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Efficacy of a Self-Monitoring Intervention for College Students with Attention Problems

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Efficacy of a Self-Monitoring Intervention for College Students with Attention Problems

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Education

by

Katharine Lee Gibson

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ABSTRACT OF THE DISSERTATION

Efficacy of a Self-Monitoring Intervention

for College Students with Attention Problems

by

Katharine Lee Gibson

Doctor of Education

University of California, Los Angeles, 2015

Professor Christina A. Christie, Co-Chair

Professor Diane Durkin, Co-Chair

College students with ADHD are a unique at-risk population. Though cognitively capable, many college students with ADHD fail to thrive academically and are at risk of academic underperformance, probation, and dropping out. Disability offices provide accommodations and assistance in many areas; however, even the most comprehensive services cannot assist students when they are required to regulate attention during independent academic tasks. Self-monitoring of attention (SMA) interventions have successfully improved attentive behaviors in secondary students, but have not been widely used or developed for college students. This study evaluated the efficacy of a self-monitoring of attention intervention *(Focus Check)* delivered via smartphone app on the

attention, effortful control, and academic self-efficacy of college students with self-defined attention difficulties.

This mixed-methods study used a randomized experimental design with experience sampling survey and social validity survey complements. Measures of the Barkley Adult ADHD Rating Scale (BAARS-IV), Mind-Wandering Scale, Motivated Strategies for Learning Questionnaire, and Adult Temperament Questionnaire were taken at pre test, after the initial two-week experimental period, and at the conclusion of the four-week experiment. The control group (n = 21) and the experimental group (n = 27) were comprised primarily of female undergraduate students. No statistically significant differences were found between groups on pre test measures.

Results of multiple measure ANOVA's found statistically significant results between the experimental and control groups on measures of BAARS-IV: Inattention subscale, and BAARS-IV: Sluggish Cognitive Tempo subscale suggesting that the SMA intervention contributed to reducing scores on these measures. Additional significant results were found for the smaller subsample of participants with likely ADHD (n = 15) on measures of Mind-Wandering and Academic Self-Efficacy. Furthermore, additional statistically significant findings from pre test to post test were found for both the experimental and control groups on measures of the BAARS-IV, Mind-Wandering, and Effortful Control: Effortful Attention, suggesting that participation in this study resulted in improved scores on these measures. Experience sampling and social validity survey results show that participants enjoyed using *Focus Check* and found it to be helpful in regulating attention during independent academic tasks.

Participation in the study involved strategy use and purposeful reflection on patterns of attention, as well as use of the *Focus Check* SMA Intervention. The significant findings for the group as a whole combined with the promising preliminary findings on the SMA intervention open the door for research on several self-regulation interventions for college students, particularly those students with impairing levels of ADHD symptomology. Should future research confirm the exploratory findings found here, *Focus Check*, or similar SMA interventions, could provide college students with a reliable, cost-effective, and self-administered means of regulating variable attention during independent academic tasks.

The dissertation of Katharine Lee Gibson is approved.

Sandra Loo

Jeffrey Wood

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University of California, Los Angeles

2015

DEDICATION

For my touchstones, Albert and Henry Dayan,

and my parents Frank Gibson and Sandra Thompson,

with love and gratitude.

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My parents have provided unending love and support. The resiliency that sustained me through rewrites, new directions, doubts, and deadlines, I learned from them. My father taught me to value my mind, my independence, and my education. His hard work and generosity afforded me the opportunities that landed me here. My mother's adventurous spirit taught me to take risks and enjoy life. Through her example and encouragement, I discovered that it's absolutely possible for a woman to reinvent herself after forty. Thank you both.

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VITA

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CHAPTER ONE

Introduction

The negative impact of Attention Deficit Hyperactive Disorder (ADHD) on a host of post-secondary educational outcomes is well documented (R. Barkley, 2006; R. Barkley, Murphy, & Fischer, 2008). One aspect of functioning impacted by ADHD is self-regulation: the ability to direct one's own thoughts and actions. Since the 1970s researchers have documented the benefit of self-regulatory interventions on the academic and social functioning of children and adolescents with ADHD (Hallahan, Lloyd, Kosiewicz, Kauffman, & Graves, 1979; S. M. Prater, 1999; Reid, Trout, & Schartz, 2005). However, few researchers have examined the impact of these interventions on college students. Paradoxically, college students with attention difficulties may be more in need of regulatory interventions than their younger counterparts.

Younger students with ADHD are able to rely on external sources, such as the structure of the school day or verbal prompting from adults, to help regulate their mental and physical activities, but college students are expected to regulate themselves. The transition from high school to college is difficult for most students; however, for college students with ADHD, shifting from externally provided regulation to internal regulation can be particularly demanding (Wilmshurst, Peele, & Wilmshurst, 2009).

Researchers have found depressed academic achievement for college students with ADHD compared to non-ADHD peers. College students with ADHD report poorer academic performance despite similar scores on markers of cognitive ability such as IQ and standardized achievement tests (R. Barkley et al., 2008; Blase et al., 2009; DuPaul, Weyandt, O'Dell, & Varejao, 2009; Heiligenstein, Guenther, Levy, Savino, & Fulwiler, 1999; Meaux, Green, & Broussard, 2009). College students with attention problems have identified inattentiveness,

which can be a symptom of even sub-threshold levels of ADHD, as a particular academic concern (Vance & Weyandt, 2008). Effective regulatory interventions that could help students with attention difficulties return their focus to a self-selected goal could be of substantial academic assistance. Interventions targeting self-regulation, particularly self-monitoring of attention (SMA) have proven successful for elementary and secondary students (Harris, Friedlander, Saddler, Frizzelle, & Graham, 2005); appropriately adapted, they might benefit college students as well.

The self-monitoring process requires that a student record the presence or absence of a pre-defined behavior in response to a prompt. Regularly focusing the student's attention on the desired behavior enables the student to stay on track. Simultaneously, the student is prompted to assess performance. As awareness of any discrepancy between enacted behavior and expected behavior increases, the student adjusts in the direction of the desired behavior. (Reid et al., 2005). The basic premise is that increased awareness at the moment of performance increases the capacity for self-regulation, and numerous studies have shown that it does just that. At the elementary and secondary level, researchers have documented substantial improvements in attentive academic behavior as a result of self-monitoring interventions (Harris et al., 2005; Reid & Harris, 1993; Rock, 2005). As mentioned earlier, previous to this study, the SMA intervention had not been evaluated on a post-secondary population.

This study sought to examine the efficacy of an SMA intervention, delivered via smartphone app, on the ability of college students with self-defined attention difficulties to manage their attention during critical academic activities. The app (*Focus Check*) prompted participants to quickly monitor and, if needed, adjust focus during lectures or academic reading. The overall purpose was to assess the SMA intervention with the intent of eventually providing

students with attention difficulties with an effective, portable, and independently administered learning tool to assist with attention regulation.

Background of the Study

Inattentiveness, as compared to the other primary characteristics of ADHD: impulsivity and hyperactivity, is particularly detrimental to post secondary academic achievement (Vance & Weyandt, 2008). In a 2009 study, college students with ADHD were surveyed about the challenges they faced transitioning from high school to college. Students who flourished with the external supports provided by parents and the rigid schedule of high school floundered when faced with the daunting freedom of college life. Many college students with ADHD continued to rely on external support, such as friends and parents, to help them manage college life. Smartphones were also found to be particularly helpful, and students reported using alarms and reminders regularly to aid in time management (Meaux et al., 2009). However, internal cognitive regulation, specifically controlling focus and attention, remained stubborn challenges for most. Other studies as well have found that inattentiveness, distractibility, and an overall inability to harness attention at will are significant sources of concern for college students with ADHD (DuPaul et al., 2009; L. L. Weyandt & DuPaul, 2008; L. E. Wolf, Simkowitz, & Carlson, 2009).

Self-Regulation and Self-Monitoring Interventions

Self-regulation is defined as the process of observing, planning, monitoring, and reflecting on a particular phenomena (Zimmerman & Schunk, 2011). It is a cyclical process intended to improve some aspect of one's functioning. An individual plans a task and proceeds to perform it. During performance of the task, observation unearths maladaptive behaviors. The maladaptive behaviors are adjusted and replaced with new, potentially more effective behaviors, which in turn are adjusted and maintained through ongoing monitoring and reflection. The

observation and adjustment stages of self-regulation are targeted by self-monitoring interventions. Although the SMA intervention targets only one phase of the cycle, self-regulation theorists have noted that each phase in a cycle of self-regulation affects the others in either a positive or negative feedback loop (Bandura, 1977; Zimmerman, 1995).

A robust collection of K-12 studies demonstrates that self-monitoring improves targeted academic behaviors (Axelrod, Zhe, Haugen, & Klein, 2009; Maag, Rutherford & Digangi, 1992; M. A. Prater, Hogan, & Miller, 1992; Rock, 2005; Shimabukuro, Prater, Jenkins, & Edelen-Smith, 1999; Trammel, Schloss, & Alper, 1994). In one study, students rated their time on task each time a tone was administered over headphones. On average, on-task behavior rose from a baseline of 55% to an intervention rate of 94% time on-task (Harris et al., 2005). While self-monitoring interventions improved targeted behaviors for both elementary and secondary students, some evidence suggests that secondary students may not have found the intervention socially valid, or acceptable, and therefore may have resisted using it. One potential solution is to improve the social validity of the SMA intervention by administering it via smartphone app.

Self-monitoring via mobile device has shown promise in both educational and health settings. One study attempted to improve the social validity of the self-monitoring process by having participants record attention or non-attention through text messaging and social networking systems. As in earlier self-monitoring studies, on task behavior improved significantly. Furthermore, the students reported enjoying the process and felt that it helped them improve focus during the time of intervention (Peña Lasiste Bedesem, 2010). Another researcher noted the ease with which children with ADHD self-recorded symptoms and behaviors on a small electronic device (Whalen et al., 2006). These pilot studies, as well as research on the efficacy of self-monitoring of health via smartphone app (Price et al., 2014; Torous et al., 2015),

suggest that delivering a self-monitoring intervention via smartphone would likely improve its accessibility, functionality, and social-validity.

Purpose of the Study

This study investigated the efficacy of a self-monitoring intervention delivered via smartphone app for college students with self-identified attention difficulties. Participants monitored on-task attention during lectures and independent reading using a self-monitoring intervention: *Focus Check* app. The intervention was modeled on existing cue and record self-monitoring interventions employed successfully in secondary settings. Participants were cued to record on-task or off-task attention during 10-minute intervals. The active intervention lasted for two weeks. An experimental pre and post test design measured changes in attention, effortful control, and academic self-efficacy. Social validity, a construct capturing participants' perception of the usefulness and acceptability of an intervention, was also measured. This study sought to answer the following questions:

1. Does the SMA intervention affect measures of attention, effortful control, and academic self-efficacy as measured by pre and post test scores?

2. What pattern of usage do students demonstrate when using the self-monitoring intervention?

3. How, if it all, does usage correlate with task-focused attention ratings?

4. How do participants rate the social validity of the SMA intervention?

Research Design

For this study, a mixed methods design with a primary quantitative component and secondary qualitative component was used. Because an experimental design is thought to control for most plausible alternative explanations of change between pre tests and post tests, it afforded me the best opportunity of discovering if the SMA intervention improved specific learning

attitudes and behaviors in college students with attention difficulties (Jaeger, 1990). Pre and post test measurements of validated measures of attention, effortful control, and self-efficacy were collected.

In order to assess the potential use of the intervention outside the parameters of this experiment, I also collected qualitative data aimed at capturing the participants' subjective experience of using the intervention: experience sampling surveys and a social validity survey.

Methods

The efficacy of the intervention was evaluated during a four-week experiment. After a screening test, eligible participants were randomly selected to one of two groups: the experimental or lagged treatment group. Both groups were presented with the purpose of the intervention, taught a reading and listening comprehension strategy to operationalize on-task attention during lectures and academic reading, and given pre test measures of attention, effortful control, and academic self-efficacy. The experimental group was additionally given access to the *Focus Check* app and instructions on how to use it. At the end of two weeks, both the experimental and lagged treatment groups completed post test measures. The lagged treatment group then received the intervention during the second two weeks. At the end of the second two-week interval, both the experimental and lagged treatment groups completed a second round of post test measures. Both groups completed the experience sampling surveys during the initial and secondary two-week sessions, and both completed the social validity survey at the conclusion of the experiment.

Data Collection and Analysis

The main outcome measures were post test scores on a battery of self-report scales, all of which have been validated and used in previous studies. The particular scales chosen most

closely aligned with the constructs it was hypothesized the intervention would affect: attention control, effortful control, and academic self-efficacy. The following scales were used: *BAARS-IV: Inattention subscale; BAARS-IV: Hyperactivity/Impulsivity subscales; BAARS-IV: Sluggish Cognitive Tempo subscale; Mind-Wandering Scale; MSLQ: Metacognitive Self-Regulation subscale; MSLQ: Metacognitive Self-Regulation subscale; MSLQ: Effort Regulation subscale; Effortful Control Scale: Activation subscale, and Effortful Control Scale: Effortful Attention subscale.*

Pre and post test scores were analyzed using significance testing, with a null hypothesis that the independent variable, the SMA intervention, has no effect on dependent variables, scores on the post test measurements. Both within and between group data were compared using multiple measure ANOVAS, with significance levels set at .05%. Experience sampling and social validity surveys were analyzed using descriptive statistics.

Participants and Site Selection

Participants were volunteer undergraduate students at UCLA who self-identified as experiencing difficulty maintaining attention during lectures and independent academic reading. UCLA was chosen as a site because entrance requirements are competitive, so presumably the majority of students are cognitively capable of meeting the academic requirements of a selective university. The high enrollment numbers also increased the chances of obtaining an adequate sample size. Participants were recruited from UCLA using flyers posted throughout the campus as well as e-mail requests to student run organizations and clubs.

Public Engagement

I plan to share the findings of this study with organizations that specialize in disseminating information about adult ADHD, particularly Children and Adults with ADHD

(CHADD), and the Attention Deficit Disorder Association (ADDA).

CHAPTER TWO

Literature Review

ADHD was once thought of as a childhood behavioral disorder. It is now recognized that for a substantial number of individuals the symptoms of ADHD continue into adulthood (R. A. Barkley, Fischer, Smallish, & Fletcher, 2006; Biederman et al., 2006) Individuals diagnosed with childhood ADHD who pursue post-secondary education make up a minority of their ADHD cohort and are at risk for numerous academic difficulties (Blase et al.; Heiligenstein et al., 1999; Rabiner, Anastopoulos, Costello, Hoyle, & Swartzwelder; L. E. Wolf et al.). Furthermore, the demands of college can exacerbate previously non-impairing symptoms of ADHD (Meaux et al., 2009). While Adult ADHD has become a recognized and fairly well researched disorder, fewer research studies have examined the subset of adults with ADHD who attend college (L. Weyandt et al., 2013). Those that have indicate that the disorder is related to significant academic impairment, warranting further research on this population.

ADHD has been shown to negatively influence students' graduation rates, academic standing, GPA, study skills, and overall academic efficacy (R. A. Barkley et al., 2006; Frazier, Youngstrom, Glutting, & Watkins, 2007; Heiligenstein et al., 1999). Of the numerous ADHD symptoms affecting academic outcome, inattentiveness stands out as particularly deleterious (DuPaul et al., 2009). Despite the negative effects of ADHD on young adults, research on interventions for college students with attention difficulties is scarce.

Contrarily, research on interventions for elementary and secondary students with ADHD is abundant. Strategies used to help students attend to academic tasks are well documented for elementary and secondary students. Self-monitoring interventions have significantly improved students' time on task and academic achievement (Harris et al., 2005). Despite the beneficial

results of self-monitoring, it has not been widely implemented with older students, perhaps because some students have found the process laborious and socially unacceptable (Harris et al., 2005). Researchers in health and psychology have adapted the self-monitoring process to work on mobile devices and the results have been favorable (Clough & Casey, 2011; Liu, Holroyd, Zhu, Shen, & Zhou, 2010). Self-monitoring via mobile device has shown promise at improving the classroom behavior of children with autism, and in one pilot study, at improving the on-task behavior of secondary students with ADHD (Peña Lasiste Bedesem, 2010).

In this literature review, I begin by examining ADHD in the post-secondary setting: its prevalence, how college students with ADHD are identified, and how ADHD affects academic outcome. Following that, I will present an overview of self-regulation research; explicitly focusing on the use of self-monitoring for students struggling with attention issues. Finally, I will survey the literature examining the use of mobile devices to facilitate self-monitoring.

Adult ADHD

Historically, ADHD has been viewed primarily as a childhood disorder (Barkley, 2006). Although individual clinicians recognized forms of adult ADHD as early as 1960, it wasn't until the 1990s that the disorder began to receive scientific attention as an identifiable and distinct combination of symptoms (Barkley, 2008). Several longitudinal studies tracking the progression of ADHD symptoms found that impairment often continued well past childhood, thus cementing the conception of ADHD as an adult disorder. In addition, the clinical and scientific community began to recognize that those who are first diagnosed with ADHD as adults may exhibit different characteristics than those who are first diagnosed as children (R. Barkley et al., 2008). The DSM-V recently updated the diagnostic criteria of ADHD to more accurately reflect the manifestation of symptoms in adults (American Psychiatric Association, 2013). The change in

the DSM-V diagnostic criteria exemplifies the scientific communities' increasing recognition of the distinctiveness of adult ADHD, a disorder affecting approximately 5% of the population: over eleven million people (R. Barkley et al., 2008; Kessler et al., 2005).

Prevalence of ADHD in post-secondary students. The number of college students diagnosed with ADHD remains unknown. Post-secondary prevalence rates have been difficult to calculate primarily because students with ADHD are not required to disclose their disability, and many choose not to do so (L. E. Wolf et al., 2009). The diverse methods used to identify ADHD in college students further compounds the issue: ADHD self-report instruments have captured as little as 2.5% or as much as 20% of the population depending on the criteria and variance from the norm used to identify the disorder (L. L. Weyandt & DuPaul, 2012). A 2009 synthesis of six studies on ADHD prevalence among college students reported that 2 - 8% of students met the clinical diagnostic threshold according to the DSM-IV criteria (DuPaul, et al., 2009). More recently, a 2012 national survey stated that an average of 5.1% of entering freshman self-identify as diagnosed with ADHD. Rates according to type of college differed from a low of 2.4% for private black colleges and universities to 7.6% for non-sectarian four-year colleges (Pryor, 2012). Although researchers cannot currently determine the exact number of post-secondary students with ADHD, estimates indicate that a significant number of students experience some symptoms of the disorder.

It is likely that some of the darkness surrounding ADHD in college populations stems from the relatively hidden nature of the disorder in many adults. Overt hyperactivity, one of the calling cards of ADHD, is often expressed in adults as the less noticeable trait of internal restlessness (Barkley, et al., 2008; Weyandt et al., 2003). Individuals with ADHD describe this restlessness as distractibility, daydreaming, intrusive thoughts, impatience, mind-wandering, and

an unceasing flow of thoughts unrelated to the task at hand (Smallwood, Fishman, & Schooler, 2007; Weyandt, 2003). Moreover, many young adults with undiagnosed ADHD are not impaired by their symptoms until college life requires them to regulate and structure their own environment (Heiligenstein et al., 1999; Rabiner et al., 2008; L. E. Wolf et al., 2009). As adults, they are more likely to experience the negative consequences of inattentiveness than hyperactivity or impulsiveness. Inattentiveness may not be visible to others, making it difficult for counselors or others to spot ADHD in college students. Some researchers suggest that college students with ADHD may be an unrecognized population at risk for poor academic functioning (Heiligenstein, et al., 1999) and decreased academic performance (Meaux, et al., 2009; Norvilitis, Sun, & Zhang, 2010; Norwalk, Norvilitis, & MacLean, 2009; Frazier, Youngstrom, Glutting, & Watkins, 2007).

Academic performance of college students with ADHD. Current research indicates that the academic performance of college students with ADHD does not match the performance of students without ADHD despite equivalent IQ and presumed cognitive capacity. One study found that scores on the attention problems scale of a survey completed by 316 college students in introductory psychology and sociology classes accounted for 7% of GPA variability (Schwanz, Palm, & Brallier, 2007). Another study found similar results: stronger ADHD symptoms predicted lower end of year grades (Frazier et al., 2007). Although both these studies indicate a correlation between attention problems and lower GPA, neither controlled for interacting conditions such as depression, anxiety, or health. However, in their evaluation of students with diagnosed ADHD without comorbid anxiety or depression, Heiligenstein and colleagues found that students with ADHD were more likely than students in a non-ADHD control group to earn lower GPAs and be on academic probation. Because this particular

experiment controlled for comorbidity, ADHD appeared to be the most likely indicator of lower GPA (Heiligenstein et al., 1999). A more recent study at Louisiana State University examined the impact of medication on the GPA of students with diagnosed ADHD compared to a non-ADHD control group. The researcher found that students with ADHD on stimulant medication received statistically lower GPAs; they were also significantly more likely to withdraw from a class and significantly less likely to complete assignments and avoid distractions. Medication alone did not address the academic deficits of students with ADHD (Advokat, Lane, & Luo, 2011). Finally, a longitudinal UMASS study examined the archival records of adults with ADHD who had not been diagnosed until after college. Those with ADHD received significantly higher numbers of Ds, Fs, and course withdrawals; and significantly lower GPAs than either a community control group or a clinic control group comprised of individuals with psychiatric complaints unrelated to ADHD. In contrast, the SAT scores of all three groups were statistically equivalent (R. Barkley et al., 2008). Cumulatively, the research points to a correlation between ADHD and poor academic functioning relative to same age students without ADHD.

Graduation rates of college students with ADHD. College students with ADHD are less likely than their peers to flourish academically, not surprisingly, they are more likely than their peers to drop out of college. One study found that only 20% of the students diagnosed with ADHD as children pursued higher education, and of that 20%, only 5% graduated. The comparison graduation rate for a community control group was 41% (Weiss, 1993). In 2011 the Department of Education published a longitudinal study assessing the educational outcomes of students with disabilities up to eight years after high school. Twenty percent of the students in the "other disability" category, which included ADHD, enrolled in a four-year college at some point. Of that 20%, approximately 60% did not graduate. ADHD diagnosed in childhood appears

to be highly predictive of low college graduation rates. Preliminary research indicates that graduation rates are higher for individuals who are first diagnosed as adults, but outcomes for this group remain unclear (R. Barkley et al., 2008).

Academic concerns of college students with attention problems. Students point to the academically impairing effects of ADHD as a significant concern. An in-depth qualitative studies found that students with ADHD reported struggling with a host of academic competencies including staying focused, failing to complete work, poor reading skills, and insufficient study skills (Meaux et al., 2009). In a study comparing students with ADHD, students with learning disabilities, and a non-disabled control group, the students with ADHD reported the poorest performance in concentration skills, ability to self-regulate, and ability to manage time effectively (Reaser, Prevatt, Petscher, & Proctor, 2007). Students with ADHD, who scored high on measurements of inattentiveness, also reported more academic concerns than those students who did not identify as having ADHD. The researcher noted that students with ADHD had poor academic self-concept despite having achieved enough academic success to enroll in a highly competitive private university (Rabiner, Anastopoulos, Costello, Hoyle, & Swartzwelder, 2008). Another researcher identified inattentiveness as correlated with perceived negative academic adjustment and poor study skills among college students with self-reported ADHD. As was true in the study by Advocat, the use of attention medication did not seem to influence student's academic adjustment or study skills (Norwalk, Norvilitis, & MacLean, 2009). These self-report findings point to an overall deficit in academic self-efficacy, the belief that one is capable of succeeding, among college students with ADHD.

Students with ADHD are not alone in reporting difficulty concentrating or managing academic tasks, it is the degree to which they find such deficits impairing that distinguishes them

from their peers without ADHD. For example one study reported that 91.4% of students with ADHD reported difficulty sustaining attention, while 33.4% of the non-diagnosed control group reported difficulty. Ninety-one percent of students with ADHD struggled with distraction compared to 54.1% of the non-diagnosed group, and 80.6% of the ADHD group had to read material several times in order to understand it compared to 52% of the non-diagnosed group (Lewandowski, Lovett, Codding, & Gordon, 2008). The researcher in this study noted that students with ADHD perceive themselves to be struggling academically at a more frequent rate than their non-diagnosed peers, but that symptoms of ADHD are apparent across the college population. His conclusion was that clinicians should be wary of using self-report alone as a means of ascertaining ADHD (Lewandowski et al., 2008). Another possible interpretation of these findings is that both clinical and sub-clinical ADHD symptoms cause serious academic concerns among a significant proportion of the college population regardless of diagnosis.

Mind-wandering and comprehension. Indeed, researchers examining the construct of mind-wandering, defined as both intentional and non-intentional task unrelated thoughts, have found that mind-wandering levels among college students account for significant discrepancies in academic functioning (Smallwood, McSpadden, & Schooler, 2008). ADHD-prone college students appear to be particularly susceptible to high frequencies of mind-wandering and, in particular, to non-intentional mind-wandering (Smallwood, 2011). Smallwood hypothesized that the spontaneous nature of off-task thoughts indicates that individuals who are prone to ADHD lack the requisite metacognitive regulatory skills to catch themselves mind-wandering and return their attention to the task at hand (Smallwood, Fishman, & Schooler, 2007). Further research on a population of college students with sub-clinical ADHD impairment found correlations between detrimental mind-wandering and ADHD levels. Moreover, participants with ADHD were found

to be less aware of incidents of mind wandering than participants without ADHD. In other words, they failed to catch their mind when it drifted off (Franklin et al., 2014).

According to Smallwood's theory of cascading inattention, comprehension is increasingly compromised as task unrelated thoughts disrupt the creation of a coherent mental representation of the presented material (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012; Smallwood, 2011). Reading comprehension in particular appears to deteriorate with increasing numbers of task unrelated thoughts resulting in what has been termed "mindless reading" (Franklin, Smallwood, & Schooler, 2011; Smallwood, 2011). Several studies demonstrated that mind-wandering while reading occurs frequently among adults and is deleterious to comprehension requiring sustained attention (Franklin et al., 2011; Smallwood et al., 2008). Mind wandering was found to compromise lecture comprehension as well. One researcher found significantly diminished scores on recall of lecture material for a high mind-wandering group of college students compared to a low mind-wandering group (Risko et al., 2012). Interestingly, the researcher noted that lower recall occurred only for those test items that referred to information presented before an auditory cue. Recall rates for questions occurring directly after a cue were equivalent for the high and low mind-wandering groups. The researcher noted that the cues likely returned participants' attention to the lecture, thus enabling them to recall the information following the cue. Although this study was not investigating potential interventions for students with high levels of task unrelated thoughts, the observation about the unintentional academic benefits of prompts is noteworthy. It supports the theory that externalized regulation interventions may help students with attention difficulties return their thoughts to a self-selected task, thereby increasing comprehension and retention. Recent research examining the relationship between mind-wandering and ADHD also suggests the mediating effect of meta-

awareness on detrimental mind wandering. The researcher suggests that externalized prompting or reminders that would guide an individual to become more aware of attention could ameliorate some of the negative consequences of a wandering mind (Franklin et al., 2014).

Limits of Self-Regulation for Students with Attention Problems

Self-regulation defined. Several different taxonomies of the self-regulation construct exist. For the purposes of this study, I will use Zimmerman's definition of self-regulation and his description of the skills needed to effectively self-regulate. Zimmerman identifies self-regulation as the ability to set goals, monitor progress, and evaluate a product in an evolving feedback loop. Self-regulation involves activating internal motivational and cognitive strategies, such as initiating action, persevering, and adapting to feedback, as well as external behavioral strategies, such as record keeping, environmental structuring, and help-seeking. Self-regulatory processes are not thought to be intractable traits, but teachable skills that can be improved regardless of age, cognitive ability, or disability status (Pintrich, 1995). Students who adopt the belief that self-regulation can be learned are more apt to benefit from self-regulatory training (VanZile-Tamsen & Livingston, 1999). Adopting a growth orientation may be particularly useful for individuals with ADHD, who often find their own inability to regulate themselves discouraging and incomprehensible (Toner, O'Donoghue, & Houghton, 2006). From a theoretical perspective, the field of self-regulation examines the various components of self-regulation: behavior, motivation, and cognition. From a practical perspective the field studies the process of self-regulation as it occurs in the context of learning, particularly the means by which individuals can improve their self-regulatory capacity.

Self-regulation applied to learning. Self-regulation is described as a cyclical process beginning with a plan, proceeding to an action, followed by reflection, and returning again to a

revised plan. (Zimmerman & Schunk, 2011). Several skills comprise each stage. The planning stage consists of identifying and analyzing a task, setting a goal, choosing a learning strategy, and activating motivation. The performance stage consists of monitoring, adjusting, and recording behavior as it relates to the self-selected goal or task. The reflection stage includes evaluation of performance and outcome and the attendant adjustment of goals and strategies in preparation for the next action. Learners who are more adept at self-regulation are able to activate the internal and external resources needed to accomplish the task at hand (Zimmerman & Schunk, 2011).

ADHD and the self-regulation process. Students with ADHD are prone to have difficulty with each of the self-regulatory stages. After setting a realistic goal, strong self-regulators choose a strategy to guide their thinking process or work production while poor self-regulators dive headlong into a task without first determining the most effective route through it. Students with ADHD tend to do the later, despite often knowing appropriately useful learning strategies (R. Barkley et al., 2008), (Reaser, Prevatt, Petscher, & Proctor, 2007). In a study comparing the learning profiles of college students with LD to college students with ADHD, researchers found that both groups possessed similar knowledge of effective learning strategies. However, those with ADHD demonstrated less skill at triggering the strategies needed to complete an academic task effectively (Reaser et al., 2007). That students with ADHD do not consistently activate previously learned strategies is particularly salient as it indicates that providing students with an ever-growing list of strategies will not necessarily result in improved academic functioning. This deficit also indicates that interventions designed to draw strategic learning possibilities into consciousness may be beneficial for students with ADHD

During the performance stage of self-regulation, individuals observe and monitor their performance, adjusting the quality as needed. Researches have noted performance-monitoring deficiencies in both children and adults with ADHD (McLoughlin et al., 2009). Because of monitoring deficiencies, it is useful for individuals with ADHD to receive constant and explicit feedback about how they are doing (R. Barkley et al., 2008). By recording behavior, individuals with ADHD can become more cognizant of their performance and, if needed, adjust to meet the demands of the task at hand.

The feedback generated by self-monitoring is essential for the final stage of self-regulation: reflection. Because in general individuals with ADHD do not engage effectively in the first two stages of self-regulation, it follows that they will also find reflecting on their performance difficult. Strong self-regulators tend to accurately attribute success to effort and failure to either lack of effort or ineffective strategy use. These students are favorably disposed to use feedback to adjust performance because they believe it will help them improve. In contrast, many individuals with ADHD risk developing maladaptive coping strategies because they inaccurately assess their own role in the learning process (Knouse & Mitchell, 2015; Prevatt et al., 2011). Detailed feedback can help students with ADHD develop a more realistic assessment of the relationship between their approach to an academic task and their performance.

Self-regulation interventions. At the elementary and secondary level, classwide self-regulation programs have demonstrated positive academic and behavioral outcomes (Cleary, 2008; Gureasko-Moore, 2006; Kistner, 2010; Ness, 2011; Parker, 2009; Sanz de Acedo Lizarraga, 2010; Stoeger, 2008). At the post-secondary level, these interventions are unfeasible for a variety of reasons, foremost among them the expectation that college students learn independently. Additionally, many post-secondary faculty lack knowledge about classwide

regulation strategies or are disinclined to use them (Vance & Weyandt, 2008). College students with ADHD cannot expect to rely on their professors to provide regulatory feedback or strategies.

Academic Coaching, provided by a learning specialist primarily through the disabilities center at many colleges and universities is one model that has been shown to help students develop and monitor self-regulation and executive functioning skills (Parker, Hoffman, Sawilowsky, & Rolands, 2011; Swartz, Prevatt, & Proctor, 2005). The coaching model, while beneficial, requires students to disclose ADHD, which many students are reluctant to do (Meaux et al., 2009; L. L. Weyandt & DuPaul, 2012). Furthermore, the coaching model is costly, difficult to scale up, and not widely available. Because of these limitations, academic coaching cannot successfully meet the need for self-regulation interventions for the majority of students with ADHD; alternative interventions are needed. SMA interventions delivered via smartphone app offer one potential solution.

Self-Monitoring

Self-monitoring defined. Self-monitoring is one of the components of the performance stage of self-regulated behavior. The process of self-monitoring is believed to have a reactive effect on self-control. In other words, simply by observing and recording a target behavior, the behavior changes. Self-monitoring interventions have been used successfully in the fields of medicine, mental health, and education. Three decades of educational research on self-monitoring have demonstrated consistent improvements in students' time on task, pro-social behavior, academic productivity, academic accuracy, and academic performance (DiMaggi, 1991; DuPaul, 2011; Bedesem, 1998; Harris, 2005; Mathes, 1997; Reid, 2005; Rooney, 1984; Shimabukuro, 1999; Zimmerman, 2011). According to DuPaul & Stoner (2003), self-monitoring

offers the additional benefit of improving students' sense of control over their learning. As mentioned earlier, individuals with ADHD are often frustrated with the variable and unpredictable nature of their regulatory skills; the increase in autonomy and control over learning offered by self-monitoring interventions, therefore, may be particularly beneficial for college students with ADHD.

Self-monitoring interventions. Self-monitoring studies have typically focused on either self-monitoring of performance (SMP), or self-monitoring of attention (SMA). During SMP a student checks his or her work against a standard or a set of steps. Students who are taught to monitor performance concentrate on items such as the number of problems attempted or completed, or the amount of time spent planning. The focus is on academic output rather than on internal states. SMA, in contrast, involves cueing students, generally by a tone delivered via headphones, to note whether or not they are on-task at the moment in which they hear the tone (Reid et al., 2005). Students record the occurrence or non-occurrence of on-task behavior on a tally sheet, which is sometimes graphed as well. During the process of self-monitoring a student's focus hones in on a single behavior. Concrete steps for identifying and recording the behavior provide the student with an achievable proximal goal while simultaneously protecting against the pull of competing stimuli. SMA is thought to be more beneficial in improving the study behaviors of students with ADHD than SMP (Harris et al., 2005; Reid et al., 2005).

Research has demonstrated SMA substantially improving the time on task for students with learning disabilities, emotional and behavioral difficulties, and ADHD (Axelrod, 2009; DiMaggi, 1991; Harris, 2005; Mathes, 1997; Prater, 1991; Reid, 1996; Shimabukuro, 1999). Most studies use a time series design, observing baseline time-on-task, introducing the SMA intervention, and then observing time on task during the intervention. Results from many studies

have been quite dramatic. For instance, in a study assessing the effect of SMA on three elementary school students with ADHD, three students increased from baseline time on task scores of 40%, 38%, and 37%, to intervention scores of 97%, 87%, and 94% respectively . Another study gauged the effectiveness of increasing time on task for a fourteen-year old boy diagnosed with learning disabilities and behavior disorders. Self-monitoring increased his on-task behavior in resource room from 18% - 99%, in general math from 28% - 90%, and in general English from 40% - 84% (M. A. Prater et al., 1992). A seven-year old boy diagnosed with LD because of attention problems nearly doubled his on-task behavior from baseline measurement to SMA intervention measurement. His on task behavior during the SMA intervention exceeded that of children without disabilities (Hallahan et al., 1979). A later meta-analysis of self-monitoring interventions established that the positive effect sizes for self-monitoring studies measuring on-task behavior ranged from .59 − 2.96 on a scale identifying a moderate effect at .60 and a large effect at .80 (Reid et al., 2005).

Benefits of the SMA intervention for on-task behavior of secondary students. Research findings on adolescents matched those on younger students: use of the SMA improved on-task behavior. In 1991, Prater, Joy, and Chilman investigated the effects of SMA on five secondary students with learning disabilities and demonstrated attention dysregulation. Prater's study found significant improvement in time on task for all five students in most of the classes in which the SMA intervention was used. No effect was found during the social studies class of one student, presumably due to the interactive nature of the class. The authors pointed out the particular usefulness of the SMA for high school students due to the increased academic demands and reduced personal nature of the student-teacher relationship (M. A. Prater et al., 1992). They also surmised that SMA could help students with LD and attention problems

mainstream into general education classrooms as students using the intervention maintained on-task rates similar to, or in some cases greater than, their non-disabled peers (M. A. Prater et al., 1992).

In addition to identifying the constructive effects of the SMA intervention on in-class on-task behavior, research also showed the SMA intervention improving homework completion (Axelrod et al., 2009). Five students between the ages of 13-16 with diagnosed ADHD used the SMA intervention during independent assignment completion. The effectiveness of the intervention was evaluated using non-overlapping data points (NDP) between baseline and treatment. Typically NDP scores between 70% and 90% represent effective interventions, and scores above 90% represent very effective interventions. For on-task behavior all five participants NDP scores were 100% when cue intervals were set at three minutes. When cue intervals were set at ten minutes, four of the participants NDP scores were 100% and one was 80% (Axelrod et al., 2009). Although this study did not statistically examine the relationship between on-task behavior and homework completion, it did calculate the number of missing or incomplete assignments before and during the intervention. The students began with missing assignments rates between 44.8% and 85.7%. By the end of the SMA intervention period the percentage of missing assignments ranged from 0% − 6.3%. Clearly the SMA intervention improved assignment completion as well as on-task behavior.

Results from SMA studies on adolescents show that the effects of the intervention are not limited to younger students, but can enhance the regulatory behavior of adolescents with attention problems as well. It is important to note that the SMA intervention improved on-task behavior for adolescents in two essential academic environments: the social, public environment of the classroom, and the presumably more private environment conducive to homework

completion. The findings of these studies provide a stable point of reference from which to conjecture that the adaptation of the SMA intervention for college students with attention problems may help students harness their attention during lectures and academic reading.

Functionality of the SMA intervention: On-task variable and reactivity. Researchers on self-monitoring have delivered the intervention in a fairly consistent manner: a prompt cues students to monitor their on-task or off-task behavior and then the students record the presence or absence of the behavior. However, there are some variations of the delivery model that researchers have identified as improving the functionality of the SMA intervention: the operationalization of "on-task" and graphing to improve reactivity.

One potential limitation of the intervention is that improved observable time on task behavior, does not necessarily lead to improved academic outcome, and is therefore more of a behavioral modification than an academic one. While most SMA intervention studies identified time on task as remaining seated and keeping eyes on the teacher or on the paper, two studies included academic components: checking problems, requesting assistance related to content, and actively attending to assigned work by writing, reading, or checking reference material. (DiMaggi, 1991; Axelrod, 2009). Both studies that defined on-task behaviors closely related to the academic demands at hand resulted in improved academic performance. Classes and activities demanding engaged cognition rather than the outward appearance of on-task behavior appear to benefit from operationalized on-task behaviors that specify the relevant mental processes. In adapting an SMA intervention for college use, this research indicates that an on-task definition centered on the pertinent cognitive processes involved during lectures and reading would be the most useful at improving the academic functioning of post-secondary students with attention problems.

Reactivity. Researchers have surmised that the SMA intervention produces a reactive effect on students: the intervention directs students' focus to the ways in which they are or are not meeting the on-task requirements, thereby initiating the self-regulation cycle. One researcher posited that the entire self-monitoring process, including the devices used to deliver the cues and record the data, acts as an external agent to induce behavior change (Nelson & Hayes, 1981). Later research corroborated this theory, showing that self-monitoring process induced similar behavior changes as an external cueing process in the form of explicit instructions (Hayes & Nelson, 1983). In other words, any cue that directs an individual's attention to the target behavior is likely to affect the target behavior. The reactive nature of self-monitoring was shown to effectively change target behavior regardless of how accurately participants recorded the presence or absence of the behavior (Hayes & Nelson, 1983).

Reinforcements. Researchers have attempted to strengthen the reactivity effect of self-monitoring by adding additional components to the self-monitoring process. The three components most often incorporated are self-reinforcements, external reinforcements, and graphing. Self-reinforcement is defined as rewarding one's self with praise, while external reinforcements are defined as teacher praise or small rewards, such as candy or stickers. Self-reinforcement has not been shown to improve the reactivity of SMA (DiMaggi, 1991). The effect of external reinforcements is unclear. In some cases external reinforcements for accurate self-monitoring appear to keep students engaged (M. A. Prater et al., 1992) or to increase time on task (Graham-Day, Gardner III, & Hsin, 2010). However, other researchers have found no added benefit to external reinforcements (Axelrod et al., 2009).

Graphing. Graphing, however, does seem to reliably improve the reactivity effect of SMA. DiMaggi (1991) has noted that graphs allow students to visually track their own

performance and growth. In a study assessing the results of self-monitoring alone and self-monitoring plus graphing on two students, the first student substantially increased both time on task and academic performance when graphing was added to self-monitoring. The second student did not show increased time on task with the addition of graphing, however, he did improve his academic performance. In another study, students rated graphing as their favorite component of a self-regulation intervention (Graham-Day et al., 2010). Graphing is one of the few additions that appear to have improved on the self-monitoring intervention introduced by Hallahan and Lloyd in the late 1970's.

Sustainability of SMA results. Little evidence supports the sustainability of the gains seen during the SMA treatment phase. For instance, one study found that the on-task behavior of three students jumped from baselines of 40%, 38%, and 37% to 97%, 87%, and 94% during the first phase of SMA, but fell to about 60% as soon as the intervention was removed. Researchers again initiated SMA, and the students' scores jumped back up to on-task rates in the high nineties. The students maintained strong results during the final phase of the treatment, which faded out the self-recording instrument. However, the students continued to be reminded by their teacher to monitor their on-task behavior . Similar results have been found in other SMA studies, with the general trend represented by a strong spike in on-task behavior when SMA is introduced followed by a substantial drop in on-task behavior once all instruments and cues involved in the intervention are removed. The SMA intervention does not fix or train an individual’s attention; it acts as an external moderator of attention.

These findings are particularly germane for college students with attention difficulties. As mentioned earlier, the shift from external regulation provided by parents, teachers, and the relatively structured world of high school to self-regulation can be particularly difficult for

students with symptoms of ADHD. The SMA intervention, appropriately adapted, might be a feasible stand in for the external regulation formerly provided by adults. As it has been traditionally implemented, however, it likely lacks enough social validity for college age students to use it independently.

Social validity. Social validity is a construct that emerged out of Applied Behavior Analysis, as did the Self-Monitoring of Attention intervention. Applied Behaviorists are concerned with practical interventions that affect observable behavior and are socially valuable. However, in the 1970's, the principal applied behaviorists began to realize that the recipient's subjective experience of an intervention also warranted attention (M. M. Wolf, 1978). The feelings an intervention engendered in a recipient not only influenced the efficacy of the intervention, but also it's social value. By including the participants' subjective reactions in intervention evaluations, applied behaviorist began to form a constructivist rather than positivist view of what constituted an effective treatment (M. M. Wolf, 1978). Because college students would self-select the SMA intervention, social validity is a vital component of its potential effectiveness.

Social validity results of the SMA intervention in previous studies have been mixed. Younger students commented that it helped keep them out of trouble , while others enjoyed trying to beat their previous day's tally of on-task behavior (McCarl, et al., 1991). Older students, however, were not so keen on using it, despite often recognizing the academic utility of the intervention. Previous studies have required students to record the presence or absence of behavior on paper graphs and students report boredom and frustration with the paper and pencil tallying (Harris et al., 2005). During Prater, Joy, and Chilman's study with five secondary students, one boy returned the tape recorder and headphones after the fifth day of the

intervention, wanting to quit. He adhered to the protocol only after researchers added the allure of reinforcement candy (M. A. Prater et al., 1992). In another study which surveyed teachers and adolescents on the acceptability of SMA, teachers rated the intervention more highly than did students (Axelrod et al., 2009). The teachers reported a high likelihood of recommending the intervention to other teachers or using it with other students. The students, in contrast, reported that they were unlikely to use the intervention independently or recommend it to others (Axelrod et al., 2009). Another study found similar results: students rated the intervention less highly than teachers. Although the students agreed that the cueing chimes helped keep them on task, they were unlikely to use the SMA intervention in other classes or to tell other students about it (Graham-Day et al., 2010). According to social validity research, adolescents found the SMA intervention unacceptable.

There are several possible explanations for why many adolescents did not enjoy using the SMA intervention, none of which the research addressed with any depth. On the surface, it would seem that the physical requirements of the intervention, bulky headphones and tally sheets, might have proven burdensome or stigmatizing to adolescents.

A few studies have examined the self-monitoring process delivered via mobile device. The results of these studies indicate that delivery of the SMA intervention via mobile device could improve its social validity and thus its utility for motivated college students with attention difficulties.

Intervention delivered via mobile device. Mobile Devices, i.e. smartphones and tablets, are increasing being used to provide individuals with access to mental health interventions when they need them. Although this model is flourishing in the mental health field, it has not yet been widely employed for individual education interventions. The few studies that have used mobile

devices to deliver individual interventions show promise and indicate that educational interventions via mobile device could be a viable and cost-effective method of delivery.

Forecast for mobile device use in higher education. According to several national and international reports, the use of smartphones is increasing at a rapid rate. The Pew Research Center reports that in 2014, 85% of all adults age 18 - 29 owned a mobile device capable of Internet connectivity and rates are expected to increase every year (*The Smartphone Difference*, April 2015). The New Media Consortium Horizon Report (Johnson, Adams Becker, Estrada, & Freeman, 2014) reports yearly on the six technologies that are most likely to change education in the coming years. The use of smartphones to track aspect of one's functioning, known as the quantitfied self, is expected to become one of the most important technologies in higher education in the next six years. Smartphones have already become essential mainstream educational instruments. Smartphone use for educational purposes is up from approximately 35% in 2013 to 70% in 2014 (Dahlstrom, Walker, & Dziuban, 2014). Furthermore, students report a positive attitude toward using their smartphones. Given the ubiquity of mobile devices, and the popularity of apps for productivity, it seems likely that college students would be likely to find an intervention delivered via smartphone app acceptable and useful.

Use of mobile devices to collect self-reported data. Mobile devices are already being used to help individuals in other areas, particularly health and psychology. In a recent literature review on the use of technology to supplement psychological treatment, researchers identified handheld mobile computers as a promising technology for collecting information about participants moods (Clough & Casey, 2011). Participants reported high acceptance rates regarding the use of the hand held computer and compliance was significantly higher than when participants recorded data with paper and pencil. Clough surmised that the high compliance rate

was a likely result of individuals carrying their mobile phones with them everywhere, making it less likely that they would forget to monitor their symptoms or feel self-conscious doing so (Clough & Casey, 2011). A recent meta review of smartphone delivery of mental health interventions also concluded that mental health apps provided several benefits including accessibility, in the moment symptom monitoring, ease of use, and the potential to improve treatment adherence (Donker et al., 2013). The results of these reviews indicate that individuals are likely to find self-recording via mobile device non-intrusive and potentially beneficially.

Mobile device use for SMA interventions. Two published studies and one dissertation have examined the effectiveness of mobile devices to self-monitor attention. One of the studies examined the use of a handheld computer to deliver static picture prompts depicting on-task behavior to three middle school students with high-functioning autism (Cihak, Wright, & Ayres, 2010). The pictures showed the students engaged in various on-task behaviors, such as looking at the teacher, raising a hand to ask a question, or reading. The pictures changed every 30 seconds. The change of a picture acted as a prompt for students to self-record "yes" or "no" for on-task behavior on a 3 x 5 card taped to their desks. As with other SMA studies, students showed a marked increase in time on task during the intervention. The combined mean of the students task engagement rose from a baseline of 29% to an intervention level of 94% (Cihak et al., 2010). Additionally, the students were given a social validity survey following the intervention; all students agreed that the intervention was easy, facilitated important personal changes, improved their grades, and improved their skills. They also all agreed that they would recommend the intervention to others (Cihak et al., 2010). The social validity piece is particularly important because the students completed the intervention within a general education classroom. The acceptance of the intervention indicates that the students did not find it intrusive or embarrassing.

However, because students with autism tend to have difficulty with social processing, it is possible that these findings are not relevant to students with ADHD.

A study exploring the use of a mobile device to record the occurrence or non-occurrence of on-task behavior demonstrated similar results. An eight year old student with attention difficulties had in immediate improvement in on-task behavior when the SMA intervention was introduced, climbing to a mean of 98% from a baseline level of 64% (Gulchak, 2008). The limited research makes it difficult to draw conclusions, but initial positive results as well as the findings from research on e-health interventions warrant further investigation on the potential benefits of delivering an SMA intervention via mobile device.

Conclusion

College students with ADHD need tools to help them monitor their attention during lectures and academic reading. They may not be able to, or may choose not to, rely on services provided by the disability center. Self-monitoring, a component of self-regulation, has been found to help elementary and secondary students with ADHD monitor time on task but has not received adequate social validity to be considered a viable intervention. Individuals have reported high social validity for other mental health interventions delivered via smartphone. Therefore, it seems plausible that adapting the SMA intervention to address college students' academic needs and delivering it via smartphone to improve its social validity could result in an effective SMA intervention. If so, the SMA intervention would have the potential of providing college students with ADHD an autonomous, effective, and enjoyable means of increasing control over variable attention during lectures and academic reading.

CHAPTER THREE

Methods

Postsecondary students with ADHD are a unique population among individuals with ADHD. Research has shown that college students with ADHD are at risk for poor academic achievement and for dropping out of college (R. Barkley, 2006; R. Barkley et al., 2008). One of the primary concerns of college students with ADHD is the inability to control attention during key academic activities, resulting in detrimental mind-wandering, zoning out, and other off-task cognitive failures (Advokat et al., 2011; Franklin et al., 2014; Lewandowski et al., 2008; Rabiner et al., 2008). Recent research has confirmed that college students with ADHD experience higher levels of cognitive failure and use more mental energy to maintain attention than their peers without ADHD (Franklin et al., 2014; Gray, Fettes, Woltering, Mawjee, & Tannock, 2015).

One intervention that has helped younger students gain control over off task behavior is self-monitoring of attention (SMA): a simple process by which students attune to and tally attentive behaviors. SMA interventions have been tested for the past three decades with consistently strong improvement in attentive behaviors (Harris et al., 2005; Reid & Harris, 1993). Despite the success of the SMA intervention with both elementary and secondary students, it has not been tested on a college population. There may be several reasons for this. In previous studies, the SMA intervention was administered by a teacher or psychologist (Mathes, 1997; Webber, 1993). Post-secondary instructors do not generally offer class-wide learning interventions of this sort. Furthermore, the measure of attentive, or on-task, behaviors -- eyes on teacher or paper, sitting still, pencil on paper -- do not make sense for post-secondary students. Most college students with attention problems can manage their behavior; it is their internal distractibility that remains impairing (R. Barkley et al., 2008; L. L. Weyandt et al., 2003). The

social undesirability of using a visible and therefore potentially stigmatizing intervention may also have prevented further exploration of SMA interventions with college students (Peña Lasiste Bedesem, 2010; Graham-Day et al., 2010).

This study examined the potential efficacy of a self-monitoring intervention delivered via mobile device on attention, effortful control, and academic self-efficacy for college students with self-identified attention difficulties. The study was guided by the following questions:

1. Does the SMA intervention affect measures of attention, effortful control, and academic self-efficacy as measured by pre and post test scores?

2. What pattern of usage do students demonstrate when using the self-monitoring intervention?

3. How, if it all, does usage correlate with task-focused attention ratings?

4. How do participants rate the social validity of the SMA intervention?

Research Design

A mixed methods design with a randomized experiment as the primary component and qualitative surveys as the secondary components was used to address the study questions. The experimental design enabled me to test the effect of a Self Monitoring of Attention (SMA) Intervention on levels of attention, effortful control, and academic self-efficacy as measured by validated instruments in pre and post tests. Randomized experiment is thought to best control for alternate and rival explanations of changes in the experimental group, and, therefore, be the most reliable means of testing a causal hypothesis (McBride, 2010; Jaeger, 1990). To ensure that the control group also received treatment, I used a lagged treatment design, providing the control group with the SMA intervention during the second two-week phase of the experiment.

The study also examined the experiences and perceptions of the participants during the active phase of the study. Data was collected via experience sampling surveys and a social

validity survey. The collection of survey data complemented the findings from the experiment by providing information about the participants' subjective experience of using the intervention as well as shedding light on the experimental findings.

In this study, the daily experience sampling surveys shed light on how often participants were using the SMA intervention and how much they felt it was helping them focus in the moment. It also provided information about how often an alternate strategy was used. In addition, the social validity survey provided information about how useful participants found the SMA intervention overall, and how comfortable they felt using it in different situations.

Finally, monitoring SMA intervention usage rates allowed me to collect information about fidelity and any impact of usage rates on post test ratings (both between and within group comparisons).

The experimental and qualitative components of this study worked together to provide a more thorough understanding of how participants perceived, used, and potentially benefited from the SMA intervention. Mixed-methods design, introduced by Campbell and Fiske in the mid-twentieth century, sought to address some of the weakness of purely experimental or purely qualitative design by helping the researcher not only seek out causal evidence, but also information that could aid in explaining the how and why of the findings (Creswell, 2003).

Site Selection

The site for this study was University of California, Los Angeles. The university is considered one of the most selective state universities in the country: 90.9% of students enter with a GPA above 3.75, the majority of students score above 1700 on the SAT, and earn a composite score above 23 on the ACT (UCLA Common Dataset, 2012). The school also seeks out students who have completed academically rigorous high school courses such as honors and

AP classes. In addition, all students have met the basic A-G requirements, which indicate a certain level of proficiency in higher-level academics. Selecting participants from this highly selective university ensured that the majority of participants had been academically competent in high school and presumably possessed the cognitive ability to comprehend college level material. Additionally, choosing a large research university from which to recruit participants increased the chances of finding an adequate sample size to test the hypotheses.

Sample Selection and Recruitment

Volunteer participants were recruited via flyers posted throughout the campus and through e-mails sent to a variety of student groups and clubs on campus. Recruitment sought out students who self-identified as experiencing difficulty maintaining attention during lectures and/or academic reading (Appendix A). Participant recruitment took place during the Spring 2014 and Summer 2014 quarters from April through July. Interested participants were assigned an id number and sent a short eligibility questionnaire via e-mail. The eligibility questionnaire included a written description of the study and requirements of participation. The voluntary nature of both the study and the eligibility survey was emphasized and participants were requested to acknowledge consent. To be eligible for the study, participants were required to be 18 or older, own a working smartphone, enrolled as a full time student, enrolled in at least one class requiring lecture attendance or academic reading, and be willing to commit to the requirements of the experiment. Exclusion criteria included current substance dependence, a history of psychotic illness, or severe depression or anxiety (requiring hospitalization) in the past six months. Participants with other co-morbid conditions, such as learning disabilities or mild anxiety were included in the sample. Eligible participants were randomly selected into the control or lagged treatment group by id numbers. During an initial meeting held with each

participant, the researcher reviewed the purpose and voluntary nature of the study, described guidelines for completing the study, and obtained written consent for study participation.

Participants

Both the experimental group (n = 21) and the lagged treatment group (n = 27) were comprised primarily of females (95% and 74% respectively). All participants were undergraduates. As inattentiveness levels were a primary concern of this study, all participants were assessed for likely ADHD using the BAARS-IV Inattention Scale. Table 1 provides sample information.

Table 1.

Number of Participants with likely ADHD

	Likely ADHD*	Total Participants
Experimental Group	n = 8	n = 21
Lagged Treatment Group	n = 7	n = 27
Total	n = 15	n = 48

** As defined by BAARS-IV*

Group comparisons of pre test measures. Between-group comparisons on mean pre test scores of all measures were conducted using one-way ANOVAs to ensure that the experimental and lagged treatment group were equivalent at the start of the experiment. Table 2, shows that no statistically significant differences were found between the experimental and the control group on measures of attention, effortful control or self-efficacy.

Table 2.

Group Comparisons of Pre Test Measures

	Sum of Squares	df	Mean Square	F	Sig.
Baars IV - Inattentive Symptom Count	7.9	1	7.9	1.8	.19
Baars IV- Hyperactive/Impulsive Symptom Count	1.19	1	1.19	.505	.481
Baars IV - Sluggish Cognitive Symptom Count	12.44	1	12.44	1.854	.180
Mind-Wandering Scale	.028	1	.028	.034	.855
MSLQ - Academic Self Efficacy Scale	.342	1	.342	.217	.643
MSLQ – Metacognitive Self-Regulation Scale	.036	1	.036	.039	.845
MSLQ - Effort Regulation Scale	.770	1	.770	.481	.491
Effortful Control - Activation Scale	.026	1	.026	.087	.769
Effortful Control - Attention Scale	.002	1	.002	.007	.932

As the focus of this study was to compare outcome measures among students who self-identified with attention difficulties, comparative analysis was limited to group comparisons on pre test measures. The lack of statistically significant differences between the control and lagged treatment groups on pre test measures justified the use of General Linear Model testing used in this study.

Study Procedures

Participants enrolled in a four-week study consisting of two phases: the initial two week experimental phase, during which participants in the experimental group received the SMA

intervention just after pre testing and a second two-week phase during which the control group, the lagged treatment group, received the SMA intervention. Participation in the study was conducted on a rolling basis. Once a participant had met eligibility, an individual introductory session with the researcher was scheduled. During the introductory session, the researcher reviewed the purpose of the study, collected written consent, administered the web-based pre tests, and taught participants a reading and listening comprehension strategy to operationalize attentive processing. In addition, participants in the experimental group downloaded the SMA Intervention, *Focus Check* app, to their smartphones and were provided with instructions on how to use the app. Participants in the experimental group were instructed to use the *Focus Check* app for at least one hour a day for the initial two-week phase of the experiment.

For the first five days after the introductory session was completed, participants would receive experience sampling surveys via e-mail three times daily. The remaining nine days of the experiment did not involve any contact with the researcher unless a participant was seeking assistance with a technical difficulty. At the end of the initial two-week experimental period, each participant was sent a link to the first series of post tests. Once the initial post tests were completed, those in the experimental group continued to use *Focus Check* at a self-selected rate. Those in the lagged treatment group were sent a code enabling them to download *Focus Check* as well as a link to a video with detailed instructions on downloading and using the app. The video was meant to replicate, as closely as possible, the individualized nature of instruction given to participants in the experimental group. Participants in the lagged treatment group were asked to use the *Focus Check* app for a minimum of one hour a day. As during the initial two-week period, during the second phase participants were sent experience sampling surveys three times daily for the first five days after receiving *Focus Check*. At the end of the second two-week

period, all participants were sent a link to the final post tests, the social validity survey, and an optional demographic survey. The completion of the social validity survey marked the end of the experiment.

Data Collection

Pre-tests scores were collected via internet survey during the introductory session between participant and researcher, initial post test scores were collected via internet survey two-weeks after the introductory session, and final post test scores and social validity survey results were collected via internet survey after the second two-week phase of the experiment. Experience sampling data was collected three times daily for the first five days of the initial phase and three times daily for the first five days of the second phase of the experiment. Usage data, defined as the number of times a participant responded to a prompt, was automatically uploaded from each participant's *Focus Check* app to a database.

Instrumentation

The instruments used in this study are described below. A copy of each instrument is included in Appendix B.

Instruments used to assess experimental results. Pre and post test scores assessing attention, effortful control, and academic self-efficacy were collected to address research question #1 using the following validated instruments:

The Barkley Adult ADHD Rating Scale (BAARS-IV). A 27-item self-report rating scale measuring participants perceptions of how often they engage in behaviors symptomatic of ADHD. The scale measures four domains: inattention, hyperactivity, impulsivity, and sluggish cognitive tempo. Internal consistency for each subscale (Cronbach's alpha) is as follows: Inattention = .902, Hyperactivity =.776, Impulsivity = .807. Test-retest reliability was also found

to be satisfactory with Pearson correlations ranging between .66 and .88 on all current symptom subscales . Participants chose from 4 responses rating degree of symptom occurrence ranging from 1 = never or rarely, through 4 = very often for each item.

The Mind-Wandering Questionnaire (MWQ). A 5-item scale designed to measure the frequency of task-unrelated thoughts (Mrazek, Franklin, Phillips, Baird, & Schooler, 2013). The recently developed scale has been used with undergraduates measuring task-unrelated thoughts during working memory span tasks and with adolescents during reading comprehension tasks. The scale has been found to have good internal consistency (Cronbach's alpha =.85) as well as strong internal reliability and non-redundant items. The MWQ has also been tested for construct validity and items found to effectively assess a single construct. Convergent validity with the thought sampling method of determining levels of task-unrelated thoughts has been established. Respondents chose from 6 responses rating degree of symptom occurrence ranging from 1 = almost never, to 6 = almost always.

The Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ (Pintrich, 1991) has been widely used in studies examining the academic habits, values, and beliefs of college students (Credé & Phillips, 2011). In this study, the MSLQ subscales targeting self-efficacy (8-items, alpha = .93), metacognitive self-regulation (12-items, alpha =.79), and effort regulation (4-items, alpha = .69) were used. Participants rated themselves on a seven-point Likert scale from 1 = not at all true of me, to 7 = very true of me.

The Effortful Control Scale. One of the factor scales of The Adult Temperament Questionnaire (Evans & Rothbart, 2007), the Effortful Control Scale measures 3 domains: activation control, effortful attention, and inhibitory control. For the purposes of this study, only the items related to activation control and effortful attention were used. Cronbach's alpha scores

for the two scales are .84 and .88 respectively. The Adult Temperament Questionnaire has been used widely to assess various aspects of temperament (Evans & Rothbart, 2007).

Instruments used to assess participant experience and perception. The following researcher created surveys were used to capture participants' subjective experiences in order to answer research question #4 as well as some aspects of research questions #2 and #3:

Experience Sampling Survey. The experience sampling survey consists of 10 items designed to capture participants' subjective experience of attention, effortful control, and self-efficacy as well as information about activities within the preceding five minutes. The experience sampling method (ESM) used here can come close to producing an objective record of cognitive and emotional states, including levels of concentration, alertness, and satisfaction (Csikszentmihalyi, 1987; Whalen et al., 2006). Experience sampling, which alerts participants throughout the day and asks them to record their experience within the previous five minutes, minimizes estimation. Surveys took approximately two minutes to complete and were collected three times a day for the first five days of the initial and second phases of the experiment. The experience sampling survey was designed according to guidelines set forth by Csikszentmihalyi and Larson (1987).

Social Validity Survey. The social validity survey, a modified version of the Credibility/Expectancy Questionnaire (Devilly, 2000), consists of 6-items asking participants to identify aspects of their subjective experience of using the SMA intervention. The Credibility/Expectancy Questionnaire has been widely used in psychological research to capture patients' perceptions about the logic, potential outcome, and acceptability of behavioral interventions, including self-monitoring and cognitive reframing interventions. The questions in

the social validity survey designed for this study have been modified to more accurately reflect the conditions of the SMA intervention.

Usage data. Participants' usage of the *Focus Check* app was automatically uploaded to a database. Data collected included the number of times each participant recorded on-task attention as well as the number of total times participants responded to a prompt. Usage data was used to address research questions #2 and #3.

Fidelity and Completion

To ensure that participants completed measures and surveys, participants were paid $5.00 for completing each of the three rounds of measurements (pre test, initial post tests, and final post tests) as well as $5.00 for completing the majority of experience sampling surveys. In addition, those participants who completed all measures and experience sampling surveys were entered into a raffle drawing for an I-Pad mini.

Data Analysis

General linear models. The experimental and lagged treatment groups were compared for significant differences in outcome measures following the initial two week phase of the experiment and again at the conclusion of the second two week phase for the following measures: *BAARS-IV: Inattention subscale; BAARS-IV: Hyperactivity/Impulsivity subscales; BAARS-IV: Sluggish Cognitive Tempo subscale; Mind-Wandering Scale; MSLQ: Metacognitive Self-Regulation subscale; MSLQ: Metacognitive Self-Regulation subscale; MSLQ: Effort Regulation subscale; Effortful Control Scale: Activation subscale, and Effortful Control Scale: Effortful Attention subscale.* Mean differences between pre and post test scores for each of the measures were compared using 2x2 repeated measures ANOVAs. Pairwise comparisons were conducted to analyze within and between group differences. In addition two other sets of scores

were compared: 1) participants in each group who scored as likely to have clinically significant ADHD symptomology were compared using the above mentioned analyses; and 2) participants were ranked according to usage levels and compared according to high and low usage rates using the above-mentioned analyses.

Descriptive statistics. Descriptive statistics were run for the results of the experience sampling surveys, social validity survey, and usage data using SPSS.

Reliability and Validity

My primary interest in this study was to determine if the self-monitoring intervention has the potential to improve attention, effortful control, and academic self-efficacy during lecture periods and academic reading. A randomized experiment afforded me the best chance of being able to do so, as randomized assignment creates two groups likely to be comparable at the outset. Any change in the experimental group not mirrored by the control group is statistically likely to have been caused by the intervention (Shadish, Cook and Campbell, 2002). This study was designed to minimize threats to internal validity at some costs to the threats to external validity. Internal validity was strengthened by deliberate measures taken to improve fidelity and reduce attrition. Further research will be needed to assess external validity. The findings from the comparative analysis and descriptive analysis in this study were triangulated using multiple sources of data as well as multiple theoretical frameworks in order to strengthen the validity of the findings. These findings are presented in Chapter 4.

CHAPTER FOUR

Results

This study was designed to examine attention, self-efficacy, and effortful control outcomes as well as participant experiences during a two-week experiment using a self-monitoring of attention intervention (SMA) delivered via Smart Phone. All participants were college students with self-reported attention difficulties. Four principle questions were addressed: 1) Does the SMA intervention affect measures of attention, effortful control, and academic self-efficacy as revealed by pre and post test scores? 2) What pattern of usage do participants demonstrate when using the SMA intervention? 3) How, if it all, does usage correlate with task-focused attention ratings? 4) How do participants rate the social validity of the SMA intervention? The four research questions were designed to provide complementary data about the overall effectiveness of the SMA intervention.

This chapter presents information in three sections. The first section summarizes the results of general linear model statistical analysis of both between group and within group scores on pre and post measures of attention, self-efficacy and effortful control. The second section describes usage rate findings. The third section examines the results from the experience sampling surveys and social validity survey. The chapter closes with a summary of the findings to be discussed in Chapter Five.

General Linear Model Tests

The use of General Linear Models (GLM) requires that several assumptions be met. For this study all assumptions were met with the exception of normal distribution of the mean for two measures (See Appendix C). Group equivalency was established by comparing pre test scores across all measures. The results of the assumptions testing and between group equivalency

support the decision to compare the mean differences between the control and the experimental group using General Linear Model Tests.

Pre and post test scores were analyzed using significance testing, with a null hypothesis that the independent variable, the SMA intervention, had no effect on dependent variables, scores on the post test measurements. Both within and between group means were compared using general linear models with significance levels set at .05%.

Between-Group Comparisons. There were 21 participants in the experimental group and 27 participants in the lagged treatment group. I hypothesized that participants in the experimental group would show greater differences between pre and post test means compared to participants in the lagged treatment group on measures of attention, effortful control, and academic self-efficacy. To test this hypothesis, I used a series of mixed model ANOVAs (see Appendix D). The within subjects measures were the pre tests and initial post tests, and the between subject measures were the experimental and lagged treatment group conditions.
A main effect of the interaction of time by group (the extent to which group membership affects post-score results), of time (pre test vs. initial post test), and of group were tested to see if there were any differences in the following outcomes: *BAARS-IV: Inattention subscale; BAARS-IV: Hyperactivity/Impulsivity subscales; BAARS-IV: Sluggish Cognitive Tempo subscale; Mind-Wandering Scale; MSLQ: Metacognitive Self-Regulation subscale; MSLQ: Metacognitive Self-Regulation subscale; MSLQ: Effort Regulation subscale; Effortful Control Scale: Activation subscale, and Effortful Control Scale: Effortful Attention subscale.* Results testing interactions between time and group showed significant main effects for BAARS IV: Inattention subscale (p = .03) and BAARS IV: Sluggish Cognitive Tempo subscale (p = .02) indicating that use of the *Focus Check* self-monitoring intervention did have a significant effect on these post test

measures. These interactions supports the conclusion that the participants who received the SMA Intervention did significantly improve on outcome measures of attention compared to participants who did not receive the intervention.

No significant interactions between time and group, or between group were found for measures of mind-wandering, effortful control, metacognitive self regulation, or academic self-efficacy. Thus, using the SMA Intervention in this experiment did not result in statistically significant improvements on measures of mind-wandering, effort regulation, or self-efficacy but did result in statistically significant improvements on measures of attention, specifically inattention and sluggish cognitive tempo.

Within Group Comparisons. Because both the experimental and lagged treatment groups received some form of intervention immediately prior to the initial two-week testing period (a reading and listening comprehension strategy), a main effect of time for both groups was tested. Results indicate there was a significant main effect of time (pre test to initial post test), on BAARS-IV: Inattention subscale (p = .02), BAARS-IV: Sluggish Cognitive Tempo subscale (p = .00), Mind-wandering (p = .00), and Effortful Control: Attention Control subscale (p =.01). These tests indicate that, on average, participation in this study resulted in improved mean scores of attention regulation for all participants.

ADHD sub-group comparisons. The sample I was most interested in assessing was the subset of students with likely ADHD; therefore, a subsequent analysis was run for those members of the sample who tested as having likely ADHD (Appendix E).

Results from this analysis varied slightly from the primary analysis. As in the original analysis, a main interaction effect of time by group was found for BAARS IV: Inattention subscale (p = .03) and BAARS IV: Sluggish Cognitive Tempo subscale (p = .03). In addition, a significant

interaction between time and group was found for Mind-wandering (p =.02) and Academic Self-Efficacy (p =.04), with those in the experimental group improving significantly more on mean post test scores compared to those in the lagged treatment group. These analyses, while inconclusive due to the small sample size (n = 15), indicate that for participants with likely ADHD, the SMA Intervention may have had a more substantial effect than for participants without ADHD.

Within Group Comparisons: Collapsed Experimental Group. Finally, to enhance the power of the analysis of the effect of the SMA intervention, a collapsed experimental group was created with the results of the first two weeks of the experimental group combined with the results of the second two weeks of the lagged treatment group. The resulting sample consisted of 48 participants, 15 of whom would likely meet the diagnostic criteria for ADHD.

Again, a series of mixed model ANOVAs was used. The within subjects measures were the pre tests and initial post tests, in this case assessing the difference between pre tests and post test means for all participants during the two-weeks in which they used the SMA Intervention. Between subject identification was determined by ADHD or Not ADHD group conditions. A main effect of time (pre test vs. initial post test for the collapsed group), a main effect of group (ADHD vs. not ADHD), and an interaction of time by group were tested to see if there were any differences in outcomes.

Replicating the results from the experimental and lagged treatment groups, a main effect of time was found for BAARS-IV – Inattention subscale (p = 0.0), BAARS-IV – Sluggish Cognitive Tempo subscale (p = 0.0). Additional main effects between pre test and post test were found for Mind-wandering (p = 0.0), Effortful Control: Effortful Attention (p = 0.4), and MSLQ – Motivated Strategies for Learning (p = .04). These results indicate that it is likely that using the

SMA Intervention had a positive effect on post test scores of attention, effortful control and strategy use for participants with and without ADHD symptomology.

Testing interactions between group and time yielded a main effect of group (ADHD or non-ADHD) on post test results for Effortful Control: Effortful Attention subscale (p =.03), MSLQ: Metacognitive Self-Regulation subscale (p =.04), and Academic Self-Efficacy subscale (p =.04). These results indicate that for those participants with ADHD, using the SMA intervention resulted in significantly improved scores on these measures compared to participants without ADHD.

Taken together, these analyses show that, as hypothesized, use of the SMA intervention resulted in significant improvements on measures of attention (BAARS IV Inattention and Sluggish Cognitive Tempo subscales). They also point to the conclusion that for those participants with ADHD, use of the SMA intervention contributed to statistically significant improvements on more outcome measures than for those without ADHD; though these conclusions must be taken in light of the small sample size of participants with ADHD as well as the lack of a control group for the collapsed sample. Additionally, the results show use of the SMA intervention may have improved scores on mind-wandering, attention regulation, strategy use, and, for those with ADHD, academic self-efficacy, though again, these conclusions must be taken in light of the study limitations. Finally, the results indicate that participation in this study resulted in significantly improved scores on measures of attention, mind-wandering, and strategy use for all participants. These conclusions will be discussed in detail in Chapter 5.

Usage Rates

Research Questions 2 and 3 address usage rates in the experimental groups: What patterns of usage do participants demonstrate and how, if it all, does usage correlate with

outcome measures? To address these questions frequencies of usage were assessed for the experimental group and a series of mixed model ANOVAs were used. Usage was defined as each time a participant responded "yes" or "no" to the prompt: "Are you on task?". Mean usage for the experimental period was 42 responses; median usage was 36. Twenty-five percent of the participants responded to a prompt fewer than 10 times, 50% responded between 10 – 62 times, and 25% responded more than 62 times.

Between Group Comparisons: High and Low Usage. Subjects were divided into two groups for the between subjects measures: high usage > 36 and low usage ≤ 36. The within subjects measures were the pre tests and initial post tests. A main effect of group (experimental vs. lagged treatment), and an interaction of time by group were tested to see if there were any differences in the following outcomes: BAARS –IV subscales, Mind -wandering, MSLQ subscales, and Effortful Control subscales. Results indicate that a main effect of group was found for Effortful Control: Attention and a main effect of the interaction between time and group was found for Effortful Control: Activation. These analyses indicate that for this sample SMA Intervention usage rates likely had a substantial effect on Effortful Control, but not on Attention or Self-Efficacy.

Social Validity

Social validity is a construct that includes participants' felt sense of the effectiveness and acceptability of an intervention. It was measured in this experiment with experience sampling surveys and a final social validity survey. Results indicate that participants found the SMA intervention to be both effective and acceptable. In addition, the reading and listening strategy provided to all participants was perceived to be helpful.

Experience Sampling Survey Results. To address, research question 4, experience sampling surveys were administered to capture in-the-moment reflections of participants' experiences. All participants received a short survey via e-mail, three times daily for the first five days of the experiment. Participants were asked if they were engaged in an academic activity and, if so, if they were using either the reading and listening comprehension strategy provided to all participants or the SMA Intervention provided only to those in the experimental group. Those participants who were using a strategy were asked to rate the helpfulness of the strategy from 1 - 4, with 1 = not helpful and 4 = very helpful. During the initial two-week testing period 552 surveys were collected from 48 participants: 280 from the lagged treatment group, and 272 from the experimental group. Of those 552 surveys, participants indicated that they were engaged in academic activity 265 times (48%). The remainder of the data analyses focuses on only those 265 surveys from the initial two-weeks in which the participants indicated that they were engaged in an academic task.

Results show that of the 265 surveys collected while participants were engaged in academic tasks, 153 (57.7%) indicated that the participant was using either a paper-based strategy or the SMA intervention directly before completing the survey. The majority of participants indicate finding both the reading and lecture strategy and the SMA Intervention helped them maintain focus on academic reading or lecture comprehension (see Table 3)

Table 3.

Social Validity Data for Reading Strategy and Focus Check

	# of responses indicating use of Reading and Listening Strategy	Percentage finding strategy "helpful" to "very helpful"	# of responses indicating use of *Focus Check* app	Percentage finding *Focus Check* "helpful" to "very helpful"
Experimental Group (n = 21)	36	78%	36	92%
Lagged Treatment Group (n = 23)	80	66%		

Overall, while results indicate that while both the reading and listening comprehension strategy and the *Focus Check* SMA intervention were perceived by the participants to improve the ability to maintain focus during academic tasks, the *Focus Check* SMA intervention was more consistently perceived as helpful.

Social Validity Survey Results. The social validity survey collects information about participants' perception of the effectiveness of the intervention and their feelings about the acceptability of using the intervention. Because the social validity survey questions looked at different aspects of the SMA intervention, I look at the questions individually rather than in aggregate.

Effectiveness. Of the 36 participants who completed the social validity survey 47.22 (scores of 4 or 5) felt that the SMA Intervention was a fairly logical or very logical intervention model. 58.33% (scores of 4 or 5) of participants felt that using the SMA intervention made them more aware of their own patterns of attention. Sixty-nine percent felt using *Focus Check* resulted in a 50% or more increase in their ability to maintain focus during academic reading and lectures, while 13.89% did not feel that the intervention helped reduce inattentive symptoms

during academic tasks. Seventy-eight percent thought using *Focus Check* improved their understanding of course materials somewhat to very much.

Acceptability. Results of the social validity survey show that 78 % of participants found the SMA intervention easy to very easy to use; 83% were at least somewhat comfortable using it during lectures while 85% were at least somewhat comfortable using it while reading; 77% found it somewhat to very enjoyable to use, and 94% rated their experience using *Focus Check* somewhat to very positive.

In open-ended responses participants also commented on their positive experiences, remarking that they "really enjoyed the *Focus Check* app" and found it "very easy to use". The few negative comments mentioned that the prompts could become distracting or inconvenient to use during lectures: "It's a solid idea. The only negative about it is that the ding itself … can distract me and cause me to lose focus." In the main, however, the social validity data indicates that participants found using the SMA Intervention both effective and socially acceptable.

Conclusion

The experimental portion of this study showed that use of the SMA intervention resulted in statistically significant mean differences between the experimental and control group on measures of attention. Furthermore, use of the SMA intervention resulted in statistically significant improvements in outcome measures of attention, effortful control, and strategy use for the collapsed sample of experimental and lagged treatment participants, though these results must be taken in light of the lack of a control group for the collapsed sample. Furthermore, analysis indicate that for participants with ADHD, use of the SMA intervention may have resulted in additional statistically significant improvements in outcomes of mind-wandering, metacognitive self-regulation, and academic self-efficacy above and beyond the improvements in

attention outcomes. The experience sampling survey data and the social validity survey data demonstrated that participants perceived the SMA Intervention to be both acceptable and beneficial. Conclusive evidence for the efficacy of the SMA intervention cannot be drawn from this single experiment; however, the significant results warrant further research on the SMA intervention, particularly with college students with clinical or sub-clinical ADHD symptomology. The rationale for these conclusions will be discussed in detail in Chapter 5.

CHAPTER 5

Discussion

Introduction

College students with ADHD are at risk of academic underperformance, are more likely to be on academic probation, and are less likely to graduate with a degree compared to non-ADHD peers (Barkley, 2006; Barkley et al., 2008, DuPaul, Weyandt & DuPaul, 2006; Wolf, 2011). Students with ADHD have identified inattention and distractibility as particularly detrimental to their academic functioning (DuPaul et al., 2009; Rabiner et al.) and recent research has confirmed that college students with ADHD experience more cognitive failure and detrimental mind wandering than non-impaired peers (Franklin et al., 2014; Gray et al., 2015). While the disabilities office on campuses offer a variety of accommodations and other assistive services, many students with ADHD have reported that they do not seek out the services (L. L. Weyandt & DuPaul, 2012)., College students with ADHD need an independently administered intervention that could assist them in harnessing their attention in order to comprehend lectures or academic texts. Researchers in both ADHD and mind wandering have called for the development of interventions that would facilitate metacognitive awareness and self-regulation by providing externalized sources of support for internal cognitive processes (R. A. Barkley, 2014; Franklin et al., 2014). This study sought to analyze the efficacy of a self-monitoring of attention intervention delivered via smartphone that would address this need.

Self-monitoring of attention has been proven to improve the attentive behavior of secondary students with ADHD (Harris et al., 2005) yet few studies have focused on self-monitoring as an intervention for college students. This dissertation is an extension of previous studies on the use of Self-Monitoring of Attention interventions (SMA) for students with ADHD

and an extension of previous studies on meta-awareness and mind-wandering; in addition, it adds to the literature on college students with ADHD, the literature on Self-Regulation, and the literature on Academic Self-Efficacy. The primary purpose of this study was to determine if using a Self-Monitoring of Attention intervention adapted for college students would improve the scores on measures of Attention, Effortful Control, and Self-Efficacy for post-secondary students with attention difficulties. A second purpose was to determine if participants felt comfortable using the intervention and if they thought it improved their ability to monitor and sustain attention during independent academic tasks.

In the current study, students in the experimental group used a SMA intervention (*Focus Check* app) that prompted them every ten minutes to record whether or not they were attending to the academic task at hand: academic reading or attending to a lecture. In addition, participants were taught a simple paraphrasing strategy designed to promote active engagement with a text or lecture as a means of operationalizing an attentive state (Appendix F). Students in the lagged-experimental group were instructed on the strategy as well, but were not provided with the *Focus Check* app during the initial two-week experiment.

A discussion of the social validity results is presented first. Following that, I will discuss the relationship between pre and post test outcomes for all participants, followed by a discussion of the relationship between ADHD status and outcomes, and lastly a discussion of the relationship between experimental and control (lagged treatment) group outcomes. Possible reasons for the relationship between group, time, and outcome measures are also discussed. Finally, a discussion of limitations and implications for future research is presented.

Social Validity: the Impact on Self-Efficacy and Self-Regulation

This is the first study to use an SMA intervention delivered via smartphone app. The majority of previous studies delivered the intervention via headphones and tape recorders, though other studies have used some form of technology to provide behavioral performance cues (Peña Lasiste Bedesem, 2010; Peña L Bedesem & Dieker, 2013; Cihak et al., 2010). Based on recent findings on the utility of self-monitoring of health issues via mobile app (Donker et al., 2013; Torous et al., 2015), I hypothesized that participants would find the delivery method acceptable and enjoyable. The results bear out this hypothesis: participants report finding *Focus Check* easy to use and, on the whole, reported that their experience using *Focus Check* was a positive one.

In addition to finding *Focus Check* easy and enjoyable to use, participants generally felt that the SMA intervention benefited them academically. The majority reported that using *Focus Check* improved metacognitive awareness of attention patterns. ADHD is correlated with high degrees of mind-wandering and lack of awareness of when, how, and why attention meanders off (Franklin et al., 2014; Smallwood et al., 2008). The concrete evidence and regular external prompting provided by *Focus Check* may be particularly useful for such students. Metacognition of attention is a necessary precursor to regulation of attention: as students begin to more accurately assess their own attention levels, they also begin to more effectively reduce unintentional mind-wandering. This is particularly relevant for college students with attention difficulties, as decreased mind-wandering has been correlated with higher reading and lecture comprehension scores (Mrazek, 2013; Risko, 2011).

Indeed, more than ¾ of participants felt that using *Focus Check* improved their understanding of course materials somewhat to very much. The findings represent participants' perceptions rather than objective measures of comprehension. Further research would be needed

to assess whether the SMA intervention has a direct effect on academic performance measures. However, that participants believe using *Focus Check* improved their ability to maintain focus and understand the course materials points to the intervention's salutary effect on academic self-efficacy. Self-efficacy, the belief that an individual can accomplish a self-determined goal, is an essential academic characteristic linked to persistence, engagement, and academic performance (Zimmerman, 2000; Zimmerman, Bandura, & Martinez-Pons, 1992).

It is not surprising that participants felt an increased sense of academic self-efficacy as these findings are in line with Bandura's Social Cognitive Theory of Self-Regulation. According to Bandura and others, the cycle of self-regulation involves four interrelated phases: observation, evaluation, reaction and efficacy. *Focus Check* provides students with a reliable means to monitor and evaluate their attention and, if needed, return it to a self-selected goal (in this case academic reading or lecture comprehension). According to Bandura, when self-observation is proximal and regular and evaluation specific and standardized, as they are when using *Focus Check*, individuals become more motivated to improve performance. Improved performance, in turn, results in increased feelings of self-efficacy (Bandura, 2001; Zimmerman, 2005).

Open-ended responses from the social validity survey give weight to the theory that proximal goal setting and monitoring increases motivation. One participant commented, "[*Focus Check*] was actually quite helpful in encouraging that I focus. It required me to focus back on the material when I dozed off"; another remarked, "I found the countdown of time on the app to be the best feature, because it made my study goals seem manageable and far less daunting." As individuals begin to believe that they are capable of completing a task, they become more willing to increase effort and persist, thus succeeding in their goal: a positive feedback loop ensues.

Focus Check helps college students struggling to regulate attention tap into this essential self-regulatory feedback loop.

The social validity results in this study are important not only in relation to *Focus Check*, but for researchers and practitioners interested in improving the access to and use of post-secondary learning strategies in general. Over 85% of young adults own smartphones, feel positively about them, and use them to navigate a host of life events (Pew Research, April 2015). Previous research has indicated that students with ADHD may avoid seeking help from the office of disabilities. Moreover many students with sub-clinical symptoms of ADHD are academically impacted but ineligible for disability services (Weyandt & DePaul, 2011; Gray, 2015, Symptom Manifestation and Impairments in College Students With ADHD}. Given the positive association that young people have with smartphones and the positive social validity results found in this study, it is likely that students would be receptive to academic interventions delivered via smartphones.

Social Validity is an essential component in any treatment design, particularly for adults who simply will not use an intervention they don't find easy and beneficial, regardless of how effective research has found the intervention to be. Children too, are less likely to benefit from an intervention that they cannot see the utility of or that they perceive to be stigmatizing. It may be that the SMA intervention, which showed great promise in terms of reducing inattentive behaviors but received lackluster social validity scores from participants, never became widely used because children and adolescents found the bulky headphones and paper and pencil tallying stigmatizing or in other ways unacceptable. *Focus Check*, designed to deliver the SMA via app, has been shown to have acceptable social validity, at least among the participants in this study.

The improved social validity reopens the doors for further research on the SMA intervention, not only for college students but for secondary students as well.

Outcomes

This study was the first to measure the efficacy of an SMA intervention on a cognitive process rather than on observable behavior, the first to assess the intervention on a post-secondary population, the first to deliver the intervention via smartphone app, and the first to use an experimental design to assess an SMA intervention.

A substantial body of research on the use of SMA interventions on elementary and secondary students with ADHD has documented significant differences between baseline and post-intervention scores on measures of time on task. Based on these studies, it was hypothesized that the use of *Focus Check* by the experimental group would significantly improve outcome scores on measures of attention, mind-wandering, effortful control, and academic self-efficacy compared to the lagged experimental group.

Main effects between the experimental and lagged experimental group were found for outcome scores on the BAARS-IV inattention and sluggish cognitive tempo subscales. However, no significant effects were found between the experimental and lagged treatment groups on measures of mind-wandering, effortful control or academic self-efficacy.

When the same analyses were run for the subset of participants identified as likely ADHD, the experimental group showed significant main effects on outcomes of mind-wandering and academic self-efficacy in addition to main effects for outcomes on measures of inattention and sluggish cognitive tempo. The subset of participants with likely ADHD was small (n = 15), therefore the statistical results for the subset are not conclusive. They do, however, point to the potential benefit of the SMA intervention and the need for further research on this population.

Unanticipated improvements from pre test to post test were also found for all participants, regardless of experimental or lagged treatment status, on outcome measures of the BAARS-IV inattention, hyperactivity/impulsivity, and sluggish cognitive tempo subscales; the mind-wandering scale, and the attention control scale. Those identified as having ADHD additionally showed statistically significant improvements, regardless of *Focus Check* use, on outcome measures of the MSLQ: Metacognitive Self Regulation subscale.

In the main, participation in this study, regardless of *Focus Check* use, resulted in statistically significant improvements on outcome measures of ADHD, mind-wandering, and attention control, with *Focus Check* use resulting in a statistically significant improvement above and beyond that shown by the group as a whole on measures of inattention and sluggish cognitive tempo.

Discussion of Within Group Results: Social Cognitive Theory

The findings that the group as a whole improved on several of the attention regulation outcome measures ran contrary to expectations. The nature of the population obtained for this study, the Social Cognitive Theory of self-regulation, and planned and unplanned aspects of the study design, offer possible explanations.

Participants in this study were postsecondary students from UCLA who self-identified as having difficulty sustaining attention during academic tasks. However, of the 48 participants, only 15 screened as likely to meet the criteria threshold for ADHD. Individuals with ADHD have been found to have poorer self-regulation than their peers without ADHD. It is possible that the method of securing participants via self-selection resulted in a sample that learned and employed strategies more quickly and efficiently than a sample comprised of participants with ADHD

would have. A sample with higher self-regulation would likely improve on outcome measures without the prompting provided by *Focus Check* use.

In this study, participants were provided with the task to attend to academic reading or a lecture. All participants were taught a reading and listening comprehension strategy. Furthermore, all participants were prompted through experience sampling surveys to think metacognitively about their attention and approach to academic tasks. According to the Social Cognitive Theory of self-regulation, for students without ADHD impairment, the strategy and experience sampling reinforcements may have been enough to significantly improve outcomes.

The Social Cognitive Theory of self-regulation, as mentioned previously in this chapter, suggests that individuals select a goal, make plans to achieve that goal, and then monitor and adjust their behavior in pursuit of it (Zimmerman & Bandura, 1994). Each of these stages influences the others and each stage draws on several cognitive and behavioral attributes. Bandura and Zimmerman point out the necessity of recognizing the interplay between the various cognitive and behavioral characteristics required for effective self-regulation: motivation, self-efficacy, metacognition, goal-maintenance, monitoring, and strategy use (Bandura, 1977; Zimmerman, 2002). For the purposes of this study, I am going to discuss goal-maintenance, it's relation to working memory capacity, and it's usefulness in helping to understand why these particular participants may have shown improvement in attention regulation outcome measures regardless of whether or not they used the *Focus Check* intervention.

The role of working memory on goal maintenance and the need for external prompting. To look at why students without ADHD might be more likely to make gains without using *Focus Check*, it is important to touch briefly on the role of working memory in goal maintenance. Students with ADHD have been shown to have deficits in working memory

(Barkley, 1997), which, broadly speaking is the ability to hold a visual or verbal concept in mind while simultaneously performing related tasks. It is essential in the establishment and maintenance of a proximal goal (McVay & Kane, 2012). If an individual can hold the goal in mind, they are able to harness cognitive resources in pursuit of that goal, notice if they veer away from it, and course correct quickly (McVay & Kane, 2012). The goal serves as both a guide and a touchstone for measuring progress. Though the working memory capacity of the participants in this study was not measured, the fact that the majority of them did not report impairing symptoms of ADHD suggests that on the whole they would have intact working memory capacity. It follows that participants would be able to maintain a goal in mind while simultaneously harnessing their attention and applying strategic learning in pursuit of that goal, without needing the extensive prompting provided by the *Focus Check* app.

Comments from participants without ADHD bear out this explanation. Several participants without ADHD indicated that they found *Focus Check* helpful at first, but after a short time no longer needed it or found it intrusive. One participant commented, “The first couple of times help reset my focus. Then quickly I didn't need to use it to help me focus”; another remarked, “Initially the app seemed really helpful and it encouraged me to stay on track. However, after much use, every time it asked me if I was on task, up to that moment I would be, but after having to answer that question it would put me off task.” These comments add weight to the interpretation that in the main, participants without ADHD needed fewer prompts in order to activate and sustain attention during academic tasks. Thus, regardless of *Focus Check* use, participants may have improved on outcome measures as a result of initially learning the reading and listening comprehension strategy and the reinforcement of that learning through experience sampling surveys.

Possible effect of reading and listening comprehension strategy on outcome measures. The reading and lecture strategy taught to all participants at the start of this study certainly had the potential of improving self-regulated attention. It was selected as a means of operationalizing on-task attention during reading and lectures and was provided to both the experimental group and the lagged treatment group. The strategy, a variation of the University of Kansas paraphrasing strategy (RAP), was modified to suit the needs of post-secondary students. Participants were taught to mentally ask questions about the content to assist with engagement and focus and to periodically pause to chunk, paraphrase, and summarize content to assist with maintaining a gestalt of the information. While the strategy is fairly simple to learn, it requires sustained mental effort and engagement in order to be effective.

My original plan had been to deliver the reading and listening comprehension strategy to all participants in a lecture style setting because I felt that this method would introduce the strategy enough to operationalize "attentive academic processing" without being impactful enough to solidify the details of the strategy in most participants' minds. However, because participants were recruited across several weeks instead of in one session, I ended up modeling the use of the strategy with each participant individually. This method may have unintentionally increased bias within the study. First, participants interacted with me personally in a way that I had not intended, which may have increased the demand characteristics of the study and led participants to strive more than they would have otherwise. Research on demand characteristics has found that participants who have positive personal interaction with the researcher tend to behave in ways that they believe will aid the study (Nichols & Maner, 2008). Secondly, the individualized instruction may have served to more effectively teach the strategy and therefore increase its usage regardless of whether or not participants were simultaneously using *Focus*

Check. Research also bears out the explanation that modeling improves performance, specifically that modeling effective reading strategies results in improved self-regulation of reading among secondary students (Shunk & Zimmerman, 2007). It is plausible that by modeling the reading and lecture strategy to individuals rather than by presenting it to a group, I unintentionally motivated participants to use the strategy both more effectively and more often than I had hypothesized they would.

In fact, participants did record that they found the reading and lecture strategy beneficial. Results of the experience sampling surveys captured 116 in the moment reactions of participants while using the strategy: 80 responses from the lagged treatment group and 36 from the experimental group. The majority of responses from both groups indicate that participants found the reading and listening comprehension strategy useful. Given the characteristics of this sample, the individualized modeling of the reading and listening comprehension strategy, and the positive responses captured in the experience sampling surveys, it seems reasonable to conclude that in this study, the reading and listening comprehension strategy likely contributed to statistically significant improvements in outcome measures of attention control regardless of *Focus Check* use.

Reactivity effect of experience sampling surveys. In addition to the reading and listening comprehension strategy, all participants received daily experience sampling surveys that may also have heightened participants' self-regulation and contributed to improved outcome measures. Although I was aware that the experience sampling survey had the potential to prompt and reinforce attention control in the lagged treatment group, I chose to deliver it to both groups in order to ensure equivalent conditions. I hypothesized that the experience sampling surveys would not be reinforcing enough for students with attention difficulties to elicit change.

However, given the characteristics of the sample obtained for the study, it seems likely that the experience sampling surveys did provide enough reinforcement to aid in producing positive results in the lagged treatment group.

The experience sampling survey, "Daily Attention Monitoring" was delivered via e-mail to all participants three times a day for the first five days of the study. It consisted of twelve questions that prompted participants to rate the level of focus required by their current activity and make note of the strategies they were using to improve focus, if any. Regardless of whether or not participants were engaged in an academic activity at the time (48% of the time they were), they were prompted to reflect on harnessing and monitoring their attention fifteen times during the first week of the experiment. And participants in this study were surprisingly diligent about completing and returning their surveys. Participants in the lagged experimental group returned 280 surveys and those from the experimental group returned 272. The substantial return rate indicates that the majority of participants did pause to reflect on their attention patterns and approach to academic tasks several times over the course of the study.

Reactivity studies on self-regulation interventions posit that the presence of a self-monitoring intervention, including simply the device used to deliver the intervention, can serve as an external cueing process that initiates the self-regulation cycle (Nelson & Hayes, 1981). It seems possible that students reacted to the experience sampling surveys as a de-facto SMA intervention as it prompted them to reflect on their attention. For participants in this study, the majority of whom did not have ADHD, it is likely that the experience sampling surveys combined with the modeled reading and lecture strategy provided sufficient instruction and reinforcement thereby enabling participants to internalize a self-regulated approach to reading and lectures. Once internalized, participants would no longer need prompting in order to activate

the strategy and thus, would improve across measures of attention control regardless of *Focus Check* use. That use of *Focus Check* significantly improved outcome measures of inattention and sluggish cognitive tempo above and beyond the improvements found for the group as whole will be discussed in a later section.

Discussion of Between Group Outcome Measures: Likely ADHD Sub-Sample

The majority of participants secured for this experiment did not experience impairing symptoms of ADHD, therefore, likely would not experience ensuing deficits in self-regulation, and would not need the same level of reinforcement and prompting that individuals with poor self-regulation require. It follows that participants with ADHD, who need regular and reliable external monitoring, should find the *Focus Check* app more beneficial than participants without ADHD. The findings bear out this hypothesis.

As was true with the experimental and lagged treatment groups, participants in the likely ADHD experimental group showed main effects on measures of the BAARS-IV inattention, and sluggish cognitive tempo scales compared to the likely ADHD lagged treatment group. However, the likely ADHD experimental group showed additional main effects on outcome measures of mind-wandering and academic self-efficacy. These findings are not surprising given previous research on the self-regulation deficits due to limited working memory capacity in individuals with ADHD (Barkley, 1997). Working memory and self-regulation deficits suggest that individuals with ADHD would benefit from external prompting more than their non-impaired peers.

According to the Social Cognitive Theory of self-regulation, goal-maintenance drives many aspects of the self-regulation cycle: planning, executing, monitoring, and reflecting. Because students with ADHD in general have lower working memory capacity, they are less

able than non-impaired peers to maintain a goal in mind while simultaneously pursuing it. Regardless of how motivated a student is, a proximal goal, such as maintaining focus on a complex text, may disintegrate over time. However, if prompted externally and regularly, an individual with ADHD can choose to consciously return attention to the proximal goal and initiate previously learned strategies. The external prompting, in effect, bolsters an inefficient working memory system and provides individuals with the support they need to use what they know (Barkley, 1997). A recent study on mind-wandering supports this theory. Participants with ADHD symptomology experienced higher degrees of mind wandering but as the participants became aware of mind wandering they were able to exert a level of control over it. It seems that the use of *Focus Check* externalizes the self-regulating process for students for whom wholly internalized self-regulation is not cognitively possible, thereby resulting in significant improvements on measures of mind-wandering and academic self-efficacy in addition to attention.

Main effect on measures of attention in likely ADHD sub-group. Participants with likely ADHD in the experimental group showed statistically significant improvements on three measures of attention control: the BAARS-IV Inattention subscale, the BAARS-IV Sluggish Cognitive Tempo subscale and the Mind-Wandering Scale. The BAARS-IV Inattention scale consists of nine item that capture the inability to persistently give attention to a selected activity while the BAARS-IV Sluggish Cognitive Tempo sub scale consists of eight items that capture the qualities of "spacing out," unintentional daydreaming, and general mental and physical lethargy. The Mind-Wandering Scale consists of five items assessing an individual's ability to sustain attention on a given task or stimulus. It is particularly relevant to this study as it specifically identifies the ability to attend to lectures and reading. The finding that participants

with ADHD improved significantly on these three scales has substantial consequences as researchers have identified inattention, cognitive failure, and unintentional mind-wandering as particularly troublesome for college students with ADHD (Weyandt & DuPaul, 2011; Franklin, 2014; Gray, 2015).

The mind-wandering subscale, together with the BAARS-IV inattentive and cognitive sluggish tempo subscales, captures the qualities of inattentive processing that the *Focus Check* app was designed to ameliorate. *Focus Check* is meant to help individuals approximate sustained attention by regularly prompting them to become conscious of their thoughts. If desired, an individual then has the opportunity to usher wandering thoughts back to the previously selected goal or task. The role of sustaining a goal is in a sense off-loaded to the self-monitoring intervention, in this case, the *Focus Check* app. Though inconclusive due to the small sample size (n = 15) the positive findings from this study point to the likelihood that *Focus Check* use may prove particularly beneficial at helping college students with ADHD gain a measure of control over inattentiveness, thereby providing support for those students who are motivated to achieve self-selected academic goals.

It should be noted that the actual amount of improvement in attention that these results indicate is not conclusive; further research would need to be conducted to establish levels of attention processing improvement. The BAARS-IV has been previously used in treatment research, primarily for medication studies, but also for at least one cognitive behavioral intervention (Saffren, et al., 2005). The author of the BAARS-IV, Russell Barkley has established a threshold that identifies a clinically significant improvement at 30% or more reduction of symptoms after treatment. In this study, most participants did not reach that level of

improvement, though given the nature of the study further research is recommended to retest the findings with a population of participants with ADHD.

The Mind-Wandering Scale has not been previously used in treatment research. Researchers have, however, established convergent validity between the Mind-Wandering Scale and levels of mind-wandering captured via thought sampling. Thought sampling is a method of capturing mind-wandering or failures in attention that has been validated with a variety of methodologies including fMRIs (Smallwood, et al. 2008, Christoff, et al. 2009). The negative correlation between scores on the Mind-Wandering Scale and scores on a task of working memory has also been established (Mrazek, et al. 2013). Moreover, in a recent study participants with higher levels of AHDH symptomology also showed higher levels of unintentional mind-wandering (Franklin, 2014). Thus, significant improvement on the Mind-Wandering Scale would likely indicate a significant level of improvement in attention control.

Research on Mind-Wandering has established that mind-wandering has a negative impact on reading comprehension and lecture comprehension. Students with higher levels of mind-wandering are less able to create a gestalt of presented information because of the interference of task unrelated thoughts (Smallwood, 2011). The ability to decrease mind-wandering would obviously be of immense academic benefit. Researchers on mind-wandering are starting to explore possible remedies for individuals who wish to harness their attention and decrease mind-wandering. Among the treatments being looked at are mindfulness meditation practice and working memory training (Mrazek, et. al., 2014). If further research corroborates the findings here that *Focus Check* decreases mind-wandering for students with impairing symptoms of ADHD, it would be of significant value to the field of mind-wandering, as well as to secondary and post-secondary students with attention difficulties.

Academic self-efficacy outcomes: ADHD only sub-sample. It was hypothesized that participants in the experimental group would improve on measures of Academic Self-Efficacy; however only those in the experimental group designated as likely ADHD showed significant mean improvements. Again, this finding is not surprising in light of previous research establishing that students with ADHD in general have depressed academic self-efficacy relative to their non-impaired peers (Rabiner, et al., 2008; Tabassam, et al., 2007). In particular, students with ADHD have noted difficulty managing inattentiveness (DuPaul et al., 2009; Rabiner et al.). Therefore, an intervention such as *Focus Check*, that provides students with a reliable means of harnessing attention, would likely increase feelings of control and self-determination. This finding is significant, as strong academic self-efficacy has been correlated positively to increased retention and academic performance (Zimmerman, 2011).

Overall, the subsample of participants with ADHD in the experimental group showed significant improvements in attention regulation and academic self-efficacy. These findings are particularly salient as inattentiveness and low academic self-efficacy have been tied to academic outcome and identified by students with ADHD as particularly impairing. Though the findings must be taken in light of the small sample size used here, if validated by further research, they could be immensely beneficial to any individual with sub-threshold or impairing levels of ADHD who experiences difficulty maintaining focus on a self-selected task. The results indicate that individuals with ADHD are not at the mercy of their cognitive profile when it comes to harnessing attention, but can find and use strategies, such as *Focus Check* or other SMA interventions, to bolster a faulty working memory, support the self-regulation cycle, and more effectively pursue a self-selected goal.

Experimental Results

I chose to perform an experiment for this study because I wanted to use the most stringent scientific means available to assess the efficacy of *Focus Check*. In this study, the experimental group, on average, showed significant mean improvements on measures of BAARS:IV inattentiveness and sluggish cognitive tempo compared to those in the lagged treatment group. The significant experimental results point to a preliminary conclusion that the *Focus Check* app was effective in reducing symptoms of inattentiveness and sluggish cognitive tempo among this sample of college students with self-identified attention difficulties. Further research will need to be done in order to determine the clinical significance of these findings. In order to fully assess the efficacy of *Focus Check* using Barkley's treatment effect guidelines, a more extensive experiment with participants who fall outside the normal range of scores on inattentiveness and sluggish cognitive tempo is needed.

This randomized controlled experiment extends the research on self-monitoring of attention and extends studies on metacognition and mind-wandering. It adds important information to the literature on ADHD in general and on college students with ADHD in particular; the literature on reading and listening comprehension strategies; the literature on self-regulation; and the literature on the use of technology in education. The significant findings for the experimental group on measures of inattention and sluggish cognitive tempo, and for the ADHD sub-group on measures of inattention, sluggish cognitive tempo, mind-wandering, and academic self-efficacy along with the positive social validity results give rise to several future studies that could further examine the results found here.

Limitations

In order to appropriately assess the discussions of these findings, limitations inherent the design and additional limitations that arose during the experiment are summarized here.

This dissertation study was designed as a preliminary study to examine the efficacy and social validity of a Self-Monitoring of Attention intervention: *Focus Check* on attention, effortful control, and self-efficacy among college students with self-identified attention difficulties at a highly selective public research university. Therefore, findings from this study cannot be generalized to the general population of college students with attention problems, college students with ADHD, or college students in general.

The study did not control for the dosage of the reading and listening comprehension strategy. All participants were taught the strategy immediately following the initial pre test and given a paper copy of it. Monitoring the use of the strategy during academic reading and lectures was beyond the scope of this study. Experience sampling survey results indicate that participants in both groups used the strategy, but it is unknown if they recalled it from memory or referred to the paper instructions. It is possible that changes in outcome measures for both the experimental and control group in part reflected use of the reading and listening strategy. Further research should consider evaluating the impact of the paper based reading and listening comprehension strategy without *Focus Check*, evaluating *Focus Check* without the attendant reading and listening comprehension strategy, or controlling exposure to the strategy.

The experience sampling surveys may also have provided a confounding influence on outcome measures, particularly with the highly motivated sample used in this study. Experience sampling surveys delivered thrice daily for the first five days of the study may have served as enough of an external prompt to effectively shift the outcome measures of attention during the

two-week experimental period. Though the information gleaned was valuable for this initial exploratory study, further research should consider eliminating the experience sampling surveys.

Perhaps the most impactful limitation is the low percentage of participants who scored as having likely ADHD. While this study was designed to measure the efficacy of *Focus Check* on college students with self-defined levels of attention difficulties, its primary purpose was to evaluate the efficacy of the intervention on students with at least sub-threshold attention impairment. Researcher attempts to recruit a larger sample of participants with likely ADHD were not successful. Because of the small sample size of the ADHD only group, differences in outcome measures may be underestimated. Further research should examine larger samples of college students with ADHD in order to effectively evaluate differences in outcome measures.

Finally, the use of the Adult Temperament Scale questionnaire as a measure for treatment efficacy is perhaps not sensitive to treatment effect. Though there were some significant findings on the ATS outcome measures; the scale is primarily a temperament and personality scale designed to measure relatively stable traits. The BAARS-IV attention scale, mind-wandering scale, and motivated strategies for behavior scales, on the other hand, are more sensitive to changes in behavior and are, therefore, more suitable to capture treatment effects. Future studies should evaluate which instruments are the most sensitive to the outcomes addressed by the intervention. Furthermore, treatment effect should be evaluated in light of the needs of college students with sub-threshold levels of ADHD, as well as those with diagnosed ADHD (Weyandt and DePaul, 2011). For example, the subscales of inattention and sluggish cognitive tempo are more relevant to academic achievement for college students than the subscale of impulsivity/hyperactivity (L. Weyandt et al., 2013). Also, it is possible that smaller shifts in ability may be relevant for college students with ADHD, who tend to be more motivated and less

impaired, than the typical adult population with ADHD (Weyandt and DePaul, 2011). Further research using only the BAARS-IV inattention and sluggish cognitive scales or the Mind-Wandering Scale may provide more find-grained results than those found here.

Implications and Recommendations for Future Research

The findings from the current study engendered several ideas for future research both directly and indirectly related to the *Focus Check* attention monitoring intervention.

Researchers investigating mind-wandering might focus more specifically on the effect of *Focus Check* on measures of mind-wandering during lectures or academic reading, particularly as research on the effect of mind-wandering on reading and lecture comprehension is already being pursued, as is the potentially beneficial effect of mindfulness on mind-wandering and the beneficial effect of external prompting on mind-wandering (Mrazek, et al., 2014; Franklin, 2014). As *Focus Check* mimics some aspects of mindfulness, (i.e. bringing awareness to one's own thoughts in a non-judgmental way), and is an external prompting intervention that stimulates metacognition, it seems a fitting companion piece to current research on mind-wandering.

The social validity and experience sampling surveys indicate that college students find using an educational intervention delivered via smart phone acceptable and effective, thus opening the door for a variety of academic interventions that college students could access via smartphone and employ during academic reading or lectures. Furthermore, the use of attention prompting and strategic cueing within existing technologies, such as e-books, could intensify the academic benefit of those technologies. The results from this study indicate that exploring the use of attention prompting and other technology imbedded interventions to assist college

students with sustaining attention during academic reading and lectures warrants further investigation.

Furthermore, the significant post test outcomes for all participants suggests that fairly straightforward and simple strategy training for college students regardless of ADHD diagnosis might be an effective way to increase academic engagement. Further research on the effectiveness of a modified version of the RAPS strategy on the reading and lecture comprehension for college students is suggested. The benefit of the RAPS strategy for college students has been documented elsewhere (Weyandt & DuPaul, 2011) and the relative ease with which it can be taught and utilized as well as it's cost-effectiveness make it a particularly attractive target for research.

Finally, this study generated valuable insight on the research design for future studies investigating Self-Monitoring of Attention interventions delivered via smartphone for college students with attention difficulties. Further research should consider replicating this study with a sample consisting of students with threshold and sub-threshold levels of ADHD to evaluate the impact on the population for whom the intervention was designed. Furthermore, future SMA intervention studies may want to limit the outcome measures to the inattention and sluggish cognitive tempo subscales of the BAARS-IV, as well as establishing "treatment effect" criteria that reflects the needs of a college population, which may be more sensitive to improvements in inattentive behavior than the typical adult population with ADHD.

It is also suggested that future research investigating the effectiveness of *Focus Check* on college students provide an effective reading and listening comprehensions strategy, such as the one used here, as a means of operationalizing on-task attention, but that the strategy be taught to

all individuals in a group setting a few days before the start of the intervention to lessen the potentially confounding effect of the strategy on outcome measures.

Although this study did not find significant results for dosage, in a sample of more typical participants with ADHD or sub-threshold levels of ADHD dosage rates might make a significant difference; therefore it is suggested that future studies assess the efficacy of the SMA intervention delivered via smartphone in light of dosage rates.

Finally, in this study, using *Focus Check* significantly improved academic self-efficacy for participants with ADHD. Academic self-efficacy has been tied to positive academic outcomes, particularly motivation and persistence. It's also an area in which college students with ADHD self-report feeling vulnerable (Rabiner, 2007). Further research on the impact of *Focus Check* and other self-selected academic interventions on the academic self-efficacy of college students with ADHD is suggested.

Conclusion

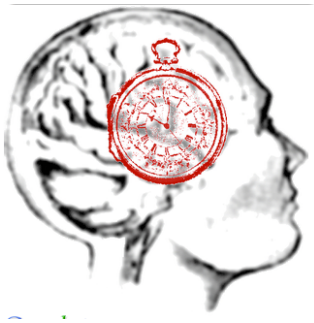
Young adults with ADHD are enrolling in college in ever increasing numbers, yet in the main they are not thriving., A significant number of them experience academic anxiety, depressed GPAs, academic probation, and failure to graduate (R. Barkley et al., 2008; Blase et al., 2009; DuPaul et al., 2009; Heiligenstein et al., 1999; Meaux et al., 2009). Inattentiveness, mind-wandering, and cognitive failure have been found to be particularly problematic (L. L. Weyandt et al., 2003; Gray, 2015; Franklin, 2014). This study found that using *Focus Check*, a self-monitoring of attention intervention delivered via smartphone app, resulted in statistically significant reduction of symptoms on measures of inattention and sluggish cognitive tempo among college students with self-identified attention difficulties. Furthermore, statistically significant results were found for the small subset of participants with likely ADHD on measures

of inattention, sluggish cognitive tempo, mind-wandering, and academic self-efficacy. If future research validates these exploratory findings, *Focus Check*, or similar attention monitoring apps, would provide students with a cost-effective, reliable, and independently administered method of reducing mind-wandering, sustaining attention, and improving self-regulation. The byproduct of increased self-determination and the potential for improved academic persistence and productivity make the prospect of future research on this intervention even more relevant.

APPENDIX A

Volunteer Recruitment Flyer

Are you experiencing difficulty *focusing* during lectures or while studying?



Volunteers wanted for UCLA research study

Effect of self-monitoring on attention

What is the project?

Study will examine how attention management tools might help students improve focus during academic activities, such as reading and lectures.

Who is eligible?

- UCLA students over 18
- i-phone required
- currently having difficulty remaining focused during lectures or reading

What will you be asked to do?

- Attend an initial 1/2 hour session.
- Regularly record observations about your attention levels through e-mail or i-phone app (provided).
- Complete one paper & pencil, and two online surveys.

Compensation?

- Up to $20.00 for your participation.
- Opportunity to enter raffle for I-pad.

Potential benefits

- You may benefit by becoming more aware of your own patterns of attention.
- You may find the interventions beneficial.

If you have any questions or are interested in participating please contact the Principal Investigator Katharine Gibson

kgibsondayan@ucla.edu **818-307-2126**

UCLA

This study is conducted under the supervision of Dr. Tina Christie, Dept. of Education. & Information Studies
University of California, Los Angeles Department of Education IRB# 14-000180

APPENDIX B

Instrumentation

B1. *Post test and social validity survey*

Attention Monitoring Study: Final Post-Test & Social Validity Survey

Baars Attention Rating Scale

* 1. What is your participant id?

Participant ID

Instructions

For the first 27 items, please click on the circle that best describes your behavior during the past two weeks.

2. Fail to give close attention to details or make careless mistakes in my work or other activities

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

3. Difficulty sustaining my attention in tasks or fun activities

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

4. Don't listen when spoken to directly

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

5. Don't follow through on instructions and fail to finish work or chores

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

6. Have difficulty organizing tasks and activities

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

7. Avoid, dislike, or am reluctant to engage in tasks that require sustained mental effort

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

8. Lose things necessary for tasks or activities

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

9. Easily distracted by extraneous stimuli or irrelevant thoughts

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

10. Forgetful in daily activities

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

11. Fidget with hands or feet or squirm in seat

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

12. Leave my seat in classrooms or in other situations in which remaining seated is expected

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

13. Shift around excessively or feel restless or hemmed in

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

14. Have difficulty engaging in leisure activities quietly (feel uncomfortable, or am loud or noisy)

○	○	○	○

15. I am "on the go" or act as if "driven by a motor" (or I feel like I have to be busy or always doing something)

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

16. Talk excessively (in social situations)

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

17. Blurt out answers before questions have been completed, complete others' sentences, or jump the gun

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

18. Have difficulty awaiting my turn

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

19. Interrupt or intrude or others (butt into conversations or activities without permission or take over what others are doing)

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

20. Prone to daydreaming when I should be concentrating on something or working

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

21. Have trouble staying alert or awake in boring situations

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

22. Easily confused

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

23. Easily bored

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

24. Spacey or "in a fog"

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

25. Lethargic, more tired than others

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

26. Underactive or have less energy than others

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

27. Slow moving

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

28. I don't seem to process information as quickly or as accurately as others

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

Attention Monitoring Study: Final Post-Test & Social Validity Survey

Mind-Wandering Scale

This survey asks you questions about how often and when you find your mind-wandering from the task at hand.

29. I have difficulty maintaining focus on simple or repetitive work.

Almost never	Very infrequently	Somewhat infrequently	Somewhat frequently	Very frequently	Almost always
○	○	○	○	○	○

30. While reading, I find I haven't been thinking about the text and must therefore read it again.

Almost never	Very infrequently	Somewhat infrequently	Somewhat frequently	Very frequently	Almost always
○	○	○	○	○	○

31. I do things without paying full attention

Almost never	Very infrequently	Somewhat infrequently	Somewhat frequently	Very frequently	Almost always
○	○	○	○	○	○

32. I find myself listening with one ear, thinking about something else at the same time.

Almost never	Very infrequently	Somewhat infrequently	Somewhat frequently	Very frequently	Almost always
○	○	○	○	○	○

33. I mind-wander during lectures or presentations.

Almost never	Very infrequently	Somewhat infrequently	Somewhat frequently	Very frequently	Almost always
○	○	○	○	○	○

Attention Monitoring Study: Final Post-Test & Social Validity Survey

Effortful Control Scale

Please answer the questions below as honestly as you can. Thank-you.

34. I am often late for appointments.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

35. I often make plans that I do not follow through with.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

36. I can keep performing a task even when I would rather not do it.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

37. I can make myself work on a difficult task even when I don't feel like trying.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

38. If I think of something that needs to be done, I usually get right to work on it.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

39. I usually finish doing things before they are actually due (for example, paying bills, finishing homework, etc.).

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

40. When I am afraid of how a situation might turn out, I usually avoid dealing with it.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

41. It's often hard for me to alternate between two different tasks.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

42. When I am trying to focus my attention, I am easily distracted.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

43. When interrupted or distracted, I usually can easily shift my attention back to whatever I was doing before.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

44. It is very hard for me to focus my attention when I am distressed.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

45. When I am happy and excited about an upcoming event, I have a hard time focusing my attention on tasks that require concentration.

Never or rarely	Sometimes	Often	Very Often
○	○	○	○

Thank-you for taking the time to fill out this survey. If you have any questions or comments, please contact Katharine Gibson at kgibsondayan@ucla.edu

Attention Monitoring Study: Final Post-Test & Social Validity Survey

Motivated Strategies for Learning Survey

Please answer the following questions as honestly as possible on a scale from "Not at all true of me" to "Very true of me". Thank-you!

46. During class time I often miss important points because I'm thinking of other things.

1 = Not at all true of me	2	3	4	5	6	7 = Very true of me
○	○	○	○	○	○	○

47. When reading for my courses, I make up questions to help focus my reading.

1 - Not at all true of me	2	3	4	5	6	7 - Very true of me
○	○	○	○	○	○	○

48. I often feel so lazy or bored when I study for class that I quit before I finish what I planned to do.

1 - Not at all true of me	2	3	4	5	6	7 - Very true of me
○	○	○	○	○	○	○

49. When I become confused about something I'm reading for this class, I go back and try to figure it out.

1 - Not at all true of me	2	3	4	5	6	7 - Very true of me
○	○	○	○	○	○	○

50. If course materials are difficult to understand, I change the way I read the material.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

51. I work hard to do well in this class even if I don't like what we are doing.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

52. Before I study new course materials thoroughly, I often skim it to see how it is organized.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

53. I ask myself questions to make sure I understand the material I have been studying in this class.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

54. I try to change the way I study in order to fit the course requirements and instructor's teaching style.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

55. I often find that I have been reading for class but don't know what it was all about.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

56. When course work is difficult, I give up or only study the easy parts.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

57. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

58. Even when course materials are dull and uninteresting, I manage to keep working until I finish.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

59. When studying for this course I try to determine which concepts I don't understand well.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

60. When I study for this class, I set goals for myself in order to direct my activities in each study period.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

61. If I get confused taking notes in class, I make sure I sort it out afterwards.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

62. I believe I will receive an excellent grade in my classes.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

63. I'm certain I can understand the most difficult material presented in the readings for this course.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

64. I'm confident I can understand the basic concepts taught in this course.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

65. I'm confident I can understand the most complex material presented by the instructor in this course.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

66. I'm confident I can do an excellent job on the assignments and tests in this course.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

67. I expect to do well in this class.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

68. I'm certain I can master the skills being taught in this class.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

69. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.

Not at all true of me						Very true of me
○	○	○	○	○	○	○

Attention Monitoring Study: Final Post-Test & Social Validity Survey

Social Validity Survey

The following survey asks you questions about your experience using the Focus Check app. Please answer as honestly as possible. Thank-you!

70. At this point, how logical does the Focus Check app method of improving focus seem to you?

Not at all logical		Somewhat logical		Very logical
○	○	○	○	○

71. To what extent do you feel like using the Focus Check app made you more aware of your own patterns of attention?

Not at all improved awareness		Somewhat improved awareness		Very much improved awareness
○	○	○	○	○

72. At this point, how successful do you think using the Focus Check app is at reducing inattentive symptoms during lectures and academic reading?

Not at all successful		Somewhat succesful		Very succesful
○	○	○	○	○

73. By the end of the experiment period, how much improvement in your ability to maintain focus during lectures or academic reading do you think occurred?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
○	○	○	○	○	○	○	○	○	○	○

74. How much do you feel like using Focus Check helped you improve your understanding of your course material in the past two-weeks?

Not at all improved		Somewhat improved		Very much improved
○	○	○	○	○

75. How easy was the Focus Check app to use?

Not at all easy to use		Somewhat easy to use		Very easy to use
○	○	○	○	○

76. How much did you enjoy using the Focus Check app?

Not at all enjoyable		Somewhat enjoyable		Very enjoyable
○	○	○	○	○

77. How comfortable did you feel using the Focus Check app during lectures?

Not at all comfortable		Somewhat comfortable		Very comfortable	N/A
○	○	○	○	○	○

78. How comfortable did you feel using the Focus Check app in front of others while studying or reading?

Not at all comfortable		Somewhat comfortable		Very comfortable
○	○	○	○	○

79. How confident would you be in recommending the Focus Check app to a friend who has difficulty maintaining attention during lectures or while studying?

Not at all confident		Somewhat confident		Very confident
○	○	○	○	○

80. How likely do you think it is that you will continue to use Focus Check after the experiment?

Not very likely		Somewhat likely		Very likely
○	○	○	○	○

81. Overall, how positively would you rate your experience using the Focus Check app?

Not at all positive		Somewhat positive		Very positive
○	○	○	○	○

82. I am interested in your feedback and observations about using the Focus Check app. Please feel free to comment here about your experience.

83. Do you have any suggestions that you think would make the Focus Check app more effective, easy to use, or pleasant to use?

Thank you so much for your participation in the Attention Monitoring Experiment. You have now completed the study and are eligible to be entered into the raffle for an I-pad mini. Once the study is completely over, I will be contacting you with the results of the study. Thank you again!

B2. Experience Sampling Survey

Daily Attention Monitoring

The following survey asks questions about your recent activities. Please answer as honestly as you can. Thank-you.

* 1. What is your participant id?

2. Which activity best describes what you are doing right now?

- [ ] Relaxing alone
- [ ] Relaxing with friends
- [ ] Academic Reading
- [ ] Attending class
- [ ] Other academic activity
- [ ] Other

3. In your opinion, how much effort does your current activity require?

Little or none	Some effort	Sustained effort	Extreme effort
○	○	○	○

4. How focused are you on your current activity?

Not at all focused	Occasionally focused	Mostly focused	Extremely focused
○	○	○	○

5. If you are engaged in an academic activity, are you using any strategies or other methods to keep yourself focused and on-task?

- [ ] N/A
- [ ] No
- [ ] Reading strategy
- [ ] Lecture strategy
- [ ] FocusCheck

Other (please specify)

6. How helpful do you find the strategies you are using?

Not at all helpful	Somewhat helpful	Helpful	Very helpful	N/A
○	○	○	○	○

7. Approximately how much sleep did you get last night?

- [ ] 8 or more hours
- [ ] 7 hours
- [ ] 6 hours
- [ ] 5 hours
- [ ] under 4 hours

8. Approximately how many caffeinated drinks have you had today, including coffee, tea, and soda?

- [ ] 0
- [ ] 1-2
- [ ] 3-4
- [ ] over 4

9. About how many drinks (1 glass of wine, 1 beer, or 1 mixed drink) have you consumed in the last 24 hours?

- ( ) 0
- ( ) 1-2
- ( ) 3-4
- ( ) 4-5
- ( ) over 5

10. How are you feeling right now?

- [ ] Relaxed
- [ ] Anxious
- [ ] Alert
- [ ] Lethargic
- [ ] Positive Mood
- [ ] Negative Mood
- [ ] Neutral Mood

Other (please specify)

Thank-you for taking the time to fill out this survey. If you have any questions or comments, please contact me at kgibsondayan@ucla.edu.

APPENDIX C

Assumptions Testing

C1. Assumptions Testing

Several assumptions must be met in order to use General Linear Model Tests. The sample size must be >10 + number of levels in the repeated factor, or 12. This assumption was met for all tests with the smallest sample = 47. In addition the smallest cell must be ≥ 5. This assumption was satisfied for all tests with the smallest value in any cell = 19. The repeated measures variable must be an interval level variable. Although the repeated measures variables tested were ordinal level measurements, they are treated here as interval level variables in order to run linear models.

Group membership in the experimental or lagged treatment group is dichotomous and therefore meets the factor requirement. Lastly, the data must be normally distributed around the mean. Distribution for mean scores on all measures except BAARS IV: Inattention, and BAARS IV: ADHD total score met the assumptions of normality: skew and kurtosis of the distribution between the range of -1 and +1. Table 3 contains the means, standard deviations and standard error of scores in the total sample as well as information about the distribution for each of these variables. The assumption of homogeneity of variance is supported for each measure by Levene's test for equality of variances. The assumption of sphericity was met using Mauchly's Test of Sphericity. The level of measurement requirement and the sample size requirement were satisfied for all measures.

C2. Table of means, standard deviations, and standard error for pre tests.

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
PreBaars Inattentive Symptom Count	0	27	2.3704	2.05965	.39638	1.5556	3.1851	.00	7.00
	1	21	3.1905	2.18218	.47619	2.1972	4.1838	.00	9.00
	Total	48	2.7292	2.13122	.30762	2.1103	3.3480	.00	9.00
PreBaars HypImp Symptom Count	0	27	1.7778	1.55250	.29878	1.1636	2.3919	.00	5.00
	1	21	2.0952	1.51343	.33026	1.4063	2.7841	.00	6.00
	Total	48	1.9167	1.52753	.22048	1.4731	2.3602	.00	6.00
PreBaars SCT Symptom Count	0	27	2.9259	2.46399	.47419	1.9512	3.9006	.00	8.00
	1	21	3.9524	2.74729	.59951	2.7018	5.2029	.00	9.00
	Total	48	3.3750	2.61440	.37736	2.6159	4.1341	.00	9.00
Mean of Pre Mind Wandering Scale	0	27	4.1037	.87595	.16858	3.7572	4.4502	1.80	5.80
	1	21	4.1524	.94637	.20652	3.7216	4.5832	2.00	5.60
	Total	48	4.1250	.89787	.12960	3.8643	4.3857	1.80	5.80
Academic Self Efficacy pre	0	27	4.6792	1.32615	.25522	4.1546	5.2038	1.63	7.00
	1	21	4.8495	1.15779	.25265	4.3225	5.3765	3.00	7.00
	Total	48	4.7537	1.24523	.17973	4.3921	5.1153	1.63	7.00
Mean of MSLQ Pre Learning Strategies	0	27	3.9360	.87735	.16885	3.5890	4.2831	2.18	5.73
	1	21	3.9913	1.06713	.23287	3.5056	4.4771	1.64	5.36
	Total	48	3.9602	.95455	.13778	3.6831	4.2374	1.64	5.73
MSLQ Effort Regulation Pre	0	27	4.4815	1.26515	.24348	3.9810	4.9820	2.25	7.00
	1	21	4.2262	1.26468	.27597	3.6505	4.8019	2.00	6.00
	Total	48	4.3698	1.25794	.18157	4.0045	4.7351	2.00	7.00
Effortful Control Activation Pre	0	27	3.8307	.50900	.09796	3.6293	4.0320	2.71	5.00
	1	21	3.8776	.59124	.12902	3.6084	4.1467	2.43	4.86
	Total	48	3.8512	.54095	.07808	3.6941	4.0083	2.43	5.00
Effortful Control Attention Pre	0	27	4.7111	.45178	.08694	4.5324	4.8898	3.60	5.40
	1	21	4.7238	.57088	.12458	4.4639	4.9837	3.80	5.80
	Total	48	4.7167	.50163	.07240	4.5710	4.8623	3.60	5.80

C3. Levene's Test of Homogeneity of Variances

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
PreBaars Inattentive Symptom Count	.009	1	46	.925
PreBaars HypImp Symptom Count	.347	1	46	.558
PreBaars SCT Symptom Count	.026	1	46	.871
Mean of Pre Mind Wandering Scale	.215	1	46	.645
Academic Self Efficacy pre	.065	1	46	.801
Mean of MSLQ Pre Learning Strategies	.845	1	46	.363
MSLQ Effort Regulation Pre	.002	1	46	.961
Effortful Control Activation Pre	.262	1	46	.611
Effortful Control Attention Pre	2.060	1	46	.158

APPENDIX D

Descriptive Data and General Linear Model Results:

Experimental and Lagged Treatment Groups

BAARS IV ADULT ADHD RATING SCALE
BAARS IV: Inattention Subscale

Descriptive Statistics

	Experimental =1 or Lagged Experimental Group = 0	Mean	Std. Deviation	N
Total Count PreBaars Inattention	0	18.7037	4.40118	27
	1	20.2000	5.26758	20
	Total	19.3404	4.79255	47
Total Count Post1 - Baars Inattention	0	18.2222	5.27208	27
	1	17.4500	5.76263	20
	Total	17.8936	5.43833	47

Measure: BAARS-IV – Inattention Subscale

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	59.989	1	59.989	10.744	.002
Time * EX or LTG	Linear	29.563	1	29.563	5.295	.026

a. Computed using alpha = .05

BAARS IV: Sluggish Cognitive Tempo Subscale

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
Total Count PreBaars Sluggish Cognitive Tempo	0	20.0741	5.25449	27
	1	21.8000	5.91697	20
	Total	20.8085	5.55071	47
Total Count Post1 Baars Sluggish Cognitive Tempo	0	19.0370	5.35998	27
	1	17.7500	4.31491	20
	Total	18.4894	4.93379	47

Measure: BAARS IV – Sluggish Cognitive Tempo Subscale

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	148.661	1	148.661	16.981	.000
Time * EX or LTG	Linear	52.150	1	52.150	5.957	.019

a. Computed using alpha = .05

BAARS IV: Impulsivity/Hyperactivity Subscale

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
BAARSIMPHYP_Mean_Pre	0	1.8107	.41438	27
	1	1.8833	.42726	20
	Total	1.8416	.41686	47
BAARSIMPHYP_Mean_Post1	0	1.6831	.40965	27
	1	1.6583	.31025	20
	Total	1.6726	.36710	47

Measure: BAARS IV – Impulsivity/Hyperactivity Subscale

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.714	1	.714	7.739	.008
Time * EX or LTG	Linear	.055	1	.055	.591	.446

a. Computed using alpha = .05

MIND –WANDERING SCALE

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
Mean of Pre Mind Wandering Scale	0	4.1037	.87595	27
	1	4.1500	.97089	20
	Total	4.1234	.90751	47
Mean of Post Mind Wandering Scale	0	3.4222	1.07751	27
	1	3.4000	.97333	20
	Total	3.4128	1.02355	47

Measure: Mind-wandering Scale

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	11.772	1	11.772	38.595	.000
Time * EX or LTG	Linear	.027	1	.027	.088	.768

a. Computed using alpha = .05

MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE (MSLQ)

MSLQ: Academic Self-Efficacy Subscale

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
Academic Self Efficacy pre	0	4.6380	1.33469	26
	1	4.9586	1.14987	19
	Total	4.7734	1.25646	45
Academic Self Efficacy Post1	0	4.5337	1.54133	26
	1	5.0000	1.20546	19
	Total	4.7306	1.41370	45

Measure: MSLQ: Academic Self-Efficacy

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.022	1	.022	.042	.838
Time * EX or LTG	Linear	.117	1	.117	.227	.636

a. Computed using alpha = .05

MSLQ: Metacognitive Self-Regulation subscale

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
Mean of MSLQ Metacognitive Self Regulation	0	3.9021	.87648	26
	1	4.0718	.95518	19
	Total	3.9737	.90383	45
Mean of MSLQ Post1 Metacognitive Self Regulation	0	3.9038	.74338	26
	1	4.3142	.78746	19
	Total	4.0771	.78081	45

Measure: MSLQ: Metacognitive Self-Regulation

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.327	1	.327	1.099	.300
Time * EX or LTG	Linear	.318	1	.318	1.068	.307

a. Computed using alpha = .05

MSLQ: Effort Regulation subscale

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
MSLQ Effort Regulation Pre	0	4.4615	1.28587	26
	1	4.3684	1.23987	19
	Total	4.4222	1.25320	45
MSLQ Effort Regulation Post1	0	4.3750	.97275	26
	1	4.8553	1.12211	19
	Total	4.5778	1.05370	45

Measure: MSLQ: Effort Regulation

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.880	1	.880	1.190	.281
Time * EX or LTG	Linear	1.805	1	1.805	2.442	.125

a. Computed using alpha = .05

EFFORTFUL CONTROL SCALE

EFFORTFUL CONTROL: Activation Subscale

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
Effortful Control Activation Pre	0	3.8307	.50900	27
	1	3.8872	.62193	19
	Total	3.8540	.55245	46
Effortful Control Activation Post1	0	3.8413	.59079	27
	1	3.9173	.62690	19
	Total	3.8727	.60025	46

Measure: Effortful Control: Activation subscale

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.009	1	.009	.091	.764
Time * EX or LTG	Linear	.002	1	.002	.021	.885

a. Computed using alpha = .05

EFFORTFUL CONTROL: Effortful Attention subscale

	Ex =1 or LTG = 0	Mean	Std. Deviation	N
Effortful Control Attention Pre	0	4.7111	.45178	27
	1	4.8000	.54160	19
	Total	4.7478	.48705	46
Effortful Control Attention Post1	0	4.8593	.39151	27
	1	5.0184	.43436	19
	Total	4.9250	.41268	46

Measure: EFFORTFUL CONTROL: Attention Control Subscale

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.749	1	.749	6.767	.013
Time * EX or LTG	Linear	.028	1	.028	.249	.620

a. Computed using alpha = .05

APPENDIX E

Descriptive Data and General Linear Model Results:

Likely ADHD sample: Experimental and Lagged Treatment Groups

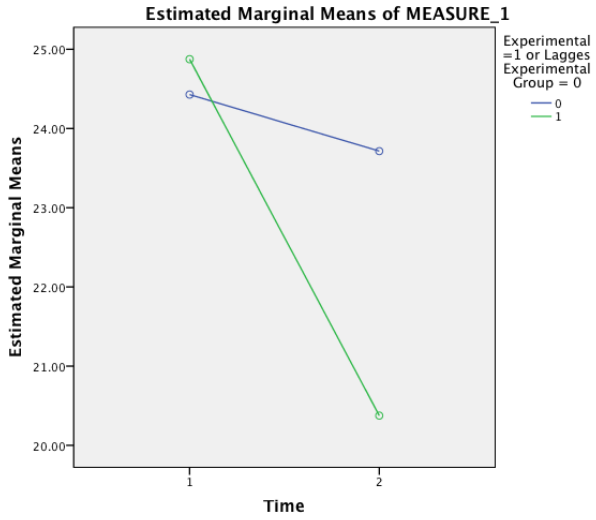
General Linear Model: BAARS- IV, INATTENTION

Descriptive Statistics

	Experimental =1 or Lagged Treatment Group = 0	Mean	Std. Deviation	N
Total Count PreBaars Inattention	0	24.4286	2.43975	7
	1	24.8750	5.02671	8
	Total	24.6667	3.90360	15
Total Count Post1 -Baars Inattention	0	23.7143	2.69037	7
	1	20.3750	7.15017	8
	Total	21.9333	5.62478	15

BAARS IV, Inattention

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	50.752	1	50.752	11.633	.005
Time * Ex or LTG	Linear	26.752	1	26.752	6.132	.028
Error(Time)	Linear	56.714	13	4.363		



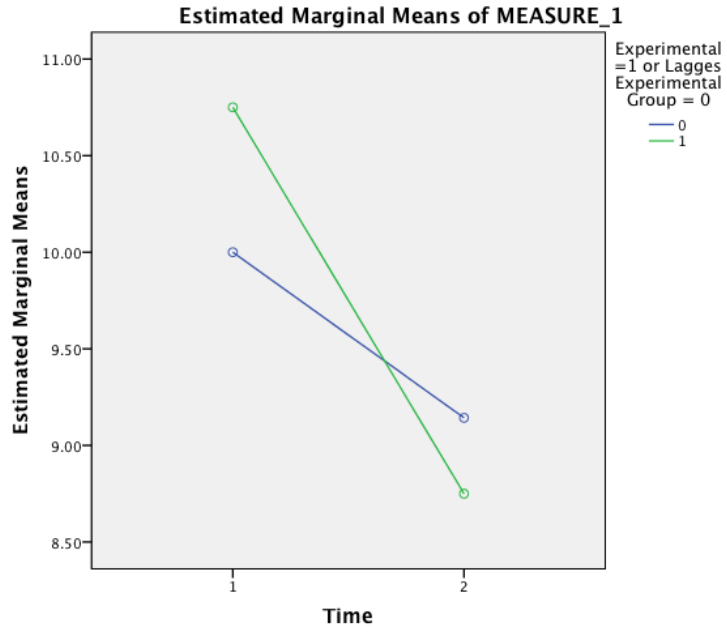
General Linear Model: BAARS IV - HYPERACTIVITY

Descriptive Statistics

	Experimental =1 or Lagged Treatment Group = 0	Mean	Std. Deviation	N
Total Count PreBaars Hyperactivity	0	10.0000	2.23607	7
	1	10.7500	1.98206	8
	Total	10.4000	2.06328	15
Total Count Post 1 Baars Hyperactivity	0	9.1429	2.03540	7
	1	8.7500	1.48805	8
	Total	8.9333	1.70992	15

BAARS IV- Hyperactivity

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	15.238	1	15.238	4.900	.045
Time * EX or LTG	Linear	2.438	1	2.438	.784	.392
Error(Time)	Linear	40.429	13	3.110		



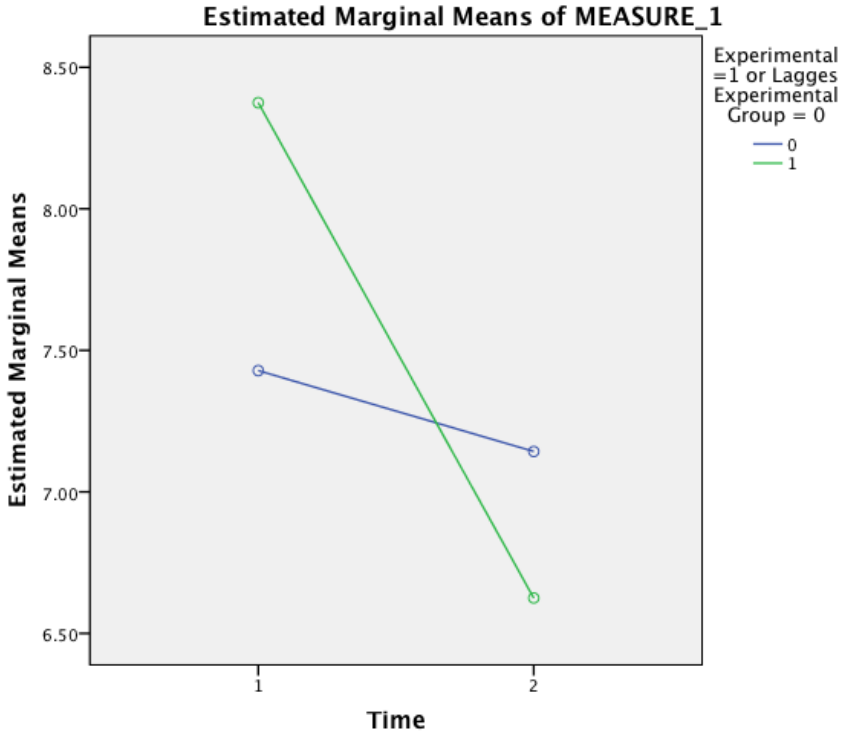
General Linear Model: BAARS IV, IMPULSIVITY

Descriptive Statistics

	Experimental =1 or Lagged Treatment Group = 0	Mean	Std. Deviation	N
Total Count Pre Baars Impulsivity	0	7.4286	3.35942	7
	1	8.3750	3.46152	8
	Total	7.9333	3.32666	15
Total Count Post1 Baars Impulsivity	0	7.1429	2.11570	7
	1	6.6250	2.06588	8
	Total	6.8667	2.03072	15

BAARS IV - Impulsivity

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	7.736	1	7.736	3.196	.097
Time * EX or LTG	Linear	4.002	1	4.002	1.654	.221
Error(Time)	Linear	31.464	13	2.420		



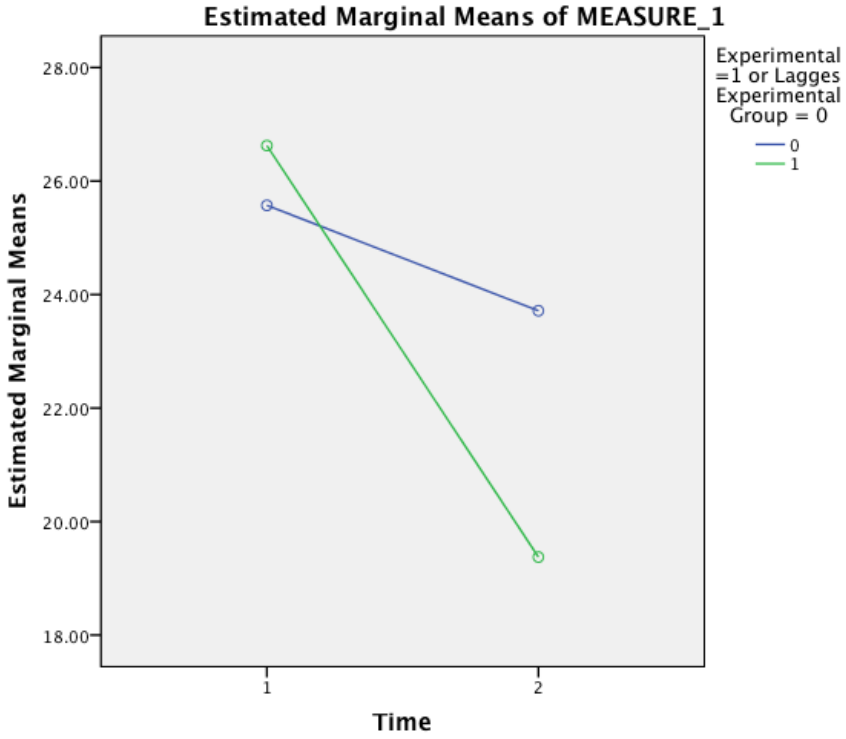
General Linear Model: BAARS IV, Sluggish Cognitive Tempo

Descriptive Statistics

	Experimental =1 or Lagged Treatment Group = 0	Mean	Std. Deviation	N
Total Count PreBaars Sluggish Cognitive Tempo	0	25.5714	3.86683	7
	1	26.6250	5.01248	8
	Total	26.1333	4.38938	15
Total Count Post1 Baars Sluggish Cognitive Tempo	0	23.7143	6.10230	7
	1	19.3750	4.03334	8
	Total	21.4000	5.39577	15

BAARS-IV, Sluggish Cognitive Tempo

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	154.821	1	154.821	16.888	.001
Time * EX or LTG	Linear	54.288	1	54.288	5.922	.030
Error(Time)	Linear	119.179	13	9.168		



General Linear Model: MIND-WANDERING

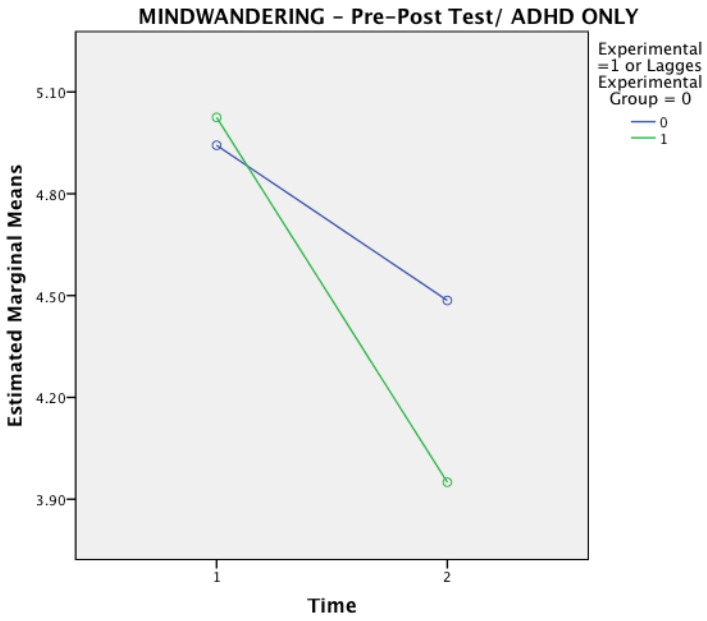
Descriptive Statistics

	Experimental =1 or Lagged Experimental Group = 0	Mean	Std. Deviation	N
Mean of Pre Mind Wandering Scale	0	4.9429	.75467	7
	1	5.0250	.49497	8
	Total	4.9867	.60694	15
Mean of Post Mind Wandering Scale	0	4.4857	.88587	7
	1	3.9500	.74642	8
	Total	4.2000	.83152	15

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	4.382	1	4.382	46.461	.000
Time * EGorLEG	Linear	.713	1	.713	7.556	.017
Error(Time)	Linear	1.226	13	.094		



General Linear Model: MSLQ – Academic Self-Efficacy

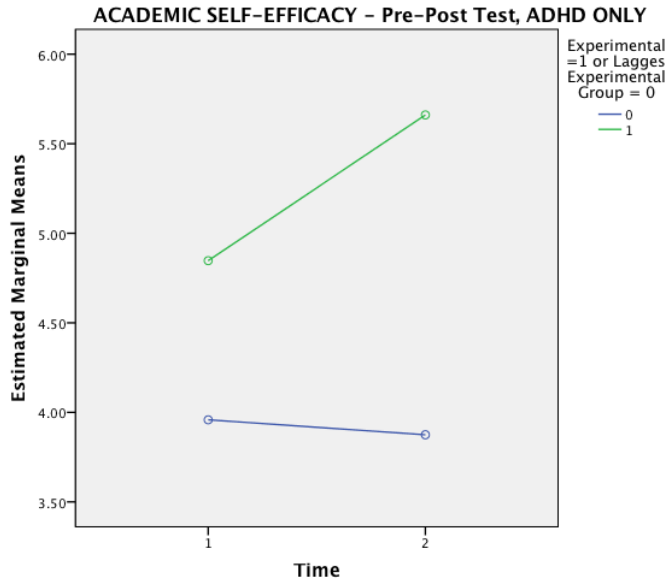
Descriptive Statistics

	Experimental =1 or Lagged Experimental Group = 0	Mean	Std. Deviation	N
Academic Self Efficacy pre	0	3.9583	1.26409	6
	1	4.8469	1.49439	7
	Total	4.4368	1.41244	13
Academic Self Efficacy Post1	0	3.8750	1.46629	6
	1	5.6607	1.25564	7
	Total	4.8365	1.59457	13

Measure: MEASURE_1

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.862	1	.862	3.603	.084
Time * EGorLEG	Linear	1.300	1	1.300	5.434	.040
Error(Time)	Linear	2.632	11	.239		

a. Computed using alpha =.05



General Linear Model: MSLQ: Effort Regulation

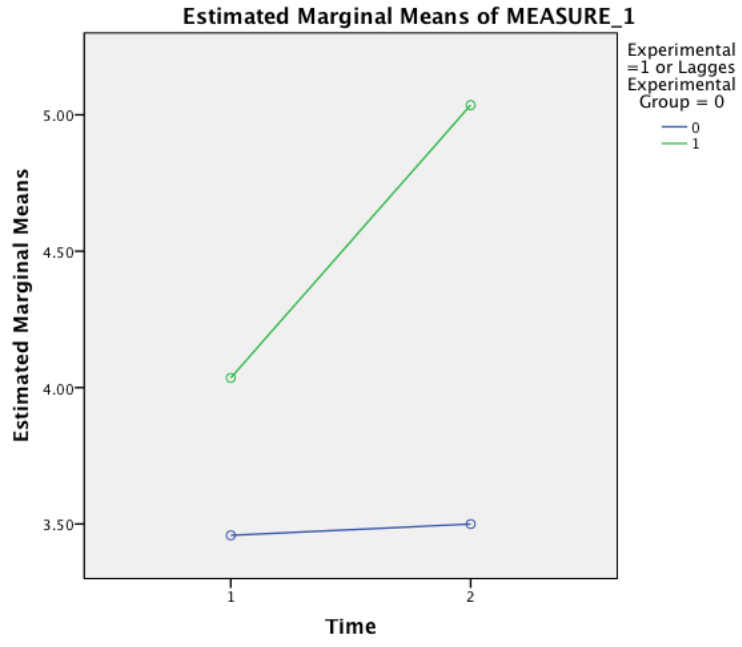
Descriptive Statistics

	Experimental =1 or Lagged Experimental Group = 0	Mean	Std. Deviation	N
MSLQ Effort Regulation Pre	0	3.4583	.96717	6
	1	4.0357	1.35730	7
	Total	3.7692	1.18349	13
MSLQ Effort Regulation Post1	0	3.5000	.96177	6
	1	5.0357	1.23684	7
	Total	4.3269	1.33613	13

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	1.753	1	1.753	3.743	.079
Time * EGorLEG	Linear	1.484	1	1.484	3.168	.103
Error(Time)	Linear	5.151	11	.468		



General Linear Model: MSLQ: Metacognitive Self Regulation

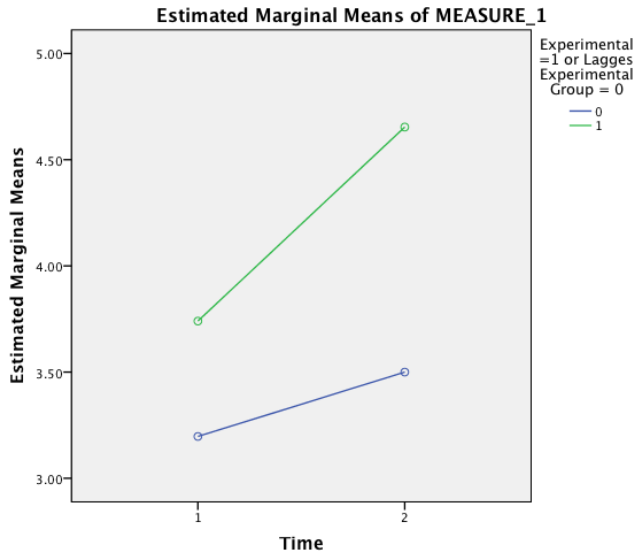
Descriptive Statistics

	Experimental =1 or Lagged Experimental Group = 0	Mean	Std. Deviation	N
Mean of MSLQ Metacognitive Self-Regulation	0	3.1970	.50915	6
	1	3.7403	1.31785	7
	Total	3.4895	1.02754	13
Mean of MSLQ Post1 Metacognitive Self-Regulation	0	3.5000	.63246	6
	1	4.6537	.75498	7
	Total	4.1212	.90000	13

Measure: Metacognitive Self-Regulation

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	2.390	1	2.390	10.462	.008
Time * EGorLEG	Linear	.602	1	.602	2.634	.133
Error(Time)	Linear	2.513	11	.228		

Profile Plots



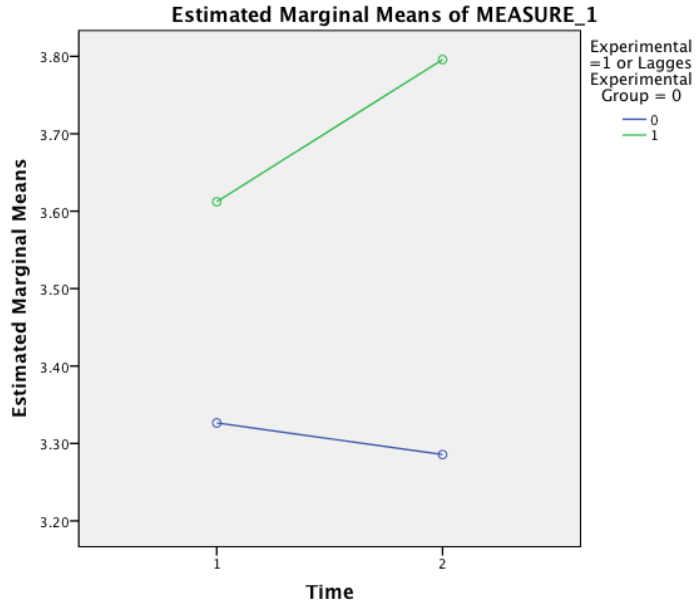
General Linear Model: EFFORTFUL CONTROL ACTIVATION

Descriptive Statistics

	Experimental =1 or Lagged Experimental Group = 0	Mean	Std. Deviation	N
Effortful Control Activation Pre	0	3.3265	.31638	7
	1	3.6122	.58736	7
	Total	3.4694	.47687	14
Effortful Control Activation Post1	0	3.2857	.31944	7
	1	3.7959	.82831	7
	Total	3.5408	.65867	14

Measure: Effortful Control Activation

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	.036	1	.036	.443	.518
Time * EGorLEG	Linear	.088	1	.088	1.093	.316
Error(Time)	Linear	.968	12	.081		



General Linear Model: EFFORTFUL CONTROL: Effortful Attention

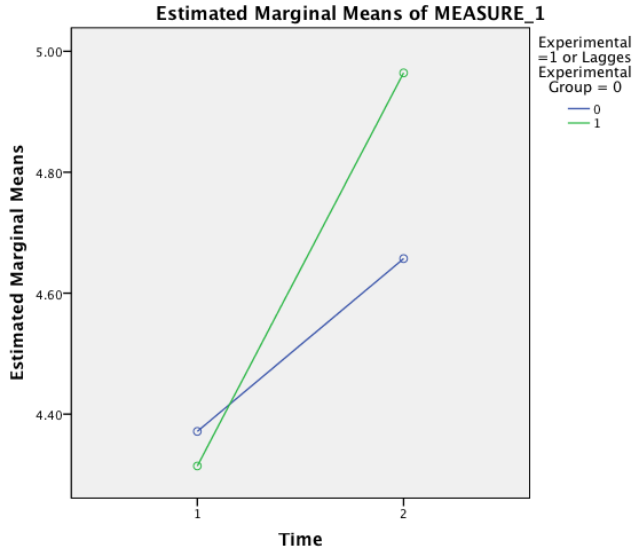
Descriptive Statistics

	Experimental =1 or Lagged Experimental Group = 0	Mean	Std. Deviation	N
Effortful Control Attention Pre	0	4.3714	.48206	7
	1	4.3143	.34365	7
	Total	4.3429	.40328	14
Effortful Control Attention Post1	0	4.6571	.32071	7
	1	4.9643	.68235	7
	Total	4.8107	.53643	14

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	1.532	1	1.532	12.621	.004
Time * EGorLEG	Linear	.232	1	.232	1.913	.192
Error(Time)	Linear	1.457	12	.121		



APPENDIX F

Reading and Listening Comprehension Strategies

FOCUSING WHILE READING

Active Reading

Before you start a reading session, identify your purpose for reading, and bring to mind anything you already know about the subject. This will activate your brain and provide relevance to new information.

While reading practice the following strategy:

Read a paragraph

Ask yourself what the main ideas, themes, and concepts are.

Put the main ideas in your own words and jot them down in the margins.

Summarize the main ideas every 10 paragraphs or so (or as often as you feel you need to).

The easy way to remember this strategy is the mnemonic **RAPS:**

R ead a paragraph

A sk yourself what the main idea is

P ut the main idea in your own words

S ummarize the main ideas

FOCUSING DURING LECTURES

Active Listening

Tune into the speaker – listen for the information and try not to get distracted by the tone of voice, looks, or mannerisms of the lecturer. Note when the lecturer makes a list, compares two points, or spends a lot of time explaining one point.

Review or recall the information you already know about the topic. This will activate your brain and provide relevance to new information.

Ask yourself what the main ideas, themes, and concepts are.

Put the ideas and concepts in your own words when the lecturer pauses. Chunk information by capturing only the key words. Chuck information if you feel like you didn't understand it or if the lecturer is moving on (you can always ask a question or review with friends later).

The easy way to remember this strategy is the mnemonic **TRAP:**

T une in

R ecall

A sk yourself what the main idea is

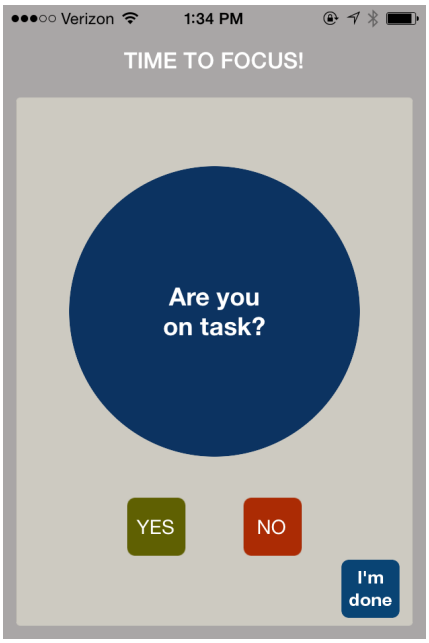
P ut the main ideas in your own words

and the phrase:

Chunk it or chuck it.

APPENDIX G

Images of *Focus Check* App



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