THE INFLUENCE OF EXECUTIVE FUNCTION AND EMOTIONAL SELF-REGULATION ON ENGAGEMENT IN HEALTH BEHAVIORS

by

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ABSTRACT

SYDNEY E. PARK. The influence of executive function and emotional self-regulation on engagement in health behaviors. (Under the direction of DR. SARA LEVENS)

Increasing positive health behaviors as well as limiting negative health behaviors is critical for maintaining physical and mental health. Two self-regulatory facets, executive functions (EF) and emotion regulation/coping (emotional self-regulation; ESR), are both theorized to be related to health outcomes, such that strengths in these skills are related to better or enhanced physical and mental health, whereas weaknesses are associated with poor health outcomes. Thus, gaining a better understanding of these constructs may provide insight into opportunities to alter health behaviors. The present study aimed to explore the relationships among EF, ESR, and health behaviors. A sample of 114 college students completed EF performance-based tasks and self-report questionnaires related to their emotional self-regulation strategy use, physical activity, sleep, COVID-related stress, anxiety, and depression. An exploratory factor analysis revealed ten ESR factors, seven of which were used in regression analyses and four were used in path analyses. Hierarchical multiple regression analyses indicated EFs did not significantly predict health behaviors, although expressive support seeking predicted physical activity and positive focus predicted sleep quality. Path analyses revealed that the indirect effects of EF on health behavior through ESR were not significant. Across all analyses, COVID-19 variables significantly predicted health behaviors. Interpretations of the current results were presented, and future directions were suggested.

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CHAPTER 1: INTRODUCTION

Increasing positive health behaviors, such as exercising and eating fruits and vegetables, as well as limiting negative health behaviors, such as smoking and alcohol consumption, are critical for maintaining physical and mental health. Chronic diseases that require the maintenance of good health behaviors now account for the largest health burden in the developed world (Hall & Fong, 2007; World Health Organization, 2005). Critically, the prevalence of these chronic health conditions has increased, even though many can be prevented by increasing healthy behaviors and reducing unhealthy behaviors. Moreover, research has demonstrated that engaging in healthful behaviors, such as physical activity, eating fruits and vegetables, not smoking, and only drinking alcohol in moderation, can increase one's life expectancy by up to 14 years, compared to people who engage in unhealthy behaviors (Khaw et al., 2008). Therefore, it is important to learn more about what helps people engage in healthy behaviors and avoid unhealthy actions. One factor that is critical for the engagement in health behaviors is self-regulation. There are two facets of self-regulation, executive functions and emotion regulation, which are both posited to be related to health outcomes, such that strengths in these abilities are associated with improved physical and mental health, whereas weaknesses are associated with detrimental health (Diamond, 2013; Gross, 2013; Gross & Munoz, 1995; Goldstein et al., 2014; Hall & Fong, 2007; Izard et al., 2011). Thus, there is a need to better understand these self-regulatory constructs that contribute to health behavior engagement in order to identify opportunities for change and intervention.

CHAPTER 2: LITERATURE REVIEW

Health Behavior Change Background

The promotion of health behavior change has increased in recent years as researchers gain a better understanding of the mechanisms that drive engagement in healthy actions and disengagement in detrimental behaviors. Furthermore, the focus in health care has begun to shift from infectious disease to chronic illness and quality of life, both of which can be improved and well managed with consistent engagement in health behaviors. This research has also catalyzed the development of new programs to monitor and improve health (e.g., individualized medicine, health management mobile applications, fitness trackers, etc.). Despite the increased knowledge and tools available for self-management of health, health behavior engagement and maintenance remain low (Anderson et al., 2016; Center for Disease Control [CDC], 2019; Kanstrup et al., 2018). More information is needed on the basic regulatory mechanisms, such as self-regulation, that support self-management of health and behavior change (Riddle, 2015). Executive function and emotion regulation are two constructs that influence one's ability to and tendency to self-regulate. Therefore, obtaining a greater understanding of these constructs, their interaction, and their relation to health behavior engagement may provide insight into intervention targets that could facilitate effective health behavior change.

Behavior change is critical to help individuals live in ways that are healthful across the lifespan. Many health behavior change theories (Ajzen & Madden, 1986; Bandura, 1998; Fishbein, 1967; Prochaska et al., 1992), which are briefly reviewed below, were developed to better understand how behavior change occurs. For instance, social cognitive theory explores how the motivation and influence from one's self-efficacy and sociocultural determinants influence health behavior change (Bandura, 1986; Bandura, 1998). The transtheoretical model,

on the other hand, involves five stages of change that can help an individual alter their behavior through pre-contemplation (no intention to change), contemplation (realizing there is a problem and thinking about change, but not ready to act), preparation (intention), action (the desired behavior), and maintenance (committing to the new behavior; Prochaska et al., 1992). Another theory that proposes stages of change is the health action process approach (HAPA; Schwarzer, 2011). This theory incorporates motivational and volitional influences as well as different types of planning to explain/predict health behavior change (Schwarzer, 2011).

Other theories, such as the theory of reasoned action, focus on the role of one's attitude and subjective norms in intention and behavior (Ajzen & Fishbein, 1977; Fishbein, 1967). The theory of planned behavior in turn extends the theory of reasoned action by incorporating perceived behavioral control, which can influence behavior directly and through intention (Ajzen & Madden, 1986). The theory of planned behavior is the most prominent in the health behavior change literature (Schwarzer, 2011). Relatedly, the health belief model (Rosenstock, 1974) considers how one's beliefs (e.g., their perceptions around the likelihood of developing disease, benefits and barriers to preventing disease) lead to behavior (Champion & Skinner, 2008). The dual process model of self-control suggests impulsive factors (e.g., automatic reactions) and reflective factors (e.g., self-regulatory actions) influence health behavior (Hofmann et al., 2008). The COM-B system includes components of the aforementioned models as well as environmental factors into a system of three factors that contribute to behavior and behavior change: capability, opportunity, and motivation (i.e., "COM"; Michie et al., 2011). While a thorough review of behavior change theories is beyond the scope of this dissertation, a common theme in behavior change theories is an intention-behavior link, such that the level of intention determines the likelihood of the desired behavior occurring.

One emerging theoretical framework that provides a route for exploring the intention-behavior link more explicitly is the temporal self-regulation theory (TST; Hall & Fong, 2007; Hall & Fong, 2013; Sheeran et al., 2017). TST incorporates the additional influence of cognitive resources, habitual behavioral patterns, and self-regulation within the environmental context on health behaviors (Hall & Fong, 2007). Although intention, or the plan to engage in a health behavior, is a vital part of being a healthy individual, TST specifically proposes that intention is moderated by behavioral prepotency and self-regulatory capacity (Hall & Fong, 2013). Behavioral prepotency is one's tendency to engage in habitual or automatic behavior patterns (Hall & Fong, 2007). While, self-regulatory capacity, on the other hand, is one's ability to purposefully control and monitor one's actions in relation to short- and long-term goals (Hall & Fong, 2007). Accordingly, I will now discuss behavioral prepotency and self-regulatory capacity in more detail for readers to gain a fuller understanding of the role of self-regulation in behavior change initiation and maintenance.

Behavioral prepotency refers to the likelihood of engaging in a behavior based on past behavior, automatic or habitual actions, and environmental cues (Baumeister & Heatherton, 1996; Hall & Fong, 2007; Hall & Fong, 2013; Ouellette & Wood, 1998). Behavioral prepotency is considered an individual's "default status" of behavior (Hall & Fong, 2013, p. 37). For example, if an individual always hits the snooze button upon waking, they are more likely to continue to do so, regardless of intention. Behavioral prepotency is also influenced by emotions, specifically short-term hedonic emotions which aim to increase pleasure in the moment. The link between prepotent responses and emotion is critical in health behavior. How one experiences an emotion including their sensitivity to, intensity, and duration of that emotion (Nock et al., 2008; Zelkowtiz & Cole, 2016) can be a prepotent response. For example, the pleasure one feels in

hitting the snooze button and snuggling back into the covers is an emotional prepotent response that would need to be overridden for an individual to get up early to exercise. The stronger the emotional prepotent response (e.g., pleasure in sleeping in, or pleasure in eating a cookie), or the stronger the habitual prepotent response (e.g., the act of hitting the snooze button), the more self-regulation is required to override and change behavior. Further, it may be particularly difficult to override a prepotent response that has an emotional component (Nock et al., 2008), making it critical to identify regulatory routes that can override habitual and emotional prepotent responses to implement behavior change.

Self-regulatory capacity influences behavioral prepotency—it has the ability to override prepotent actions (Hall & Fong, 2007). There is a push-pull association between them. An individual uses self-regulatory resources to effortfully control and adjust their behavior, thoughts, and emotions in ways that are in line with their short- and long-term goals. The focus on self-regulation and its role in health behavior is one of the contributions of TST. Although some of the health behavior theories I introduced earlier (e.g., HAPA, social cognitive theory, dual process model of self-control, COM-B system, etc.) include aspects of self-regulation, they do not provide the same type of framework for how these constructs interact as TST does. For example, the HAPA model incorporates self-regulatory processes (e.g., goal setting, goal pursuit, planning; Schwarzer, 2011), but does not approach self-regulation from a basic level. In the COM-B system, on the other hand, self-regulation is represented by combining the psychological aspects of "capability" and the automatic aspects of "motivation" (Michie et al., 2011). Self-regulation also plays a critical role in social cognitive theory (Bandura, 1986) which was developed to explain observational learning and extended later to health behavior (Bandura, 1998). Finally, there is also the dual process model of self-control, which is the closest to the

TST model in terms of the association between self-regulation and prepotent responses. The dual process model of self-control is derived from neuroimaging research and purports that self-regulatory regions of the brain (e.g., prefrontal cortex) institute top-down control, while prepotent response regions of the brain (e.g., amygdala) provide bottom-up influence (Hofmann et al., 2008). The TST theory proposes the same associations as the dual process model of self-control but goes into greater depth about the associations between self-regulation and prepotent responses and establishes these associations in habitual behavior, intention strength, and how they evolve over time (Hall & Fong, 2013).

TST theory proposes, for example, that individuals with stronger self-regulation skills are able to act more in line with their intentions (Hall & Fong, 2013) since they would have greater regulatory capacity to overcome habitual responses. TST also proposed that those with lower behavioral prepotency (weaker habitual tendencies) would be more able to use self-regulation to overcome unhealthy habitual tendencies as it would be less cognitively effortful to overcome them than for someone with strong habitual tendencies. On the other hand, those with weaker self-regulatory skills or stronger behavioral prepotency would have more difficulty with behavioral change as they would be greatly influenced by their habits, emotions, and environmental factors. According to TST, if one's behavioral prepotency is high and their self-regulatory capacity is low, it is less likely that they will engage in their intended behavior (e.g., exercise) and more likely that they will engage in an existing habit (e.g., watch TV) or that they will be more susceptible to hedonic motivations (e.g., acting in ways that promote immediate positive emotions; Tamir et al., 2008), their emotions, and other contextual factors (e.g., inconvenience, worry about pain/soreness). However, if one's behavioral prepotency is low and their self-regulatory capacity is high, an individual should be more able to engage in their

intended behavior (e.g., exercise) and override their habitual behavior (e.g., watch TV) as well as negative emotions, hedonic motivations, and contextual barriers.

There are two forms of self-regulation that may be particularly influential in overriding prepotent responses and ultimately altering health behavior: executive functions and emotional self-regulation (see Figure 1). Executive functions are the cognitive processes that allow individuals to make decisions, problem-solve, and change behavior (Miyake & Friedman, 2012; Suchy, 2016). Emotional self-regulation is a term I will be using to subsume both emotion regulation and coping, both of which involve altering one's emotional state (emotion regulation; Gross, 1998b) or managing one's response to a stressor (coping; Folkman & Moskowtiz, 2004). There is substantial literature linking executive functioning abilities with emotion regulation and coping strategies (Campbell et al., 2009; Kegel et al., 2014; Krpan et al., 2007; Lantrip et al., 2015; McRae et al., 2012; Pe et al., 2013; Sperduti et al., 2017; Xiu et al., 2016). Briefly, stronger executive functions are associated with greater use of reappraisal and weaker executive functions are related to greater use of suppression (Lantrip et al., 2015; Pe et al.2013; Sperduti et al., 2017). Relatedly, individuals with weaker executive functions tend to utilize less adaptive coping styles, such as avoidant coping, and rely less on more adaptive strategies, such as emotional expression (Campbell et al., 2009; Kegel et al., 2014; Krpan et al., 2007).

By drawing from the TST theory, this study aimed to explore executive functions and emotional self-regulation in relation to specific health behaviors to better understand the basic role of these functions in health behavior engagement and maintenance. I begin by first presenting each self-regulatory mechanism in greater detail and situating it within the TST framework and health behavior literature.

Executive Function

Executive functions (EFs) are the cognitive abilities or processes that allow individuals to make decisions, problem-solve, and actively choose to alter their behavior despite different situational factors and demands or constraints (Miyake & Friedman, 2012; Suchy, 2016). EFs are often described as an umbrella construct consisting of cognitive skills or processes which are pertinent for goal-directed behavior and purposeful decision-making (Hofmann et al., 2012; Suchy, 2009; Williams & Thayer, 2009). EFs allow individuals to regulate their thoughts and behaviors, keep pertinent information in the front of their mind, switch back and forth between different tasks or ideas, as well as plan, reason, make decisions, and problem-solve (Goldstein et al., 2014; Suchy, 2009).

Although there are multiple types of EFs, dominant cognitive theories postulate that EF operates within working memory, an interactive storage system that involves the active maintenance and manipulation of information from the environment and long-term memory (e.g., mental math, maintaining a grocery list, connecting ideas, etc.; Diamond, 2013; Suchy, 2016). While there are multiple models of EF (e.g. Baddeley, 1992; Miller & Cohen, 2001; Miyake et al., 2000; Luria, 1973; Posner & Snyder, 1975; Suchy, 2009), there are three predominant EF processes that are present in the majority of working memory EF models: inhibitory control (also known as inhibition), set shifting, and updating, (Chung et al., 2014; Diamond, 2013; Miyake et al., 2000; Sperduti et al., 2017). However, given the theoretical relationship between these processes and the health behaviors I am assessing, as well as the lower sensitivity of available measures to assess updating in healthy samples, I will be focusing on inhibitory control and set shifting in this dissertation.

Inhibitory Control

Inhibitory control helps maintain active and relevant information in working memory by inhibiting or suppressing distractors (Diamond, 2013). More broadly, inhibitory control allows inhibiting, resisting, or overriding automatic, habitual or pre-dispositional responses, which is pertinent for controlling thoughts, emotions, and behavior (Diamond, 2013; Miyake et al., 2000; Miyake & Friedman, 2012; Williams & Thayer, 2009). For instance, inhibitory control allows one to inhibit or stop unwanted thoughts or memories (i.e., cognitive inhibition; MacLeod, 2007), which can be helpful when under duress or when trying to prevent impulsive behaviors (such as impulsive eating). Inhibitory control also helps individuals selectively attend to what is desired or necessary and ignore or suppress unwanted information (Diamond, 2013). A type of inhibitory control is interference resolution (Miyake et al., 2000; Persson et al., 2007). When individuals are faced with two competing ideas, conflict in the form of interference can arise between the original and new mental representations. To resolve interference, one must increase the relevant information and inhibit or suppress the less important information. For example, when in class, a student must attend to what the teacher is saying and ignore students talking near them. Inhibitory control plays a unique role in helping individuals engage in their desired health behaviors as it gives one the ability to resist prepotent/automatic thoughts or behaviors in order to engage in behavior that in accordance with their health goals (Hall et al., 2008). For instance, inhibitory control can be used to resist pushing the snooze button to ensure one wakes up early to exercise or to turn off the next Netflix episode in order to get a full eight hours of sleep. In sum, inhibitory control is pertinent for the suppression of goal-undermining behaviors in the short term, which allow individuals to obtain long-term health goals.

Set Shifting

The final common EF is set shifting, which allows one to switch between tasks or ideas in accordance with current demands or goals (Diamond, 2013; Miyake et al., 2000). For example, when an individual is balancing multiple projects at work and/or at school, set shifting allows them to switch back and forth between tasks to facilitate overall project completion. A type of set shifting is dual-task monitoring, which requires set shifting specifically for switching back and forth between tasks to complete two tasks simultaneously (or nearly simultaneously; Collette et al., 2005). Set shifting also allows one to think more flexibly. For instance, if a person had plans to engage in one behavior but a conflict arose, those with better set shifting abilities may be more able to shift to an alternative. Specifically, research has demonstrated that when individuals plan to engage in physical activity, but were prevented from doing so, those with greater set shifting abilities were able to substitute alternative activities to meet their health goal (Kelly & Updegraff, 2017). Although these activities were often less intense than the planned exercise, these participants still engaged in some physical activity. Thus, demonstrating the health advantage of greater set shifting abilities.

Inhibition and set shifting are basic EFs required for self-regulation (Hofmann et al., 2012) as they allow for planning, reasoning, and problem-solving (Diamond, 2013) in line with one's goals. For instance, to act in line a health goal, one must: regulate their actions by inhibiting the automatic tendencies (e.g., to skip the gym and watch TV instead) and when barriers arise (e.g., something came up that interfered with a scheduled workout or forgot to pack his or her workout clothes) one must shift behavior from their original plan of action to another plan of action (e.g., choosing to squeeze in a workout at a later time or talking a walk break during the day) to still act in line with their health goal (Hofmann et al., 2012). In this way,

inhibition and set shifting allow a person to make and follow a plan, reason when they make decisions, and problem-solve when barriers arise.

Executive Function and Health. In support of the link between EF and health behavior, literature indicates that generally poor EFs are associated with a myriad of physical and mental health problems. For example, individuals with EF deficits experience higher rates of obesity, diabetes, hypertension, vascular disease, lung disease, HIV/AIDs, struggle to adhere to medical treatment programs, and report worse overall self-rated health (Diamond, 2013; McHugh & Lawlor, 2016; Reimann et al., 2018; Williams & Thayer, 2009). Problems with EF are also related to increased problems in relationships, high-risk behavior, crime, and violence (Diamond, 2013). Furthermore, EFs are often impaired in mental health disorders including, substance abuse, Attention-Deficit/Hyperactivity Disorder (ADHD), conduct disorder, depression, obsessive compulsive disorder (OCD), and schizophrenia (Diamond, 2013) and those with poor EF skills tend to utilize more avoidant coping styles (Kegel et al., 2014; Wilder-Willis et al., 2002). Thus, deficits in EF hold implications for many facets of health.

Research has also demonstrated EFs have a direct influence on different health behaviors. For instance, better EF skills are associated with healthier eating behaviors, increased levels of exercise, improved treatment adherence, greater ability to quit smoking, and in some cases safer driving (Reimann et al., 2018). Additionally, worse EF is associated less engagement in healthy behaviors and greater unhealthy behaviors, such as poorer eating choices and less physical activity (Hall et al., 2008; Reimann et al., 2018). Prior research has also parsed out the different types of EFs and measured the association between specific EFs and specific health behaviors. One of the most heavily studied health behaviors with respect to each of the different EF facets and general EF more broadly is eating behavior (Allom & Mullan, 2014; Diamond, 2013; Dohle

et al., 2018; Guerrieri et al., 2007; Jasinska et al., 2012; Hall et al., 2008; Lavagnino et al., 2016; Reimann et al., 2018; Spinella & Lyke, 2004; Williams & Thayer, 2009). Research has shown that better EF is associated with greater intake of healthy food (Hall et al., 2008) and deficits in EF are associated with greater intake of unhealthy food and increased food cravings (Dohle et al., 2018; Spinella & Lyke, 2004). Prior studies have also shown links between eating and inhibitory control (Allom & Mullan, 2014; Dohle et al., 2018; Guerrieri et al., 2007; Jasinska et al., 2012) and set shifting (Dohle et al., 2018), such that greater control through these specific EFs is associated with greater ability to regulate eating behaviors in line with health goals. As eating behavior has been studied more extensively, this study will focus on two less studied health behaviors: physical activity and sleep.

Executive Function and Physical Activity. Physical activity is effortful and requires one to upregulate themselves using sympathetic nervous system activation (Christensen & Galbo, 1983). It also takes time for benefits of physical activity to become apparent. Therefore, certain EFs may be particularly useful in initiating and maintaining physical activity. To date, research has demonstrated that stronger general EFs have been associated with greater levels of physical activity (Davis et al., 2011; Hall et al., 2008). Specifically, one study found greater EF was related to more moderate-to-vigorous physical activity (Joyner & Loprinzi, 2017). Relatedly, a literature review reported three studies that demonstrate the relationship between greater EF and higher levels of physical activity (Reimann et al., 2018). With regard to specific EFs, inhibitory control has been most studied and greater inhibitory control is associated with increased engagement in physical activities (Hall et al., 2008). Set shifting has also been associated with increased ability to make flexible decisions regarding exercise (Kelly & Updegraff, 2017).

Relatedly, research has also explored the beneficial effect of physical activity on EF. Multiple studies have found that higher levels and more frequent physical activity improves EF (Fanning et al., 2017; Giles et al., 2017; Hall & Marteau, 2014; McAuley et al., 2013; Lambrick et al., 2016) or can lessen age-related changes in EF (Colcombe et al., 2004; Cotman & Bertchtold, 2002). There may, therefore, be a reciprocal association between EF and physical activity. Although the association between increased exercise and improved EF has been established, the mechanisms for this process are not well known (Williams & Thayer, 2009). Further, while there is literature supporting the reciprocal association between EF and physical activity, encouraging more physical activity to increase physical activity in, for example, sedentary individuals, requires more nuanced knowledge about how specific EFs support physical activity engagement and maintenance. Therefore, I will focus on the associations between specific executive function capabilities and the time spent engaging in physical activity (walking, moderate activity, and vigorous activity) per week. Although there is some research studying specific EFs and physical activity, it is often generalized to an overall EF factor. Thus, more research is needed to elucidate the relationship between specific EF capabilities and physical activity health behaviors. Based on existing research however, I expected that stronger inhibition and set shifting would be positively associated with physical activity. Specifically, I posited inhibition and set shifting ability would be positively associated with physical activity because stronger inhibition and set shifting abilities may allow for a more opportunities to strengthen physical activity intention by increasing the likelihood of engaging in alternate physical activities and/or inhibiting potentially more desirable sedentary activities when obstacles arise.

Executive Function and Sleep. Sleep is a less commonly discussed health behavior as compared to eating and physical activity, yet it is critically vital to overall health (Perry et al., 2013). Contrary to physical activity, sleep requires parasympathetic nervous system activation to calm the body down and prepare for sleep (Fink et al., 2018). Although sleep is important, often an individual's prepotent response is to stay awake due to stimulation (e.g., phone screen, TV), arousal (e.g., stress), or simply lack of an appropriate/consistent bedtime routine. EFs may be critical in exhibiting more control over or altering those habitual behaviors/prepotent responses to increase behaviors that promote restful sleep. However, research assessing the impact of EFs on sleep is limited.

One study assessing the relationship between sleep quality and EF found that "poor" sleepers (as categorized by the Pittsburg Sleep Quality Index; Buysse et al., 1988) had worse self-reported EFs as compared to "good" sleepers (Ferraro et al., 2015). While there is little research linking specific EFs or a general EF factor to sleep behaviors, there is a significant amount of literature evidencing the importance of sleep for general cognitive function that may be illustrative of the role of EF on sleep (Deak & Stickgold, 2010; Diamond, 2013; Jenni & Dahl, 2008; Wilckens et al., 2014). Literature exploring the relationship between EF and sleep largely demonstrates how improved sleep positively influences EF performance. For example, increasing sleep over a period of six months improved EF (Fanning et al., 2017). Additionally, teaching sleep hygiene has shown to be effective at improving sleep quality, as well as EF (Almondes et al., 2017). However, more research in this area, specifically how EFs influence sleep, needs to be conducted to better understand the relationship between EF and sleep to promote longstanding changes. While developing a hypothesis on the associations between inhibitory control and set shifting was difficult given the dearth of research in this area, based on

the role of EF in reducing activity before sleep, I hypothesized that inhibitory control capabilities would be particularly important in promoting sleep hygiene behaviors. I predicted set shifting would also play a prominent role as greater set shifting abilities may help one mentally shift from an active task to a more relaxing task.

In sum, while there are considerable gaps in research exploring the associations between specific EFs and physical activity and sleep, there is research consistently linking EFs with health behaviors. Most notably, there is an abundance of literature looking at EF and eating habits, yet there are fewer studies exploring the influence of EFs on physical activity and sleep. TST suggests that one's self-regulatory capacity, such as EFs, play a critical role in increasing behavior engagement directly and through intention. Research focusing on the relationships between specific EFs and physical activity and sleep, is needed to identify how to improve engagement in and maintenance of these critical behaviors—a research need that this dissertation study aimed to contribute to.

Emotional Self-Regulation

The second common form of self-regulation is emotional self-regulation (ESR). Although *emotional* self-regulation is not specifically mentioned in the TST framework (only self-regulation more broadly), the overarching TST framework accommodates ESR well. TST states that self-regulation is required to override prepotent responses and also discusses emotions as a form of prepotent response that may need to be overridden—setting up the framework for including ESR. As stated earlier, ESR includes the fields of emotion regulation (ER) and coping. Although ER and coping are unique, they share multiple key characteristics and rely on the same underlying emotion modulation mechanisms. Accordingly, as ESR encompasses both ER and coping I used the term ESR moving forward to refer to the broader umbrella concept that

includes ER and coping. I reserved the specific terms of ER and coping for presenting key concepts, strategies, and research from each subfield.

ER is a hallmark form of self-regulation focused on modifying one's emotional prepotent response to meet a goal or objective (Diamond, 2013) or to derive personal meaning (Gross & John, 2003; Sheppes, 2014). Specifically, ER is the process of attending to, processing, and modifying one's emotional state in response to an emotional situation or stimulus (Gross, 1998b; Gross, 2014). Coping, on the other hand, while closely related to ER, is defined as the process of utilizing thoughts and behaviors to manage one's response to a stressful situation (Folkman & Moskowtiz, 2004). Coping specifically targets negative stressors, while ER is broader and can be applied to both stressful and non-stressful situations in which individuals may wish to increase or decrease positive or negative emotions (Gross, 2014). Critically, both ER and coping strategies are regulatory in nature and can be implemented depending on the individual's cognitive capabilities, natural tendencies, personality characteristics, and specific context (Aldao, 2013; Bonanno & Burton, 2013; Webb et al., 2012).

One of the shared characteristics between ER and coping is that both ER and coping strategies have been distinguished by the point in processing that they are utilized, including proactive (antecedent-focused) and reactive (response-focused) strategies (see Figure 2; Gross, 1998b). According to the process model of emotion regulation there are five ER strategies or points that can be used to modify one's emotional reaction to a stimulus. Situation selection (e.g., avoidance), situation modification, attention deployment (e.g., distraction), and cognitive change (e.g., reappraisal) are all *antecedent* ER strategies that occur before an emotional response is fully realized (Gross, 1998a; Gross, 1998b; Sheppes et al., 2011). Once an emotional response occurs an individual can also use a response-focused modulation strategy, such as suppression, to

alter their reactivity (Gross, 1998a). This structure can also be used to characterize coping strategies. Proactive coping strategies are used in anticipation of a stressor and follow a five-stage process in which one acquires resources, acknowledges a potential stressor, appraises said stressor, begins to use coping strategies, and finally, evaluates the effectiveness of the coping strategy employed (Aspinwall & Taylor, 1997; Moring et al. 2011). Proactive coping strategies that typically occur in advance of the stressor (but can also occur as the stressor is experienced), include reappraisal, avoidance, planning, goal setting, etc. (Moring et al., 2011). On the other hand, reactive coping strategies typically occur after the stressor has occurred (but can also occur as the stressor is experienced); these strategies include expression (also referred to as seeking social support), denial, and mental/behavioral disengagement (Carver et al., 1989; Moring et al., 2011).

As the iterative or cyclic nature of ER and coping can influence the characterization of strategies as proactive and reactive, ER and coping can also be categorized based on whether one engages or disengages with the emotional or stressful stimulus (see Figure 2). The ER literature conceptualizes engagement strategies as those which require one to stay actively involved in the processing of the stimulus (e.g., reappraisal, Sheppes, 2014), while the coping literature refers to these types of strategies as approach-oriented strategies in which individuals turn themselves or their attention toward a threat or stressor (Roth & Cohen, 1986). Disengagement strategies, on the other hand, are labeled similarly across the ER and coping literature. Disengagement ER strategies involve separating oneself from the emotional stimuli (Sheppes, 2014) and disengagement coping strategies require individuals to orient away from a stressor (Roth & Cohen, 1986).

The goal of reviewing the proactive/reactive and engagement/disengagement characterizations across coping and ER (see Figure 2) is to identify common, shared or overlapping strategies to identify a way to unite ER and coping literatures. Further, these organizational dimensions highlight the strategies that should be focused on for examining the impact of ESR on health behaviors. Strategies that are characteristically proactive are reappraisal and avoidance (Gross, 1998a; Moring et al., 2011), while those that are typically reactive are expression and suppression (Sheppes, 2014; Skinner, 2013). In terms of engagement or approach orientation, the primary strategy from the ER toolbox is reappraisal (i.e., reinterpreting a stimulus), whereas from the coping literature the primary strategies are reappraisal/reinterpretation and emotional expression (experiencing and sharing one's feelings) (Mendes et al., 2003; Sheppes, 2014). The dominant disengagement ER strategies are suppression (inhibiting emotional expression) and avoidance (directing attention away from a stressor), while the dominant disengagement coping strategy is avoidance, which in the coping literature includes proactive avoidance of the situation as well as reactive avoidance of resulting emotions (Carver et al., 1989; Moos & Schaefer, 1993; Rosenstiel & Keefe, 1983; Sheppes, 2014). The shared proactive-reactive and engagement-disengagement conceptualizations and strategies across the ER and coping literatures give rise to four overlapping strategies which this study focused on: reappraisal, suppression, expression, and avoidance (see Figure 2). I will now discuss each strategy in greater detail.

Emotional Self-Regulation Strategies

Reappraisal. Reappraisal is a strategy that is explicitly common across the ER and coping frameworks. In the ER literature, reappraisal is the process of reframing or modifying the meaning of an emotional stimulus or situation to alter one's emotions (Gross, 2014; Sheppes,

2014). In coping, reappraisal is always viewed as positive and is conceptualized as the process of dealing with negative emotions associated with a stressor and reinterpreting the stressor in a more positive way or giving meaning to a stressor (Carver et al., 1989; Folkman & Moskowitz, 2004). More specifically, reappraisal allows one to look for a positive aspect of what is occurring and try to learn from the experience to help themselves feel better (Carver et., 1989; Moos & Schaefer, 1993). As apparent from both definitions of reappraisal, it is antecedent/proactive, and engagement oriented in both the ER and coping frameworks (see Figure 2). Greater use of reappraisal is often associated with positive mental health outcomes (i.e., greater life satisfaction, more positive affect, less psychopathology; Aldao et al., 2010; Hu et al., 2014; Troy et al., 2010), as well as improved physical health (e.g., greater heart rate variability, which is a physiological marker for good health; Denson et al., 2011; Thayer et al., 2010).

Expression. The coping literature states that expression is the process of sharing or self-disclosing ones' emotions in a purposeful manner (Carver et al., 1989; McMahon & Naragon-Gainey, 2019; Mendes et al., 2003; Moos & Schaefer, 1993). While one could argue expression and suppression fall on a continuum, some ER literature suggests expression may be a different construct from suppression (Harber & Cohen, 2005; Rimé, 2009). Importantly, emotional expression in this vein does not refer to simple expression of negative emotion (i.e., venting), which can have detrimental effects to health similar to suppression because it is perpetuating negative emotions (Skinner, 2013). When referring to emotional expression, as defined previously, it involves the purposeful sharing of emotions in relation to a specific situation or stressor. Similar to suppression, emotional expression occurs after one has experienced emotions and is therefore, a response-focused strategy; and it requires an individual to delve deeper into their emotional experience, process, and communicate their feelings, thus it is an engagement or

approach-oriented strategy (see Figure 2; Roth & Cohen, 1986). Regarding health, expression is related to greater well-being and improved immune system functioning (Mendes et al., 2003).

Suppression. Suppression involves actively inhibiting emotional expression in response to an emotional stimulus (Gross & John, 2003). For instance, if one receives upsetting news about their health, they may inhibit expression of their emotions or keep them inside in attempt to reduce them. As discussed previously, this strategy is considered a response-focused/reactive, strategy as it is implemented after an emotional experience has occurred (Gross, 1998b) and disengagement/avoidance-oriented, as it prevents one from continuing to experience their emotional and psychological reactions to stressors (see Figure 2; Suls & Fletcher, 1985). Compared to reappraisal and expression, suppression and avoidance often have the opposite effect, such that greater use of suppression and avoidance is related to worse mental health outcomes (Aldao et al., 2010; Berking & Wupperman, 2012; Hu et al., 2014; Joorman et al., 2006; Levens et al., 2009; Penley et al., 2002). For example, Aldao and colleagues (2010) compared different emotion regulation strategies with psychological disorders and found reappraisal to be associated with lower rates of anxiety and depression, whereas suppression and avoidance were correlated with greater rates of the same disorders. Suppression often does not reduce one's emotions but inhibits the experience of emotions and actually increases rates of arousal (Gross, 2002; Hofmann et al., 2009). It is also associated with poor interpersonal interactions (Butler et al., 2003; Peters et al., 2014). Suppression can also have negative effects on exercise performance (Wagstaff, 2014) and has been associated with greater rates of cardiovascular disease, hypertension, and decreased immune system functioning likely due to an increased sympathetic nervous system response (Gross, 1998b).

Avoidance. Avoidance is conceptualized in both the coping and ER frameworks. Within the coping literature, avoidance is described as the process of disengaging or directing attention away from a stressor or from one's emotions (Suls & Fletcher, 1985). Within the ER framework, avoidance is a form of situation selection (Gross, 1998a), in which an individual chooses to not participate in situations that will give rise to negative emotions. Avoidance typically occurs in a proactive manner, such that, an individual may take steps to disengage from a stimulus before interacting with it to avoid further stress or unwanted emotions (see Figure 2; Blalock & Joiner, 2000; Moos & Schaefer, 1993). Avoidance has been associated with negative physical health outcomes when it leads one to engage in harmful health behaviors or engage in fewer healthy behaviors (e.g., avoiding a doctor's appointment; Penley et al., 2002; Roth & Cohen, 1986). Despite the common negative associations, it is important to note that suppression and avoidance can have beneficial effects when utilized in the short-term in response to intense situations as they can provide temporary relief from emotions or a stressor (Aldao et al., 2010; Suls & Fletcher, 1985).

Emotional Self-Regulation and Health. ESR is typically investigated in the context of mental health (Aldao et al., 2010; Gross, 2013; Gross & Munoz, 1995). For instance, many mental health disorders are characterized by deficits in ER, including anxiety, depression, borderline personality disorder, and the symptoms of many disorders include difficulties with ER, such as schizophrenia, ADHD, and autism spectrum disorder (Aldao et al., 2010; Gross, 2013). Similarly, difficulties in coping are associated with disorders such as, depression, anxiety, substance use disorder, and eating disorders (Aldao et al., 2010; Berking & Wupperman, 2012). Relatedly, greater ER abilities and increased use of reappraisal are associated with greater rates of well-being and positive affect, and lower rates of depression (Haga et al., 2009; Troy et al.,

2010), and greater use of engagement (or approach-oriented) coping strategies are associated with greater positive psychological outcomes (Moos et al., 1990). Furthermore, flexible use of ER and coping strategies, in which an individual does not rely on the same strategies across contrasting situations, is also associated with positive mental health outcomes (Bonanno & Burton, 2013), highlighting the similarities and shared functions of ER and coping.

Although ESR has been explored extensively in the context of mental health, there is a dearth of research examining ESR and physical health, despite strong theoretical rationales to explore this intersectionality. Recent research in this area demonstrates promising associations. Sagui and Levens (2016) found that individuals with higher perceived stress reactivity and lower reappraisal ability tend to be overweight or obese, whereas those with higher perceived stress reactivity and higher reappraisal ability tend to fall in a healthy weight range. Poor ER is also associated with greater rates of anger and stress, which can have a negative impact on inflammation and cardiovascular health (Gross, 2013). Furthermore, studies exploring the associations between habitual ER and inflammation found greater rates of reappraisal are associated with lower levels of inflammation, while higher rates of suppression are linked with greater rates of inflammation (Appleton et al., 2013). When applied to the risk of developing coronary heart disease, those who habitually reappraise are projected to be significantly less likely to develop heart disease, meanwhile habitual suppression had the opposite effect (Appleton et al., 2014). In addition, when individuals are faced with trauma, poor ER skills are associated with poorer physical health outcomes (Cloitre et al., 2019). In regard to coping, one study found that certain coping strategies are associated with better physical health, including improved immune functioning and fewer health care appointments (Mendes et al., 2003). For individuals with chronic health conditions, use of disengagement coping strategies was also

associated with poorer physical health outcomes (e.g., general health, body pain, physical limitations, etc.; Cheng et al., 2020). While the emerging research in this area is encouraging and warrants further exploration of the relationship between ESR and physical health, there is little research on ESR and physical activity and sleep. Accordingly, I review existing research that is illustrative of the types of associations I may observe.

Emotional self-regulation and physical activity. Attempting to increase physical activity is a difficult process frequently associated with negative emotions (e.g., fear, shame, discouragement, pain, etc.) that may require an individual to alter their prepotent responses (e.g., exercise in response to stress instead of drinking alcohol). Despite strong theoretical rationales, research examining the associations between ESR and exercise or physical activity is limited. Penley and colleagues (2012) found that disengagement strategies are associated with decreased activity and poorer performance when participating in physical activity. Specifically, avoidance has been associated with a lack of engagement in exercise, among other health behaviors (Penley et al., 2012). Relatedly, another study demonstrated that the use of suppression before completing physical activity was associated with slower exercise performance and participants felt they gave greater physical effort as opposed to those who did not use suppression (Wagstaff, 2014). Research consistently shows that exercise or physical activity improves mood (Hoffman & Hoffman, 2007); however, no research has investigated the association between use of specific engagement ESR strategies and physical activity. I postulate that more habitual use of engagement-oriented strategies, such as reappraisal and expression, may make it easier for individuals to engage in desired physical activity. For example, reappraising negative emotions or sharing them with a friend who is also trying to make healthy changes (expression) during the process of incorporating physical activity into one's routine may allow them to overcome their

barriers and form healthy habits. This proposed association is supported by exercise support groups. When exercise support groups have been implemented, an increase in physical activity is noted (Martin et al., 2010) and participants report improved perspective on exercise, increased level of exercise, and improved self-efficacy relating to exercise (Gregory et al., 2007). Participants also received reassurance from professionals and group members that the exercise was doable, more access to health professionals, and a sense of comradery that made physical activity more positive (Gregory et al., 2007). Overall, more research is needed on the associations between ESR strategies and physical activity, yet based on the existing research and theoretical associations, I predicted that habitual reappraisal and expression would be positively associated with physical activity engagement, while habitual suppression and avoidance would negatively impact physical activity engagement.

Emotional self-regulation and sleep. As discussed earlier, sleep is critical for overall health but is easily influenced by other factors. Emotions and ESR affect how easily one is able to fall and stay asleep (Baglioni et al., 2010; Kahn et al., 2013). In addition, deficits in ESR are associated with sleeping difficulties, including pathological disorders (e.g., depression, insomnia; Aldao et al., 2010; Baglioni et al., 2010; Kahn et al., 2013; Vantieghem et al., 2016). Vantieghem et al. (2016) proposes that sleep deficits associated with ESR are due to an increased level of arousal from not being able to adequately regulate one's emotions in general or is response to poor ESR following a stressful event. Regarding specific emotional self-regulation strategies, arousal modulation, and sleep, those with a natural tendency to engage more with their emotions through reappraisal and expression, tend to have better sleep quality than those who try to disengage from their emotions via suppression or avoidance (Kahn et al., 2013; Thomas et al., 2010; Vantieghem et al., 2016). Suppression is associated with greater rates of arousal (e.g.,

increased heart rate), while use of reappraisal allows one to adaptively maintain their state of arousal and potentially decrease it as needed (Aldao et al., 2010; Hofmann et al., 2009). Avoidance is also related to worse sleep quality, specifically greater sleep latency (taking longer to fall asleep; Kahn et al., 2013; Thomas et al., 2010). Research has also found that greater use of avoidance, particularly in relation to patients with cancer and other chronic illness, is associated with a greater level of distress and poorer psychological adjustment, thus negatively impacting sleep (Thomas et al., 2010).

Reappraisal, on the other hand, is associated with greater overall well-being, which is postulated to positively influence sleep. In addition, reappraisal as well as emotional expression have been linked with greater sleep quality or no change in sleep quality (Gross & John, 2003; Kahn et al., 2013; Vantieghem et al., 2016). In sum, those who tend to rely on disengagement ESR strategies (e.g., suppression, avoidance) report worse subjective sleep quality and those who engage in more engagement focused strategies (e.g., reappraisal, expression) report enhanced sleep quality (Vantieghem et al., 2016). While existing research supports strategy specific associations between ESR and sleep, more research is needed on the associations between ESR strategies and sleep habits to identify routes to facilitate better quality sleep. Similar to physical activity, I predicted that habitual reappraisal and expression would enable arousal reduction to facilitate sleep, while habitual suppression and avoidance would negatively impact sleep behaviors and quality.

The Current Study

The current study explored relationships among EF, ESR, and health behaviors (see Figure 1). For the purpose of this cross-sectional study and my goal of exploring mechanisms

underlying health, I examined EF and ESR as precursors to health by testing three hypotheses and a research question.

Hypothesis 1. Regarding EF, a clear link has been established between EFs and mental and physical health, as well as specific health behaviors, as discussed above (Allom & Mullan, 2014; Diamond, 2013; Dohle et al., 2018; Guerrieri et al., 2007; Hall et al., 2008; Jasinska et al., 2012; Lavagnino et al., 2016; Reimann et al., 2018; Spinella & Lyke, 2004; Williams & Thayer, 2009). However, more research is needed to assess the associations between specific EFs and physical activity and sleep. Research examining the unique contributions of specific EFs on physical activity and sleep is limited (Testa et al., 2012), with most studies examining EF capabilities more broadly (Espy, 2018; Miyake et al., 2000). To address these gaps, I explored the impact of each EF on sleep and physical activity. Although I kept this hypothesis broad since it is exploratory, I predicted that inhibition and set shifting would be associated with physical activity and sleep outcomes. Greater inhibitory control would likely allow one to engage in their goal driven behaviors (e.g., engaging in exercise, following a consistent sleep hygiene routine) and may help inhibit unwanted thoughts before bed. Meanwhile greater set shifting abilities would likely allow individuals to be more flexible in their physical activities despite potential barriers and may help one shift form an active task to a more relaxing task.

H1) Capabilities in each EF (inhibition and set shifting) will be positively associated with increased physical activity, higher quality sleep, and better sleep hygiene behaviors.

Hypothesis 2 and Research Question. Despite the similarity of ESR strategies, ER and coping have largely been examined and expanded upon in distinct research fields, thus hindering

efforts to elucidate the role of ESR in health behavior change. To address this gap, I utilized the engagement/disengagement and proactive/reactive framework (see Figure 2) to explore the overlapping strategies of these fields with the following research question:

RQ) Do the ER and coping strategies overlap across the proposed engagement vs. disengagement and proactive vs. reactive dimensions?

Within these ESR disciplines, there is extensive literature demonstrating the relationship among ER and coping and mental health (Aldao et al., 2010; Bonanno & Burton, 2013; Gross, 2013; Gross & Munoz, 1995; Haga et al., 2009; Troy et al., 2010); however, there is limited research investigating the effects of ER and coping on physical health. Moreover, research is needed looking at the associations between ESR and health behaviors. Thus, I explored the relationships among ESR, physical activity, and sleep. While this study was exploratory, I posited that habitual suppression and avoidance (disengagement strategies) would be negatively associated with physical activity and sleep, while reappraisal and expression (engagement strategies) would be positively associated with physical activity and sleep. My hypothesis was:

H2) ESR and physical activity and sleep will be associated, such that greater engagement ESR strategy habits (e.g., reappraisal, expression) will be associated with more physical activity and better sleep, while greater disengagement ESR strategy habits (e.g., suppression, avoidance) will be associated with less physical activity and poorer sleep.

Hypothesis 3. In addition to analyses focused on the unique contributions of EF and ESR on physical activity and sleep, I also conducted a series of path analyses that holistically explored

the impact of EF capabilities and ESR habits on physical activity and sleep behaviors. A shortcoming of the EF and health association literature as well as the ESR and health literature is that while EF and ESR fall under the self-regulation umbrella, EF and health behavior studies typically do not control for ER habits and vice versa. As discussed previously, there is literature linking EF abilities with ER and coping strategies. Accordingly, this study aimed to explore five relationships across the constructs of EF, ESR, and physical health (see Figure 3). Specifically, using path models I assessed the effect of EFs on 1) physical activity and 2) sleep, via ESR strategies. I also investigated the relationships between ESR and 1) physical activity and 2) sleep.

H3) The association between EF and engagement in health behaviors will be mediated by ER. Specifically, better EF performance will be associated with more engagement strategies, which in turn will be associated with greater endorsement of health behaviors.

CHAPTER 3: METHODS

Participants

Participants were University of North Carolina at Charlotte (UNCC) students ranging from 18- to 25-years-old. This population range was chosen to target young adults who are cognitively similar and who are in a similar phase of life. Other inclusion criteria included fluency in English, access to a laptop or desktop computer, stable internet connection, video call/screensharing abilities, and a quiet place to complete the study with limited distractions. Although the online neuropsychological platform being used allowed for some tasks to be completed across different types of devices and corrects for device in scoring, research indicates there was variance among scores depending on test device (Germine et al., 2019). In particular, there was a difference between tablets and phones compared to computers. Therefore, to increase the consistency among the data, only participants with access to a laptop or desktop computer were included. Exclusion criteria included non-traditional students (e.g., students beginning their college careers later in life, such as over 25 years old), non-English speakers, individuals under 18-years-old and 25-years-old and older, and individuals without computer or laptop access. The exclusionary criteria relating to computer access may unfortunately exclude students of lower socioeconomic backgrounds; however, this was necessary due to the administration guidelines for the neuropsychological tasks. Recruitment was completed through an online system (SONA Systems). Students in psychology courses were able to access the SONA Systems portal online, which includes a brief study description and timeslots for participants to self-select. Participants received course research credit for their participation.

An a priori power analysis was conducted on G*Power (Faul et al., 2007) to determine the target sample size. All power analyses were set to determine an 80% chance of having an

effect ($\alpha = .05$). The power analysis indicated 80 participants would be necessary to detect a small effect size ($\eta = .2$) (Cohen, 1992) if all primary study variables were used in multiple regression analyses (i.e., 2 EF facets, 4 ESR strategies, and 3 health outcomes). Additionally, if incorporating the covariates (i.e., 3 COVID-19 variables, age, and gender), the power analysis suggested 53 participants would be necessary to detect a small effect size. This is consistent with prior literature, which suggests cognitive tasks tend to yield lower effect sizes (Joormann et al., 2010; Levens et al., 2009). However, research recommends at least 10 times the number of variables being analyzed should be used in path analyses (Kline, 1998), thus, as there were 12 variables in the present study (including the independent variables, dependent variables, and covariates) a minimum of 120 participants were needed for the proposed path analyses, consequently the study aimed for an analytic sample of 150. Since proposed analyses include a path analysis assessing these relationships, the study aimed to recruit 200 participants with the expectation that not all participants would have usable data allowing the study to yield the desired analytic sample of 150 participants. Recruiting 200 participants would allow for accounting for issues with data collection and poor-quality data.

A total of 135 participants were recruited from the University of North Carolina at Charlotte. Of the 135 participants, 15 were excluded for missing test or survey data, three were excluded for not including gender (which was necessary to analyze the EF data), and three were excluded because they were over age 25. Thus, results gave rise to a final sample of 114 participant. While the final sample is lower than 120 due to COVID-19 data collection challenges, the 114 participants obtained is close to the desired 120 participants and above the 80 participants recommended by the power analysis. Therefore, analyses were continued.

Procedure

Participants were recruited through SONA Systems where they were able to self-select virtual timeslots to complete the study. Prior to the participants session, the principal investigator or a trained research assistant (RA) emailed a copy of the informed consent form and a Zoom link. The participant used their university Zoom account to meet the examiner at their selected time. The examiner began by verifying the student's name and email and then reviewed the informed consent along with a brief explanation of the procedure. Once all questions were answered and the participant agreed to participate in the study, they used DocuSign to provide their consent. A copy of the signed consent was emailed back to the participant for their records and an electronic copy was kept in a password protected university DocuSign account. After the examiner had confirmation of the participant's consent, the examiner proceeded with the study. All communication occurred verbally through the Zoom call or through the Zoom chat. Notably, all Zoom chats are erased once the call is ended; therefore, any information shared during the call was private. The examiner asked the participant to close all other applications and websites (e.g., social networking websites), turn off notifications on their computer, and turn off or silence their cell phone for the duration of the study. The neurocognitive tasks were always administered first to the participant to ensure optimal attention levels and to allow the examiner to guide them through the neurocognitive tasks.

First, the examiner explained that the participant would complete a brief series of cognitive tasks on the computer; however, they would remain on the Zoom call together throughout this portion. The examiner sent the link for the neurocognitive battery through the Zoom chat. The online neurocognitive battery was run through the TestMyBrain (TMB) Digital Toolkit (Germine et al., 2019), which provided a unique code for each participant. The examiner linked this code with the assigned participant ID on a separate document. No identifiable

information was associated with these linked numbers. The order of neurocognitive tasks was counterbalanced across participants. The examiner made note of this order prior to the beginning of the session so they were able to clearly guide the participant through each of the tasks. For example, one participant completed one TMB task first and then the other or vice versa.

The cognitive tasks were self-administered online on the TMB Digital Toolkit while the participant shared their screen with the examiner on Zoom. The examiner guided the participant through which task to select based on the counterbalanced order and was available to answer any questions during task instructions and administration. Although research indicates that self-administered cognitive tasks yield quality data (Germine et al., 2012), the goal was to mimic in-person data testing by having the examiner present to obtain the highest quality data.

After completion of the neurocognitive tasks, the examiner sent the participant the link to Qualtrics survey as well as the designated participant ID they are to use in during the survey via the Zoom chat. The questionnaires in the survey were counterbalanced as well—though the presentation order was managed by Qualtrics and not the experimenter. The participant was able to complete the questionnaires at their own pace once the Zoom call had ended. Participants were offered a brief break between tasks. The participant was also instructed on how to reach the PI or RA if they had any questions arise after the session ended. After completion of the session, as determined by completion of the questionnaires, the participant received 2 research credits on SONA systems as the study took approximately 1.5 hours.

Measures

Neuropsychological Tests

TestMyBrain: Gradual Onset Continuous Performance Test. This is a continuous performance test (CPT) designed to measure response inhibition as well as sustained attention

and cognitive control (Germine et al., 2019). Similar to other CPTs, participants were rapidly presented with certain stimuli in which they must respond to with the exception of specific types of stimuli. Specifically, in this task, participants were presented with a black and white picture of a city or a mountain and asked to only press the space bar when a city image is shown; they were instructed not to press anything when a mountain image appears. Mountain images were only displayed 10-20% of the time. The images transitioned rapidly, thus requiring the participant to quickly respond to the city images and to inhibit pressing the space bar when the mountain appeared. There were three practice trials which built upon each other. The first was a slow presentation of the stimuli with corrective feedback. The second was faster stimuli presentation still with corrective feedback and the third matches the test in that it was a faster presentation without corrective feedback. This test takes six minutes to complete on average.

One score was provided upon completion of this task: a discrimination or accuracy score. The discrimination score was calculated by taking the Z scores of the omission errors minus the commission errors, in which higher scores represented better response inhibition/inhibitory control (Germine et al., 2019). This score was used in analyses. All scores raw scores were converted to Z scores based on age, gender (male or female), years of education (7-11; 12; 13-15; 16; 17+), and testing device (Mac, Windows, Unknown, etc.). Regarding psychometrics, reliability for both scores within this task are good (discrimination $\alpha = .77$ and criterion $\alpha = .78$; Germine et al., 2019).

This CPT is sensitive to age-related changes and has been validated against in-person assessments. The normative sample for this specific test is comprised of 23,757 people (Germine et al., 2019). The overall TMB normative sample is comprised of 4,000 to 60,000 individuals (depending on the test) ranging from 12 to 90 years old (*M* 29; *SD* = 14). The sample is

comprised of 58% female participants and is primarily White (9% Hispanic Americans, 4% African Americans, 6% have a primarily language other than English). Approximately half of the sample collected for the current study was White. The statistics collected with the TMB sample largely underrepresented racial and ethnic minorities and therefore may not accurately capture the EFs of the sample. TMB sample participants frequently chose to participate to gain information about themselves, to learn more about the brain, or for recreational purposes (Germine et al., 2019). It does not appear that participants were actively recruited but instead sought out the research platform; this is likely a limitation in the sample.

TestMyBrain: Connecting Dots. This is a trail making task modified from the original trail making test (Reitan, 1992) to an online format (Germine et al., 2019). This test includes two parts, Trail Making Test A and B. Each part begins with a practice trial. In Part A, the participant must connect numbers randomly placed across the screen in sequential order starting at 1 and going to 25. Instead of using a paper and pencil, the participant clicked the mouse when to begin and move their cursor from number to number. Notably, the participant did not need to hold the mouse down the whole time, but simply click once and navigate their mouse. Errors were prompted with corrective feedback by the computer in red words at the top of the screen (e.g., "That's wrong: go back to '2', then go to '3'!") and would not let the participant continue until they made the correct move. This correction and delay in continuation, therefore, increased their completion time. Part A trials do not measure executive function, rather they provided a measure of processing speed, visual scanning, and motor control, which acts as a baseline for comparison to Part B (Germine et al., 2019). Part B trials are similar to Part A trials; however, Part B trials incorporate letters in addition to numbers. Thus, the participant had to switch back and forth between connecting numbers and letters (e.g., 1 – A – 2 – B – 3 – C, etc.) from 1 to 13 and A to

L. While this trial also assessed processing speed and involved working memory (Lezak et al., 2012), Part B measured the EF ability of set shifting. This task does require a level of attentional and inhibitory control; however, the trail making test is regarded and validated as a measure of executive control/set shifting (Arbuthnott & Frank, 2000).

Three scores were produced from each part of this task: the total time to complete the task in milliseconds, the median time to connect two points, and the total number of errors (Germine et al., 2019). As with the TMB CPT, each raw score was converted to a Z score correcting for age, gender, education, and testing device. The total time score for Part B was used in analyses as this is the EF measure. In terms of psychometrics, reliability for both trials is excellent (Part A α = .95 and Part B α = .96; Germine et al., 2019). This test is sensitive to age-related changes but has not yet been validated against in-person assessments. Therefore, results yielded from this measure will be interpreted with caution. The normative sample for this test is comprised 7,451 individuals (Germine et al., 2019).

Questionnaires

Emotion Regulation Questionnaire (ERQ). The 10-item Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) was used to determine participants' habitual ER strategy use, which includes suppression and reappraisal (see Appendix A). The scale is broken into two factors: reappraisal (six items; e.g., "When I'm faced with a stressful situation, I make myself think about it in a way that helps me stay calm.") and suppression (4 items, e.g., "When I am feeling negative emotions, I make sure not to express them."). Each item was rated on a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*). The sum of responses on each scale produced a reappraisal score and suppression score, in which high scores indicate greater use of that strategy. Both scores were used in analyses. Strong internal consistency has been

found in the reappraisal and suppression subscales, Cronbach's coefficients for the validity sample are .79 and .73, respectively (Gross & John, 2003). The present study Cronbach coefficients were .84 for the reappraisal subscale and .72 for the suppression subscale. Convergent and divergent validity is supported (Gross & John, 2003).

Coping Responses Inventory. The Coping Responses Inventory (CRI; Moos, 1997; Moos & Schaefer, 1993) is a 48-item self-report measure that assesses the frequency of engaging in specific thoughts or behaviors in order to cope with a stressful situation or problem on a 4-point Likert scale (0 = *Not at all* to 3 = *Fairly Often*; (see Appendix A). The measure is broken into two broad types of coping: approach and avoidant oriented coping scales, each of which are comprised of four subscales. The approach scales include logical analysis ("Think of different ways to deal with the problem"), positive reappraisal ("Think about how this event could change your life in a positive way."), seeking guidance and support ("Talk with your spouse or other relative about the problem."), and problem solving ("Make a plan of action and follow it."). The avoidant scales include cognitive avoidance ("Try to forget the whole thing."), acceptance or resignation ("Realize that you have no control over the problem"), seeking alternative rewards ("Spend more time in recreational activities."), emotional discharge ("Yell or shout to let off steam.").

Internal consistencies across the subscales are adequate and range from (α = .61 to .74; Moos et al., 1990). Validity is supported as the CRI is able to distinguish between clinical groups and healthy individuals (e.g., problem drinkers, who tend to use more approach-oriented strategies versus non-problem drinkers, who tend to use more approach strategies), while controlling for negative life events (Moos et al., 1990). Further, approach coping tended to be related to greater resolution following a stressful event, while avoidant strategies were associated

with poorer resolution and outcomes (Moos et al., 1990). The following three subscale scores were used in analyses as they align with the specific coping strategies the study explored: positive reappraisal, cognitive avoidance, and seeking guidance and support (expression). Higher scores on the subscales indicate greater use of those strategies. Cronbach's coefficients for these subscales in the current study were .74, .69, and .54, respectively.

COPE Inventory. The COPE Inventory (Carver et al., 1989; Carver, 2013) is a 60-item assessing individuals' behavioral and emotional responses to stressful events using a 4-point Likert scale (1 = *I usually don't do this at all* to 4 = *I usually do this a lot;* (see Appendix A). The scale is comprised of fifteen subscales to address many different types of coping including, positive reinterpretation and growth, mental disengagement, focus on and venting of emotions, use of instrumental social support, active coping, denial, religious coping, humor, behavioral disengagement, restraint, use of emotional social support, substance use, acceptance, suppression of competing activities, and planning. Scales with items specifically relevant to the study strategies were used in analyses, including positive reinterpretation and growth ("I try to see it in a different light, to make it seem more positive."), focusing on and venting emotions ("I let my feelings out."), and use of emotional social support ("I discuss my feelings with someone."). Cronbach's coefficients are broadly acceptable across scales ranging from .45 (mental disengagement) to .92 (turning to religion) but concentrated in range of .60 to .80 (Carver et al., 1989). Alphas from the validation sample for the specific scales utilized in the present study were as follows: positive reinterpretation and growth .68, focusing on and venting emotions .77, and use of emotional social support .85. Cronbach's coefficients for these subscales in the current study were .75, .77, and .91, respectively. Test-retest reliability is relatively stable (Carver et al., 1989). Convergent validity is supported as the different coping strategies were

associated with theoretically related personality traits (e.g., positive reinterpretation and growth is associated with optimism, feelings of control in a stressful situation, self-esteem, and hardiness) and discriminant validity is supported as although the strategies are correlated with expected personality traits, the correlations were significant but not extremely high; thus the COPE inventory is not measuring personality traits but coping strategies utilized (Carver et al., 1989).

International Physical Activity Questionnaire (IPAQ): Long Last 7 Days Self-Administered Format. The IPAQ Long Form is comprised of 27 questions (IPAQ Group, 2002). It asks participants to consider the types of physical activities they have participated in over the past week. It breaks down into 5 sections: 1) job-related physical activity; 2) transportation physical activity; 3) housework, house maintenance, and caring for family; 4) recreation, sport, and leisure-time physical activity; and 5) time spent sitting (see Appendix A). The first four sections ask about vigorous activity (e.g., "heavy lifting, aerobics"), moderate activity (e.g., "carrying light loads, doubles tennis"), and walking, with the exception of section 3 which excludes questions about walking. The last sections consider time spent sitting on weekdays and weekend days. Questions inquired about the number of days per week an activity was completed, as well as how many hours and minutes per day. A MET is one's metabolic rate at rest and METs are the multiples of your resting metabolic rate depending on the amount of physical activity or energy one exerts (Jette et al., 1990). An overall physical activity score was calculated in MET-minutes per week by summing the total MET-minutes per week score for the different physical activity levels (walking, moderate activity, and vigorous activity); this score was used in analyses. A higher score indicated greater levels physical activity. Time spent sitting was not included in the physical activity analysis. Criterion validity and concurrent validity are

supported as the IPAQ produces similar results with the CSA accelerometer and MTI accelerometer (Craig et al., 2003; Hagstromer et al., 2005). Test-retest reliability is also moderate to high (Brown et al., 2004; Craig et al., 2003). Furthermore, reliability and validity results from the IPAQ are consistent with a review of seven other self-report measures of physical activity (Craig et al., 2003; Sallis & Saelens, 2000). The Cronbach's coefficient for this measure in the current study was .50.

Pittsburgh Sleep Quality Index (PSQI). The PSQI is a 10-question self-report measure that assesses sleep quality and sleep patterns (Buysse et al., 1988; see Appendix A); however, only the first nine items were used as the last is to be completed by a partner or roommate (if applicable). The scale is comprised of four open-ended questions about time going to bed and waking, time spent in bed, and hours of sleep. The next set of questions utilize a 4-point Likert scale (0 = *Not during the past month* to 3 = *Three or more times a week*) referring to reasons for sleep problems and interference with daily functioning. One of these items is comprised of 10 subitems to pinpoint specific causes of poor sleep. The final question assesses the participants overall sleep quality on a 4-point Likert scale (0 = *Very good* to 3 = *Very bad*). The time of reference is over the past month; therefore, it represents an overall picture of recent sleep and can help account for any specific sleep interference (e.g., exams). This measure yields seven components: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, using of sleep medication, and daytime dysfunction, all of which were combined to produce an overall Global PSQI Score. Higher scores indicated worse sleep and a cutoff score of 5 or higher denotes a "poor" sleeper. This score was used in analyses. Internal consistency is high (α = .83) and test-retest reliability demonstrated no significant changes over time (Buysse et al., 1988; Carpenter & Andrykowski, 1998). The Cronbach's coefficient for this measure in the current study was .80.

Convergent validity is supported as the global PSQI scores were moderately to highly correlated with other scales or subscales relating to poor sleep quality (e.g., Sleep, Energy, and Appetite scale; Symptom Experience Report: sleep problems; CES-D: sleep restlessness) and divergent validity is supported as the global score was minimally correlated with constructs not related to sleep (e.g., Symptom Experience Report: change in taste).Validity is also supported as the PSQI is able to distinguish good and poor sleep quality comparatively with other measures across controls and individuals with clinical disorders (e.g., depression, insomnia; Buysse et al, 1988). Specifically, criterion validity is supported as self-report on the PSQI is highly correlated with sleep diaries (Grandner at el., 2006).

Sleep Hygiene Practice Scale (SHPS). The Sleep Hygiene Practice Scale (SHPS) is a 30-item self-report questionnaire assessing various factors that influence sleep and sleep hygiene (Lin et al., 2007; (see Appendix A). There are four subscales: 1) sleep scheduling (e.g., "Bedtime is not consistent daily"); 2) arousal-related behavior (e.g., "Unpleasant conversation prior to sleep."); 3) eating/drinking behavior (e.g., "Drinking caffeinated drinks within four hours prior to bedtime."); and 4) sleep environment (e.g., "Sleep environment is either too noisy or too quiet."). Items are rated on a 6-point Likert scale (1 = *Never* to 6 = *Always*) to determine how frequently each item is consistent with the participants experience. Each of the individual scores were summed to create a total sleep hygiene score, which was used in analyses. Higher scores indicate worse sleep hygiene. In the validation sample, Cronbach's α coefficients for the overall scale range from .78 to .88 for individuals with insomnia and good sleepers, respectively (Lin et al., 2007). In the current study, the Cronbach's coefficient was .86. Validity is supported as individuals with diagnosed insomnia rated poorer sleep than controls (also known as good sleepers; Yang et al., 2010).

Psychological Stress Associated with the COVID-19 Crisis Survey. This is a 24-item survey the incorporates 14 questions regarding lifestyle changes during COVID-19 and the 10-item Perceived Stress Scale presented in the context of COVID-19 (see Appendix A; Adamson et al., 2020). The lifestyle section includes 4 questions regarding one's recent home environment (e.g., "Are you providing homeschooling due to COVID-19?") and COVID-19 exposure (e.g., "Have any of your friends or family tested positive for COVID-19?"), which are answered on a yes or no basis. The remaining questions refer to the frequency of engaging in different behaviors (e.g., sleep, exercise, meditation; "How much sleep are you getting currently during COVID-19?") and whether this is a change since the pandemic began ("Is this more or less than before COVID-19?"). The frequency questions are broken down into ranges (e.g., 0-2 hours, 2-4 hours, 4-6 hours, etc.) based on the behavior in question, such that high numbers indicated more sleep or physical activity.

The Perceived Stress Scale items (e.g., "In the last month, how often have you felt nervous and stressed?") are completed based on a 5-point Likert scale (0 = *Never* to 4 = *Always*), except for 4 items which are reverse scored (0 = *Always* to 4 = *Never*). Greater scores indicated higher levels of perceived stress due to COVID-19. Although this new measure is not yet published, the 10-item Perceived Stress Scale has been used in college students and in a variety of health contexts including smoking and diabetes (Cohen, 1994), and has well established psychometric properties (Cronbach's α coefficients >.70; test-retest reliability coefficients >.70; construct validity is supported; Lee, 2012; Roberti et al., 2006). The Cronbach's coefficient for COVID-19 Perceived Stress Scale in the current study was .35. This COVID-19 measure is provided on a list compiled by the National Institute of Health (NIH) Office of Behavioral and Social Sciences Research (OBSSR) and the NIH Disaster Research program (DR2). The

questions referring to frequency of sleep and exercise, as well as the overall perceived stress score were used as control variables in analyses.

Generalized Anxiety Disorder 7-Item Scale (GAD-7). The GAD-7 is a brief measure of general anxiety symptoms (see Appendix A; Spitzer et al., 2006). Seven items will be answered on a 4-point Likert scale (0 = *Not at all sure* to 3 = *Nearly every day*). Participants were told to consider how often they have been bothered by each of the symptoms over the past two weeks. The sum of each item response was calculated to obtain a total score, which was used as needed as a covariate in analyses. Additionally, if the participant has endorsed any of the symptoms, they rated how difficult these symptoms have made it for them to function in daily life on a scale from *Not difficult at all* to *Extremely difficult.*

Internal consistency is excellent in the standardization sample (α = .92; Spitzer et al., 2006). The Cronbach's coefficient for this measure in the current study was .89. Convergent validity is supported as it is highly correlated with two other measures of anxiety, the Beck Anxiety Inventory (r = .72) and the Symptom Checklist-90: Anxiety subscale (r = .74; Spitzer et al., 2006). Discriminant validity is difficult to assess since anxiety symptoms overlap with many other mental health disorders; however, studies have shown the GAD-7 is weakly correlated with other mental health disorders, such as bipolar disorder (Beard & Bjorgvinsson, 2014). Further, although anxiety and depression are commonly comorbid disorders, Spitzer and colleagues (2006) demonstrated the GAD-7 and a depression measure (Patient Health Questionnaire-8) load on distinct factors. The total score can be used as a continuous variable or researchers suggest a cut off score of 10 or higher for the best sensitivity (89%) and specificity (82%; Spitzer et al., 2006).

Patient Health Questionnaire-9 Item (PHQ-9). The PHQ-9 is a brief measure of depressive symptoms pulled from the larger Patient Health Questionnaire, which includes modules for other mental health disorders in addition to depression (see Appendix A; Kroenke et al., 2001). Participants were asked to consider how often they have been bothered by the list of nine problems over the past two weeks. They responded on a 4-point Likert scale (0 = *Not at all* to 3 = *Nearly every day*). The sum of each item response was calculated to obtain a total score, which was used as needed as a covariate in analyses. Additionally, similar to the GAD-7, if the participant has rated any of the symptoms, they indicated how difficult these symptoms have made it for them to function in daily life on a scale from *Not difficult at all* to *Extremely difficult.*

The PHQ-9 can be used to look at depressive symptoms in a continuous manner or utilizing a cut off score (i.e., greater than or equal to 10 indicates depression). It was used in a continuous manner in the present study, though the cut off score was also looked at to better understand the sample. Using this specified cut off score of 10 is associated with high sensitivity (88%) and specificity (88%) for diagnosing major depression (Kroenke et al., 2001). This measure demonstrates acceptable (α = .74 in a sample being treated for depression; Titov et al., 2011) to good internal consistency (α = .89 in a primary care sample and α = .86 in an obstetrics/gynecological sample; Kroenke et al., 2001). The Cronbach's coefficient for this measure in the current study was .88. Convergent validity was supported as it correlated highly with the Beck Depression Inventory, Second Edition (BDI-II) and divergent validity is supported as the PHQ-9 is correlated with the Sheehan Disability Scale, but not as much as the BDI-II (Titov et al., 2011).

Health History Checklist. In order to gain a better understanding of the participants' medical and mental health history, the author created a brief form that assesses whether a

participant has been diagnosed with various medical and mental health conditions (yes/no responses; see Appendix A). Each of these conditions are likely to impact EF and ESR and are therefore included. These responses were collected to compare results by condition or possibly be used as exclusionary criteria; however, there was not sufficient power to break down analyses by condition.

Demographic Questionnaire. A brief demographic questionnaire was given to obtain each participant's age, sex, race, ethnicity, current grade, relationship status, and highest level of education completed by both parents (see Appendix A). Age and gender were used as covariates in regression analyses.

Analysis

Specific study variables were scored as recommended by the test or questionnaire. This includes reverse scoring as necessary to ensure the items are reading on the same scale. Descriptive statistics and correlations were analyzed across demographic and study variables using IBM SPSS Version 26.0.

The research question was analyzed using an exploratory factor analysis in IBM SPSS Version 26.0 to determine if the ER and coping strategies load across the proposed dimensions (e.g., engagement vs. disengagement). Reappraisal was comprised of the ERQ Reappraisal subscale, the CRI Positive Reappraisal subscale, and the COPE Positive Reinterpretation and Growth subscale. Suppression was assessed using the ERQ Suppression subscale. Avoidance was represented using the CRI Cognitive Avoidance subscale. Lastly, expression was assessed using the CRI Seeking Guidance and Support subscale, and the COPE Focusing on and Venting Emotions subscale and Use of Emotional Social Support subscale. Items from each of these subscales were entered into the factor analysis.

Primary analyses for hypotheses one and two were also conducted using IBM SPSS Version 26.0. To analyze hypothesis one, a series of multiple linear regressions were conducted in which each EF facet score (inhibition and set shifting) was entered together as predictors on the outcome of 1) physical activity (total physical activity score); 2) sleep quality (global PSQI Score); and 3) sleep hygiene (total sleep hygiene score). Therefore, three multiple linear regressions were conducted. Entering each of the predictors together controlled for the other EF facets to determine the unique influence of each one on the health variables. COVID-19 questions (frequency of sleep and exercise, and the overall perceived stress score), age, and gender were entered as control variables.

The exploration of the influence of ESR on health behaviors depended on the results from the research question. If ESR strategies aligned across the proposed dimensions of engagement and disengagement, the second hypothesis would be analyzed using a series of three multiple linear regressions in which engagement factors and disengagement factors would be entered together as predictors on the outcome of 1) physical activity (total physical activity score); 2) sleep quality (global PSQI Score); and 3) sleep hygiene (total sleep hygiene score). On the other hand, if the strategies did not align across these dimensions, the results from the factor analysis would be used to identify which strategies should be included and how they should be grouped. COVID-19 questions (frequency of sleep and exercise, and the overall perceived stress score), age, and gender were also entered as control variables.

Finally, to combine the study variables to assess the influence of EF and ESR on health behaviors (H3), path analyses were used. It was predicted there would be a direct effect of each EF facet (inhibitory control and set shifting) on 1) physical activity (total physical activity score); 2) sleep quality (global PSQI Score); and 3) sleep hygiene (total sleep hygiene score). This

would also be mediated by the engagement ESR factors, such that those with greater EF skills would utilize more of the engagement factors, which in turn would be associated with more physical activity, better sleep quality, and better sleep hygiene. Covariates included gender, age, and impact of COVID-19 (frequency of sleep and exercise, and the overall perceived stress score). This path analysis was conducted using PROCESS Version 4.0 for SPSS (Hayes, 2018).

Data Analysis and Design Considerations. Since we were in the midst of a pandemic during data collection, it is important to note the potential impact of COVID-19 on study outcomes. It was posited individuals would endorse poorer sleep quality given the increased stress as well as decreased levels of physical activity due to gym closures and a shift to working from home. Additionally, individuals were likely experiencing higher levels of prolonged stress in an environment with restrictions (e.g., social distancing, working from home) that may interfere with their usual coping methods (e.g., expression of emotions in person). However, other avenues of communicating (e.g., Zoom, FaceTime) may also make it easier for individuals to connect in ways they did not before the pandemic began. Furthermore, depending on the individual and their personal circumstances, COVID-19 may cause an increase in stress regarding basic needs (e.g., increased rates of unemployment, fear of going out in public to get food and other essential items), which likely influenced their emotion regulation, coping, and cognitive skills. Accordingly, to address these potential pandemic effects a measure was included to evaluate effects of COVID-19 broadly, as well as the specific influence on sleep, physical activity, and stress. These variables were used as covariates in study analyses.

Additionally, due to COVID-19 this study was conducted entirely online for safety of the participants and researchers. While the researchers made every attempt to replicate in-person testing (i.e., the use of a Zoom timeslot) as much as possible design shifts were made that may

have impacted data quality. For example, less well studied neuropsychological measures (i.e., TestMyBrain) were used that may give a different pattern of results than standard tests. Nevertheless, results can inform the research questions and hypothesis, providing a strong foundation for future research. In the future, one could replicate and/or expounded upon the present study using in-person measures.

Zoom is an online videoconferencing platform. Although it is less ideal than in-person data collection, research indicates videoconferencing is the best alternative (Irani, 2019). Zoom is a preferable platform for a variety of reasons. First, the participant did not need to have a Zoom account to use it (Lobe et al., 2020). Although each participant was a UNCC student and thus had access to a Zoom account, the ability for the participant to simply click the invitation link and join the meeting likely helped circumvent any issues related to logging into an account or forgotten passwords. Second, Zoom is secure as it allows the host (e.g., the examiner) to approve each member in the "waiting room" before allowing them into the meeting; thus, if somehow an individually accidentally joined the participant meeting, they would not be allowed in by the examiner and no breech of data or identity would occur (Lobe et al., 2020). Zoom is also reported to be compliant with the Health Insurance Portability and Accountability Act (HIPAA; Lobe et al., 2020). Third, participants stated Zoom was easy to use in comparison to other platforms, despite not using it previously (Archibald et al., 2019). Lastly, participants rated their experience from qualitative interviews conducted over Zoom as "highly satisfactory" (Archibald et al., 2019, pp. 1). Although many of the studies assessing the use of Zoom and other videoconferencing platforms are in reference to qualitative research, my use of Zoom was similar to the qualitative studies, such that it was used to provide an explanation of the study, obtain informed consent, and guide the participant to click on the appropriate neuropsychological

measures. The actual data collection is done electronically through the TestMyBrain server, not through the Zoom conference. Therefore, the existing research applies to my study. While there was still a risk of technological challenges arising, I felt this was the best alternative to in-person data collection.

In addition to set shifting and inhibitory control, updating is a commonly measured EF process. However, there appeared to be a greater theoretical relationship between inhibitory control and set shifting with physical activity and sleep than updating. Additionally, the available updating measures were likely less sensitive in detect meaningful differences in the proposed sample (Harrison et al., 2010). Therefore, updating was removed from the study.

CHAPTER 4: RESULTS

The study results are organized into sections beginning with descriptive statistics for demographic information and descriptive statistics and zero-order correlations between measured study variables (i.e., EF tasks, ESR subscales, health behaviors). The next section includes the factor analysis associated with the research question, as well as additional zero-order correlations that were conducted with the newly proposed ESR composites. Next, the regression analyses related to hypotheses one and two are presented. Finally, the path analyses associated with hypothesis three are presented.

Demographics

Descriptive statistics were conducted for demographic information, as were descriptive statistics and correlations for primary study variables. The mean age of the sample was 19.97 (*SD* = 1.76) and ranged from 18 through 25 years old. The sample was evenly split between males (50.9%) and females (49.1%). Participants were predominantly white (56.6%). The next most frequently identified race was Asian (16.8%), followed by Black (12.4%), biracial (2.7%), and Pacific Islander/Native Hawaiian (0.9%). Approximately 16% of individuals identified as Hispanic/Latino. The majority of the sample were freshman (33.3%) or sophomores (28.9%), followed by juniors (19.3%) and seniors (14.9%). There were four graduate students (3.5%). Data regarding physical and mental health conditions was also collected. Anxiety, depression, and ADHD were among the most common diagnoses (16.7%, 14%, 10.5%, respectively). Notably, although only a portion of the sample was reportedly diagnosed with anxiety and depression, the majority of the sample rated symptoms consistent with probable anxiety and depression using proposed cut off scorers of 10 and above on the GAD-7 and PHQ-9 (84% and 94%, respectively; Kroenke et al., 2001; Spitzer et al., 2006). In addition to these mental health

diagnoses, the most common physical health conditions included headache (10.5%) and history of concussion (18.4%). For a full breakdown of demographic characteristics of the experimental sample, see Table 1.

Initial Descriptive Statistics and Correlations

Descriptive statistics and zero-order correlations were calculated for primary study variables (e.g., EFs, ESR subscales, and health behaviors) and COVID-19 covariates (e.g., perceived stress due to COVID-19, and frequency of sleep and physical activity during COVID-19). Significant correlations were observed largely in expected directions (see Table 2). Results revealed the EF facets were significantly correlated ($r(112) = .21$, $p = .02$). Neither set shifting, nor inhibitory control were significantly correlated with any of the ESR subscales, health behaviors, COVID-19 variables, or anxiety and depression.

Among ESR subscales, each of the reappraisal subscales were significantly correlated with each other (ERQ and CRI: ($r(112) = .48$, $p < .001$); ERQ and COPE: ($r(112) = .45$, $p < .001$); CRI and COPE: ($r(112) = .58$, $p < .001$). The expression and suppression subscales were also significantly associated, such that the ERQ Suppression subscale was negatively correlated with the CRI Seeking Guidance and Support subscale ($r(112) = -.44$, $p < .001$) as well as with the COPE subscales related to expression: Focusing on and Venting Emotions $r(112) = -.32$, $p < .001$) and Emotional Social Support ($r(112) = -.52$, $p < .001$). The COPE expression subscales (Emotional Social Support and Focusing on and Venting Emotions) were significantly correlated with each other ($r(112) = .56$, $p < .001$). The CRI Cognitive Avoidance subscale was also correlated with the ERQ Suppression subscale in a positive direction ($r(112) = .19$, $p = .04$).

Considering ESR subscales, health behaviors, COVID-19, anxiety and depression, nothing was significantly associated with physical activity as measured by the IPAQ. There was

a significant negative correlation between COPE: Positive Reinterpretation and Growth and anxiety, such that greater use of positive reinterpretation and growth was associated with less anxiety ($r(112) = -.19$, $p = .04$). There was a significant positive correlation found between COPE: Focusing on and Venting Emotions with sleep quality ($r(112) = .26$, $p = .005$), perceived stress due to COVID-19 ($r(112) = .33$, $p < .001$), anxiety ($r(112) = .42$, $p < .001$), and depression ($r(112) = .35$, $p < .001$), as well as and a significant negative correlation with physical activity during COVID-19 ($r(111) = -.31$, $p < .001$), suggesting more use of venting led to worse sleep quality, more perceived stress, more anxiety and depression, and less physical activity. The CRI Avoidance subscale was significantly associated with sleep quality ($r(112) = .30$, $p = .001$), sleep hygiene $r(112) = .25$, $p = .008$), perceived stress due to COVID-19 ($r(112) = .33$, $p < .001$), anxiety ($r(112) = .27$, $p = .003$), and depression ($r(112) = .40$, $p < .001$),indicating more avoidance was related to worse sleep quality and sleep hygiene, more perceived stress, and more anxiety and depression.

Regarding the health behavior, COVID-19, anxiety and depression measures, physical activity as measured by the IPAQ was significantly positively correlated with frequency of physical activity during COVID-19 ($r(111) = .33$, $p < .001$). Sleep quality was significantly correlated with sleep hygiene ($r(112) = .62$, $p < .001$), frequency of sleep during COVID-19 ($r(112) = -.21$, $p = 03$), perceived stress due to COVID-19 ($r(112) = .41$, $p < .001$), anxiety ($r(112) = .46$, $p < .001$), and depression ($r(112) = .53$, $p < .001$), indicating worse sleep quality was associated with worse sleep hygiene, less sleep during COVID-19, and more perceived stress, anxiety, and depression. Sleep hygiene was also positively correlated with perceived stress due to COVID-19 ($r(112) = .21$, $p = .03$), anxiety ($r(112) = .32$, $p < .001$), and depression ($r(112) = .53$, $p < .001$), and negatively correlated with physical activity during COVID-19

($r(111) = -.20$, $p = .03$), suggesting worse sleep hygiene was related to more perceived stress, anxiety, and depression, and less physical activity during COVID-19. Perceived stress due to COVID-19 was also significantly positively correlated with anxiety ($r(112) = .48$, $p < .001$) and depression ($r(112) = .40$, $p < .001$), suggesting more perceived stress is associated with more anxiety and depression. Frequency of sleep during COVID-19 was significantly correlated with frequency of physical activity during COVID-19 ($r(111) = -.26$, $p = .005$), such that greater sleep was associated with less physical activity during COVID-19. Frequency of physical activity during COVID-19 was also significantly correlated with depression ($r(112) = -22$, $p = .02$), indicating more depression was associated with less physical activity. Lastly, anxiety and depression were significantly positively correlated ($r(112) = .66$, $p < .001$).

Research Question

To explore the research question, assessing whether the ER and coping strategies overlap across the proposed engagement versus disengagement and proactive versus reactive dimensions an exploratory factor analysis was conducted using an orthogonal (Varimax) rotation. This rotation was selected as it assumes there is shared variance, and these measures were assessing similar constructs. The analysis revealed ten factors (see Table 3). Each item loading onto a factor met the minimum criteria of 0.4. First the factor loadings were examined for patterns and possible cross-loadings. For each cross-loading, the higher loading was used. The content of questions on the items with cross-loadings were further reviewed to ensure the higher loading fit with each factor. Then the question content was used to form labels for the factors. Next all the labeled factors were collectively evaluated with respect to the engagement/disengagement and proactive/reactive framework (see Figure 2).

The factor analyses revealed ten factors. For each factor, we present the items that load on the factor, the label and rationale, and how the factor theme/label aligns with the proposed framework (see Figure 2). Factor one included the following items: “I talk to someone about how I feel;” " I discuss my feelings with someone;" "I try to get emotional support from friends or relatives;" "I get sympathy and understanding from someone;" "Talk with your spouse or other relative about the problem;" " Talk with a professional person (e.g., doctor, lawyer, clergy);" "Talk with a friend about the problem;" and "Seek help from persons or groups with the same type of problem." There was also one negative loading within this factor on a suppression measure (“I keep my emotions to myself”); however, this was consistent with the other expression-related loadings because of the negative relationship. Each of these items included discussion of one’s feelings with or getting help from a friend, relative, or professional; therefore, it was labeled “expressive support seeking” (see Table 3). This factor aligned with the engagement and reactive aspects of the framework, as it required one to connect with their emotions after they have begun experiencing them.

Factor two contained these items: “I control my emotions by changing the way I think about the situation I’m in;” "When I want to feel more positive emotion (such as joy or amusement), I change what I’m thinking about;" "When I want to feel less negative emotion (such as sadness or anger), I change what I’m thinking about;" "When I’m faced with a stressful situation, I make myself think about it in a way that helps me stay calm;" When I want to feel more positive emotion, I change the way I’m thinking about the situation;" and "When I want to feel less negative emotion, I change the way I’m thinking about the situation." This factor was labeled “positive reframing” because it comprised items related to active altering of an emotional situation and often items had a positive angle to this reframing (see Table 3). Factor two aligned

with the engagement and proactive dimension, since it required one to engage with the emotional situation before their emotions are fully realized.

Factor three, included: “I look for something good in what is happening;” "I try to see it in a different light, to make it seem more positive;" "Try to see the good side of the situation;" and "Try to tell yourself that things will get better." While these items are similar to factor 2, they lacked the reframing piece but emphasized the positive aspects of a situation. Thus, factor three was labeled “positive focus” (see Table 3). Similar to factor two, factor three was consistent with the engagement and proactive elements of the framework.

Factor four included the following items: “Try to deny how serious the problem really is;” "Try to forget the whole thing;" "Try to deny how serious the problem really is." Since these items related to denial and avoidant thinking, it was labeled “avoidance” (see Table 3). This factor fell along the disengagement and proactive dimensions as it required one to create distance from the material before the emotion is fully realized.

Factor five consisted of these items: “I get upset and let my emotions out;” "I get upset and am really aware of it;" "I let my feelings out;" and "I feel a lot of emotional distress and I find myself expressing those feelings a lot." As it was comprised of general expression of emotions without active support of another person, it was labeled “venting” (see Table 3). Factor five was consistent with the disengagement and reactive elements of the framework, such that one must disengage with the emotions after they have started feeling them.

Factor six included “When I am feeling negative emotions, I make sure not to express them;” and "I control my emotions by not expressing them." This factor was labeled “suppression of negative emotions” as it referred to inhibiting expression of negative emotions (see Table 3). Consistent with past literature, this factor fell along the disengagement and

reactive aspects of the framework, as one must inhibit their emotions after they have been realized.

Factor seven brought out a unique aspect of reappraisal through the following items: “I learn something from the experience;” "I try to grow as a person as a result of the experience;" "Think about how this event could change your life in a positive way;" and "Try to find out more about the situation." Since these items focused on learning, growing, and adding context to a situation, it was labeled “contextualizing and learning” (see Table 3). As with factors two and three, factor seven aligned with the engagement and proactive elements of the framework.

Factor eight included: “Remind yourself how much worse things could be;” and “Think about how you are much better off than other people with similar problems.” These items referred to comparing oneself to others or to worse situations and thus were labeled “comparison” (see Table 3). While this factor has similar aspects of reappraisal, it did not fit neatly into the engagement and proactive dimensions.

Factor nine was comprised of “Pray for guidance and/or strength;” and "Daydream or imagine a better time or place, than the one you are in." These were fairly distinct items and difficult to label together; therefore, they were labeled “prayer and daydreaming” (see Table 3). These items did not clearly fit into the engagement/disengagement and proactive/reactive framework (e.g., one required engagement and the other disengagement).

Factor ten included the following items: “Try to put off thinking about the situation, even though you know you will have to at some point;” and "Wish the problem will go away or somehow be over with." These questions included aspects of avoidant thinking but were more passive in nature and different than the factor 4 (avoidance) items; thus, this factor was labeled

"passive avoidance" (see Table 3). This factor aligned best with the disengagement and proactive elements of the framework.

Overall, these ESR factors were more granular than expected. Based on the proposed analysis plan, the factor loadings, and a more detailed item analysis, the first seven factors were selected for further study because compared to the first seven factors, factors eight (comparison), nine (prayer and daydreaming), and ten (passive avoidance) aligned the least with the proposed engagement/disengagement and proactive/reactive framework and/or did not appear consistent with one ESR strategy when looking at the item content. Within these seven, there were two items related to expression, three related to reappraisal, one to avoidance, and one to suppression. Composites were made for each of these seven ESR factors and these were used in the regression analyses. For the path analyses, these seven factors were further narrowed to four of the factors (positive focus, expressive support seeking, venting, and avoidance), based on analysis of zero-order correlations. This is discussed further in the hypothesis three section.

Descriptive Statistics and Correlations including ESR Composites

After defining the new seven ESR strategy composites, descriptive statistics and correlations were again conducted for primary study variables (e.g., EFs, seven new ESR strategy composites, and health behaviors) and COVID-19 covariates (e.g., COVID-19 perceived stress, frequency of sleep and physical activity during COVID-19). Significant correlations were broadly observed in predicted directions (see Table 4). Relating to the EF facets, the avoidance composite was significantly correlated with set shifting ($r(112) = .18$, $p = .05$), suggesting worse set shifting is associated with greater avoidance. Suppression of negative emotions ($r(112) = .22$, $p = .02$) was significantly correlated with inhibitory control, such that stronger inhibitory control

was associated with greater suppression. No other variables were significantly correlated with EFs.

Among the ESR composites, each of the reappraisal-related subscales were significantly positively correlated with each other (positive reframing and positive focus: (r(112) = .52, p <.001); positive focus and contextualizing and learning (r(112) = .60, p <.001); positive reframing and contextualizing and learning: (r(112) = .38, p <.001)). Positive focus was significantly correlated with sleep quality (r(112) = -.20 , p = .04), such that greater use of positive focus was related to better sleep quality. None of these composites (i.e., positive reframing, positive focus, and contextualizing and learning) were significantly correlated with any other heath behaviors. Positive focus; however, was significantly correlated with anxiety (r(112) = -.28, p = .004) and depression (r(112) = -.22, p = .02), indicating greater use of positive focus led to less depression and anxiety.

The expression-related composites and suppression composite were also significantly associated, such that expressive support seeking was positively correlated with venting (r(112) = .53, p <.001) and negatively correlated with suppression of negative emotions (r(112) = -.51, p <.001). In other words, more expressive support seeking was associated with more venting and less suppression. Similarly, venting was significantly negatively correlated with suppression of negative emotions (r(112) = -.31 , p = .001), suggesting more venting was related to less suppression. Expressive support seeking was also significantly negatively correlated with frequency of physical activity during COVID-19 (r(111) = -.19, p = .04), such that greater expressive support seeking was related to less physical activity. Venting was significantly positively correlated with sleep quality (r(112) = .26, p = .005) and sleep hygiene (r(112) = .18, p = .05), indicating more venting was associated with worse sleep quality and sleep hygiene.

Venting was also significantly correlated with COVID-19 perceived stress ($r(112) = .38$, $p < .001$), anxiety ($r(112) = .42$, $p < .001$), depression ($r(112) = .35$, $p < .001$), and frequency of physical activity during COVID-19 ($r(111) = -.31$, $p < .001$), suggesting more venting was related to greater perceived stress, more anxiety and depression, and less physical activity.

The avoidance composite was significantly correlated with suppression ($r(112) = .20$, $p = .04$), such that greater use of avoidance was related to greater use of suppression of negative emotions. The avoidance composite was also significantly correlated with sleep quality ($r(112) = .20$, $p = .04$) and sleep hygiene ($r(112) = .18$, $p = .05$), as well as COVID-19 perceived stress ($r(112) = .20$, $p = .03$), anxiety ($r(112) = .21$, $p = .02$), and depression ($r(112) = .31$, $p < .001$), suggesting greater use of avoidance led to worse sleep quality and sleep hygiene, and more perceived stress. Suppression of negative emotions was significantly correlated with frequency of physical activity during COVID-19 ($r(111) = .25$, $p = .007$), such that greater use of suppression was associated with more physical activity during COVID-19.

Hypothesis One

To evaluate hypothesis one, three hierarchical multiple regression analyses were conducted to determine whether set-shifting and inhibitory control influenced one's physical activity, sleep quality, and sleep hygiene, respectively, while controlling for COVID-19[1], age, and gender. Notably, due to variable inconsistency among the included variables (e.g., some variables produced long score numbers, others were small, while others were standardized), all variables were converted to *z* scores for the regression analyses. The first model in which physical activity was predicted by EFs was significant (R = .34) and accounted for approximately 12% of the variance in physical activity. Precisely, set shifting and inhibitory control uniquely accounted for 1% of the variance in physical activity net control variables.

Results demonstrated the frequency of physical activity during COVID-19 significantly predicted physical activity, such that greater physical activity during COVID-19 was associated with greater physical activity as measured by the IPAQ. However, set shifting and inhibitory control did not predict physical activity (see Table 5).

The model predicting sleep quality was also significant (R = .46) and included 21% of the variance in sleep quality. More specifically, set shifting and inhibitory control account uniquely for 1% of the variance in sleep quality when considering the impact of control variables. The analysis indicated that perceived stress due to COVID-19 and frequency of sleep during COVID-19 significantly influenced sleep quality; however, set shifting and inhibitory control did not (see Table 6). Therefore, greater perceived stress due to COVID-19 and less sleep during COVID-19 led to worse sleep quality.

The third hierarchical multiple regression analysis was conducted to determine whether set-shifting and inhibitory control influenced one's sleep hygiene, while controlling for COVID-19, age, and gender. As with the other models, this model was significant (R = .33) and accounted for approximately 11% of the variance in sleep hygiene. Uniquely, set shifting and inhibitory control accounted for 1% of the variance in sleep hygiene once the impact of COVID-19, age, and gender were controlled for. This analysis suggested that frequency of physical activity during COVID-19 and perceived stress due to COVID-19 significantly influenced sleep hygiene, such that, less physical activity and greater perceived stress led to worse sleep hygiene behaviors. However, set shifting and inhibitory control did not significantly predict sleep hygiene

[1] When initially running exploratory regressions, anxiety (GAD-7) and depression (PHQ-9) measures were included. Results indicated depression accounted for a significant amount of the variance. It appeared to have a suppressive effect in the context of COVID-19. Based on the goals of the study and since the data was not powered to include all of these variables, it was decided to use the variables that captured COVID-19 related stress and changes that were not suppressive. This allowed for exploration the specific strategies while controlling for the collective trauma of COVID-19.

(see Table 7). Overall, hypothesis one was not supported, as set shifting and inhibitory control did not significantly predict physical activity, sleep quality, or sleep hygiene.

Hypothesis Two

Hypothesis two was examined using three hierarchical multiple regression analyses to determine whether the ESR composites influenced one's physical activity, sleep quality, and sleep hygiene, respectively, while controlling for COVID-19, age, and gender. Again, all scores were converted to *z* scores. The model predicting physical activity was not significant (R = .30) It accounted for approximately 10% of the variance in physical activity. More specifically, the seven ESR composites: expressive support seeking, venting, positive reframing, positive focus, contextualizing and learning, avoidance, and suppression of negative emotions accounted for 10% of the variance in physical activity when controlling for COVID-19, age, and gender (see Table 8).

Although this model was not significant, the factor analysis yielded more factors than initially expected, which may have affected the fit of the model. As this was an exploratory study, and the results were partially consistent with zero-order correlations, they were included. Though, these results should be interpreted with caution. Results demonstrated greater frequency of physical activity during COVID-19 significantly predicted more physical activity during the past week, which was consistent with correlation analyses. Interesting, less expressive support seeking and less suppression of negative emotions also significantly predicted greater levels of physical activity over the past week. While this was not demonstrated in the correlations at the level of significance, the negative relationship between expressive support seeking and physical activity was evident and in fact it was close to significance in correlation analyses ($r(112) = -.17$, $p = .07$). The relationship between suppression of negative emotions and physical activity on the

IPAQ; however, was not found in the correlational analyses and therefore will not be discussed further.

The model predicting sleep quality was significant (R = .46) and accounted for approximately 21% of the variance in sleep quality. More specifically, expressive support seeking, venting, positive reframing, positive focus, contextualizing and learning, avoidance, and suppression of negative emotions account for 8% of the variance in sleep quality when controlling for COVID-19, age, and gender. The analysis indicated that perceived stress due to COVID-19, sleep frequency during COVID-19, and positive focus significantly influenced sleep quality, such that, less perceived stress, as well as more frequency of sleep during COVID-19 and more positive focus (e.g., reappraisal) led to better sleep quality. However, none of the other ESR strategies significantly predicted sleep quality (see Table 9).

Lastly, the final model with sleep hygiene as the outcome was not significant (R = .31) and should be interpreted with caution. It accounted for approximately 10% of the variance in sleep hygiene. More specifically, expressive support seeking, venting, positive reframing, positive focus, contextualizing and learning, avoidance, and suppression of negative emotions uniquely contributed to 6% of the variance in sleep hygiene after considering control variables. The results revealed that physical activity during COVID-19 and perceived stress due to COVID-19 significantly influenced sleep hygiene, such that, less physical activity and greater perceived stress led to worse sleep hygiene behaviors. These relationships were supported by zero-order correlations. However, none of the ESR strategies significantly predicted sleep hygiene (see Table 10). In sum, hypothesis two was partially supported as positive focus (e.g., reappraisal) predicted sleep quality and cautiously interpreted, expressive support seeking predicted physical activity as well.

Hypothesis Three

Finally, to test the third hypothesis looking at all study variables combined, a path analysis was proposed to be completed in AMOS. However, due to software challenges, PROCESS Version 4.0 for SPSS (Hayes, 2018) was utilized instead. Although this software has limitations, it allowed for the assessment of mediation models with the study variables assessing the impact of EF and ESR on health behaviors, while controlling for effects between EF and ESR. PROCESS only allowed for one predictor and one outcome variable at a time. Thus, four separate path models (PROCESS Model 4) were conducted, with set shifting and inhibitory control each as the predictor on the health behaviors physical activity and sleep. Of note, sleep quality and sleep hygiene were combined into a composite score for these analyses due to their high correlation. As with the regression analyses, all variables were converted to *z* scores for the path analyses. Bootstrapping was conducted at 1,000 samples and the confidence interval was set at 95%.

Based on the proposed engagement/disengagement and proactive/reactive framework and zero-order correlations, the positive focus, expressive support seeking, venting, and avoidance composites were selected to be the mediators in the path analysis. Expressive support seeking and positive focus align along the engagement dimension and venting and avoidance along the disengage element. Additionally, of the reappraisal-related composites, positive focus was most highly correlated with the other reappraisal-related factors (i.e., positive reframing and contextualizing and learning) and therefore would act as a good representation of this domain. It was also significantly correlated with sleep quality. This relationship between positive focus and sleep quality was also demonstrated in the regression analyses of hypothesis two. Expressive support seeking was significantly correlated with the venting composite, suppression of negative

emotions, and physical activity during COVID-19, but based on individual items it appeared to be assessing something other than venting. Therefore, both expressive support seeking and venting were included in the path analyses. Venting was also significantly correlated with suppression, both sleep variables, and COVID-19 variables, which indicated it may be a good fit in the path models. Lastly, avoidance was significantly correlated with set shifting, suppression of negative emotions, sleep, and COVID-19 perceived stress and therefore was included.

The first two mediation models assessed the impact of variables on the outcome of physical activity. The first (Figure 4) included set shifting as the predictor, expressive support seeking, venting, positive focus, and avoidance composites as mediators, and age, gender, perceived stress due to COVID-19, and frequency sleep and physical activity during COVID-19, as covariates, and physical activity as the outcome measure. The second model (Figure 5) included the same mediators (selected ESR composites), covariates, and outcome (physical activity), except the predictor was inhibitory control. Standardized coefficients (β) for direct and indirect effects are presented in Figure 4 for the set shifting model and in Figure 5 for the inhibitory control model.

In the set shifting model (Figure 4), expressive support seeking significantly predicted physical activity (b_2 = -.25, p = .04), such that less expressive support seeking lead to more physical activity. No other significant direct (c' = .23, $t(98) = 1.64$, p = .10) or indirect effects were noted within this model. More specifically, when controlling for age, gender, COVID-19 perceived stress, and frequency of sleep and physical activity during COVID-19, positive focus, expressive support seeking, venting, and avoidance did not significantly mediate the relationship between set shifting and physical activity. These variables accounted for approximately 16% of the variance in physical activity. All the bootstrap 95% confidence intervals based on 1,000

samples for the indirect effects of set shifting on physical activity via positive focus (a_1b_1), expressive support seeking (a_2b_2), venting (a_3b_3), and avoidance (a_4b_4) included zero; and therefore, the indirect effects were not significant. Covariates; however, did produce significant results. Specifically, physical activity during COVID-19 significantly positively predicted physical activity ($c_4 = .33$, $p = .002$).

In the second model with inhibitory control and physical activity (Figure 5), there was no significant direct ($c' = -.02$, $t(98) = -.17$, $p = .86$) or indirect effects. Positive focus, expressive support seeking, venting, and avoidance did not mediate the relationship between inhibitory control and physical activity when controlling for age, gender, COVID-19 perceived stress, and frequency of sleep and physical activity during COVID-19. Here, study variables explained 14% of the variance. The bootstrap confidence intervals (95%) for the indirect effects of inhibitory control on physical activity via positive focus (a_1b_1), expressive support seeking (a_2b_2), venting (a_3b_3), and avoidance (a_4b_4) included zero and were not significant. Covariates produced significant results within the inhibitory control model, such that greater physical activity during COVID-19 predicted greater physical activity on the IPAQ ($c_4 = .33$, $p = .003$). This was consistent with correlation and regression analyses.

While the direct effects from these two models (Figures 4 and 5) were not significant, there was a positive direct effect in the first model (Figure 4) between set shifting and physical activity, where worse set shifting abilities led to more physical activity. In the second model (Figure 5), there was a negative direct effect between inhibitory control and physical activity, such that better inhibitory control led to less physical activity. Thus, it appears there was an inverse relationship between EFs and physical activity.

The third and fourth mediation models explored the sleep composite as the outcome variable. First, set shifting was entered as the predictor (Figure 6) with the same mediators (expressive support seeking, venting, positive focus, and avoidance composites) and covariates (age, gender, perceived stress due to COVID-19, and frequency sleep and physical activity during COVID-19) as above in the first and second models. The fourth model included inhibitory control as the predictor (Figure 7) with the same mediators (selected ESR composites) and covariates (COVID-19 variables, age, gender). Standardized coefficients (β) for direct and indirect effects are presented in the respective figures.

In the third model (Figure 6), the direct effect was not significant (c' = -.03, $t(98) = -.20$, $p = .84$). When controlling for age, gender, COVID-19 perceived stress, and frequency of sleep and physical activity during COVID-19, positive focus, expressive support seeking, venting, and avoidance did not significantly mediate the relationship between set shifting and sleep. These variables explained approximately 17% of the variance in sleep. Bootstrapping was based on 1,000 samples with 95% confidence intervals for the indirect effects of set shifting on physical activity via positive focus (a_1b_1), expressive support seeking (a_2b_2), venting (a_3b_3), and avoidance (a_4b_4). These confidence intervals included zero, and therefore, no significant indirect effects were found. Covariates, though, again produced significant results. Perceived stress due to COVID-19 significantly positively predicted sleep within the set shifting model ($c_3 = .22$, $p = .04$). Thus, indicating greater perceived stress led to worse sleep.

In the fourth model (Figure 7), the direct effect between inhibitory control and sleep was not significant (c' = .01, $t(98) = .12$, $p = .91$). The ESR composites did not mediate the relationship between inhibitory control and sleep, when controlling for covariates. These study variables accounted for 17% of the variance in sleep. The bootstrap confidence intervals (95%)

for the indirect effects of inhibition on physical activity also included zero and were not significant. Covariates also produced significant results within this model, wherein perceived stress due to COVID-19 significantly positively predicted sleep ($c_3 = .22$, $p = .04$). Again, highlighting the relationship between stress and sleep.

Although not significant, there was a negative direct effect in the third model (Figure 6) between set shifting and sleep, suggesting worse set shifting led to better sleep. There was a positive direct effect in the fourth model (Figure 7) between inhibitory control and sleep, such that better inhibitory control led to worse sleep. Thus, the same inverse relationship observed between EFs and physical activity was observed here between EFs and sleep. Overall, hypothesis three was not supported as the ESR composites did not mediate the relationships between EFs and physical activity and EFs and sleep.

CHAPTER 5: DISCUSSION

Overview

Overall, this study aimed to investigate relationships between executive functions (EF), emotional self-regulation (ESR), and health behaviors, grounded in Temporal Self-Regulation Theory (TST), in hopes of adding insight into potential areas of prevention and intervention for health behaviors. First, the nuances of ER and coping strategies to determine if the way we measure ER and coping strategies is unique or overlapping were explored. Through a factor analysis, seven ESR composites were obtained and selected for further study, which will be discussed first below. Followed by a review of the robust influence of COVID-19 throughout study analyses. Then, the findings regarding the self-regulatory constructs of performance-based EF and self-reported ESR as predictors to physical activity and sleep, as well as the mediation of EFs on health behaviors via ESR with respect to each of the three hypotheses will be discussed. Lastly, limitations of the study and future directions for research will be reviewed.

Emotional Self-Regulation: Deconstructed

One of the primary aims of this dissertation was to explore the differences and similarities between ER and coping strategies and to determine whether they aligned on the proposed dimensions (e.g., engagement versus disengagement, proactive versus reactive). The factor analysis across the ESR items revealed ten factors and each of these was positioned within the proposed framework. As a review, factors one (expressive support seeking), two (positive reframing), three (positive focus), and seven (contextualizing and learning) clearly align within the engagement aspect of the proposed framework (see Figure 2). Specifically, factor one (expressive support seeking) pulled from the commonly used definition of expression. However, it was not simply expressing emotions, but discussing them with others in attempt to seek help

and support and therefore required engaging with emotions. This factor also aligned with the reactive aspect of the framework, as one is dealing with the emotions after they have formed. Factors two (positive reframing), three (positive focus), and seven (contextualizing and learning) each comprised aspects of reappraisal in which one is actively engaging with emotional information by reframing it, focusing on the positive aspects, or putting it into context and attempting to learn more. Consistent with reappraisal, these three factors were proactive in nature because they attempt to change the way one feels about the situation before the emotions are fully realized. Factors four (avoidance), five (venting), and six (suppression of negative emotions), on the other hand, represent disengagement strategies. Each of these involved disengaging with emotions or an emotional situation through avoiding, sharing feelings in a passive and unproductive way, and actively inhibiting them. Additionally, factor four (avoidance) was proactive in the sense that one is trying to avoid or deny the emotion before it is felt or before it is felt again. Whereas factors five (venting) and six (suppression of negative emotions), were reactive and occur after the emotion has been realized. Factors eight (comparison), nine (prayer and daydreaming), and ten (passive avoidance) did not align as clearly along the proposed framework and/or appeared fundamentally different. For instance, while the items on factor eight were related to reappraisal, they were more geared towards comparing your situation to others and have less of an engagement aspect. Relatedly, the ninth factor (prayer and daydreaming) was comprised of contrasting items on the framework (e.g., one requires engagement and the other disengagement) and fell into opposing domains on the CRI. Lastly, the tenth factor included aspects of avoidance and therefore, was related to the proactive and disengagement aspects of the framework; however, these items were more passive and did not load with the other avoidance items. Overall, this factor analysis highlighted more unique

aspects of ESR strategies than anticipated. These will be discussed further in relation to ESR themes (e.g., reappraisal, expression, suppression, avoidance).

Research demonstrates there are a few different types of reappraisal, while a full review of these is outside the scope of this study, there are three types of reappraisal that appear consistent with the reappraisal-related study composites. It is likely that the study results are highlighting these different reappraisal strategies, which include situation-based reappraisal: change of the current circumstance, explicitly positive reappraisal, and technical-analytic-problem-solving reappraisal. The factor analysis produced three reappraisal-related factors used in analyses (factor 2: positive reframing, factor 3: positive focus, and factor 7: contextualizing and learning), as well as one that was excluded (factor eight: comparison). The positive reframing composite seems most consistent with the general definition of reappraisal in the ER literature (e.g., modifying the meaning of an emotional stimulus or situation to alter one's emotions; Gross, 2014; Sheppes, 2014), which is also consistent with the more specific type of situation-based reappraisal: change of the current circumstance (McRae et al., 2012). "Positive reappraisal" or "explicitly positive reappraisal" appears consistent with the positive focus composite as it aims to find the benefit of a situation (McRae et al., 2012; Shiota & Levenson, 2012). Within the coping literature, factors two, three, and seven (positive reframing, positive focus, and contextualizing and learning, respectively) are consistent with the general aspects of reappraisal. For example, in coping research, reappraisal is positively focused and involves reinterpretation of a stressful situation in a more positive manner (Carver et al., 1989; Folkman & Moskowitz, 2004), thus subsuming the positive reframing and positive focus factors. Furthermore, reappraisal involves learning from the experience to improve emotions (Carver et., 1989; Moos & Schaefer, 1993), which aligns with the contextualizing and learning composite.

Lastly, factor eight, comparison, did not neatly fit into any of the reappraisal types across ER and coping research. It was closest to the "changing current circumstances" type of reappraisal, but this lacks the comparison aspect, which is the essence of the factor. Instead, this comparison factor appears to include components of social comparison theory, in which people assess their thoughts and feelings based on their perception of others (Goethals & Darley, 1987). Thus, suggesting factor eight is measuring something other than reappraisal.

Interestingly, there were unique relationships between these reappraisal-related factors and health behaviors. For example, positive focus was significantly correlated with sleep quality, such that more use of positive focus was related to better sleep quality. This is consistent with research (Kahn et al., 2013; Thomas et al., 2010; Vantieghem et al., 2016) and will be discussed in more detail in the regression analyses. However, the other reappraisal factors were not significantly correlated with sleep or physical activity. It may be that positive focus is also harnessing aspects of gratitude, which may explain the relationship with sleep quality. Gratitude is defined as an appreciation or positive focus on what one has (e.g., relationships, possessions; Boggiss et al., 2020; Wood et al., 2009). In fact, greater levels of gratitude are associated with better sleep quality through the mechanism of purposefully thinking about positive things before bed (Wood et al., 2009). While reappraisal was not explicitly assessed in this study, it is possible that these positive thoughts could contain aspects of reappraisal, such as focusing on the positives of a situation that happened during the day. Relatedly, a literature review exploring the impact of gratitude interventions found greater use of gratitude was associated with better sleep quality (Boggiss et al., 2020). Although preliminary, this may suggest that focusing on the positive and perhaps feeling grateful is a particularly beneficial aspect of reappraisal in the context of sleep.

The expression-related factors included expressive support seeking and venting. This was a notable distinction, which is supported in the literature. The expressive support seeking factor was consistent with the earlier definition of expression (e.g., sharing emotions in a purposeful way; Carver et al., 1989; McMahon & Naragon-Gainey, 2019; Mendes et al., 2003; Moos & Schaefer, 1993), whereas venting was a more basic expression of negative emotions (Skinner, 2013). Another study found similar results, such that expression with emotional support was separate from venting (Duhachek, 2005). Parlamis (2012) further noted the differences in these constructs by highlighting the importance of interaction from others in expression (e.g., asking someone for help in processing an emotional situation). In other words, venting lacked the meaningful supportive and interactive aspect of the expressive support seeking composite. Additionally, while both expressive support seeking and venting were reactive strategies, these expression-related composites appear to be fundamentally different in terms of engaging or disengaging with emotional material. Expressive support seeking involved active engagement with emotions which are explored with another individual, whereas venting was described as the act of getting out or releasing emotions and disengaging with them (Parlamis, 2012; Taylor et al., 2015).

Based on the correlation results, the expressive support seeking and venting composites were positively related; however, they were associated with different health outcomes. Most notably, venting was significantly correlated with sleep quality, sleep hygiene, perceived stress, and physical activity during COVID-19, such that more venting was associated with problems in each of these areas. Whereas expressive support seeking was only negatively correlated physical activity during COVID-19, indicating more expressive support seeking led to less physical activity. While there is little evidence regarding the relationship between expressive support

seeking and venting on physical activity in the literature, the relationship between venting and poor sleep is evidenced in the research (Seymour et al., 2013; Taylor et al., 2015). Therefore, it may be useful to make this distinction when assessing this area of ESR.

The expression factors (expressive support seeking and venting) were also significantly negatively correlated with suppression of negative emotions, which is demonstrated in some of the literature (Peters et al., 2014). However, it also seemed that while some aspects of expression and suppression may fall on a continuum (e.g., communicating versus not sharing emotions), other features (e.g., an active control or inhibition emotions, as opposed to simply not sharing them) distinguish them as different factors, which is consistent with past research (Harber & Cohen, 2005; Rimé, 2009). In terms of the proposed framework (see Figure 2), venting and suppression of negative emotions were more similar, such that they both aligned on disengaging and reactive elements, whereas expressive support seeking, while reactive, requires engagement. In addition to expression composites, suppression of negative emotions was also significantly correlated with physical activity during COVID-19, such that more suppression was related to more physical activity during COVID-19. While there is little research assessing this relationship, some literature indicates that greater use of disengagement strategies, like suppression, is related to less physical activity (Penley et al., 2012). Another study demonstrated that the use of suppression before completing physical activity is negatively impacted exercise performance (Wagstaff, 2014). However, one of the key reasons as to why the opposite relationship may have found here is that this finding was within the context of COVID-19 and not physical activity as measured by the IPAQ. It may be that during COVID-19, people who relied more on suppression to manage their negative emotions also had more time available for activities, such as exercise. Exercise could also be a mechanism for suppression, such that it may

allow individuals to not directly deal with strong emotions. However, this finding and these possible explanations need to be explored separately in future research to draw firmer conclusions.

Suppression of negative emotions was also significantly positively correlated with the avoidance composite. Although avoidance is considered proactive and suppression is reactive, this positive correlation is consistent with research indicating these strategies require one to disengage from an emotional situation (Aldao et al., 2010; Berking & Wupperman, 2012; Hu et al., 2014; Joorman et al., 2006; Levens et al., 2009; Penley et al., 2002). The avoidance composite was also significantly correlated with sleep and perceived stress due to COVID-19, indicating more avoidance led to problems with sleep and greater perceived stress. This is supported in literature as greater use of avoidance is considered to be less adaptive and is associated with problems with health behaviors, including sleep (Kahn et al., 2013; Thomas et al., 2010). Curiously, factor ten (passive avoidance) did not load onto the main avoidance factor (factor 4). While one of the items, “Try to put off thinking about the situation, even though you know you will have to at some point” closely loaded with the factor four items, the other item "Wish the problem will go away or somehow be over with” has an element of desire or hope that appears to be different from the other avoidance items. There is more of a passive nature to it and therefore, may not have loaded with the other items. However, this would need to be researched further in the future to better understand these nuances.

Impact of COVID-19

Another notable outcome from this project was the impact of the COVID-19 pandemic on health behaviors. Specifically, COVID-19 variables were the only significant variables in hypothesis one analyses and were the majority of the significant results in hypothesis two and

three. Regression and path analyses revealed greater physical activity during COVID-19 predicted more physical activity on the IPAQ outcome measure. Regressions also demonstrated greater perceived stress due to COVID-19 and less frequency of sleep during COVID-19 negatively influenced sleep quality. Less physical activity and more perceived stress during COVID-19 also predicted worse sleep hygiene behaviors. This was similar to the path analyses, which indicated greater perceived stress due to COVID-19 predicted worse sleep.

Our findings are consistent with past research demonstrating that COVID-related stress is associated with less engagement in health behaviors among undergraduate students (Choompunuch et al., 2021; Moriarty et al., 2021; Suksatan et al., 2021). For example, Moriarty and colleagues (2021) found that greater levels of stress were correlated with less physical activity and sleep in U.S. college students during the COVID-19 pandemic. When conducting regression analyses, researchers found that less physical activity and sleep predicted greater levels of stress. This occurred while controlling for demographic factors (e.g., gender, income). Another study found similar results, such that greater perceived stress predicted less engagement in health behaviors in adults (Li et al., 2020). These studies demonstrate the significant impact of COVID-19 on health behaviors. They also suggest that engaging in health behaviors can play an important role in mitigating stress. The current study adds to this emerging literature related to the pandemic.

In addition to this clear link between COVID-19 and health behaviors, it is also important to note that due to the significance of the pandemic and the consistently found impact of COVID-19 on the data, it is likely that the COVID-19 variables accounted for a large amount of the variance and therefore, made it more difficult to parse out other relationships between EFs, ESR composites, and health behaviors. The authors feel that the results should be interpreted

with caution due to the clear impact of COVID and it may be helpful to conduct a similar study after the pandemic has more fully resolved to determine if any of these relationships persist or become apparent without this collective trauma.

Executive Functions, Emotional Self-Regulation, and Health Behaviors

Each hypothesis built on each other to gain greater understanding of the relations among EFs, ESR, and health behaviors and thus will be presented together. The first hypothesis was that EF performance would be positively associated with health. Specifically, it was posited that stronger set shifting and inhibitory control would be related to greater physical activity and better sleep quality and sleep hygiene behaviors. However, hypothesis one was not supported, as set shifting and inhibitory control did not significantly predict physical activity, sleep quality, or sleep hygiene.

Within the second hypothesis, it was predicted that engagement ESR strategies would be associated with positive health behaviors (e.g., more physical activity, better sleep quality), while disengagement strategies would be associated with less physical activity and poorer sleep quality and hygiene. Each of the selected ESR factors fit into the proposed framework, either engagement (i.e., expressive support seeking, positive reframing, positive focus, contextualizing and learning) or disengagement (i.e., venting, avoidance, suppression) domains. Hypothesis two was partially supported with positive focus predicting sleep quality, such that greater use of positive focus was associated with better sleep quality. Regression analyses also indicated expressive support seeking and suppression of negative emotions significantly predicted physical activity. Although this model was not significant, it partially aligned with zero-order correlations, such that less expressive support seeking predicted more physical activity. The

relationship between suppression of negative emotions and physical activity; however, was not supported by correlations.

The relationship between positive focus and sleep quality is broadly supported by the literature. Specifically, greater use of reappraisal has been associated with better sleep (Kahn et al., 2013; Thomas et al., 2010; Vantieghem et al., 2016). This is theorized to be due to better management of arousal (Aldao et al., 2010; Hofmann et al., 2009) or due to greater overall well-being with frequent use of reappraisal (Gross & John, 2003; Kahn et al., 2013; Vantieghem et al., 2016). My findings further suggest that focusing on the positive aspects of an emotional situation may be particularly useful in maintaining good sleep. It is also important to consider the context of COVID-19. It may be that focusing on the positive in a difficult and largely uncontrollable situation, such as the pandemic, is more beneficial than other aspects of reappraisal, such as contextualizing and learning, which was difficult to do during the pandemic as new information about COVID-19 was frequently changing.

Another finding from the ESR regressions, suggested that greater use of expressive support seeking was associated with less physical activity. While there is limited research on this idea, the sample of college students may be a consideration. For instance, one study demonstrated that few college students engaged in physical activity, but most of them reported strong interpersonal connection and support (Lee & Loke, 2005). It may be that students prioritize expressive support seeking and have more of an opportunity to engage in this behavior as opposed to physical activity. This opportunity for physical activity and support seeking behaviors may also be an impact of those living on campus as compared to those who live off campus. For instance, one going through a difficult time may prioritize spending time with friends catching up or getting coffee, as opposed to focusing on exercise. Therefore, more

expressive support seeking and in theory greater time spent with friends and family may leave little time for exercise, particularly when one also has other strong priorities, such as completing schoolwork and attending classes.

There are a few potential reasons why there was a lack of significant findings between EFs and ERs on physical activity and sleep. First, TST proposes that the relationship between behavioral prepotency and self-regulatory capacity is moderated *behavior intention* (Hall & Fong, 2013). Self-regulatory capacity was measured in regard to EFs but individual *intention to change* physical activity, sleep quality, or sleep hygiene was not assessed. While it was not the goal of the study to measure intention, it may be a key factor. Furthermore, the health behavior questionnaires measured behavioral prepotency (i.e., habitual or automatic actions) for physical activity and sleep but did not assess attempts to alter these behaviors. Specifically, the IPAQ assessed physical activity patterns over the past seven days in a variety of areas (e.g., transportation, housework) and levels of exertion (IPAQ Group, 2002). The PSQI measured sleep behaviors and quality over the past month (Buysse et al., 1988). The SHPS inquired about "common sleep habits" (Lin et al., 2007). It may be that even if the EFs were present and strong, if there was no intention to alter these behaviors, having these strong EFs would not matter. As TST states, ones' self-regulatory capacity has the ability to override prepotent responses, but this is also influenced by their intended behavior and whether or not this includes manipulating said behavior (Hall & Fong, 2013). It is possible that EF ability is most pertinent when attempting to change these prepotent actions and therefore, missing intention may have impacted the statistical outcomes of this study. It is likely that participants' self-regulatory or EF capacity is appropriate for them to maintain their current levels physical activity and sleep habits, and therefore, there were no significant relationships. However, had an intention or attempt to change component

been included, the expected associations (e.g., better EFs would lead to better sleep and more physical activity) may have been apparent.

Relatedly within the context of TST (Hall & Fong, 2013), ESR is a self-regulatory ability, but similar to how the health behaviors were measured, the ESR questionnaires were largely habit-focused (e.g., the ERQ asked about life generally, the COPE inventory inquired about how one generally responds). It is possible that more findings were not significant because, as with the EFs, there was no intention to change. Or it may be that expected relationships were not observed because habitual ESR use was measured as opposed to their ability to regulate their emotions on self-report measures or in an objective way with a performance-based measure such as the Emotion Regulation Choice Task (Sheppes et al., 2011). This could be explored further in future studies.

Additionally, it is possible that the individual EF constructs, set shifting and inhibitory control, were not predictive of physical activity and sleep, but rather, it may be that a combination of EFs (e.g., general EFs), not isolated functions, best explains the correlation between EF and health behaviors found in other studies (Joyner & Loprinzi, 2017; Reimann et al., 2018). This use of general EFs in research was one of the reasons this study aimed to assess these more specific facets through this project; however, the lack of significant findings may demonstrate that assessing overall EF ability is more beneficial. When looking at these individual facets, there was limited existing literature exploring the relationship between set shifting and inhibitory control with exercise. One study found greater inhibitory control was related to more physical activity (Hall et al., 2008), which the present study did not find. However, another study found that better set shifting ability was associated with greater flexible decision making in the context of physical activity (Kelly & Updegraff, 2017). It is possible that

set shifting was associated with this flexible decision making, but not necessarily increased physical activity. Therefore, there may not be a significant association between set shifting and physical activity as demonstrated by this study. Similarly, there was little research assessing how specific EFs predict sleep. Most of the research looked at how sleep impacts EFs (Deak & Stickgold, 2010; Diamond, 2013; Fanning et al., 2017; Ferraro et al., 2015; Jenni & Dahl, 2008; Wilckens et al., 2014). Unfortunately, my findings did not add to this gap in the literature.

As with EFs, it may be that breaking up the ESR strategies into smaller composites limited their utility. In other words, perhaps the overarching strategies (e.g., reappraisal, expression, avoidance, suppression) are needed to see these relationships more clearly. For instance, research demonstrated use of strategies requiring engagement with emotions (e.g., reappraisal) was better for sleep than disengaging (e.g., avoidance; Aldao et al., 2010; Hofmann et al., 2009; Kahn et al., 2013; Thomas et al., 2010; Vantieghem et al., 2016). Whereas research is limited in terms of ESR strategy use and physical activity. There is a link between disengagement strategies (e.g., avoidance) and less engagement in or more effortful exercise (Penley et al., 2012, Wagstaff, 2014), but this area is largely unexplored. Comparatively, maybe the key to better understanding ESR strategies and health behaviors is the combination of which ESR strategies one tends to use consistently or how flexibly one is able to use strategies. It may be that this overall ability or pattern of use is what leads to better well-being and participation in health behaviors. In fact, this has been evidenced in relation to mental health outcomes (Bonanno & Burton, 2013). Additionally, reducing the strategies to the factor composites may have reduced the power in the analyses and negatively impacted the results.

Another factor to consider about the results was how the variables were measured. Due to the nature of the study and COVID-19 limitations, most of the variables were measured with

self-report questionnaires. While it is possible, that the difference in measurement (e.g., performance-based vs. self-report) may have had an impact on the findings, based on past literature this is not likely to be the primary reason for the results. It is possible that self-report of EFs would have been better predictors and more consistent with the other data that was collected. One recent study demonstrated significant relationships between self-reported EFs and health behaviors, such that those who were deemed "healthy" tended to have greater EFs as compared to other participants (McGrath et al., 2021). However, this is not the norm, as other studies have used similar designs (e.g., measured EFs with a performance-based task and measured other variables with self-report) and found significant relationships (Fanning et al., 2017; Giles et al., 2017; Joyner & Loprinzi, 2017). In fact, in a literature review performance-based measures of EFs were reported to be the most commonly used measure of EF in research (Reimann et al., 2018). Relatedly, using performance-based tasks for the ESR strategies may have provided different results; however, self-report measures are the most frequently used assessment of ESR (Aldao et al., 2010; Koechlin et al., 2018; Sloan & Kring, 2007; Tull & Aldao, 2015; Weiss et al., 2014). Nevertheless, the variability in variable measurement could be a limitation of the study, but again is not likely the primary explanation for the lack of significant findings.

Holistic Assessment of Study Variables

A limitation of the EF and health literature as well as the ESR and health literature is that while EF and ESR fall under the self-regulation umbrella, EF and health behavior studies typically do not consider the impact of ER habits on EFs and vice versa. Therefore, the association between EF and health behavior would be mediated by ER strategies. Although each of the seven ESR factors were used in regression analyses, for the path analyses four factors were chosen that aligned more clearly along the engagement/disengagement framework and

were indicated by correlations to have relationships with health behaviors. These included engagement factors: positive focus and expressive support seeking and disengagement factors: venting and avoidance.

Results from the path models were largely not significant. That is, the relationship between the EF facets and health behaviors was not mediated by the ESR composites (positive focus, expressive support seeking, venting and avoidance) and hypothesis three was not supported. However, there were a few significant relationships. First, within the set shifting and physical activity model, less expressive support seeking predicted more physical activity, which was consistent with the prior regression analyses. The COVID-19 variables also significantly predicted health behaviors across all four path models, as discussed above.

Although the direct effects were not significant across all four models, the directions of these relationships were notable. There was an inverse relationship between the EFs and health behaviors, where better EFs led to less engagement in physical activity and poor sleep. While this inverse relationship between EFs and physical activity and sleep may be curious at first, again, it is important to consider the college context. It is speculated that students with stronger EF skills are likely to be highly motivated and focused on doing well in school. It may be that these individuals are too focused on school, such that it is negatively impacting their engagement in health behaviors. Students may be more concerned with staying up late to finish a paper, as opposed to getting a good night's sleep. They may be more focused on attending classes and completing homework than making sure they get to the gym for regular exercise. This idea is also consistent with the significant relationship between expression and physical activity observed in the path analysis, which suggested students may be prioritizing expressive support seeking instead of physical activity. While the hypothesized explanation of the EF findings on

health behaviors cannot be verified, based on my data, it aligns with aspects of prior research and may be worth exploring in the future. For instance, one study demonstrated that master's level physical therapy students prioritized school over exercise and sleep, despite their awareness of the importance of these health behaviors (Smetaniuk et al., 2017). Another study found that later bedtimes were associated with better college entrance exam scores in adolescents (Wang et al., 2016). While this study did not explicitly evaluate the reason for later bedtimes, it was posited that these students prioritized this time to study instead of sleep. Relatedly, Hedin and colleagues (2020) indicated that adolescents completed schoolwork late at night due to other factors, but regardless, this was prioritized over sleep (Hedin et al., 2020). Research also shows that university students tend to prefer to stay up late and follow similar sleep schedules to adolescents, regardless of early class times (Azevedo et al., 2008); and therefore, are not obtaining quality sleep or having energy to exercise. While these articles did not explicitly look at EFs, there is an overall pattern of prioritizing school over health.

Finally, the lack of significant results within the path models may be due to a variety of reasons. For example, the COVID-19 variables could have been accounting for too much of the variance. Additionally, since there were not many significant relationships between EFs, ESR strategies or composites, and health behaviors in earlier study analyses, it was not overly surprising to see a lack of significant results in the path analyses. Finally, due to the high number of variables for the sample size, there may not have been enough power to find significant results.

Clinical Implications

The idea that focusing on the positive or practicing gratitude is beneficial for sleep is one skill that could be easily implemented in clinical interventions and taught on college campuses to

improve sleep. For example, if an individual presents to a therapist's office with complaints of trouble sleeping, the first few steps often include assessment of mental health and medical conditions, as well as sleep habits and sleep hygiene behaviors (Buboltz Jr. et al., 2009). In fact, one of the most common causes for sleep challenges in college students is poor sleep hygiene or lack of awareness of sleep hygiene behaviors (Kloss et al., 20211; Suen et al., 2008). While these strategies have been demonstrated to be helpful, they may not be the easiest for college students to implement. For instance, one recommendation of good sleep hygiene is to limit screen time in the time leading up to bed. However, if a student is busy managing classes, homework, and a job, the only time to finish schoolwork might be before bed, thus, making it difficult to limit late night screen time. Encouraging one to focus on things they are grateful for every night before bed; however, might be more easily implemented. Therefore, this may be one way to reach this population that often has trouble adhering to good sleep hygiene rules.

Additionally, this relationship between positive focus and sleep was demonstrated within the context of COVID-19. As everyone is attempting to find the best way to cope with the stress and uncertainty of COVID-19, the current study may suggest that focusing on the positive is more beneficial than other strategies. As discussed above, this practice of gratitude may simply be the easiest to implement in comparison with other strategies that may require more cognitive effort. Or it may be that while certain strategies, such as contextualizing and learning which is typically helpful when faced with a medical stressor (Groff et al., 2005; Peel et al., 2004), are less easy to implement given that COVID-19 was new and unpredictable. Attempting to learn about the correct COVID-19 precautions and guidance relating to healthcare options in and of itself could be stressful for people. Much of the information surrounding COVID-19 required adequate health literacy knowledge, which disproportionally affected minorities (Van Scoy et al.,

2021). There was also a lot of distrust in the information provided by the government and by medical providers (Van Scoy et al., 2021). Thus, instead of easing one's feelings about COVID-19, using a strategy such as contextualizing and learning may have increased negative emotions. Sharing that positive focus may be easier to implement and may have more health benefits (e.g., better sleep quality) than other ESR strategies may provide some much-needed relief to individuals dealing with the stress of COVID-19. Therefore, colleges and mental health professionals can use this information to target interventions and reduce stress relating to COVID-19. Students could be encouraged to think of three positive things that happened that day or three things they are grateful for. This simple act of focusing on the positive may improve their sleep quality and reduce stress. Relatedly, if an individual is faced with an emotionally challenging situation, focusing on the positive factors may be beneficial in processing that information.

The different relationship between expressive support seeking and venting on sleep also holds clinical implications. If someone is struggling with managing their emotions, it could be helpful to clarify whether their use of "expression" includes an interactive component (i.e., expressive support seeking) or is more consistent with venting. Either way, individuals could be encouraged to engage in purposeful sharing of their emotions with another individual as this may be the better option, whereas frequent use of venting may lead to problems with sleep (Seymour et al., 2013; Taylor et al., 2015). This minor adjustment in how one expresses emotions (i.e., with or without support of another) could hold notable implications for sleep quality.

***Sample Characteristics*.** Other factors that may have impacted the study results include sample characteristics, such as mental and physical health conditions and cultural factors. First, approximately 15% of the sample was diagnosed with anxiety or depression by a professional.

Note, comorbidities of these diagnoses were not assessed. However, a significant portion of the sample also rated symptoms at a level that was indicative of probable anxiety and depression (84% and 94% respectively). This difference in the amount of people reporting diagnosed disorders and those reporting symptoms consistent with disorders, may indicate a few things. It may be that there is a large number of college students struggling with undiagnosed anxiety and depression. It is also possible that given the additional stress, uncertainty, and changes due to COVID-19, that more participants are experiencing symptoms of anxiety and depression than pre-COVID-19. While rates of depression and anxiety before and after COVID-19 were not assessed, the high correlation between perceived stress due to COVID-19 and depression and anxiety provides some evidence for newly developed anxiety and depression symptoms within the context of COVID-19. Additionally, the high level of anxiety and depression provides greater context in relation to COVID-19 and highlights an area of intervention. This high level of symptom report is alarming and worthy of bringing to the attention of universities and healthcare providers who would be able to provide information regarding stress reduction techniques and resources for mental health treatment. Furthermore, students could be encouraged to engage in healthy behaviors such as exercise and sleep hygiene, in order to mitigate current stress and prevent worsening stress from developing.

Additionally, other factors such as environment and mood could have impacted the study outcomes. It could be that due to the changes and limitations (e.g., environmental and financial barriers) placed because of COVID-19, people had less access and means to engage in healthy behaviors. For instance, perhaps a student became unemployed and had to move in with their parents or other relatives, or a student now had to help take care of other family members due to

lack of childcare or inability to work, this would make it much more difficult to focus on things such as regular exercise or quality sleep.

Furthermore, given the high rate of anxiety and depressive symptoms, the impact of mood likely had a great impact on individual motivation to engage in healthy behaviors. Research indicates that daily fluctuations in mood influence health behavior engagement, such that negative mood is associated with less engagement in health behaviors, including exercise (Jones et al., 2007). Also, anxiety and depression are associated with poorer sleep quality (Oh et al., 2019). The mood challenges of the current study sample may have limited their ability to engage in health behaviors, such as physical activity, and appeared to impact their ability to obtain quality sleep as demonstrated in the correlations. Additionally, disorders such as anxiety and depression are associated with difficulty regulating emotions or use of maladaptive ESR strategies (Aldao et al., 2010; Gross, 2013). It may be that the present sample had greater difficulty regulating their emotions due to pre-existing mental health disorders or newly developed depression and anxiety symptoms secondary to COVID-19. Regardless, these symptoms of anxiety and depression should be addressed.

Cultural Considerations. Another important area that was not assessed in the present study is the role of culture in the development of self-regulation, which is an understudied area of research (Trommsdorff, 2009). Self-regulation can be driven by individualistic or collectivistic goals. Seeing as the United States is largely individualistic (Trommsdorff, 2007), much of the research on self-regulation, including the present study, was completed with this assumption that self-regulation would be aimed toward individual success. Specifically, in the present study, it was aimed at individual health. Whereas other cultures, such as parts of Asia, tend to have goals that are geared toward betterment of the whole group (Trommsdorff, 2009).

ESR is one area of self-regulation that is largely impacted by culture, such that certain societies favor and encourage engaging with emotions, while others prefer disengaging. For example, in the United States, being able to express oneself is often valued, while in some Asian cultures it is customary to withhold emotions (Trommsdorff, 2009). Additionally, the types of emotions that are more valued vary from culture to culture. For example, one study demonstrated that in line with a more independent model of self-regulation, German children were encouraged to express anger as it was viewed as a way to assert themselves, whereas Indian and Japanese children were encouraged to inhibit the expression of anger (Trommsdorff, 2006). Additionally, while European Americans are encouraged to seek support from others, studies have demonstrated that Asian Americans are taught to avoid asking for help (Trommsdorff, 2009). Although the present study was conducted in the United States, it is possible that these underlying cultural values differ from family to family and thus from participant to participant. These differences thereby impact the way one would regulate their emotions.

Relatedly, a review study indicated that there are significant racial and ethnic differences in ESR. Specifically, minority racial and ethnic groups tended to rely more heavily on suppression than White individuals in the United States (Weiss et al., 2021). However, the findings regarding use of reappraisal are more mixed, in that some studies demonstrated greater use of reappraisal in Asian cultures and others show no difference. Additionally, research suggests that while minority groups use more suppression, this is thought to be related to collectivistic ideals in which expressing emotions is frowned upon. Relatedly, some studies have demonstrated a greater range of different ESR strategy use in minority groups in attempt to regulate and even inhibit expression of emotions. For example, in a study conducted outside of the United States, White participants were found to use less adaptive strategies compared to non-

White participants (Weiss et al., 2021). The effectiveness of ESR also varies by racial and ethnic groups. The findings are variable but highlight the impact of culture. For instance, one study demonstrated White participants had greater difficulty accepting emotions than Black and East Asian participants, but another found that Asian participants had more difficulty accepting emotions (Weiss et al., 2021).

Although less studied than ESR, EFs are also impacted by culture. Some studies indicate there is greater variability in EF performance across racial and ethnic groups, while others suggest minimal differences (Dore et al., 2015; Flores et al., 2017; Merz et al., 2017). A recent meta-analysis revealed differences in EF performance between White and minority groups, wherein White individuals demonstrated stronger EF performance (Rea-Sandin et al., 2021). Specifically, this study indicated that these differences in performance were greater between White and minority groups, compared to the variability between different minority groups or within the same minority group. This was posited to be related to social inequalities within the minority groups and should be studied further.

Another area influenced by culture is COVID-19. Social determinants of health have long contributed to health disparities among minority groups (Tai et al., 2021). This has been further exacerbated by COVID-19. Minority populations have been more negatively affected across areas such as finances, job flexibility (e.g., working from home versus being required to go into work), living accommodations (e.g., higher housing density), access to healthy food and healthcare resources, and air quality as compared to White individuals (Tai et al., 2021). Thus, making challenging situations even more difficult. In addition to racial and ethnic minorities, sexual and gender minorities have been impacted at a greater rate due to COVID-19 across mental health outcomes when controlling for other factors such as family support and pre-

existing mental health conditions (Kamal et al., 2021). These factors may have made it more difficult to regulate one's emotions and engage in health behaviors during this challenging time.

In sum, there is a notable impact of culture on self-regulation and although a detailed exploration of these factors was outside the scope of this study, it would be useful to replicate this study targeting different cultural groups for direct comparison. For instance, while this sample was comprised of participants attending a typical four-year university, to better address these cultural factors, it would be interesting to conduct a similar study at Historically Black Colleges and Universities (HBCUs) or with non-traditional college students.

Limitations and Design Considerations

There are several limitations within this study. First of all, the sample size is a limitation, particularly for the path analysis. Relatedly, the path analysis software, PROCESS, was not the first choice given the goal of the hypothesis three analysis. Ideally, more data would have been collected and all of the variables would have been assessed at one time in AMOS to better understand the impact of potential mediators and these variables overall. PROCESS allowed for the assessment of only one predictor on one outcome. While all the desired mediators were included, the goal was to assess both EFs and health behaviors at the same time within the model to account for additional variance. The path analysis could not be administered in AMOS because the software would not run with bootstrapping. Bootstrapping is a resampling technique that creates additional representations of the sample distribution for the indirect effects (Hayes, 2018). It produces the confidence intervals for indirect effects and increases the power of the data (Hayes, 2018). Therefore, it is an important piece to this analysis and as it could not be conducted, the decision was made to switch to PROCESS, which did allow bootstrapping.

Although the path analyses results were largely not significant and using AMOS may not have revealed additional significant results, it is possible that the incorporation of all study variables may have demonstrated different findings had they all been successfully included in AMOS.

The COVID-19 pandemic is also a limitation. Whilst the COVID-19 variables had a significant impact on health behaviors, this accounted for substantial variance in the results. Additionally, the context of the pandemic and the associated global stress may have impacted how individuals were choosing to regulate their emotions and what health behaviors they were able to engage in. Relatedly, the virtual format could have also been a limiting factor. In-person data collection was largely emulated, and virtual data collection is supported in the literature as the next best alternative (Irani, 2019). However, technical issues (e.g., such as internet connection problems, not having the appropriate device (e.g., only having a phone and not a computer) arose at times and contributed to loss of data (e.g., internet cutting out during one of the EF tasks). While this study contributed to the literature through the use of the virtual study platform and documenting the successes and pitfalls of this new form of data collection, there was no in-person data collection to compare the results to. It would have been helpful to compare the results with an in-person study design. Regardless, the study was easy to administer and by and large, quality data were obtained. A further limitation is that participants completed the questionnaire portion of the study on their own time, which ultimately led to loss of data as a few individuals discontinued the study prior to completing the questionnaires. Ensuring participants completed the full survey after their task portion on Zoom was the greatest challenge to virtual data collection. Another consideration is that a variety of measurement methods was used (e.g., self-report, cognitive/performance-based tasks). While this is frequently done in the literature, different results may have been found if all self-report or all performance-based measures were

used. Lastly, a newer platform for neuropsychological measures (i.e., TestMyBrain) was used that may have given a different pattern of results than other standard tests.

To address the study's limitations, future studies could collect more participants and attempt to run a path analysis with similar variables in AMOS to assess for any additional relationships. Furthermore, researchers could replicate this project using in-person alongside virtual data collection to determine if the virtual format played a role in the data. If virtual data collection is used, it is recommended that future researchers complete their entire study on Zoom and confirm their completion of all portions prior to ending the session to prevent loss of data. Relatedly, if conducting the study in-person, one could compare the difference in results between the TestMyBrain measures and other commonly used EF tests. One could also utilize EF self-report measures instead of or in conjunction with performance-based tasks to further rule out any impact of difference in measurement.

Implications and Future Directions

Although the data yielded few significant results, the relationships observed are notable. Specifically, the significant relationship between use of positive focus and sleep quality emphasizes a notable area that may facilitate sleep. While this warrants further study, this unique aspect of reappraisal could be a tool to focus on in college seminars or therapy sessions. Additionally, the significant relationship between expressive support seeking and physical activity may highlight common patterns in college students. However, perhaps most remarkable finding was the impact of COVID-19, which was apparent throughout all analyses and significantly predicted both physical activity and sleep. As the pandemic has not ended, this is an area of concern and may be a point of intervention for college campuses and health professionals. Providing opportunities to collectively engage in physical activity or providing

further education on sleep may help mitigate the effects of COVID-19, such as perceived stress. Ongoing research in this area is necessary as the pandemic continues to ebb and flow.

Though it was not the goal of the study, based on the results and past literature, it is possible that intention and willingness or need to change behaviors plays a critical role in the study variable relationships. Including this aspect may highlight more of the expected relationships between EF, ESR, and health behaviors. Relatedly, although the goal of the study was to assess these variables in a non-clinical college sample, this study could be replicated using clinical samples with more variability in EF and ESR, as existing research indicates that disorders characterized by EF deficits (i.e., ADHD, schizophrenia, mood disorders) tend to also have challenges with ESR (Pe et al., 2013; Suchy, 2009), and that people with ESR disorders (i.e., depression, anxiety, posttraumatic stress disorder) often also have problems with EFs (Joormann, 2010; Joormann & D'Avanzato, 2010; Joormann & Quinn, 2014; Levens et al., 2009). Individuals with EF and ESR challenges also often have difficulty with health behaviors (Aldao et al., 2010; Baglioni et al., 2010; Dohle et al., 2018; Hall et al., 2008; Kahn et al., 2013; Penley et al., 2012; Spinella & Lyke, 2004). Therefore, this increased variability in participant EF ability and tendency to rely on different ESR strategies may lead to stronger relationships between these variables.

Conclusion

In sum, the partial support of the hypotheses provides initial evidence linking ESR strategies and health behaviors within the context of COVID-19. Specifically, greater use of positive focus predicted better sleep quality and greater expressive support seeking led to less physical activity. Helping increase individuals' awareness to these links between specific ESR strategies and health outcomes may aid in improving sleep and increasing the likelihood of

engaging in exercise. Other notable variables were the COVID-19 factors, including perceived stress, frequency of sleep, and frequency of physical activity during COVID-19, each of which impacted health behaviors. These findings add to existent literature and highlight the impact of the global pandemic on sleep functioning and physical activity. Overall, this study provided a more nuanced assessment of self-regulation and health behaviors within the context of COVID-19 and established new directions for future research.

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Table 1.
Descriptive Statistics Among Demographics

Variable	*n*	*%*	*M*	*SD*
Age	114		19.97	*1.76*
Gender	114			
Female	56	49.1%		
Male	58	50.9%		
Race/Ethnicity				
White	64	56.6%		
Black	14	12.4%		
Asian	19	16.8%		
Pacific Island/Native Hawaiian	1	.9%		
Biracial	3	2.7%		
Other	6	5.3%		
Hispanic/Latino	18	15.8%		
Education	114			
Freshman	38	33.3%		
Sophomore	33	28.9%		
Junior	22	19.3%		
Senior	17	14.9%		
Graduate Student	4	3.5%		
Health Conditions	114			
Concussion	21	18.4%		
Traumatic Brain Injury	0	0%		
Headache	12	10.5%		

Epilepsy	1	0.9%
Chronic Pain	2	1.8%
Insomnia	2	1.8%
Anxiety	19	16.7%
Depression	16	14%
Eating Disorder	1	0.9%
PTSD	3	2.6%
Learning Disorder	3	2.6%
ADHD	12	10.5%
Behavior Disorder	1	0.9%
Substance Abuse	1	0.9%

Table 2.

Descriptive Statistics and Correlations Among Initial Study Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Set Shift Z	-0.012	0.71	--																
2. Inhibition Z	-0.04	1.04	.21*	--															
3. ERQ: Reappraisal	29.31	6.59	0.04	-0.01	--														
4. ERQ: Suppression	14.86	5.07	0.03	0.12	0.09	--													
5. CRI: Pos. Reappraisal	52.46	7.60	0.03	-0.04	.48***	-0.02	--												
6. CRI: Seek Guid. & Supp.	48.64	9.07	0.06	-0.09	-0.02	-.44***	.30***	--											
7. CRI: Cog. Avoidance	56.24	8.41	0.13	0.03	.00	.19*	0.1	0.07	--										
8. COPE: Pos. Reint. & Grow	12.01	2.51	-0.04	0.03	.45***	0.03	.58***	0.16	-0.11	--									
9. COPE: Focus & Vent	9.09	3.07	-0.02	-0.04	-0.16	-.32***	-0.01	.42***	.21*	-0.1	--								
10. COPE: Em Social Supp.	9.16	3.13	0.15	-0.05	-0.16	-.52***	0.07	.64***	0.15	0	.56***	--							
11. IPAQ	7735.83	8282.66	0.13	-0.02	0.14	0.04	0.07	-0.09	-0.02	0.1	-0.07	-0.15	--						
12. PSQI	15.52	6.86	0.1	.00	-0.1	0.01	0	.19*	.30***	-0.14	.26**	0.13	0.02	--					
13. SHPS	84	19.55	-0.02	0.08	-0.04	0.08	0	-0.01	.25**	-0.16	.18*	0.04	-0.04	.62***	--				
14. COVID – PSS	21.84	4.11	0.06	-0.02	0	0.01	0.06	0.11	.33***	0.03	.38***	0.14	-0.06	.41***	.21*	--			
15. COVID – Sl	4.10	.70	.00	0.01	-0.02	0.03	-0.03	-0.08	0.03	-0.01	-0.03	0.02	-0.04	-.21*	-0	-0	--		
16. COVID – PA	2.45	.95	0.05	-0.1	0.16	.22*	0	-0.12	-0.02	0.16	-.31***	-0.18	.33***	-0.05	-.20*	-0	-.26*	--	
17. GAD-7	14.79	5.31	-0.02	0.02	-0.14	0.05	-0.14	0	.27**	-.19*	.42***	0.05	-0.07	.46***	.32***	.48***	-0.17	-0.07	--
18. PHQ-9	16.85	6.23	0.1	0.15	-0.13	0.06	-0.17	-0.03	.40***	-0.13	.35***	0.08	0.01	.53***	.59***	.40***	-0.08	-.22*	.66***

Note. $N = 114$, $*p > .05$; $**p > .01$; $***p > .001$; ERQ = Emotion Regulation Questionnaire; CRI = Coping Responses Inventory; COPE = Cope Inventory; 6. = CRI: Seeking Guidance & Support; 7. CRI: Cognitive Avoidance; 8. = COPE: Positive Reinterpretation & Growth; 9. COPE: Focusing on & Venting Emotions; 10 = COPE: Emotional Social Support; IPAQ = International Physical Activity Questionnaire; PSQI = Pittsburgh Sleep Quality Index; SHPS = Sleep Hygiene Practices Scale; COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19; GAD-7 = Generalized Anxiety Disorder 7-Item Scale; PHQ-9 = Patient Health Questionnaire 9-Item.

Table 3.
Exploratory Factor Analysis Among Emotional Self-Regulation Variables

Item	1	2	3	4	5	6	7	8	9	10
1. COPE: I discuss my feelings with someone.	***.85***	.01	-.06	-.09	.11	-.15	-.02	.06	.10	.07
2. COPE: I try to get emotional support from friends or relatives.	***.84***	-.08	.07	.01	.19	-.15	.02	.02	.09	-.11
3. COPE: I get sympathy and understanding from someone.	***.64***	.00	.01	-.02	.32	-.12	.19	.07	.19	-.07
4. COPE: I talk to someone about how I feel.	***.85***	-.03	-.02	.06	.21	-.22	.01	-.04	.01	-.01
5.CRI: Talk with your spouse or other relative about the problem.	***.77***	-.06	.01	.02	.15	-.21	.02	.06	-.22	.00
6. CRI: Talk with a friend about the problem.	***.70***	.06	.17	.19	-.10	-.26	.10	.01	.10	.04
7. CRI: Talk with a professional person (e.g., doctor, lawyer, clergy).	***.68***	.03	-.01	.00	-.04	.26	.12	-.11	-.15	.03
8. CRI: Seek help from persons or groups with the same type of problem.	***.65***	-.08	.10	-.02	.02	.23	-.01	.14	.05	.14
9. ERQ: I keep my emotions to myself.	***-.68***	.05	-.15	.07	-.12	.39	.12	.13	.10	-.15
10. ERQ: When I want to feel more positive emotion, I change what I'm thinking about	-.26	***.63***	.09	.12	.14	.05	.06	.10	.11	.15
11. ERQ: When I want to feel less negative emotion, I change what I'm thinking about.	-.03	***.56***	.20	-.02	.10	-.15	-.24	.06	.26	.29
12. ERQ: When I'm faced with a stressful situation, I make myself think about it in a way that helps me stay calm.	-.17	***.73***	.15	-.02	-.11	-.18	.28	-.07	.12	-.20
13. ERQ: When I want to feel more positive emotion, I change the way I'm thinking about the situation	.00	***.79***	.06	.09	-.06	.22	.18	-.04	.07	.04

14. ERQ: I control my emotions by changing the way I think about the situation I'm in.	.03	***.81***	.04	-.07	-.04	.07	.04	.09	-.08	-.04
15. ERQ: When I want to feel less negative emotion, I change the way I'm thinking about the situation	-.03	***.79***	.26	-.03	-.18	.00	-.12	.01	.10	.03
16. COPE: I try to see it in a different light, to make it seem more positive.	.08	.22	***.81***	-.04	.05	.07	.15	.12	-.01	-.05
17. COPE: I look for something good in what is happening.	.04	.22	***.83***	-.04	-.05	.15	.17	-.09	.02	-.09
18. CRI: Try to see the good side of the situation.	.16	**.43**	***.56***	-.10	-.13	-.12	.22	.25	-.12	.02
19. CRI: Try to tell yourself that things will get better.	.17	.39	***.43***	-.01	-.22	-.31	.25	.11	.21	-.05
20. CRI: Try to forget the whole thing	.09	.01	-.12	***.80***	-.02	.02	.01	.17	-.03	.04
21. CRI: Try not to think about the problem.	.03	.12	-.08	***.81***	.10	.03	-.15	-.02	.00	.00
22. CRI: Try to deny how serious the problem really is.	-.14	.03	.15	***.59***	.07	.19	-.06	.25	-.16	.35
23. COPE: I get upset and let my emotions out.	.27	-.06	.03	-.01	***.71***	-.22	-.01	.11	-.06	.06
24. COPE: I get upset, and am really aware of it.	.10	-.06	-.04	.08	***.77***	.11	-.03	-.15	.11	.31
25. COPE: I let my feelings out.	**.50**	-.17	.27	.03	***.52***	-.19	-.16	.07	.10	-.21
26. COPE: I feel a lot of emotional distress and I find myself expressing those feelings a lot.	**.44**	-.01	-.16	.12	***.69***	.02	-.09	-.01	.09	-.07
27. ERQ: I control my emotions by not expressing them.	-.38	.03	.01	.17	-.12	***.73***	.01	.08	.05	-.16
28. ERQ: When I am feeling negative emotions, I make sure not to express them.	-.28	.06	.11	.08	-.03	***.75***	-.04	.09	-.01	.15

29. COPE: I try to grow as a person as a result of the experience.	.04	.34	.26	.02	-.22	.26	***.55***	-.12	.18	-.13
30. COPE: I learn something from the experience.	-.05	.12	.28	-.10	-.04	-.06	***.66***	.09	.21	.08
31. CRI: Think about how this event could change your life in a positive way	.05	**.43**	.34	.00	-.07	.03	***.49***	.19	-.26	-.04
32. CRI: Try to find out more about the situation.	.26	-.05	.13	.19	.07	-.11	***.58***	.33	-.21	.03
33. CRI: Remind yourself how much worse things could be	-.11	.02	.20	.04	-.02	.08	.07	**.79**	.11	.21
34. CRI: Think about how you are much better off than other people with similar problems.	.16	.17	-.04	.18	.01	.07	.13	**.77**	.09	-.15
35. CRI: Tell yourself things to make yourself feel better.	.20	**.43**	**.42**	.15	.16	-.15	.09	.19	.18	-.07
36. CRI: Pray for guidance and/or strength	.05	.23	.04	-.12	.01	.04	.00	.16	**.72**	.05
37. CRI: Daydream or imagine a better time or place, than the one you are in	.08	-.14	-.08	.29	.26	-.04	.29	.01	**.50**	.21
38. CRI: Try to put off thinking about the situation, even though you know you will have to at some point	.07	-.11	.07	**.44**	.01	.04	.09	-.12	.07	**.52**
39. CRI: Wish the problem will go away or somehow be over with.	.11	.11	-.27	.14	.22	.00	-.01	.09	.15	**.67**
40. ERQ: When I am feeling positive emotions, I am careful not to express them.	-.15	-.12	.09	**.49**	.07	.18	-.26	-.03	.38	-.38

Note. ERQ = Emotion Regulation Questionnaire; CRI = Coping Responses Inventory; COPE = COPE Inventor; Bolded items indicate notable loadings; Bold and italicized items indicate final items chosen for each factor and used in analyses. Factor 1 = Expressive Support Seeking; Factor 2 = Positive Reframing; Factor 3 = Positive Focus; Factor 4 = Avoidance; Factor 5 = Venting; Factor 6 = Suppression of Negative Emotions; Factor 7 = Contextualizing and Learning; Factor 8 = Comparison; Factor 9 = Prayer and Daydreaming; Factor 10 = Passive Avoidance.

Table 4.

Descriptive Statistics and Correlations Among Study Variables including Emotional Self-Regulation Composites

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Set Shift Z	-0.01	0.71	-															
2. Inhibition Z	-0.04	1.04	.21*	-														
3. Expressive Support Seek	2.45	0.84	0.11	-0.1	-													
4. Venting	9.09	3.07	-0	-0	.53***	-												
5. Positive Reframing	29.31	6.59	0.04	-0	-0.09	-0.16	-											
6. Positive Focus	2.99	0.66	.00	0.01	0.18	-0.06	.52***	-										
7. Contextualiz. & Learning	3.13	0.57	0.06	0.04	0.12	-0.09	.38***	.60***	-									
8. Avoidance	2.37	0.71	.18*	-0	0.01	0.1	0.01	-0.09	-0.1	-								
9. Suppress Negative	3.96	1.62	0.03	.22*	-.51***	-.31**	0.08	0	-0	.20*	-							
10. IPAQ	7735.8	8282.7	0.13	-0	-0.17	-0.07	0.14	0.02	0.14	-0.01	0	-						
11. PSQI	15.52	6.86	0.1	0	0.13	.26**	-0.1	-.20*	-0	.20*	0	0.02	-					
12. SHPS	84	19.55	-0	0.08	0	.18*	-0.04	-0.11	-0.1	.18*	0.12	-0.04	.62***	-				
13. COVID - PSS	21.84	4.11	0.06	-0	0.14	.38***	0	0	0.01	.20*	0.02	-0.06	.41***	.21*	-			
14. COVID – Sleep	4.1	0.7	0	0.01	0.01	-0.03	-0.02	0.09	-0	0.03	0.09	-0.04	-.21*	-0.1	-0.03	-		
15. COVID - PA	2.45	0.95	0.05	-0.1	-.19*	-.31**	0.16	0.05	0.11	0.01	.25**	.33***	-0.05	-.20*	-0.05	-.26**	-	
16. GAD-7	14.79	5.31	-0	0.02	-0.01	.42***	-0.14	-.28**	-0.1	.21*	-0	-0.07	.46***	.32***	.48***	-0.17	-0.1	-
17. PHQ-9	16.85	6.23	0.1	0.15	0.01	.35***	-0.13	-.22*	-0.1	.31***	0.08	0.01	.53***	.59***	.50***	-0.08	-.22*	.66***

Note. $N = 114$, $*p > .05$; $**p > .01$; $***p > .001$; All ESR scores (#3-9) are composites; Suppress negative = suppression of negative emotions; IPAQ = International Physical Activity Questionnaire; PSQI = Pittsburgh Sleep Quality Index; SHPS = Sleep Hygiene Practices Scale; COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19; GAD-7 = Generalized Anxiety Disorder 7-Item Scale; PHQ-9 = Patient Health Questionnaire 9-Item.

Table 5.

Hierarchical Multiple Regression Analysis: Executive Functions Predicting Physical Activity

Model		*b*	S.E.	*β*	R^2	ΔR^2
Stage 1					0.12*	0.12
	(Intercept)	0.00	0.09			
	Age	-0.04	0.09	-0.04		
	Gender	-0.04	0.10	-0.04		
	COVID – PSS	-0.03	0.10	-0.03		
	COVID – PA	0.33	0.10	0.33**		
	COVID – Sleep	0.05	0.10	0.05		
Stage 2					0.13	0.01
	(Intercept)	0.00	0.09			
	Age	-0.03	0.10	-0.03		
	Gender	-0.04	0.11	-0.04		
	COVID - PSS	-0.04	0.10	-0.04		
	COVID - PA	0.32	0.10	0.32**		
	COVID - Sleep	0.04	0.10	0.04		
	Set Shifting	0.17	0.13	0.12		
	Inhibitory Control	-0.04	0.10	-0.04		

Note. $N = 114$. *$p < .05$; **$p < .01$; ***$p < .001$. *b* = unstandardized regression weight; S.E. = standard error; *β* = standardized beta weight; ΔR^2 = Change in R^2 from prior model; All scores are in Z scores. COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19.

Table 6.

Hierarchical Multiple Regression Analysis: Executive Functions Predicting Sleep Quality

Model		*b*	S.E.	*β*	R^2	ΔR^2
Stage 1					.21***	0.21
	(Intercept)	0.01	0.09			
	Age	0.04	0.09	0.04		
	Gender	-0.01	0.09	-0.01		
	COVID - PSS	0.41	0.09	.41***		
	COVID - PA	-0.09	0.09	-0.09		
	COVID - Sleep	-0.21	0.09	-0.21*		
Stage 2					0.22	0.01
	(Intercept)	0.01	0.09			
	Age	0.05	0.09	0.05		
	Gender	0.00	0.10	0.00		
	COVID - PSS	0.40	0.09	.40***		
	COVID - PA	-0.09	0.09	-0.09		
	COVID - Sleep	-0.21	0.09	-0.21*		
	Set Shifting	0.13	0.13	0.09		
	Inhibitory Control	-0.01	0.10	-0.01		

Note. $N = 114$. *$p < .05$; **$p < .01$; ***$p < .001$. *b* = unstandardized regression weight; S.E. = standard error; *β* = standardized beta weight; ΔR^2 = Change in R^2 from prior model; All scores are in Z scores. COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19.

Table 7.

Hierarchical Multiple Regression Analysis: Executive Functions Predicting Sleep Hygiene

Model		*b*	S.E.	*β*	R^2	ΔR^2
Stage 1						
	(Intercept)	0.01	0.09		.11*	0.11
	Age	-0.09	0.09	-0.09		
	Gender	-0.06	0.10	-0.06		
	COVID – PSS	0.20	0.09	0.20*		
	COVID – PA	-0.23	0.10	-.23*		
	COVID – Sleep	-0.13	0.09	-0.13		
Stage 2						
	(Intercept)	0.01	0.09		0.11	0.01
	Age	-0.09	0.10	-0.09		
	Gender	-0.05	0.11	-0.05		
	COVID - PSS	0.20	0.10	0.21*		
	COVID - PA	-0.22	0.10	-.23*		
	COVID - Sleep	-0.13	0.10	-0.13		
	Set Shifting	-0.05	0.13	-0.04		
	Inhibitory Control	0.03	0.10	0.03		

Note. $N = 114$. *$p < .05$; **$p < .01$; ***$p < .001$. *b* = unstandardized regression weight; S.E. = standard error; *β* = standardized beta weight; ΔR^2 = Change in R^2 from prior model; All scores are in Z scores. COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19.

Table 8.
Hierarchical Multiple Regression Analysis: Emotional Self-Regulation predicting Physical Activity

Model		*b*	S.E.	*β*	R^2	ΔR^2
Stage 1					0.1	0.1
	(Intercept)	0.01	0.10			
	Age	-0.04	0.10	-0.04		
	Gender	-0.02	0.10	-0.02		
	COVID - PSS	-0.05	0.10	-0.05		
	COVID - PA	0.30	0.10	0.30**		
	COVID - Sleep	0.02	0.10	0.02		
Stage 2					0.19	0.1
	(Intercept)	0.02	0.09			
	Age	-0.02	0.10	-0.02		
	Gender	-0.05	0.11	-0.05		
	COVID - PSS	-0.07	0.10	-0.07		
	COVID - PA	0.34	0.11	0.34**		
	COVID - Sleep	0.08	0.10	0.08		
	Expressive Support Seeking	-0.33	0.13	-0.33*		
	Venting	0.21	0.13	0.21		
	Positive Reframing	0.09	0.11	0.08		
	Positive Focus	-0.09	0.13	-0.09		
	Contextualizing & Learning	0.19	0.12	0.19		
	Avoidance	0.04	0.10	0.04		
	Suppress Negative Emotions	-0.24	0.12	-0.23*		

Note. $N = 114$. *$p < .05$; **$p < .01$; ***$p < .001$. *b* = unstandardized regression weight; S.E. = standard error; *β* = standardized beta weight; ΔR^2 = Change in R^2 from prior model; All scores are in Z scores. COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19.

Table 9.

Hierarchical Multiple Regression Analysis: Emotional Self-Regulation predicting Sleep Quality

Model		*b*	S.E.	*β*	R^2	ΔR^2
Stage 1					.21***	0.21
	(Intercept)	0.00	0.09			
	Age	0.02	0.09	0.02		
	Gender	0.01	0.10	0.01		
	COVID - PSS	0.38	0.09	.39***		
	COVID - PA	-0.12	0.10	-0.12		
	COVID - Sleep	-0.23	0.09	-0.22*		
Stage 2					0.3	0.08
	(Intercept)	-0.01	0.09			
	Age	0.02	0.09	0.02		
	Gender	0.01	0.10	0.01		
	COVID - PSS	0.33	0.10	.34**		
	COVID - PA	-0.13	0.10	-0.13		
	COVID - Sleep	-0.22	0.10	-0.22*		
	Expressive Support Seeking	0.11	0.12	0.11		
	Venting	0.03	0.12	0.03		
	Positive Reframing	-0.02	0.11	-0.02		
	Positive Focus	-0.27	0.12	-0.27*		
	Contextualizing & Learning	0.16	0.11	0.16		
	Avoidance	0.14	0.09	0.14		
	Suppress Negative Emotions	0.11	0.11	0.11		

Note. $N = 114$. *$p < .05$; **$p < .01$; ***$p < .001$. *b* = unstandardized regression weight; S.E. = standard error; *β* = standardized beta weight; ΔR^2 = Change in R^2 from prior model; All scores are in Z scores. COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19.

Table 10.
Hierarchical Multiple Regression Analysis: Emotional Self-Regulation predicting Sleep Hygiene Behavior

Model		*b*	S.E.	*β*	R^2	ΔR^2
Stage 1					0.1	0.1
	(Intercept)	0.04	0.09			
	Age	-0.09	0.10	-0.09		
	Gender	-0.06	0.10	-0.06		
	COVID - PSS	0.20	0.10	0.21*		
	COVID - PA	-0.21	0.10	-.21*		
	COVID - Sleep	-0.11	0.10	-0.11		
Stage 2					0.15	0.06
	(Intercept)	0.03	0.10			
	Age	-0.07	0.10	-0.07		
	Gender	-0.08	0.11	-0.08		
	COVID - PSS	0.14	0.11	0.14		
	COVID - PA	-0.23	0.11	-.23*		
	COVID - Sleep	-0.13	0.10	-0.13		
	Expressive Support Seeking	0.00	0.13	0.00		
	Venting	0.13	0.13	0.13		
	Positive Reframing	0.07	0.12	0.07		
	Positive Focus	-0.05	0.13	-0.05		
	Contextualizing & Learning	-0.08	0.12	-0.08		
	Avoidance	0.10	0.10	0.10		
	Suppress Negative Emotions	0.15	0.12	0.15		

Note. $N = 114$. *$p < .05$; **$p < .01$; ***$p < .001$. *b* = unstandardized regression weight; S.E. = standard error; *β* = standardized beta weight; ΔR^2 = Change in R^2 from prior model; All scores are in Z scores. COVID-PSS = COVID-19 Perceived Stress Scale; COVID-Sleep = sleep frequency during COVID-19; COVID-PA = physical activity frequency during COVID-19.

Figure 1.
Proposed relationships between executive function, emotional self-regulation, and health behavior.

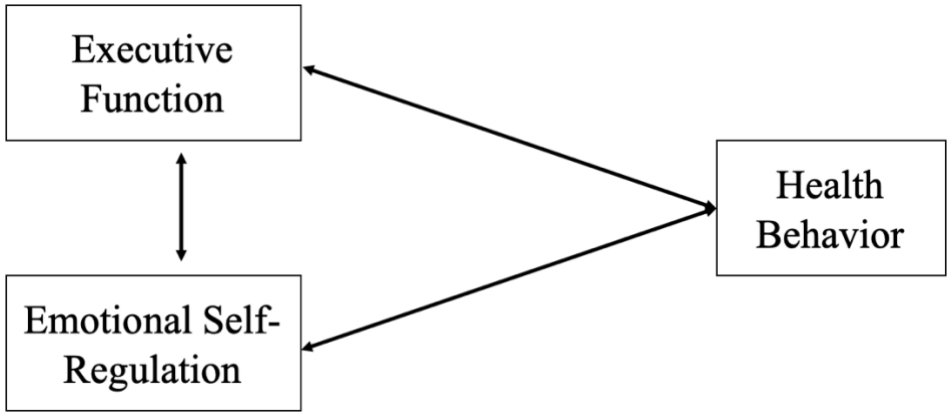


Figure 2.
Shared characteristics between emotion regulation and coping strategies.

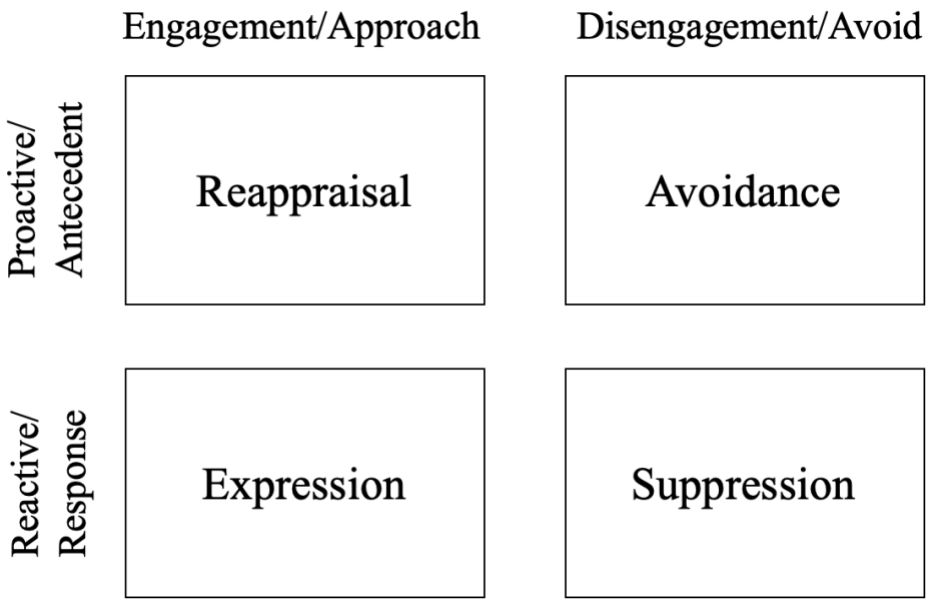
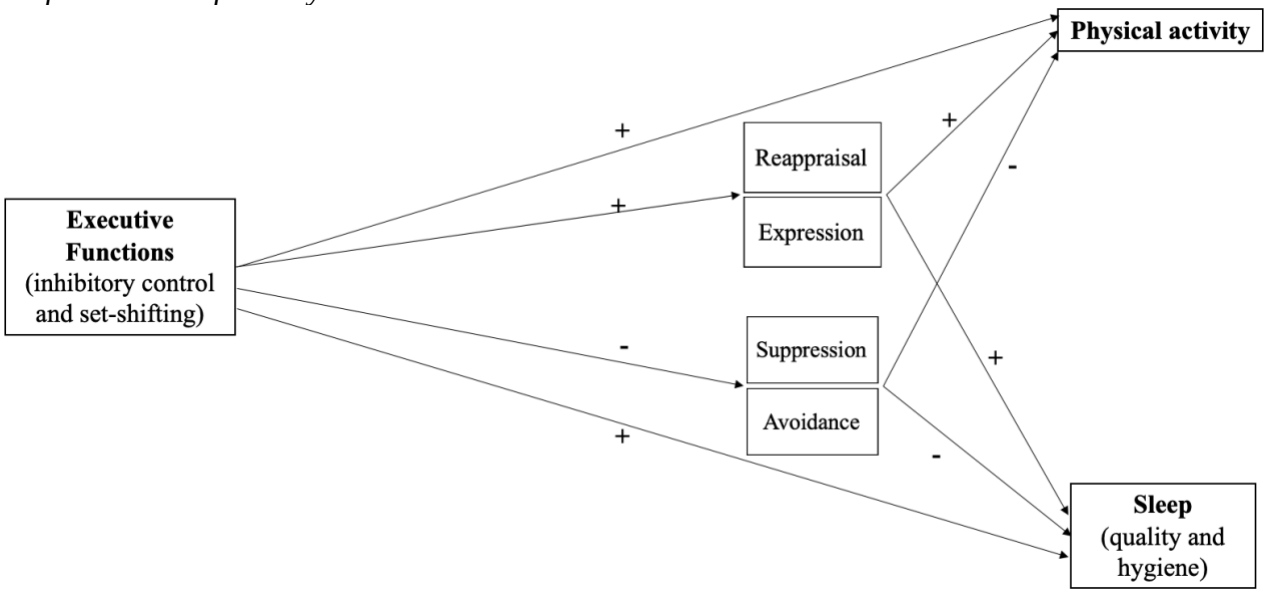
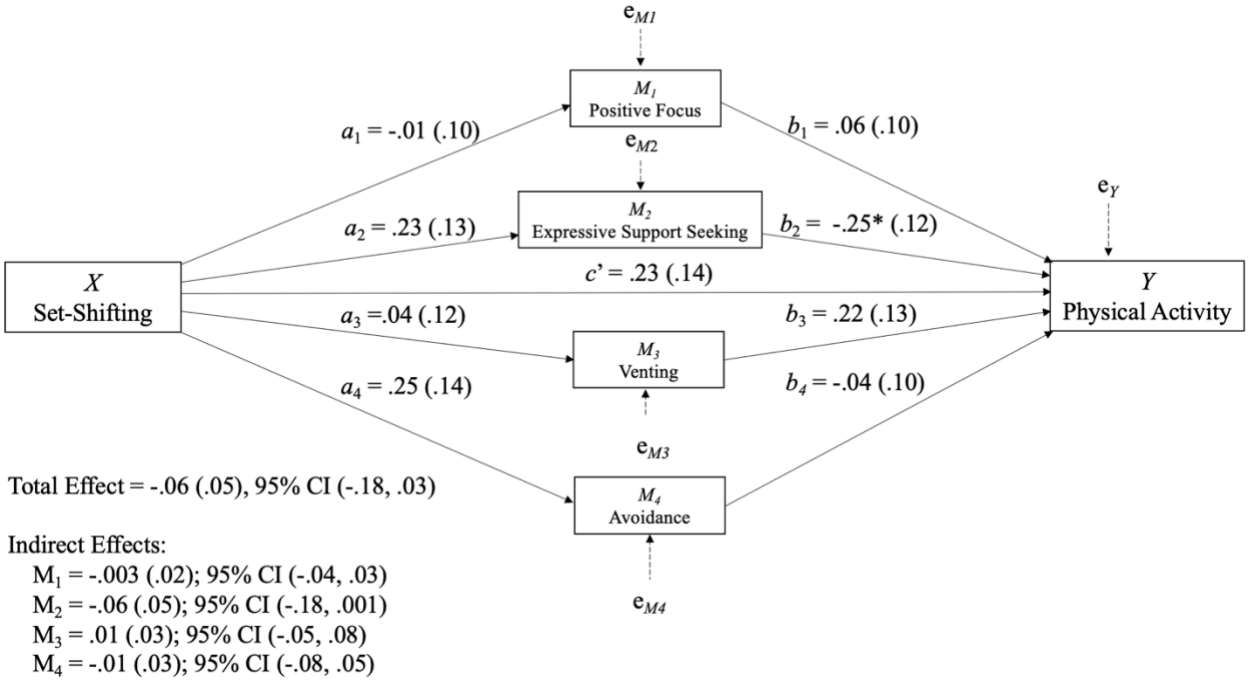


Figure 3.
Proposed model pathways.



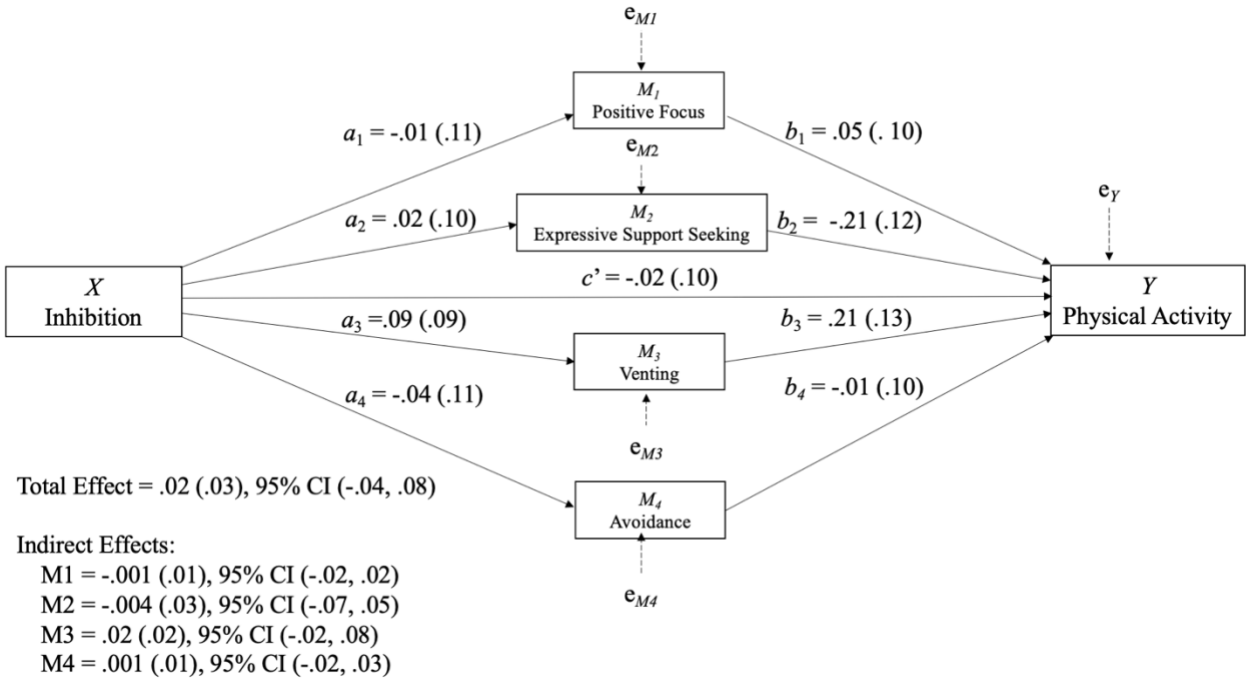
Note: All variables are observed.

Figure 4.
PROCESS Mediation Model: Set Shifting on Physical Activity



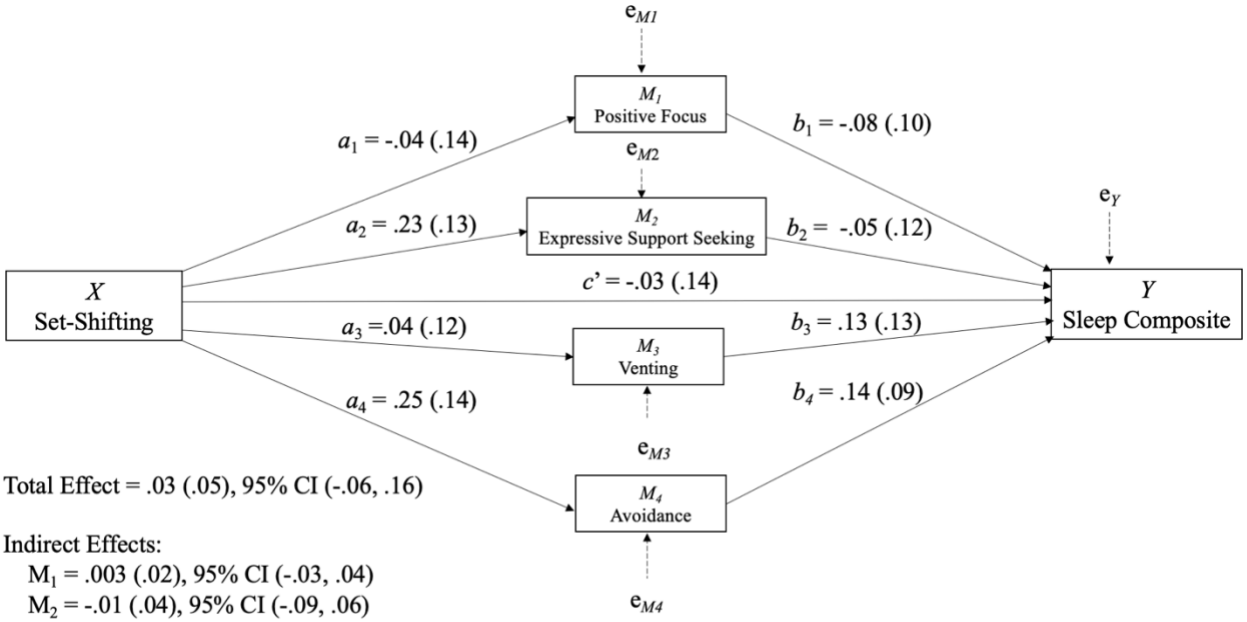
Note. $N = 114$. *$p < .05$; standard error of standardized coefficients are presented in parentheses; covariates were not pictured for clarity but were included in analyses: COVID-19 variables, age, and gender.

Figure 5.
PROCESS Mediation Model: Inhibition on Physical Activity



Note. $N = 114$. $*p < .05$; standard error of standardized coefficients are presented in parentheses; covariates were not pictured for clarity but were included in analyses: COVID-19 variables, age, and gender.

Figure 6.
PROCESS Mediation Model: Set Shifting on Sleep

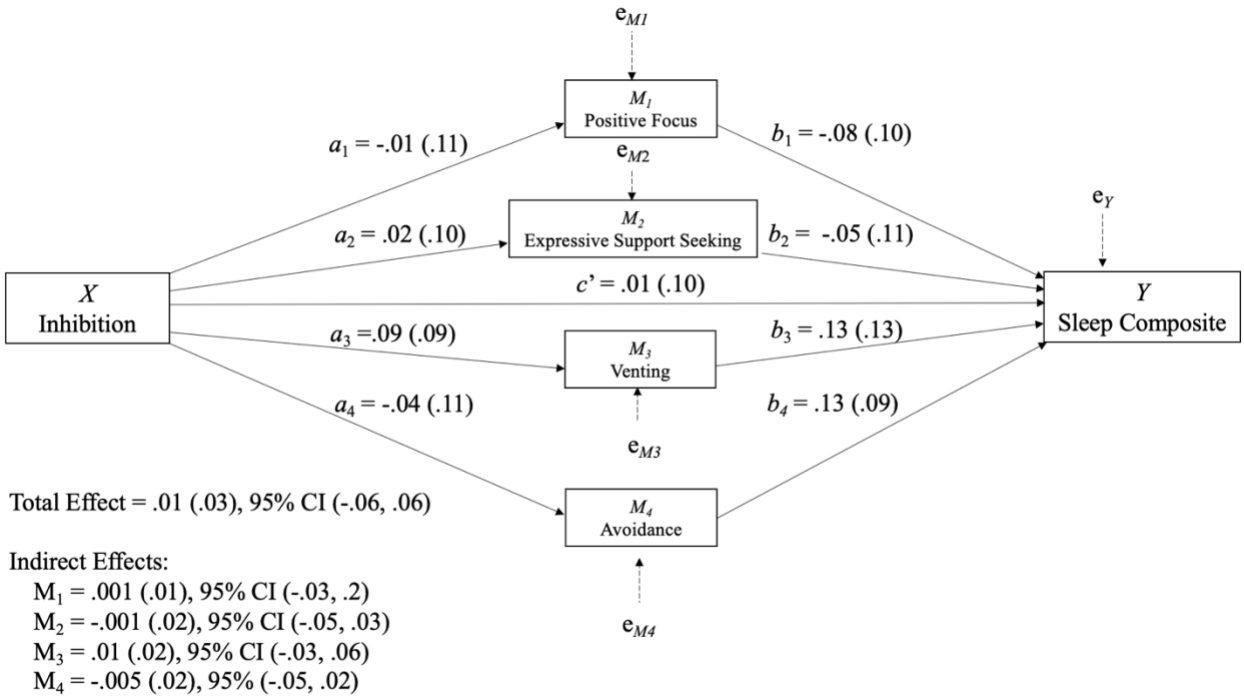


Total Effect = .03 (.05), 95% CI (-.06, .16)

Indirect Effects:
M_1 = .003 (.02), 95% CI (-.03, .04)
M_2 = -.01 (.04), 95% CI (-.09, .06)
M_3 = .06 (.02), 95% CI (-.03, .07)
M_4 = .03 (.04), 95% CI (-.02, .12)

Note. $N = 114$. $^*p < .05$; standard error of standardized coefficients are presented in parentheses; covariates were not pictured for clarity but were included in analyses: COVID-19 variables, age, and gender.

Figure 7.
PROCESS Mediation Model: Inhibition on Sleep



Note. $N = 114$. $^{*}p < .05$; standard error of standardized coefficients are presented in parentheses; covariates were not pictured for clarity but were included in analyses: COVID-19 variables, age, and gender.

APPENDIX A: SURVEY BATTERY

Emotion Regulation Questionnaire

Gross, J.J., & John, O.P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85,* 348-362.

Description:
The Emotion Regulation Questionnaire is designed to assess individual differences in the habitual use of two emotion regulation strategies: cognitive reappraisal and expressive suppression.

Instructions:
We would like to ask you some questions about your emotional life, in particular, how you control (that is, regulate and manage) your emotions. The questions below involve two distinct aspects of your emotional life. One is your emotional experience, or what you feel like inside. The other is your emotional expression, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another, they differ in important ways. For each item, please answer using the following scale:

1	2	3	4	5	6	7
strongly disagree			neutral			strongly agree

1. ____ When I want to feel more positive emotion (such as joy or amusement), I change what I'm thinking about.
2. ____ I keep my emotions to myself.
3. ____ When I want to feel less negative emotion (such as sadness or anger), I change what I'm thinking about.
4. ____ When I am feeling positive emotions, I am careful not to express them.
5. ____ When I'm faced with a stressful situation, I make myself think about it in a way that helps me stay calm.
6. ____ I control my emotions by not expressing them.
7. ____ When I want to feel more positive emotion, I change the way I'm thinking about the situation.
8. ____ I control my emotions by changing the way I think about the situation I'm in.
9. ____ When I am feeling negative emotions, I make sure not to express them.
10. ____ When I want to feel less negative emotion, I change the way I'm thinking about the situation.

Note: Do not change item order, as items 1 and 3 at the beginning of the questionnaire define the terms "positive emotion" and "negative emotion".

Scoring (no reversals); Reappraisal Items: 1, 3, 5, 7, 8, 10; Suppression Items: 2, 4, 6, 9

Coping Responses Inventory

Instructions: The next set of questions will ask you about your coping strategies. Please pay close attention to each item.

Please rate how often you tend to use the following activities to cope with a stressful situation or problem.

1	2	3	4
Not at all	Rarely	Sometimes	Fairly Often

1. Think of different ways to deal with the problem.
2. Tell yourself things to make yourself feel better.
3. Talk with your spouse or other relative about the problem.
4. Make a plan of action and follow it.
5. Try to forget the whole thing.
6. Feel that time will make a difference: that the only thing to do is wait.
7. Try to help others deal with a similar problem.
8. Take it out on other people when you feel angry or depressed.
9. Try to step back from the situation and be more objective.
10. Remind yourself how much worse things could be.
11. Talk with a friend about the problem.
12. Know what has to be done and try hard to make things work.
13. Try not to think about the problem.
14. Realize that you have no control over the problem.
15. Get involved in new activities.
16. Take a chance and do something risky.
17. Go over in your mind what you would say or do.
18. Try to see the good side of the situation.
19. Talk with a professional person (e.g. doctor, lawyer, clergy).
20. Decide what you want and try hard to get it.
21. Daydream or imagine a better time or place, than the one you are in.
22. Think that the outcome will be decided by fate.
23. Try to make new friends.
24. Keep away from people in general.
25. Try to anticipate how things will turn out.
26. Think about how you are much better off than other people with similar problems.
27. Seek help from persons or groups with the same type of problem.
28. Try at least two different ways to solve the problem.
29. Try to put off thinking about the situation, even though you know you will have to at some point.
30. Accept it; nothing can be done.
31. Read more often as a source of enjoyment.
32. Yell or shout to let off steam.
33. Try to find some personal meaning in the situation.
34. Try to tell yourself that things will get better.
35. Try to find out more about the situation.
36. Try to learn to do more things on your own.
37. Wish the problem will go away or somehow be over with.
38. Expect the worst possible outcome.

39. Spend more time in recreational activities.
40. Cry to let your feelings out.
41. Try to anticipate the new demands that will be placed on you.
42. Think about how this event could change your life in a positive way.
43. Pray for guidance and/or strength.
44. Take things a day at a time, one step at a time.
45. Try to deny how serious the problem really is.
46. Lose hope that things will ever be the same.
47. Turn to work or other activities to help you manage things.
48. Do something that you don't think will work, but at least you are doing something.

Moos, R. H., & Schaefer, J. A. (1993). Coping resources and processes: Current concepts and measures. In L. Goldberger, S. Breznitz, L. Goldberger, S. Breznitz (Eds.), *Handbook of stress: Theoretical and clinical aspects (2nd ed.)* (pp. 234-257). New York, NY, US: Free Press.

COPE Inventory

We are interested in how people respond when they confront difficult or stressful events in their lives. There are lots of ways to try to deal with stress. This questionnaire asks you to indicate what you generally do and feel, when you experience stressful events. Obviously, different events bring out somewhat different responses, but think about what you usually do when you are under a lot of stress.

Then respond to each of the following items by blackening one number on your answer sheet for each, using the response choices listed just below. Please try to respond to each item separately in your mind from each other item. Choose your answers thoughtfully, and make your answers as true FOR YOU as you can. Please answer every item. There are no "right" or "wrong" answers, so choose the most accurate answer for YOU--not what you think "most people" would say or do. Indicate what YOU usually do when YOU experience a stressful event.

1 = I usually don't do this at all
2 = I usually do this a little bit
3 = I usually do this a medium amount
4 = I usually do this a lot

1. I try to grow as a person as a result of the experience.
2. I turn to work or other substitute activities to take my mind off things.
3. I get upset and let my emotions out.
4. I try to get advice from someone about what to do.
5. I concentrate my efforts on doing something about it.
6. I say to myself "this isn't real."
7. I put my trust in God.
8. I laugh about the situation.
9. I admit to myself that I can't deal with it, and quit trying.
10. I restrain myself from doing anything too quickly.

11. I discuss my feelings with someone.
12. I use alcohol or drugs to make myself feel better.
13. I get used to the idea that it happened.
14. I talk to someone to find out more about the situation.
15. I keep myself from getting distracted by other thoughts or activities.
16. I daydream about things other than this.
17. I get upset, and am really aware of it.
18. I seek God's help.
19. I make a plan of action.
20. I make jokes about it.

21. I accept that this has happened and that it can't be changed.
22. I hold off doing anything about it until the situation permits.
23. I try to get emotional support from friends or relatives.
24. I just give up trying to reach my goal.

25. I take additional action to try to get rid of the problem.
26. I try to lose myself for a while by drinking alcohol or taking drugs.
27. I refuse to believe that it has happened.
28. I let my feelings out.
29. I try to see it in a different light, to make it seem more positive.
30. I talk to someone who could do something concrete about the problem.

31. I sleep more than usual.
32. I try to come up with a strategy about what to do.
33. I focus on dealing with this problem, and if necessary let other things slide a little.
34. I get sympathy and understanding from someone.
35. I drink alcohol or take drugs, in order to think about it less.
36. I kid around about it.
37. I give up the attempt to get what I want.
38. I look for something good in what is happening.
39. I think about how I might best handle the problem.
40. I pretend that it hasn't really happened.

41. I make sure not to make matters worse by acting too soon.
42. I try hard to prevent other things from interfering with my efforts at dealing with this.
43. I go to movies or watch TV, to think about it less.
44. I accept the reality of the fact that it happened.
45. I ask people who have had similar experiences what they did.
46. I feel a lot of emotional distress and I find myself expressing those feelings a lot.
47. I take direct action to get around the problem.
48. I try to find comfort in my religion.
49. I force myself to wait for the right time to do something.
50. I make fun of the situation.

51. I reduce the amount of effort I'm putting into solving the problem.
52. I talk to someone about how I feel.
53. I use alcohol or drugs to help me get through it.
54. I learn to live with it.
55. I put aside other activities in order to concentrate on this.
56. I think hard about what steps to take.
57. I act as though it hasn't even happened.
58. I do what has to be done, one step at a time.
59. I learn something from the experience.
60. I pray more than usual.

Scales (sum items listed, with no reversals of coding):

Positive reinterpretation and growth: 1, 29, 38, 59

Mental disengagement: 2, 16, 31, 43
Focus on and venting of emotions: 3, 17, 28, 46
Use of instrumental social support: 4, 14, 30, 45
Active coping: 5, 25, 47, 58
Denial: 6, 27, 40, 57
Religious coping: 7, 18, 48, 60
Humor: 8, 20, 36, 50
Behavioral disengagement: 9, 24, 37, 51
Restraint: 10, 22, 41, 49
Use of emotional social support: 11, 23, 34, 52
Substance use: 12, 26, 35, 53
Acceptance: 13, 21, 44, 54
Suppression of competing activities: 15, 33, 42, 55
Planning: 19, 32, 39, 56

International Physical Activity Questionnaire: Long Last 7 Days Self-Administered Format

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breath somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

   ☐ Yes

   ☐ No → ***Skip to PART 2: TRANSPORTATION***

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities you did for at least 10 minutes at a time.

   _____ **days per week**

   ☐ No vigorous physical activities → **Skip to question 4**

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

   _____ **hours per day** _____ **minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____ days per week

☐ No moderate job-related physical activity → ***Skip to question 6***

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ hours per day **_____ minutes per day**

6. During the **last 7 days**, on how many days did you walk for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did for travel to or from work.
_____ days per week

☐ No job-related walking → ***Skip to PART 2: TRANSPORTATION***

7. How much time did you spend on one of those days **walking** as part of your work?

_____ hours per day **_____ minutes per day**

PART 2: TRANSPORTATION

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ days per week

☐ No traveling in a motor vehicle → ***Skip to question 10***

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____ hours per day **_____ minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____ days per week

☐ No bicycling from place to place → ***Skip to question 12***

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

    _____ hours per day **_____ minutes per day**

12. During the **last 7 da**ys, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

    _____ days per week

    ☐ No walking from place to place → ***Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY***

13. How much time did you usually spend on one of those days **walking** from place to place?

    _____ hours per day **_____ minutes per day**

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

    _____ days per week

    ☐ No vigorous activity in garden or yard → ***Skip to question 16***

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

    _____ hours per day **_____ minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

    _____ days per week

    ☐ No moderate activity in garden or yard → ***Skip to question 18***

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

    _____ hours per day **_____ minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

    _____ days per week

    ☐ No moderate activity inside home → ***Skip to PART 4: RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY***

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

    _____ hours per day **_____ minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

    _____ days per week

    ☐ No walking in leisure time → ***Skip to question 22***

21. How much time did you usually spend on one of those days **walking** in your leisure time?

    _____ hours per day **_____ minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

    _____ days per week

    ☐ No vigorous activity in leisure time → ***Skip to question 24***

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

    _____ hours per day **_____ minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

    _____ days per week

    ☐ No moderate activity in leisure time → ***Skip to PART 5: TIME SPENT SITTING***

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

    _____ hours per day **_____ minutes per day**

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

    _____ hours per day **_____ minutes per day**

27. During the **last 7 days**, how much time did you usually spend sitting on a weekend day?
    _____ hours per day **_____ minutes per day**

This is the end of the questionnaire, thank you for participating.

The Pittsburgh Sleep Quality Index

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions. During the past month,

1. When have you usually gone to bed? _____

2. How long (in minutes) has it taken you to fall asleep each night? _____

3. When have you usually gotten up in the morning? _____

4. How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed) _____

5. During the past month, how often have you had trouble sleeping because you...	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times week (3)
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s):				
6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?				
	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)
9. During the past month, how would you rate your sleep quality overall?				

Scoring:

Component 1 Component 2

Component 3 Component 4

Component 5 Component 6 Component 7

#9
Score.....
C1_____ #2 Score (≤15min=0; 16-30 min=1; 31-60 min=2, >60 min=3) + #5a Score (if sum is equal 0=0; 1-2=1; 3-4=2; 5-6=3)
..... C2_____ #4 Score (>7=0; 6-7=1; 5-6=2; <5=3) ..... C3_____ (total # of hours asleep)/(total # of hours in bed) x 100

>85%=0, 75%-84%=1, 65%-74%=2, <65%=3
..... C4_____ Sum of Scores #5b to #5j (0=0; 1-9=1; 10-18=2; 19-27=3)..... C5_____ #6 Score
.....
C6_____ #7 Score + #8 Score (0=0; 1-2=1; 3-4=2; 5-6=3)..... C7_____

Add the seven component scores together _____ **Global PSQI Score** _____

Buysse, D.J., Reynolds, C.F., Monk, T.H., Berman, S.R., Kupfer, D.J. (1988). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, 28, 193-213.

Sleep Hygiene Practice Scale

The following items are descriptions of common sleep habits, daily life activities, and sleep environments. Please circle the number to indicate how often the situations fit your personal experiences, with 1 indication never and 6 indicating always.

Never	Rarely	Occasionally	Sometimes	Frequently	Always
1	2	3	4	5	6

1	Bedtime not consistent daily.	1	2	3	4	5	6
2	Get out of bed at inconsistent times.	1	2	3	4	5	6
3	Stay in bed after waking up in the morning.	1	2	3	4	5	6
4	Sleep in on weekends.	1	2	3	4	5	6
5	Napping or resting in bed for over one hour during the day	1	2	3	4	5	6
6	Lack of exposure to outdoor light during the day.	1	2	3	4	5	6
7	Lack of regular exercise.	1	2	3	4	5	6
8	Unpleasant conversation prior to sleep.	1	2	3	4	5	6
9	Not enough time to relax prior to sleep.	1	2	3	4	5	6
10	Falling asleep with TV or music on.	1	2	3	4	5	6
11	Pondering about unresolved matters while lying in bed.	1	2	3	4	5	6
12	Check the time in the middle of night.	1	2	3	4	5	6
13	Doing sleep-irrelevant activities in bed (e.g., watching TV, reading).	1	2	3	4	5	6
14	Worry about not being able to fall asleep in bed.	1	2	3	4	5	6
15	Worry about night-time sleep during the day.	1	2	3	4	5	6
16	Vigorous exercise during the two hours prior to sleep.	1	2	3	4	5	6
17	Drinking caffeinated drinks (e.g., coffee, tea, coca-cola) within the 4 hours prior to bedtime.	1	2	3	4	5	6
18	Drinking alcohol within the 2 hours prior to bedtime.	1	2	3	4	5	6
19	Consuming stimulating substances (e.g., nicotine) during the 2 hours prior to bedtime.	1	2	3	4	5	6
20	Going to bed hungry.	1	2	3	4	5	6
21	Drinking a lot during the hour prior to sleep.	1	2	3	4	5	6
22	Eating too much food during the hour prior to sleep.	1	2	3	4	5	6
23	Sleep environment is either too noisy or too quiet.	1	2	3	4	5	6
24	Sleep environment is either too bright or too dark.	1	2	3	4	5	6
25	Sleep environment is either too humid or too dry.	1	2	3	4	5	6
26	Feeling too hot or too cold during sleep.	1	2	3	4	5	6
27	Poor ventilation of bedroom.	1	2	3	4	5	6
28	Uncomfortable bedding and/or pillow.	1	2	3	4	5	6
29	Too many sleep-unrelated items in bedroom.	1	2	3	4	5	6
30	Sleep is interrupted by bed partner.	1	2	3	4	5	6

Scoring Instructions:

Add up items 1-7 (sleep scheduling score)
Add up items 8-16 (arousal-related behavior score)
Add up items 17-22 (eating/drinking behavior score)
Add up items 23-30 (sleep environment score)
Higher scores = WORSE sleep hygiene

Lin, S. C., Cheng, C. P., Yang, C. M., & Hsu, S. C. (2007). Psychometric properties of the Sleep Hygiene Practice Scale. *Sleep*, *30*, A262.

Psychological Stress Associated with the COVID-19 Crisis Survey

You are invited to participate in a research study on psychological stress during the COVID-19 crisis. Our purpose is to measure the level of stress during this time and characterize it according to location, gender, income and other factors. This information will be collected through an online confidential survey. You will be asked to answer confidential survey questions that measure your level of stress during this time including questions about homeschooling, dependent care, full-time remote work, and social-distancing.

1. Have any of your friends or family tested positive for COVID-19?
   Yes
   No

2. Are you providing homeschooling due to COVID-19?
   Yes
   No
   N/A

3. Are you providing homecare (caretaking of elderly, disabilities, etc.) due to COVID-19?
   Yes
   No
   N/A

4. Are you working remotely as of recent due to COVID-19?
   Yes
   No
   N/A

5. If so, how many hours a day?
   <1 hour
   >1 hour to 5 hours
   >5 hours to 8 hours
   >8 hours
   N/A

6. How have the expectations of your work changed since COVID-19?
   Much more
   Moderately more
   Slightly more
   About the same
   Slightly less
   Moderately less
   Much less

7. How much sleep are you getting currently during COVID-19?

0 – 2 hours
2 – 4 hours
4 – 6 hours
6 – 8 hours
8 – 10 hours
10 – 12 hours

8. Is this more or less than before COVID-19?
   More
   Less
   Unchanged

9. How many minutes / hours a day are you currently getting regular exercise during COVID-19?
   0
   1 – 30 minutes
   30 minutes – 1 hour
   >1 hour

10. Is this more or less than before COVID-19?
    More
    Less
    Unchanged

11. How many minutes / hours a day are you currently using meditation during COVID-19?
    0
    1 – 30 minutes
    30 minutes – 1 hour
    >1 hour

12. Is this more or less than before COVID-19?
    More
    Less
    Unchanged

13. How many minutes / hours a day are you currently connecting with family / friends through telecommunication or virtually during COVID-19?
    0
    1 – 30 minutes
    30 minutes – 1 hour
    >1 hour

14. Is this more or less than before COVID-19?
    More
    Less
    Unchanged

You are now beginning the Perceived Stress Scale (due to COVID-19). Please answer these questions as quickly and accurately as possible using the following scale.

0 = Never
1 = Almost Never
2 = Sometimes
3 = Fairly Often
4 = Very Often

15. In the last month, how often have you been upset because of something that happened unexpectedly?

16. In the last month, how often have you felt that you were unable to control the important things in your life?

17. In the last month, how often have you felt nervous and stressed?

18. In the last month, how often have you felt confident about your ability to handle your personal problems?

19. In the last month, how often have you felt that things were going your way?

20. In the last month, how often have you found that you could not cope with all the things that you had to do?

21. In the last month, how often have you been able to control irritations in your life?

22. In the last month, how often have you felt that you were on top of things?

23. In the last month, how often have you been angered because of things that happened that were outside of your control?

24. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Items 18, 19, 21, 22 are reverse scored

Generalized Anxiety Disorder 7-item (GAD-7) scale

Over the last 2 weeks, how often have you been bothered by the following problems?	Not at all sure	Several days	Over half the days	Nearly every day
1. Feeling nervous, anxious, or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it's hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3
Add the score for each column	+	+	+	
Total Score *(add your column scores)* =				

If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all _____
Somewhat difficult _____
Very difficult _____
Extremely difficult _____

Source: Spitzer RL, Kroenke K, Williams JBW, Lowe B. A brief measure for assessing generalized anxiety disorder. *Arch Inern Med.* 2006;166:1092-1097.

Patient Health Questionnaire-9 Item

Over the last 2 weeks, how often have you been bothered by any of the following problems?

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

1. Little interest or pleasure in doing things?
2. Feeling down, depressed, or hopeless?
3. Trouble falling or staying asleep, or sleeping too much?
4. Feeling tired or having little energy
5. Poor appetite or overeating
6. Feeling bad about yourself or that you are a failure or have let yourself or your family down
7. Trouble concentrating on things, such as reading the newspaper or watching television
8. Moving or speaking so slowly that other people could have noticed? Or so fidgety or restless that you have been moving a lot more than usual?
9. Thoughts that you would be better off dead or thoughts of hurting yourself in some way

If you checked off any problems, how difficult have these problems made if for you to do your work, take care of things at home, or get along with other people?

Not difficult at all _____

Somewhat difficult _____

Very difficult _____

Extremely difficult _____

Health History Checklist

Has a medical doctor or psychologist ever diagnosed you as suffering from any of the following conditions?

Diagnosis	No	Yes
Concussion	0	1
Traumatic brain injury	0	1
Migraine headaches	0	1
Epilepsy or seizure	0	1
Chronic pain/chronic pain conditions (e.g., fibromyalgia)	0	1
Insomnia	0	1
Other medical or neurologic condition. Specify _____	0	1
Anxiety disorders (e.g., anxiety disorders, panic disorders, phobias, etc.)	0	1
Eating disorders (e.g., bulimia, anorexia)	0	1
Depression (e.g., major depression, dysthymia, etc.)	0	1
Posttraumatic Stress Disorder (PTSD)	0	1
Learning disability	0	1
Attention-Deficit/Hyperactivity Disorder (ADHD/ADD)	0	1
Behavior Disorder (e.g., Conduct disorder, oppositional defiant disorder)	0	1
An alcohol or substance abuse problem/disorder	0	1
Other mental health condition. Specify _____	0	1

Demographic Questionnaire

1. How old are you in years? _____

2. How do you identify your sex?
   - Male
   - Female
   - Other
   - I prefer not to say

3. Are you Hispanic or Latino?
   - Yes
   - No
   - Don't know/Not sure

4. Which one of the groups below would you say best represents your race?
   - White
   - Black
   - Asian
   - Native Hawaiian/Pacific Islander
   - Native American
   - Biracial
   - Mixed
   - Other _____
   - Don't know/Not sure

5. What is your current grade/class standing?
   - Freshman
   - Sophomore
   - Junior
   - Senior
   - Graduate student

6. What is your relationship status?
   - Single
   - In a relationship
   - Common law marriage
   - Married
   - Separated
   - Divorced
   - Widowed

7. What is the highest level of education your mother completed?
   - Graduate/professional
   - Bachelor's degree

Associate degree
Some college
High school degree/GED
Some high school
Unknown

8. What is the highest level of education your father completed?
Graduate/professional
Bachelor's degree
Associate degree
Some college
High school degree/GED
Some high school
Unknown