals. This finding is in agreement with clinical intervention studies that found response inhibition training programs are primarily efficacious in laboratory settings but not naturalistic settings (Allom & Mullan, 2015). Importance of working memory in achievement of vegetable consumption goals is reinforced by findings of Levitsky and colleagues (2006). They found college freshman who weighed themselves daily gained significantly less weight over a period of 10 weeks than those who weighed themselves once per week. Measurement of weight daily provided the individual with a reminder of their goal to decrease their weight. Greater frequency of weighing oneself increases accessibility of goal-congruent information.

Although literature shows working memory is related to weight regulation, and a reasonable conclusion would be to increase working memory ability to lose weight, it is impossible to do so (Shipstead, Redick, & Engle, 2012). Working memory training strategies may improve an individual's score on a working memory test but do not change the underlying ability (McNamara & Scott, 2001; Turley-Ames & Whitfield, 2003). Since college freshman are often preoccupied with other goal-related activities (e.g., social events and academic deadlines), clinicians may want to target other modifiable behaviors that do not require use of working memory, such as sleep, to increase healthfulness of food choice.

Despite the relationship between sleep and weight-gain uncovered by the present literature review, only one weight-regulation treatment outcome study addressed sleep during intervention. Werch and colleagues (2008) conducted a randomized control trial to assess the efficacy of a brief physical health promotion intervention in undergraduate students ages 18 to 21. This program addressed the participant's future self-image by asking the participant to log their sleep and develop nutrition, exercise, and sleep plans (Werch, Moor, Bian, & DiClemente, et al., 2008). Results from the intervention were compared with the control condition in which participants were provided with written materials that did not include information about sleep. Undergraduates in the intervention condition reported significantly greater improvement compared to baselines in the following areas: sleep quantity, overall health-related quality of life, and engagement in moderate intensity physical activity over a 30 day period. Findings provide evidence for including sleep diaries in weight-loss interventions targeting undergraduate students. While some weight-regulation intervention studies queried about sleep timing and quantity throughout treatment, they failed to include psychoeducation about sleep in their intervention (Elder, Gullion, Funk, & DeBar, et al., 2011).

Future Directions

Results of the present study suggest a need to further investigate the role of sleep latency as a moderator in the relationship between cognitive self-control and execution of intended health behaviors. In addition, the role of anxiety should be considered in future studies, as it has been shown to positively relate to subjectively measured sleep latency in non-clinical adult samples (Koffel & Watson, 2011; Manber, Edinger, Gress, & San Pedro-Salcedo, et al., 2008; Mayers, Grabau, Campbell, & Baldwin, 2009; Ramsawk, Stein, Belik, & Jacobi, et al., 2009). Numerous studies have suggested that diet quality is inversely related to anxiety and depression symptoms in adult females (Beydoun, Kuczmarski, Beydoun, & Shroff, et al., 2010; Jacka, Mykletun, Berk, & Bjelland, et al., 2011; Nanri, Kimura, Matsushita, & Ohta, et al., 2010). Possibly treatment of anxiety may improve health behavior outcomes in undergraduate female students because it targets the sleep issues which impede the health decision making process. Research on the nonpharmacological treatment of sleep disorders has confirmed the short and long-term benefits of several behavioral techniques which focus on reduction of anxiety symptoms before bed such as progressive and autogenic relaxation, systematic desensitization, paradoxical intention, and biofeedback (Espie, Kyle, Williams, & Ong, 2012; Morgenthaler, Kramer, Alessi, & Friedman, 2006). Utilization of these treatments may be more effective in improving weight-regulating health behaviors than interventions that attempt to increase response inhibition performance. Future studies should also examine the relationship between the Consensus Sleep Diary-Core and objective measures of sleep, as this measure has not been sufficiently validated (Carney et al., 2012). Such a study would elucidate whether the perceived portion of sleep latency or sleep latency itself contributes to the model of health behavior decision making.

APPENDICES

APPENDIX A

Baylor University
Psychology and Neuroscience

Consent Form for Research

PROTOCOL TITLE:	Sleep and Self-Control
PRINCIPAL INVESTIGATOR:	Rachel Kantor
SUPPORTED BY:	Baylor University

Introduction
Please read this form carefully. The purpose of this form is to provide you with important information about taking part in a research study. If any of the statements or words in this form are unclear, please let us know. We would be happy to answer any questions. You have the right to discuss this study with another person who is not part of the research team before making your decision whether or not to be in the study. Taking part in this research study is up to you. If you decide to take part in this research study we will ask you to sign this form. We will give you a copy of the signed form. The person in charge of this study is Rachel Kantor, M.S.C.P. We will refer to this person as the "researcher" throughout this form.

Why is this study being done?
The purpose of this study is to see how sleep is related to the types of foods you decide to eat and how much you choose exercise. We are asking you to take part in this study because you are a female freshman or sophomore student at Baylor University, over the age of 18, and can speak English fluently. About 160 students will take part in this research study at Baylor University.

How long will I take part in this research study?
We expect that you will be in this research study for **total of 3 days**. During this time, we will ask you to complete some activities in person and by email. These activities will take a total of 35 minutes to complete. On day 1 you will go to a designated computer lab of the Baylor Sciences Building and complete surveys and games (25 minutes), then complete a short survey on your phone, computer or tablet on days 2 (5 minutes) and 3 (5 minutes). Day 2 and day 3 surveys are completed on your schedule and do not require you to attend any in person meetings.

Figure 1: Study Administration Schedule

Day #1 (Study Visit)	**Day #2** (Online Survey)	**Day #3** (Online Survey)
- Meet research assistants in a computer room in the BSB - Fill out consent document (*5 min*.) - Complete online surveys and activities (*15 min.*) - Measure your heights and weight in a private area (*5 min*.).	- Complete a short online survey (*5 min*.).	- Complete a short online survey (*5 min*.).

What will happen if I take part in this research study?
If you agree to take part in this study, we will ask you to sign the consent form before we do any study procedures. You are welcome to withdraw from study at any point (e.g., before participation, during participation, or after participation) and will receive credit for the parts of the study you completed. If you choose to sign the consent form and partake in the study we will ask you to participate for approximately 35 minutes across a 3 day period. You will answer surveys that will ask you about your sleep the night before. Surveys will also ask you about health behaviors including diet, exercise and sleep. You will play memory and attention computer games. Finally, a trained research assistant will measure your height and weight in a private area. No information about your height or weight will be said out loud or made available to any other participants in the room. On Day 2 and 3 we will email you a short survey that asks your health behaviors and sleep from the day/night before. You will have 1 day to complete the survey, which can be completed on any internet ready device, including your phone, tablet or computer. Each of these surveys will take less than 5 minutes to complete. In exchange for your participation in the present study you will receive research credits for the introductory psychology course at Baylor University. You will receive 1 credit for participating in day 1 of the study. You will receive an additional 1 credit (total of 2 credits) if you complete day 2 and day 3 follow up surveys.

What are the risks of taking part in this research study?
Confidentiality will be maintained to the degree permitted by the technology used. Your participation in this online survey involves risks similar to a person's everyday use of the Internet, which could include illegal interception of the data by another party. If you are concerned about your data security, please contact the researcher to schedule a time to complete a printed survey with the same questions.

Are there any benefits from being in this research study?
There are no benefits to you from taking part in this research.

What alternatives are available?
You may choose not to take part in this research study.

How Will You Keep My Study Records Confidential?

We will make every effort to keep your records confidential. Your responses and scores will be linked to your name and email address for up to 3 weeks following the study. This allows research staff to assign you the appropriate amount of research credit and organize data. However, there are times when federal or state law requires the disclosure of your records. If, during your participation in this study, we have reason to believe that you are at risk for harming yourself or others, we are required to take the necessary actions. This may include notifying your doctor, your therapist, or other individuals. If this were to occur, we would not be able to assure confidentiality.

The following people or groups may review your study records for purposes such as quality control or safety: (1) The researcher and any member of her research team, (2) Authorized members of Baylor University who may need to see your information, such as administrative staff members from the Office of the Vice Provost for Research and members of the Institutional Review Board (a committee which is responsible for the ethical oversight of the study), and (3) Federal and state agencies that oversee or review research (such as the HHS Office of Human Research Protection or the Food and Drug Administration). The study data will be stored on an electronic survey platform named Qualtrics. Within 3 weeks of obtaining data a random number will replace your name. At this time your name will no longer be associated with your data. A key, which connects your name and corresponding number, will be saved onto a single password protected thumb drive accessible solely to the researcher. Deidentified results of this study may also be used for publications or presentations at professional meetings. If your individual results are discussed, your identity will be protected by using a code number rather than your name or other identifying information.

Study Participation and Early Withdrawal

Taking part in this study is your choice. You may choose not to be in the study or to stop being in the study before it is over at any time. This will not affect your class standing or your grades at Baylor University. You will not be offered or receive any special consideration if you take part in this research study. Research staff may take you out of this study without your permission. This may happen because: (1) the researcher thinks it is in your best interest, (2) the research staff cannot schedule study visits, or (3) other administrative reasons. If you choose to withdraw from the study at any time or a research staff takes you out of the study you will receive full or partial research credit depending on the portion of the study you completed. Specifically, if you withdraw at any point on day 1 you will receive credit for all of day 1 (1 credit). If you choose not to complete either day 2 or day 3 follow up surveys you will receive credit for completing day 1 (1 credit). If you choose to withdraw your data from the study after completing the follow up survey on day 3 you will receive full credit (2 credits).

Will I get paid for taking part in this research study?

You will not be paid for taking part in this study.

What will it cost me to take part in this research study?
There are no costs to you for taking part in this research study.

What if I have any questions or concerns about this research study?
You can contact the researcher if you any questions about or related to the present study. Her contact information is listed below:

Principle Investigator:
Rachel Kantor, M.S.C.P.
Rachel_Kantor@Baylor.edu *(preferred)*
(254) 300-1567

If additional concerns arise contact the researcher's Faculty Advisor. Her contact information is listed below:

Faculty Advisor:
Christine Limbers, Ph.D.
Christine_Limbers@Baylor.edu
(254) 710-2063

If you want to speak with someone **not** directly involved in this research study, you may contact the Baylor University IRB through the Office of the Vice Provost for Research at 254-710-1438. You can talk to them about: (1) Your rights as a research subject, (2) Your concerns about the research, and/or (3) A complaint about the research.

Statement of Consent

I have read the information in this consent form including risks and possible benefits. I have been given the chance to ask questions. My questions have been answered to my satisfaction, and I agree to participate in the study.

____ ______________________

Signature of Subject Date

Signature of Person Obtaining Consent:

I have explained the research to the subject and answered all his/her questions. I will give a copy of the signed consent form to the subject.

____ _________________________

Signature of Person Obtaining Consent Date

APPENDIX B

Demographic Information

Welcome to the Sleep and Self-Control study. Please answer the following demographic and health questions before we get started! If you have any questions please raise your hand or let one of the research staff know and we will answer your questions.

First Name: ______

Last Name: ______

Baylor Email (john_smith@baylor.edu) ______

What is your age? ______

What year are you in college?
- ❍ Freshman
- ❍ Sophomore
- ❍ Other ________

Please specify your ethnicity:
- ❍ Hispanic
- ❍ Non-Hispanic White
- ❍ Non-Hispanic Black
- ❍ Asian
- ❍ Native America
- ❍ Bi-racial
- ❍ Other ________
- ❍ I prefer not to answer

What is the highest degree or level of school of any of your primary care-givers? If currently enrolled, highest degree received.   primary care giver: This can include any individual that you consider immediate family: e.g., biological parents, legal guardians, grandparents, etc.)

- ❍ Grade 7 or lower
- ❍ Grade 8
- ❍ Grade 9
- ❍ Grade 10
- ❍ Grade 11
- ❍ High School Diploma
- ❍ GED
- ❍ Some College
- ❍ Associate's Degree
- ❍ Bachelor's Degree
- ❍ Master's Degree
- ❍ Doctorate (e.g., Ph.D., M.D., J.D.)
- ❍ I prefer not to answer

How many servings of FRUITS and VEGETABLES do you intend to eat on a regular weekday? (Intend= your goal)   1 serving of FRUIT = cup/piece of fruit the size of a baseball 1 serving of VEGETABLE = cup of vegetables (not including potatoes) the size of a fist

	0	1	2	3	4 or more
FRUITS (1)	❍	❍	❍	❍	❍
VEGETABLES (2)	❍	❍	❍	❍	❍

How many minutes did/do you intend to exercise yesterday?   Exercise = any activity that causes a noticeable increase in your heart rate ______

How many minutes do you intend to exercise today?   Exercise = any activity that causes a noticeable increase in your heart rate ______

How many minutes do you intend to exercise the tomorrow?   Exercise = any activity that causes a noticeable increase in your heart rate ______

Are you currently dieting to lose weight?

- ❍ Yes
- ❍ No
- ❍ I prefer not to answer

APPENDIX C

Daily Sleep and Eating Survey

How many servings of FRUITS and VEGETABLES did you eat yesterday?
1 serving of FRUIT = cup/piece of fruit the size of a baseball 1 serving of VEGETABLE = cup of vegetables (not including potatoes) the size of a fist

______ FRUITS
______ VEGETABLES

Approximately how many minutes did you exercise yesterday?
Exercise = any activity that causes a noticeable increase in your heart rate

______ Minutes

Let's talk about SLEEP! What time did you get in bed and try to go to sleep last night?

- ❍ 5:00 pm
- ❍ 6:00 pm
- ❍ 7:00 pm
- ❍ 8:00 pm
- ❍ 9:00 pm
- ❍ 10:00 pm
- ❍ 11:00 pm
- ❍ 12:00 am
- ❍ 1:00 am
- ❍ 2:00 am
- ❍ 3:00 am
- ❍ 4:00 am
- ❍ 5:00 am
- ❍ 6:00 am
- ❍ 7:00 am
- ❍ 8:00 am
- ❍ 9:00 am
- ❍ 10:00 am
- ❍ 11:00 am
- ❍ 12:00 am
- ❍ 1:00 pm

How long (in minutes or hours) did it take to fall asleep last night?
❍ 0 hr. (fell right asleep)
❍ .25 hr. (15 min.)
❍ .5 hr. (30 min.)
❍ .75 hr. (45 min.)
❍ 1 hr. (60 min.)
❍ 1.5 hr. (90 min.)
❍ 2 hr. (120 min.)
❍ 2.5 hr. (150 min.)
❍ 3 hours (180 min.)
❍ 3.5 hours (210 min.)
❍ 4 hours (240 min.)
❍ 4 + hours (240 + min.)

How many times did you wake up in the middle of the night last night?
❍ 0
❍ 1
❍ 2
❍ 3
❍ 4
❍ 5 or more

When you woke up in the middle of the night, how many minutes were you awake? or...If you woke up MULTIPLE times, what is the TOTAL amount of time you spent awake during the night?

What time did you wake up from sleep this morning?

- ❍ 5:00 pm
- ❍ 6:00 pm
- ❍ 7:00 pm
- ❍ 8:00 pm
- ❍ 9:00 pm
- ❍ 10:00 pm
- ❍ 11:00 pm
- ❍ 12:00 am
- ❍ 1:00 am
- ❍ 2:00 am
- ❍ 3:00 am
- ❍ 4:00 am
- ❍ 5:00 am
- ❍ 6:00 am
- ❍ 7:00 am
- ❍ 8:00 am
- ❍ 9:00 am
- ❍ 10:00 am
- ❍ 11:00 am
- ❍ 12:00 pm
- ❍ 1:00 pm

What time you got out of bed to start your day this morning?

- ❍ 5:00 pm
- ❍ 6:00 pm
- ❍ 7:00 pm
- ❍ 8:00 pm
- ❍ 9:00 pm
- ❍ 10:00 pm
- ❍ 11:00 pm
- ❍ 12:00 am
- ❍ 1:00 am
- ❍ 2:00 am
- ❍ 3:00 am
- ❍ 4:00 am
- ❍ 5:00 am
- ❍ 6:00 am
- ❍ 7:00 am
- ❍ 8:00 am
- ❍ 9:00 am
- ❍ 10:00 am
- ❍ 11:00 am
- ❍ 12:00 pm
- ❍ 1:00 pm

How would you rate the quality of your sleep last night?

- ❍ Very Poor
- ❍ Poor
- ❍ Fair
- ❍ Good
- ❍ Very Good

How sleepy do you feel today?

- ❍ Not at all
- ❍ A little
- ❍ Moderately
- ❍ highly

APPENDIX D

Epworth Sleepiness Scale

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you haven't done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the most appropriate number for each situation:
0 = would never doze
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

SITUATION	CHANCE OF DOZING
Sitting and reading	
Watching TV	
Sitting, inactive in a public place (e.g. a theatre or a meeting)	
As a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after a lunch without alcohol	
In a car, while stopped for a few minutes in the traffic	

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