The Effects of Fidgets on Attention and Learning of College Students

Stephanie LeAndra Kriescher

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THE EFFECTS OF FIDGETS ON ATTENTION AND LEARNING OF COLLEGE STUDENTS

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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has been approved as meeting the requirement for the Degree of Doctor of Philosophy in College of Education and Behavioral Sciences in Department of School Psychology.

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ABSTRACT


Fidget “tools”, or objects to facilitate fidgeting, are gaining in popularity and controversy within the educational setting. Advertisers market fidget objects as evidence-based methods to improve attention, alleviate anxiety, and otherwise improve academic performance for their users. Thus, many individuals are investing in these objects to aid them in their academic studies, jobs, and other attention/focus orientated pursuits. These claims of evidence basis are made in the absence of sufficient scientific research and with conflicting theoretical basis regarding their mechanism of effect. The present study looked at the effect of facilitated fidgeting through different devices (stress ball and fidget spinner) compared to a no fidget device control condition on college student performance on a series of attention and cognitive tasks that occur during different learning processes. Data were analyzed using a 3x6 MANOVA. There were no significant differences on outcome measures, including digit span tasks, Stroop tasks, listening comprehension tasks, and reading maze task, between no fidget tool (*n* = 22), fidget spinner (*n* = 22), or stress ball conditions (*n* = 22). The study also evaluated how self-reported attention difficulties may alter this relationship between facilitated fidgeting and academic performance. Self-reported attention difficulties did not significantly affect the relationship between facilitated fidgeting and academic performance, nor were there significant differences across task performance between ADHD indicated participants
and non-ADHD indicated participants. This study, along with developing research and literature in the field suggests that fidgets have little to no effect on improving attention and learning outcomes with college students or across development and may, in some cases, lead to negative learning and behavioral outcomes. Recommendations for schools on fidget use are provided based on the findings of this study and extant literature.
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CHAPTER I
INTRODUCTION

Helping students succeed in school is a priority for students, parents, teachers, principals, school psychologists, and other school personnel. Many students struggle to succeed in schools due to a variety of factors, as evidenced by concerns regarding behavior problems, lower GPA’s, drop-out rates, and high rates of attrition at some colleges and universities. Students are diverse, with unique strengths and needs. Schools have limited resources and must meet the needs of every student. Underfunding has been a long-time issue for many American public schools (e.g., Hurtado et al., 2018; Sherman, 1977; Strauss, 2012). Underfunded schools often exist in communities already at a higher risk for academic concerns, adding to the disadvantage of their students. Similarly, many college students have limited income and outside resources to support their achievement when facing academic struggles. Because of this combination of circumstances, parents, school personnel, and students look to affordable, non-disruptive resources to help improve performance in the classroom. Fidget aids are often a desirable recommendation to aid in student self-regulation, attention, and learning. There are a variety of fidget aids marketed to teachers and students including stress balls, fidget cubes, fidget spinners, worry stones, silly putty, etc. (e.g., Biel, 2017; Tornio, 2017). The appeal of the fidget aid is its ability to facilitate controlled, non-disruptive movement in a way that theoretically supports attention, self-regulation, and learning. Through using the given object, students can, in theory, manage their behaviors and direct their attention to
what they are learning more efficiently; at least that is what many of these fidget aids’ marketing would suggest (e.g., Best, 2017).

Despite the effective marketing, large fidget aid availability, and common recommendation for use with students in the schools (Biel, 2017), well developed empirical support for their use is absent from the scientific literature (e.g., Schecter et al., 2017). Very few studies exist that examine the effect of fidget aids on attention and learning. Those that do exist provide contradicting claims, with some finding positive effects associated with the use of fidget aids (Grodner, 2015; Slater & French, 2010; Stalvey & Brasell, 2006); while others find no effect, or detrimental effects (Graziano et al., 2018; Hulac et al., in press; Kriescher et al., 2018). There also is a lack of definition clarity in the literature as to what constitutes fidgeting behavior as well as any clear discrimination between natural fidgeting behaviors and facilitated fidgeting. Additionally, while certain theories of self-regulation and sensory processing provide a rationale to the possible effectiveness of fidget aids (Ayres, 1972; Dunn, 2007), other theories on attention and cognition suggests that fidget aids would pose as a distraction, interrupting attention and learning (e.g., Choi et al., 2014; Chun et al., 2011). Many of the studies on fidget aids lack methodological rigor, have not been peer reviewed for publication, and use self-report measures (Grodner, 2015; Kriescher et al., 2018; Slater & French, 2010).

There is a large push for using evidence-based interventions within schools (Kratochwill et al., 2004). Given the extant literature, there is insufficient evidence to argue for or against an evidence-basis for fidget aids regarding their use with the general population of students at any age level, with some evidence to support they may even be
hurting the students they are intended to help, by increasing off-task behaviors (Kriescher et al., 2018) and decreasing attention (Graziano et al., 2018), and decreasing academic performance (Hulac et al., in press). Fidget aids provide a cost-effective and appealing solution for many students and remain widely recommended. Given the prolific use of fidget aids, it is imperative to further study their specific effects on attention and learning. It is unethical to continue to recommend the use of fidget aids within schools without further evidence-basis to either support their use or provide scientifically sound evidence of their negative effects.

**Significance of the Problem**

Given problems surrounding school success, the need for cost-effective resources to aid students, the wide-spread recommendation of fidget aids, and the lack of evidence-basis for these objects, further research on the effect of specific fidget aids on specific aspects of attention and learning is crucial. The present study evaluated two types of fidget aids compared to a non-fidget aid control group (stress balls and fidget spinners). The stress ball and fidget spinner were selected because they represent two unique types of fidget aids. Stress balls are small, often round, can be held in the hand and squeezed. They make little to no noise and do not contain moving parts. A fidget spinner is a small plastic or metal objects of any color and designs with a center ball bearing and two to three prongs to revolve around it. Fidget spinners, similar to fidget cubes, contain moving parts. Due to its design, the fidget spinner is often in movement when in use and omits a quiet whirring sound as the outside prongs revolve around the inner ball bearing.

This study evaluated the effect of using a stress ball, fidget spinner, or no fidget aid on direct tasks associated with attention and learning, including measures of basic
visual and auditory attention, working memory, inhibition, and reading and listening comprehension with a college student population. The findings of this study provide further evidence to the body of research addressing fidget aids and student learning through comparing how different types of fidget aids (no movement, high movement) compare to no facilitated fidgeting on a variety of direct measures. The findings also provide evidence related to different theoretical perspectives as they apply to fidget use (e.g., provide evidence in support of or against sensory processing theories and/or attention and cognition theories regarding use of stress balls and fidget spinners). Given the complex nature of human sensory processing, self-regulation, attention, and learning, the results of this study provide important insight into understanding how these constructs interact when using fidget aids during learning tasks.

This study provides important evidence into fidget aids practical use with students. New and old fidget aids will continually be marketed to students, teachers, parents, and school personnel. Following current trends, fidget aids will be recommended to students in schools at a variety of age levels. Students may also continue to seek these aids out as tools to help themselves. It is an ethical obligation to ensure these recommendations are evidence-based and to know the possible positive and/or negative effects of these objects on student learning. Claiming common-sense arguments for or against the use of fidget aids for students is scientifically irresponsible given contradicting theoretical perspectives and current evidence. For items so prolific and widely recommended in psychological and educational capacities it is alarming that there are not more methodologically rigorous empirical studies addressing this issue at this point in time.
The current study examined a college student population. While college students represent only a portion of consumers of fidget aids they can serve as a useful sample to begin to answer the question of the effect of facilitated fidgeting on learning outcomes. As previously mentioned, college students also seek tools to improve their academic performance and struggle with time and monetary limitations in selecting their resources. Additionally, while it may be expected that the attention abilities of college students are slightly above the general population, thereby enabling their success in college, previous research on some college populations has indicated this is may not be the case, especially in universities which are modeled to serve a broad range of students with different academic backgrounds. In fact, general estimates of intelligence in these populations largely remain on par with the expected performance of non-college attending young adults (e.g., Welsh et al., 2017). Attrition also remains a significant issue for many college students with some universities having average freshman attrition rates as high as 53%, with over half of the freshman class not returning after their first year of college, based on a report following national universities from fall 2013 to fall 2016 (U.S. News, 2018). Many students who qualified for special education or accommodations in high school also attend college and seek accommodations and resources to aid in their success in college classes and may rely on the strategies or tools provided to them throughout schooling. When comparing the attention and executive functioning abilities of college students to their high school counterparts there is relatively small growth made compared to other developmental periods. Therefore, the attention and executive abilities of the 18-year-old college student and the 17- or 18-year-old high school student pose little to no difference. A major spike in attentional control development occurs between
9- to 12-years-old, with small improvements continuing into early adulthood (Heim & Keil, 2012). Based on these reasons, while college students are not an exact approximation of students across all ages of schooling, they represent a reasonable sample of consumers of fidget aids who may begin to demonstrate how facilitated fidgeting may affect students’ learning abilities.

**Theoretical Basis**

There are differing theoretical perspectives providing support both for and against the use of fidget aids to facilitate student learning. The primary theories prompting the current study are Sensory Processing Theory (Dunn, 2007) and Cognitive Load Theory (Choi et al., 2014). The basis of Sensory Processing Theory is that different individuals have different sensory needs for simulation and arousal to perform optimally (Dunn, 2007). That is, individuals are able to pay attention to information and learn when they have reached their own personal “sweet spot” of arousal and sensory information. Some individuals may need greater arousal and sensory input; these people may benefit from rooms with cooler air conditioning, music in the background, walking around while they think, chewing gum, or other methods of amplifying their sensory input. Others may need less sensory information for optimal arousal. These individuals may benefit from quiet rooms with low levels of extra sensory information.

Dunn’s (2007) theory is commonly applied to working with clients with Autism or ADHD; however, she argues that the spectrum of sensory needs applies to all. In addition to varying on sensory needs, people also use more or less passive or active coping strategies to address these needs. Active self-regulators will seek out the extra information they need or remove themselves from overly stimulating environments to
reach their own “sweet spot”. Passive self-regulators, however, will often remain in situations and may, theoretically, benefit from learning more active coping skills to help them learn. One method of actively seeking simulation in line with the Sensory Processing Theory would be the use of fidget aids. Fidget aids provide extra sensory information in a regulated and relatively non-disruptive manner. A student may not be able to run laps around the classroom while the teacher is talking, but they can use a small fidget at their desk to create extra sensory information (e.g., visually, tactiley, audibly) to reach their own optimal level of arousal. This in turn, based on Sensory Processing Theory, would help them pay attention and learn class material.

While Sensory Processing Theory has adequate face validity, the notion of adding additional information to process contradicts with theories of attention and learning, such as Cognitive Load Theory (Choi et al., 2014). Attention is a complex construct and can be broken into several subcomponents depending on the area of interest (such as visual attention and auditory attention, basic attention and sustained attention, etc.) (Chun et al., 2011). However, simply speaking, attention is a limited resource. As individuals divide their attention across tasks, their overall accuracy on the tasks decreases (Adler & Benbunan-Fich, 2012), and it is impossible to pay attention to an infinite amount of information at once. Attention not only determines what information is immediately attended to and processed through working memory; it also plays a role in overall cognitive load.

Cognitive load is the theoretical demand on an individual’s cognition created by interactions between the environment, the learner, and the task (Choi et al., 2014). Factors within the individual, such as their personal working memory capacity, what they
are paying attention to in a particular moment, their mood, sleep levels, and other variables, influence their ability to think and learn. Similarly, features of a particular task place different demands on the individual. Easier tasks require less problem solving than tasks with many parts or that require many aspects of cognition (e.g., reading a math word problem, assigning variables, and computing correct answers, compared to simply adding two plus two). Each task a student or individual encounters is unique and may place different demands on cognition, contributing to overall load. The environment also adds to cognitive load. The environment provides more information that, when attended to, adds to the overall cognitive load of an individual. A distracting environment, or one with many sensory features, theoretically adds more “weight” to the load. These components (the individual, task, and environment) also interact with each other. This mental load is then filtered through an individual’s controlled (directed attention and deliberate problem-solving processes) and automatic (basic attention, working memory, long-term memory, etc.) processing to affect their performance on any given task.

Fidget aids play an important role here, as they provide additional information that has the potential to negatively affect cognitive load. Within the individual, attention may become split between the fidget aid and the task they are completing. The fidget aid may also provide additional environmental information that contributes to load (such as the presence of colors, movement, or sound). These added environmental factors not only effect the individual engaging with the fidget, but also the other students around them. Based on Cognitive Load Theory, fidget aids would have a negative effect on learning by increasing the cognitive load associated with any individual and task and divert attention. Effectively, this may prevent intake of relevant information all together if it is not
attended to, or may make performing a task more difficult, by increasing the overall cognitive load associated with that task.

** Relevant Literature **

Given the conflicting theories, it is important to look for trends in the extant literature regarding fidget aids and attention and learning. Unfortunately, there is very little literature specifically addressing the effect of fidget aids, such as stress balls and fidget spinners, on direct measures of attention and learning. Stalvey and Brasell (2006) present one of the few research studies that define the fidget aid used in their study and include a direct outcome measure, that is, creative writing scores. The authors wished to evaluate the effect of stress ball use on attention span and distraction level; however, did not gather direct data on these constructs. Rather, they relied on dividing students up by learning types (i.e., auditory, kinesthetic, and visual learners) and collecting pre-post self-report attention and distraction scales. We now know learning styles lack empirical evidence and usefulness in teaching (Stahl, 1999). Despite the wide-spread critique on learning styles proceeding Stalvey and Brasell’s (2006) study, they included learning styles in their data as a means of organizing students. Twenty-nine sixth-grade students in a language arts class completed several self-report measures of their learning preferences and study styles to distinguish which type of “learner” they were. All students were given stress balls and told they could use them voluntarily during designated instruction periods. Students continued to have access to the stress balls for use at least three times a week for thirty minutes during writing instruction for a total of seven weeks. The experimenters collected data on the frequency of stress ball use, as well as type of stress ball selected. Different students were also recorded for five-minute intervals during a
portion of the study to obtain an observational sample of their behavior while using the stress balls. Students completed self-report attention and distraction scales before and after the intervention. Students’ writing was then evaluated, through having them write a sample paper. They were instructed to use the stress ball while writing one paragraph and were instructed to not use the stress ball while writing an additional body paragraph. Both paragraphs were then evaluated using a standard writing rubric for sixth grade language arts evaluation.

Stalvey and Brasell (2006) found that students’ off-task behaviors significantly decreased in both independent practice and direct instruction when students used the stress balls. Students, on average, reported slightly lower problems with attention at the post-test after the seven-week intervention; however, the decrease in attention problems was not significant. There were no self-reported differences in distraction. When writing passages were compared, the average class writing score significantly increased in the stress-ball paragraph from 73% to 83%. While this study highlights several important factors relevant to the present study, it also poses several limitations. The authors did conduct direct behavioral observations; however, this only took place for a three-week portion of the total study. The five-minute intervals captured on camera represented a small snapshot of student behavior and the authors report no protective measures to ensure all students are being equally observed and evaluated. Further, while the authors did attempt to evaluate the effect of stress balls on attention, they used a self-report measure and found no significant differences from pre- to post-intervention. While the findings do suggest the stress balls improved writing performance for the overall class, the authors do not provide enough detail on how the students were instructed to use stress
balls while writing. It is possible the stress ball use paragraph came after the paragraph students wrote with no stress ball, posing a possible order effect. It is unclear what the causal mechanism of the improvement in scores is, and if it is related solely to the use of the stress ball. It may have been that a small handful of students performed much better on the stress ball paragraph, while other students may have shown none-to-little improvement. This would result in the boost of the overall average class score but provide little useful information on the effect of stress balls on writing. The small sample size and use of non-empirically supported learner styles also limits the generalizability of the researchers’ findings.

Aside from Stalvey and Brasell’s (2006) study, no other literature on the effect of stress ball on attention and/or comprehension and learning was found using standard search terms on popular academic search sites, such as PsychInfo and GoogleScholar. While their study provides a useful starting point, many variables need to be further defined, replicated, and evaluated using direct measures. Kriescher and colleagues (2018) and Hulac and colleagues (in press) provide a further investigation into variables relevant in this present study. Kriescher and colleagues (2018) evaluated the effect of the specific aids, fidget spinners, on on-task and off-task behavior in a class of third grade students. The authors conducted direct observations of 23-26 students’ on-task and off-task behavior during classroom activities during Reading and Math sections of the day. Student behaviors were recorded during 10-minute intervals in which they alternated between using the fidget-spinner and not having access to a fidget spinner. The researchers found that students displayed significantly more off-task behaviors in both the Reading and Math section of the class when allowed fidget spinner use.
Hulac and colleagues (in press) found that fidget spinner use also had a significant effect on the same students’ performance on brief math worksheets. The authors counter-balanced four different Curriculum-Based Measures (CBM) math probes that were selected to be appropriate for the class and grade level based on consultation with the teacher. Students were then asked to complete some worksheets while using fidget spinners and others without access to fidget spinners. Students performed significantly worse on the activity when permitted to use fidget spinners. There were several problems with both studies evaluating the effect of fidget spinners on behavior and performance that limit the generalizability of the findings. Kriescher and colleagues failed to appropriately track participants resulting in data that violates statistical assumptions of normality, random sampling, and equality of variance. These limitations affect the meaningfulness of any significant analyses reported. Additionally, the researchers were unable to control for a variety of confounding variables, including student baseline ability level, consistent sampling of students, time of the day, school events (e.g., book fair, snow day, class leading up to lunch, unforeseen transitions and interruptions from other classes and students). Because of how the data were collected, it is also unclear if certain students’ behavior were more significantly altered by the presence of the fidget spinner than others, leading to less scientifically “clean” data, but more reflective of the day-to-day realities of school and academic performance. The studies were also underpowered, utilizing small sample sizes. Based on these critiques, Kriescher and colleagues provided a snapshot into the possible effects of fidget spinners on off-task behavior; however, these findings are limited because of flaws within the study. The studies also failed to address the effect of fidget spinners on specific attention, comprehension, and/or learning
outcomes. While off-task behavior provides an approximation of learning occurring in the classroom, it is not a direct measure. This study has not passed the peer review process for publication, similar to many other studies evaluating the effect of fidget aids on student learning (e.g., Grodner, 2015; Slater & French, 2010). Hulac and colleagues’ (in press) evaluation of fidget spinners on math performance suffers from many similar limitations. The performance task was timed and many students appeared more interested in finishing the task quickly than accurately, as evidenced by overall low scores. Hulac and colleague’s findings reflect interesting possibilities about the effect of fidget spinners on math performance.

An unpublished thesis by Grodner (2015) evaluated how use of fidget aid effected a direct measure of attention (using the Stroop and visual search) with 115 college students. The author, however, failed to specify what type of fidget aid was used, simply describing the object as a handheld fidget toy. This is problematic when considering the diversity of fidget aids available for use and the different nature of these aids.

Additionally, Grodner assessed how suppressing movement (being told to sit entirely still while holding a fidget toy), compared to a neutral condition (being told that having a fidget toy in the room improves performance), and an activation condition (being given a fidget toy and told that the toy has been shown to improve performance), on tasks measuring attention. Grodner also manipulated one the experimental tasks, the Stroop test, to provide an easy and hard version of the task. Grodner found no difference on performance on the hard version of the task across conditions. For the easy task, participants performed significantly better in the activation condition compared to the participants in the neutral condition. This suggest that given an easier task, participants
actually did better when told that using a fidget toy will improve their performance; however, this effect did not remain true for the more difficult version of the task. Grodner found no significant differences across conditions in the visual search task. Grodner’s use of the suppression condition is also problematic, as rarely are students instructed to remain entirely still while completing school work. Grodner’s study provides conflicting evidence regarding how fidget aids effect attention. On one hand, the fidget toy led to slightly higher performance on an easy attention task, the Stroop task. However, this was not replicated on an additional attention task in the same study.

Graziano and colleagues (2018) further examined observed behaviors related to attention and learning in young students (mean age = 4.86 years, n=48) with diagnoses of ADHD using fidget spinners during class lessons. The researchers collected data on the number of attention related or movement related redirections students received using an ABAB experimental design. Attention related redirections were given when students were not attending to the teaching material, movement redirections were given when students were moving outside their designated area. In conjunction these captured primary areas associated with the ADHD diagnosis (inattentive and hyperactive). Observed students were randomly selected from their class each week. During the first “A” trial, students received no intervention and were observed in their class as usual. For “B” trials, students were given fidget spinners and instructed to use appropriately. A and B trials were then repeated. The researchers found that during the first fidget spinner intervention trial, using a fidget spinner decreased overall movement redirections and movement, as measured by accelerometers. This decrease in movement, however, was not found in the second intervention trial, suggesting some habituation to the stimulus of
the fidget spinner may have occurred. Additionally, on both intervention trials the students using the fidget spinners received more attention redirections, providing evidence that they were less on-task and attentive to their materials. Behavior of students in the class without a fidget spinner, however, remained unchanged regardless of the presence of the fidget spinners. This study suggests that fidget spinners may potentially pose an outlet for physical movement, however, the benefit may be short-lived and quickly habituated to. Additionally, regardless of movement, fidget spinners lead to worsened attention. This study, compared to the others, took place with young students (mean age – 4.86 years) with ADHD diagnosis. Implications of fidgets and students with ADHD will be further discussed later in the paper.

Existing literature on facilitated fidget use range across developmental stages, with studies examining students as young as four-years-old (e.g., Graziano et al., 2018) to college-age adults (e.g., Grodner, 2015); while natural fidgeting behaviors have been studied primarily with adults (e.g., Carriere et al., 2013; Farley et al., 2013). Due to the sparsity of studies regarding fidgeting it is necessary to review those across the developmental spectrum, understanding they are not perfect comparisons. Attention, executive functioning, and behaviors change across development, as will be discussed later. Yet, even in the presence of developmental changes the studies provide a basis for understanding the possible effect of facilitated fidgeting on the attention and learning outcomes for college students. Previous studies provide rationale for the different variables of fidget aid use and non-use, as well as measures of attention and learning; however, no study directly addresses all the variables of interest in a methodically
rigorous and peer reviewed way. Additionally, evidence exists supporting both positive and detrimental effects of fidget aids on student attention and learning.

**Problem Statement**

With increasing use of fidget aids in schools and extensive claims of their use, the specific effect of different fidget types remains largely unanswered. This paper examines the theories behind the potential effectiveness of fidget aids and the evidence of their effects. Specifically, Sensory Processing Theory (Dunn, 2007) provides the basis by which fidget aids may be effective interventions by allowing individuals to achieve varying levels of sensory input to facilitate optimal arousal and consequently improved attention and learning. Conversely, Cognitive Load Theory (Choi et al., 2014), provides evidence of the negative effects of additional stimuli on overall cognitive load, reducing a student’s ability to acquire new information. The lack of rigorous research leads to often conflicting and un-replicated claims of benefit or harm of fidget use to academic or behavioral outcomes. Additional research is needed to clarify the effect of specific fidget aids. The present study provided a first step in fulfilling this need.

The purpose of this study was to assess the effect of using a fidget spinner, a stress ball, or no fidget aid on direct measures of attention and learning. Specifically, I evaluated participants’ performance on a Stroop task, measuring visual attention and inhibition (Strauss et al., 2006), Wechlser’s Adult Intelligence Scale – Fourth Edition (WAIS-IV) Digit Span, measuring auditory attention and working memory (Wechsler, 2008), a reading maze task assessing reading comprehension (Hosp et al., 2016), Wechsler’s Individual Achievement Test – Third Edition (WIAT-3) Listening Comprehension task (Psychological Corporation, 2009). Visual and auditory attention
directly relate to the ability to attend to a written passage (reading comprehension) and remember facts and details presented verbally (listening comprehension). Within schools, reading books and passages as well as listening to lectures represent two main methods of learning material. As such, the study not only evaluated the subcomponents of learning (e.g., attention, working memory, and inhibition), but also complex tasks more representative of classroom learning.

**Research Questions and Hypotheses**

Considering the conflicting theories and lack of well conducted scientific research, I purposed the following research questions and hypotheses for my study:

**Q1** How does using different fidget aids (stress ball or fidget spinner) compare to not using a fidget aid on visual attention and inhibition tasks, auditory attention and working memory tasks, and reading and listening comprehension tasks?

**H1** Participants in the no fidget aid condition will perform significantly better than those in the stress ball and fidget spinner condition.

**H2** Participants in the stress ball condition will perform significantly better than those in the fidget spinner condition.

**Q2** Does total self-reported ADHD symptoms significantly affect the relationship between type of fidget used and attention and learning performance?

**H1** Self-reported ADHD symptoms will not significantly affect the relationship between type of fidget used and attention and learning performance. Presence of ADHD symptoms may indicate an initial deficit in attention and learning performance, while use of a fidget may lead to a slight improvement. The positive and negative influences may essentially negate any influence of ADHD symptoms on performance, leading to no significant relationship between type of fidget used and attention and learning performance.
CHAPTER II
REVIEW OF LITERATURE

When attempting to understand the use of fidget aids on student performance a series of questions must be addressed. Why do humans naturally fidget and what does this accomplish, and what historical evidence support this? Further, in what ways does facilitated fidgeting occur and differ from natural fidgeting? Neither of these questions has been answered definitively within the scientific literature; however, several points are raised.

Human beings naturally fidget. This may take the form of tapping a leg or fingers, shuffling around in one’s chair, clicking a pen, twirling one’s hair, or a myriad of other small movements. Existing literature lacks consistency on the definition of fidgeting and related theories. Fidgeting has been operationally defined in the research as any small or large body movements (Farley et al., 2013), doodling (Andrade, 2010), and chewing gum (Tucha, et al., 2004). At times, no definition of fidgeting is provided (Carriere et al., 2013). Fidgeting has been proposed to occur during periods of inattention (Alderson et al., 2012; Carriere et al., 2013; Farley et al., 2013), as well as alternatively, concentration and focus (Carson et al., 2001; Levine et al., 2000; Stalvey & Brasell, 2006). The lack of consensus on the definition of fidgeting muddles the understanding of the literature and implications of fidget behaviors. Within this review, natural fidgeting is defined as any large or small movement conducted while engaged in a task that is not necessary to accomplish or meet the primary goal of the task. This differs from facilitated fidgeting,
which encompasses fidgeting behaviors that are enabled through specific objects intended
to elicit fidgeting behaviors (such as fidget spinners, cubes, silly putty, stress balls,
bouncy chairs, or other objects given to students or adults to enable directed fidgeting) while completing a task. The distinction between natural fidgeting behaviors and facilitated fidgeting may seem nuanced, however has important implications. Certain natural fidgeting behaviors, such as simple finger tapping, have demonstrated to have little to no attentional cost (e.g., Kane & Engle, 2000). Facilitated fidgeting inherently introduces an additional object with a variety of features into the fidgeting process. No studies have evaluated the attentional cost of different fidget objects.

While facilitated fidgeting is the focus on this study, little to no research has differentiated between natural fidgeting and facilitated fidgeting, often blurring the definitions within their research. Very little research has specifically focused on facilitated fidgeting. To examine facilitated fidgeting, then, it is necessary to examine the basis of natural fidgeting, outcomes, and to what extent the findings may or may not apply to facilitated fidgeting.

**History of Fidgeting Research**

Interest in human fidgeting behavior began long before the interest in ways to produce and market toys or tools by which fidgeting behavior can be facilitated. References to natural fidgeting appeared as early as the 1880’s in scientific literature, as Galton (1885) attempted to assess attentiveness of audience members of long lectures through measuring fidgeting behavior, describing how the people he observed began to move more as they became less engaged in the presentation. Around this time, Ribot (1890) also philosophized that the “diffusion of ideas and diffusion of movements go
together” (p. 24). Beyond these early speculations and observations, however, the historic research of natural or facilitated fidgeting remains sparse. It was not until the latter half of the twentieth century that research again began to emerge describing natural fidgeting behavior (e.g., Mehrabian & Friedman, 1986; Sechrest & Flores, 1971). Even in these early mentions, the purpose and definition of fidgeting behaviors varies. Sechrest and Flores (1971) were evaluating “nervous mannerisms” cross culturally, while Mehrabian and Friedman (1986) were interested in individual differences in fidgeting behavior and how these related to other behaviors such as smoking, drinking, or binge-eating.

The earliest references to fidgeting through use of fidget aids in the literature is not until more recently, within the past twenty years, when occupational therapists begin to speculate that movement and additional sensory information may be useful for some individuals. Brief mentions of stress balls or other fidget aids began to emerge after the turn of the millennium (e.g., Schott, 2011; Slater & French, 2010; Stalvey & Brasell, 2006;), with most scholarship on specific fidget aids being published in the past five years (e.g., Biel, 2017; Farley et al., 2013; Graziano et al., 2018; Grodner, 2015). The most recent scientific interest in fidget aids may be linked to both the increased market of fidget toys, as well as growing support of fidget aids as a tool for those who struggle with attention. Despite the lack of scientific research behind the claims of attention improvement, many teachers, students, Occupational Therapist, and other school staff advocate for fidget aids in the classroom (e.g., Tornio, 2017).

Fidget aids/toys are continually being created and marketed for this purpose. Most recently, the fidget spinner was marketed online as a means to alleviate symptoms of anxiety, Attention Deficit/Hyperactive Disorder (ADHD), Autism, and Post-Traumatic
Stress Disorder (PTSD) as well as generally improve kid’s ability to pay attention (Belluz, 2017; Bever, 2017; Ghose, 2017). Fidget spinners are small plastic or metal objects of all colors and designs with a center ball bearing and two to three prongs to revolve around it. Per the developer of the spinner, Catherine Hettinger, the toys were not created as a treatment aid for any specific disorders, but as a toy (Belluz, 2017). While the toy itself has been around long before the recent fad, online searches began to spike for the spinners in April of 2017 (Belluz, 2017). At one point, the fidget spinner filled the top 16 spots for popular toy products on Amazon, and 43 of the top 50 spots (Best, 2017). During this time, if one tried to purchase a fidget spinner in a city of 100,000 population in the mountain-western of the United States, all department stores were sold out. Fidget spinners created such a buzz they were being banned in classrooms all across the country, due to concerns about distracting students and causing harm (Best, 2017; Belluz, 2017; Bever, 2017; Ghose, 2017; Strauss, 2017). While the fidget spinner fad has faded, fidget spinners and other fidget aids/toys are continually being produced and marketed online and in stores. It is unclear what the next fidget toy fad will be, but it will inevitably come in the future. While many teachers and schools have banned the fidget spinner, the use of fidget aids to help students in schools is still being recommended in the absence of empirical support (e.g., Biel, 2017; Tornio, 2017). Understanding the nature of facilitated fidgeting through use of fidget aids and the corresponding effect on learning is imperative moving forward in order to inform best-practice recommendations for students of all ages.
Theories Behind Why People Fidget

Fidgeting: Symptom or Cause?

Within the broader literature on natural fidgeting, there is debate. Is natural fidgeting a symptom of distraction and mind wandering, or a direct cause of distraction? Carriere and colleagues (2013) argue fidgeting as the body’s embodiment of the mind’s cognition. The notion of embodied cognition is that the body physically expresses and displays what is occurring cognitively. Therefore, when the mind becomes distracted, they argue the body will also reflect this through fidgeting. The body physically expresses the cognitive distraction or mind wandering through movement. In Carriere and colleagues’ (2013) research, the authors found that self-reported fidgeting increased during periods of inattention and spontaneous mind wandering. Therefore, fidgeting is a sign that attention and focus have been lost. Yet, Carriere and colleagues’ conclusions may be more appropriately stated as conscious fidgeting appears to be related to self-reported mind wandering and attention lapses. The authors used only self-report measures with very few items (ranging from four to eight items per scale) to measure participant’s perspective of their own fidgeting behaviors and attention loss, requiring not only an awareness of all of one’s fidgeting behaviors, but also awareness of one’s attention and mind wondering, and accurate reporting of all of the above. Further, age was a significant factor in several predictive models. When evaluated specifically within the college-age population, the relationship was the weakest ($r=.20, p<.01$). The study also suffered from other methodological flaws such as not defining what fidgeting is/ or looks like and, instead, asking participants broad questions about their daily fidgeting behaviors, such as asking them to rate how often the following statement applies to them: “I fidget,” or
“Relative to others, I feel I fidget more often.” Therefore, based on the results of their study, conscious acts of fidgeting may be related to attention loss and spontaneous mind wandering; however, these claims must remain tentative. In support of this hypothesis, an additional study found that directly observed fidget behaviors increased across time as self-reported attention and retention of information both decreased while students were viewing a video of a college psychology lecture (Farley et al., 2013).

Others have purposed alternative hypotheses as to why natural fidgeting occurs, such that while fidgeting may be the byproduct of mind wandering, it is the body’s method of self-regulating, increasing overall arousal in the brain, and helping re-facilitate attention (Farley et al., 2013). Alternatively, according to some theorist, natural fidgeting is believed to be related to stress caused by sustained attention. Synthesizing these perspectives, fidgeting, could be both a byproduct of the stress caused by sustained attention (as someone focuses for a long time, this causes stress and discomfort which is expressed in fidgeting movement), as well as a method for the body to self-regulate and alleviate that stress (Farley et al., 2013).

Facilitated fidgeting falls under the same concerns of natural fidgeting, with the element of an additional object – does it facilitate or distract attention and through what mechanism? Use of fidget aids implies a level of intentionality. Unlike natural fidgeting, facilitated fidgeting requires a level of awareness and choice, at least to initiate fidgeting. A person may naturally begin to tap their foot without conscious awareness; however, for that same individual to pick up and use a stress ball or other fidget aid, they must make the decision to select the item and begin using it. Few research studies have been completed evaluating the effect of fidget aids on attention, learning, and/or classroom
outcomes. Those that have been completed often use small sample sizes, lack methodological rigor, and were presented at conferences or published in popular media, rather than published in peer reviewed literature

**Fidgeting and Related Constructs**

Attention and self-regulation often come up in the literature of fidgeting as important constructs related to natural fidgeting as well as facilitated fidgeting. The nature of the relationship between fidgeting, attention, and self-regulation is often explained differently, based on the orientation and aims of the author behind the study. For some, fidgeting may restore attention and serve as an act of self-regulation (Dunn, 2007), while other theories suggest that fidgeting may a negative effect on attention (Choi et al., 2014). Both self-regulation and attention have been argued as aspects of Executive Functioning (Rueda et al., 2005), with some arguing that attention serves as common resource for executive functioning and self-regulation abilities (Kaplan & Berman, 2010); however, each encompass unique aspects that affect a student’s ability to attend and comprehend material in school. Self-regulation is the broader construct, dealing with how an individual maintains different aspects of their cognition and emotion (Rueda et al., 2005). In the case of using fidget aids, I review literature exploring how facilitated fidgeting may provide an opportunity for self-regulation of arousal, emotion, and attention through experimental articles and theoretical approaches. I then review the broader effect of facilitated fidgeting on attention, addressing how introducing objects affects attention and, by extension, memory and learning. Further, some research suggests the relationship between fidgeting and functioning may present differently for individuals who meet the diagnostic criteria for Attention Deficit Hyperactivity Disorder
(ADHD). As such, I also include a brief summary of the literature in this arena. Finally, I will discuss current literature addressing the use of fidget aids within the classroom within the context of self-regulation and attention.

**Self-Regulation**

Self-regulation is the ability of an individual to regulate their attention, emotion, and behaviors (Bronson, 2000). Self-regulation is key in learning because it allows an individual to mediate the impact of their internal and external cues, in order to complete a task. In the context of school this may be completing a worksheet, reading a passage, following directions, or learning from a teacher-delivered oral lecture. Individuals employ self-regulation to maintain a homeostasis, or baseline functioning. Someone experiencing too little arousal may self-regulate to maintain alertness, while someone experiencing too much arousal may seek out a less arousing context. Additionally, when individuals become emotionally aroused, they can self-regulate, coping with their emotions so they are not overwhelming (Gross, 2013). Humans also self-regulate maintaining attention on a given task. When we notice our attention is wandering, we can intentionally redirect our attention.

Self-regulation is key in learning both inside and outside the classroom (Blair & Diamond, 2008). Self-regulation is often viewed as an executive function and includes the ability to regulate emotions and cognitions. Therefore, students struggling with self-regulation are more likely to struggle with appropriate behaviors and emotional expression in school as well as self-regulation of their attention and learning. These students are more likely to get distracted during class activities, act out behaviorally with their peers, and less likely to complete assignments (Blair & Diamond, 2008). When
students enter preschool and kindergarten with low self-regulation abilities this can create cycles in which their behavior is problematic, eliciting disciplinary responses from the teachers that shape the teacher’s perceptions of the students, which in turn shapes their future behavior through self-fulfilling prophecies (e.g., Rosenthal & Jacobson, 1966). Academically, if a student is getting in trouble for behaviors, lacks the regulation to attend to material and turn in completed assignments, they will receive lower grades and retain less class-relevant information. The feedback that students receive because of lack of self-regulation in behavior interacts with their cognition, creating negative feedback loops that inflate relatively small differences in academic ability at the outset of their education to large achievement gaps later on (Alexander et al., 2001). This effect is seen with students who enter kindergarten with low executive function and self-regulation abilities, as they are more likely to drop out before graduating high school as their peers with high executive functioning and self-regulation abilities (Vitaro et al., 2005).

Individual abilities to self-regulate vary and may fluctuate based on stress, self-control exertion, and demands on the self (Muraven & Baumeister, 2000). Some individuals may also employ more active methods to self-regulate, seeking out strategies to maintain homeostasis, while others may more passively experience their context (Dunn, 2007). Teaching student’s self-regulation skills and strategies early on can improve outcomes throughout education; however, teaching self-regulation strategies at any point in a student’s academic career has the possibility of improving other executive functioning skills, such as attention (Blair & Diamond, 2008). Self-regulation strategies may target and work through different pathways.
Self-Regulation of Sensation and Arousal. From the perspective of Sensory Processing Theory (Ayres, 1972), certain children and adults may benefit from greater sensory stimulation during classroom tasks. According to the theory, focused and functional behavior is most easily produced by an individual when their neurological processing of sensory information is kept in balance (Ayres, 1972). Therefore, the ideal adaptive behavior is theoretically produced most easily by an individual when their neurological need for sensation is being met. Too little sensory input, and a student may become bored and disengaged; too much, and they are unable to concentrate and pay attention to important information. The optimal sensory level represents the perfect amount of sensory stimulation to reach optimal arousal, thereby facilitating learning. This optimal sensory level, however, may be different for different individuals.

Dunn (2007) proposes that individuals fall within different sensory profiles based on their sensory needs and self-regulation strategies. These sensory needs are captured by neurological thresholds. Dunn posits that within different sensory domains, individuals possess consistent and predictable tolerance for stimuli. Humans have a threshold of necessary stimulation to activate neurons, the neurological threshold. Too little stimulation and the neurons do not fire the right amount or frequently enough, the individual is under-aroused (e.g., they are bored or asleep). Too much stimulation and people’s neurons, theoretically, fire non-stop, leading the individual unable to attend and behave optimally. Others have argued the relationship between the neurological cellular reactions and the observed behavioral response lacks empirical evidence, therefore the behavior cannot be assumed to be the result of reactions on the cellular level (Hanft, Miller, & Lane, 2000).
Under Dunn’s (2007) theory, individuals’ cognition and behavior are best when their sensory needs for arousal are adequately met. These needs are summarized in four sensory profiles, in which individuals are categorized by whether they have a high or low sensory threshold as well as if they have active or passive self-regulation styles. The resulting four distinct sensory profiles are: sensation seeking, sensation avoiding, sensory sensitivity, and low registration (see Figure 1.). Of particular interest when considering the use of fidget aids are those individuals who have a high sensory threshold, meaning they need more sensory input to maintain their baseline levels of arousal.

**Figure 1**

*Sensory Profiles*

<table>
<thead>
<tr>
<th>Sensory Threshold</th>
<th>Self-Regulation Style</th>
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<td>Low</td>
<td>Active</td>
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<td>High</td>
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<tr>
<th>Sensation Avoiding</th>
<th>Sensation Seeking</th>
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<tr>
<td>Sensory Sensitivity</td>
<td>Low Registration</td>
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People needing more sensory information, then theoretically fall into the sensation seeking (in which individuals have a high threshold and active self-regulation profile), or low registration (in which individuals have a high threshold and passive self-regulation strategy). In both these instances individuals need a high degree of sensory information. In the classroom the sensation seeking child may often get up, move around in their seat, or cause physical distraction to others while attempting to provide the
necessary sensory information they need to learn. On the extreme ends, this may be similar to the ADHD, hyperactive type profile; however, Dunn maintains that the sensory profiles apply to all individuals, not just those with Diagnostic and Statistical Manual of Mental Disorders (DSM) diagnoses or disabilities. The low registration individual also needs a high level of sensory input, but will not seek out opportunities to provide this input. Again, on the extreme ends, this phenotype may appear similar to ADHD, inattentive type.

**Role of Fidgeting in Sensation and Arousal.** According to Dunn’s (2007) theory of Sensory Processing, the experience of sensation is related to arousal. Information perceived by the senses has the ability to arouse biologically and cognitively. Dunn argues a certain level of arousal, the “sweet spot”, so to speak, allows individuals to pay attention to incoming information. This level varies from individual to individual based on their sensory sensitivities and regulation abilities. Dunn argues movement is an active self-regulation method for individuals to control the amount of sensation and arousal they are experiencing, to thereby achieve their own optimal levels of arousal. Based on her theory, facilitated fidgeting may be a positive solution for individuals who need high levels of sensory information (e.g., the sensation seeking or low registration profiles discussed above). While large movements are often distracting, and students may or may not be allowed to freely move about the classroom without permission, movement facilitated through use of a fidget aid may, theoretically, provide a useful alternative. For the sensation seeking individual, the fidgeting provides a guided, safe, and discrete method for them to receive additional sensory input while still maintaining classroom appropriate behavior. For the low registration individual, providing the fidget aid may be
a taught self-regulation coping skill. They can learn to use the fidget aid to self-regulate more actively to help them achieve optimal functioning. In both instances, the use of a fidget aid may serve as a key self-regulating device, providing additional sensory information to maintain optimal arousal levels, thereby facilitating attention learning in the classroom. Interventions to improve adaptive behavior can also integrate sensory elements of objects in the environment to meet the sensory needs of the individual (Schaaf & Miller, 2005).

It is important to note Dunn largely lacks empirical support outside of her own research studies; however, the notion of sensory regulation or modulation remains persistent in the Occupational Therapy (OT) literature (Bar-Shalita & Cermak, 2016; Dunn, 2007; Hanft et al., 2000; Schoen et al., 2014; Tomchek & Dunn, 2007). Without outside validity research, it is difficult to assess the validity, reliability, and stability of Dunn’s specific sensory profiles. Yet, the notion of different methods of sensing the world is evident in some DSM diagnostic criteria, namely in Autism Spectrum Disorder (ASD) (e.g., Tomchek & Dunn, 2007) and ADHD (e.g., Mangeot et al., 2001) Within the OT community, there is also debate on the likelihood of a Sensory Processing Disorder, also called Sensory Modulation Dysfunction, or more broadly, Dysfunction in Sensory Integration, named based on individual difficulties regulating sensory information (Hanft et al., 2000).

Evidence for Dunn’s sensory profiles is limited. Yet, evidence for difficulties in sensory domains for some individuals, such as those with ASD or ADHD, provides support for the notion that different sensory needs and regulation abilities exist. Besides fidget aids, other sensory tools, such as weighted vests, have also been utilized as
interventions for students identified as having different sensory needs. Weighted vests, specifically, provide additional sensory information to the wearer. When used in interventions, weighted vests have led to improvements in attention-to-task and decrease in duration of self-stimulatory behavior in the classroom with preschool students (Fertel-Daly et al., 2001), as well as increased on-task behavior with elementary-age children with ADHD (VandenBerg, 2001). Like most of the literature on sensory-based interventions, these studies utilized single-case design methodology with few students and found small to moderate improvement for most students. Regardless of the support of four distinctive sensory profiles, individuals do appear to have different needs for stimulation and fidget aids can serve as a tool by which to facilitate self-regulation, helping individuals attend and learn in school. This is the rationale often employed by school OT’s recommending the use of fidget aids within the classroom.

Additionally, to address the sensory needs of students, Sensory Integration Therapy was proposed as a method to target and expand the sensory abilities of individuals. In essence, those promoting sensory integration theory are attempting to expand the neurological thresholds proposed by Dunn and work with individuals to adapt effective self-regulation strategies. This is practiced through gradually exposing clients to sensory experiences that they may view as undesirable or intolerable. Those practicing sensory integration therapy will gradually integrate different sensory experiences (e.g., sights, sounds, physical sensations) to further expand a client’s sensory thresholds. For example, a client has low tolerance for sensory information, may first gradually be exposed to the sound of a fan humming in the background. As they become comfortable with the fan sound, the therapist will introduce the physical sensation of the wind
blowing from the fan. This is also done in other ways, such as having clients play with objects with different textures and smells. In sensory integration therapy, the goal of therapy is to tolerate a wide range of sensory experiences, not to solely address an undesired sensation, as might be the cause in anxiety exposure therapy treatment. Despite its promise and acceptance with many occupational therapy professionals, some psychologists have argued it to be no more effective than a placebo treatment (Shaw, 2002). In other words, Shaw (2002) argued sensory integration therapy was likely as good as telling the client they will improve because of some variable but providing no active treatment. Other reviews have found the approach to lead to some potential improvements in self-management of distress, but no decrease in seclusion and restraint use (Scanlan & Novak, 2015).

When considering the general population of students, Dunn’s (2007) sensory profiles and sensory processing theory may provide a useful framework by which to understand individual preferences and responses to sensory experiences. However, the notion that all individuals fit into four reliable and valid sensory profiles lacks empirical support. Further, while the ability to endure different sensory experiences is a useful skill, sensory integration theory lacks support as an evidence-based intervention at this time. It is possible that students benefit from having their sensory needs met, leading to optimal levels of arousal. Fidget aids may be a non-disruptive tool for students to achieve these optimal levels of sensation and arousal, which may result in improved attention and learning; however, this effect has not been demonstrated. The regulation of arousal and attention are also observed outside of the context of sensory processing theory and can be evaluated through the lens of emotional regulation.
Self-Regulation of Emotion. As individuals attempt to regulate their sensations and arousal, so do they attempt to regulate their experience and expression of emotions. Fidgeting has been discussed in relation to stress caused by sustained attention (Farley et al., 2013), as well as stress related to other life factors, such as visits to the dentist (Barash, 1974). In such instances, the act of fidgeting or using a fidget aid may be a useful strategy in regulating emotions, either through down-regulating negative or intense emotions, or up-regulating positive emotions (similar to the up-regulation of sensation and arousal). There is little to no applied research to demonstrate this relationship. Fidget aids have also been recommended as alternative behaviors for individuals engaging in Trichotillomania (compulsive hair pulling) and Excoriation (compulsive skin picking) with positive results (Capriotti et al., 2015; Tompkins, 2014). These positive uses of fidget aids worth noting, however, do not speak specifically to the nature of fidget aids and attention and learning.

Across emotion regulation, individuals vary in their emotion regulation self-efficacy, the tools they select to regulate their emotions, and the effectiveness of those tools on modifying the outcome of the emotion (Gross, 2013). It is possible that for some individuals, the use of fidgets may be a beneficial self-regulation strategy; however, implications for loss of attention to class materials in school must also be considered. It is also possible, given the individual experience of emotion and need for useful regulation strategies, as well as possible negative consequences (e.g., harm to self), the goal in a classroom may shift from attending to relevant learning material to maintaining safety in the student and facilitating useful self-regulation strategies. Some fidget objects may impact the regulation of emotion differently. Some may act as a distractor, while others
may be useful in modifying the expression and outcome of the emotion. Use of fidget aids as a means of emotion regulation in cases of stress, anxiety, depression, or specific disorders (e.g., Trichotillomania and Excoriation) deserves further study beyond the context of this paper.

**Attention and Fidgeting**

Throughout the examination of the use of fidget aids, attention remains a key factor. Do some students need extra sensory stimulation in order to maintain attention? Can fidget aids affect the regulation of attention and arousal? While these questions have been addressed from theoretical perspectives in the preceding section the very nature of the key construct, attention, has been neglected. How attention works from a biological and physiological perspective must be explored as well as how attention relates to larger important outcomes such as comprehension and learning. The nature of human attention will be explored (e.g., how humans attend to stimulus and how aspects such as color, sound, and movement affect perception), followed by a discussion of how attention relates to memory and fits within the larger context of cognitive functioning. Attention is a complex and multidimensional cognitive capacity. Many theories and frameworks to understand the levels, modalities, and conceptualizations of attention have been proposed, with many authors arguing for multi-theoretical approach (Chun et al., 2011). For the purpose of this paper, attention will be discussed in terms of its relevance in attending to and learning materials within a school context. The specific effects of natural and facilitated fidgeting on attention will be explored throughout.

**Dual-Store Model.** Within the school environment, students, ideally, not only attend to materials and control their bodies in a manner that does not interfere with
learning (which often equates to sitting at a desk), but also to retain and synthesize the material. This process is dependent on memory. The Dual-Store model (Ormrod, 2016) of memory proposes a process in which information from the environment first is perceived by the Sensory Register. Information is left unperceived never enters consciousness and is lost. Where attention was focused determines what information continues from the sensory register to working (or short-term) memory. Again, at this stage, information that is not attended to is lost. Once information enters working memory elements of that information undergoes more in-depth processing, passing into long-term memory, resulting in information that can be retrieved, reviewed, and synthesized over time, resulting in learned information. Therefore, in a classroom, a student is constantly bombarded by sensory information. In a typical classroom, the temperature of the room, the color of the PowerPoint, the sound cars passing by or students talking in the hallway, and the teacher’s voice lecturing are all examples of different “sensations” entering the Sensory Registrar that may or may not be perceived by the student. What the student attends to, either through conscious decision or subconscious processes, then determines what information is more likely to enter working memory, and eventually long-term memory. The student’s ability to inhibit irrelevant information and stimuli largely determines the learning that takes place.

In this model, for learning to occur, information must first be attended to, stored in working memory, and transferred to long-term memory. To best understand fidgets effect on learning, it is worth studying their affect not only on simple attention (the ability to alert to a stimuli), but also on how fidget aids interact to influence and inhibition and working memory abilities. Self-regulation and sensory processing theories
assert that fidget aids can help improve attention. How does this, however, fit within models of memory and attention? The fidget aid provides an additional source of sensory information. It is unclear however, how the cognitive capacity of attention is affected with fidget aid use and therefore what information is encoded in working, and eventually long-term memory.

**Features Effecting Basic Attention.** There are several different models of attention that help explain how attention may be affected by fidget aid use. Feature Integration Theory (Treisman, 1988) proposed that visual attention is impacted by different visual features, such as color, orientation, spatial frequency, brightness, and direction of movement. When searching for a visual target, these are the factors we attend to, or can be “bound” together to help locate an object. The more features we know of a given object, the easier it is to locate. These object features, however, may also affect what we chose to attend to. Specifically, motion, size, intensity, novelty, incongruity, emotion, and personal significance are all factors that affect attention.

**Motion.** Franconeri and Simons (2003) proposed the Behavioral Urgency Hypothesis for attention. Under this approach, attention is drawn to dynamic events that are behaviorally urgent from an evolutionarily standpoint, such as the presence of new objects, objects that move suddenly, and looming objects. These features of objects are more demanding of attention because they were often linked with the identification of danger and species survival, compared to other features. Generally speaking, attention is more likely to be drawn to moving objects, compared to stationary ones (Abrams & Christ, 2003); however, the nuances of this relationship may not be as simple as outlined by the Behavioral Urgency Hypothesis. Some have proposed that motion in itself does
not attract attention if the motion serves no purpose in a task or if the object is already in
motion when presented, such as a perpetually moving disc (Hillstrom & Yantis, 1994); it
is rather the appearance of a novel object or perceived change in location caused by
motion that demands attention (Abrams & Christ, 2003).

The onset of motion has also been demonstrated to elicit attention, leading to the
conflicting Motion Onset Hypothesis of motion and attention. The Motion Onset
Hypothesis argues that elements that initiate or go through an onset in motion are
processed preferentially compared to objects that are stationary, continuously moving, or
experience an off-set in motion (Abrams & Christ, 2003). This has been demonstrated by
asking participants to identify a target letter among three distractors. Each of the four
stimuli were presented in different types of motion during different trials. The stimuli
were either always in motion, began the trial in motion than stopped, or began the trial
static and then began to move. Across trials, participants were fastest to identify the target
that began static and then initiated movement (Abrams & Christ, 2003). These findings,
however, were limited to a very small sample size (10 undergraduate students); however,
suggests that the initiation of movement demands the most attention, as opposed to
continuous movement or movement in general. Unexpected changes in direction can also
demand more attention than targets in motion following a predictable pattern (Howard &
Holcombe, 2010).

Novelty. The effect of novelty and attention relates closely to that of motion and
attention. When a novel object appears in our visual field it implies a degree of motion
was present for the object to appear there. Attention is more likely to be directed to novel
stimuli (e.g., Johnston et al., 1990); however, again, the relationship is more nuanced.
Generally, novel objects demand greater attention; however, when feature changes occur on known objects they are as effective at capturing attention. Conversely, when multiple changes in features or the presence of similar objects occur simultaneously, all changes are less likely to capture attention (Von Muhlenen et al., 2005).

**Animation.** Researchers have further proposed that it is not just novelty or motion that are important in demanding attention for species survival, but that humans even more selectively attend to animate or biological motion compared to inanimate motion (Pratt et al., 2010). Animate motion implies agency in the object moving, a self-propulsion and self-direction associated with the movement of animals and other humans. Noticing the movement of other living things above general movement, such as the waving of a branch in the wind, would be evolutionarily advantageous. Participants were quicker in identifying animate motion compared to inanimate motion (Pratt et al., 2010).

**Intensity.** Additionally, when presented with objects attention is more likely to be drawn to more intense information, such as brighter colors, louder noises, or bigger information (Ormrod, 2016). From an evolutionary perspective, attention being selectively diverted to these features makes sense. In order to ensure survival, knowing when objects around you are novel, or in motion, can inform when you are in danger. In a modern world, however, attention being selectively drawn to irrelevant stimuli because of their features may more often be a hinderance. Attention may be inadvertently redirected to the annoying commercial, the brightly colored sign, or other distractors in our environment. The effect of these elements can be measured on different aspects of attention.
**Visual Attention.** Visual attention is one of the modalities in which attention is studied and measured. As the name implies, visual attention encompasses how visually presented information is noticed, or attended to, and processed by the brain. Visual attention can be measured in many different ways including visual searches (the ability to scan an environment for an object; e.g., Neisser, 1964), using eye tracking measures (evaluating attention shifting between visual stimuli; e.g., Liu & Heynderickx, 2011), or having individuals visually attend to and identify printed stimuli.

**Auditory Attention.** Auditory attention is the ability to attend to information that people hear, but do not see. Auditory attention is slightly less studied than auditory attention but can be evaluated through presenting information audibly and evaluating how the information perceived (e.g., Jones, 1993; Owston et al., 2011). Top-down and bottom-up processing also is discussed within the context of auditory attention, specifically how individual’s beliefs about the nature and origin of a sound influence their perception of it at times (e.g., Sarter et al., 2001). Visual and auditory attention are often regulated and processed through different but overlapping areas of the brain (Chun et al., 2011).

**Visual and Auditory Attention Distinction.** While discriminating visual and auditory attention is a useful dichotomy in research, it does not necessarily reflect real-world complexity. People are often attending to and perceiving information through several sensory modalities at once. This information may be similar (e.g., reading a passage while hearing it read aloud), or different (listening to music while writing a paper). Some research suggests that students retain information best in class when presented information both visually and audibly at the same time, such as listening to
audio podcast of material while reviewing academic material (e.g., McKinney et al., 2009). Information on visual and auditory attention separately; however, can help begin to inform these complex processes.

**Distractors and Attention.** Distractors may affect these visual and auditory attention abilities, as evidenced by the multitasking research. In the classroom, multitasking is often associated with multi-attentional demands, such as competing visual and/or auditory stimuli (e.g., looking and listening to unrelated and competing material). Specifically, student reports of higher technology multitasking through social technologies (such as texting or Facebook) while listening to lectures was negatively related to grade point average (GPA) (Junco, 2012). Researchers have also evaluated the effect of switching between multiple sources of auditory information. Koch and colleagues (2011) had participants first listen to a string of numbers and letters and either remember the numbers or the letters. Then the instructions were switched, flipping what participants were expected to remember. The researchers found that participants struggled to switch between listening to numbers and words. This performance may have been a result of switching demands on auditory attention. Switching auditory demands may also occur when listening to an unrelated side conversation while also listening to a lecture. Switching from visual information to auditory information can have similar negative effects (Berti & Schroger, 2001). This is relevant in the use of fidget aids. Some fidget aids, such as fidget spinners, produce sound. This audible stimulus may interact/interfere with other audible stimuli (e.g., the teacher talking), or other visual stimuli (the reading passage given to a student). Similarly, the visual features of any
feature aid may provide additional visual stimuli that competes for visual attention and/or with auditory attention.

**Other Conceptualizations of Attention.** In addition to features affecting attention and modalities of attention, attention can be conceptualized and measured using duration. Sustained attention is attention across a long period of time; vigilance is the ability to sustain attention over that long period of time (Chun et al., 2011). Sustained attention and vigilance are both important aspects of the overall construct of attention; however, this study will focus primarily on immediate attention to a task.

**Connection to Fidget Aids.** While there is debate between theorists and researchers about what aspects of stimuli are the most attention demanding and the level of distraction and attention impact proposed by different features, it is clear that attention can be impacted and diverted through many different means and modalities, several of which apply to fidget use. Certain fidget aids, such as fidget spinners, are in motion when they are used. Fidget aids may come in a variety of bright, fun, playful colors, such as bright red silly putty, or an intense blue stress ball, or a neon green fidget cube. The clicking of a fidget cube or the whirring of a fidget spinner also demands attention. These features make the objects appealing to consumers; however, the same factors may be impacting their ability to attend to class material. Yet the effect of these aspects such as novelty and motion are so nuanced, that without further study it is difficult to infer the effect of a fidget aid on attention. Perhaps the initiation of the movement of the fidget aid, such as a fidget spinner demands greater attention than is required for continuous use. For those who are astute at their use, the negative impact on attention may then be diminished due to repeated and continuous exposure, limiting attentional demands. The lack of
animate features may also make the object less demanding of attentional resources. Further research is necessary to determine how the motion related to fidget aids effects attention.

The effect of fidgets on modalities of attention relevant to classroom learning has also not been assessed. If distracting, are fidget aids more distracting when used with information presented visually (written worksheets and readings) or audibly (listening to the teacher lecture)? Also, instructions and materials in classrooms are often presented in several modalities concurrently. How might fidget aids affect learning in this context? Referring back to the dual-store model of memory, only information that is attended to can be moved from the sensory register to working memory and eventually long-term memory to result in learning. When students are utilizing fidget aids, then, their sensory register is again being bombarded with the typical sensory information of a classroom environment in addition to the sensory information provided by a fidget aid. If this fidget aid happens to be brightly colored, makes noise, or is in motion when being used, due to the nature of attention, attention resources are naturally directed to the fidget object. The question then arises, can a student still pay attention to classroom material when using the object?

**Attention and Comprehension**

With fidget aids, attention may be affected in the following ways. The first is that attention is shifted from the desired stimuli (i.e., class lecture, video) to the fidget aid because of the naturally attention demanding features of that object. In this instance, the student would not be attending to target information, therefore they are incapable of learning and remembering that information. In the classroom, however, information is
often presented repeatedly. Therefore, missing the presentation of some information does not always result in gaps in learning. Students may attend to the information when presented later or in a different way, or they may be able to understand the information from context, even if they did not attend to the specifics.

**Procedural Memory.** Additionally, some fidget aids may be so mundane and regularly used, that they no longer fall into the attention-grabbing features. Rather than consciously attending to a fidget aid, their use may fall into procedural memory and their color, shape, and size may be bland. If objects are too boring, however, they may not be perceived as desirable and may not be used. Even if fidget aids negatively effects attention, their consequence on broader learning may be dependent on several factors that are often outside of the control of school policy or parental knowledge.

**Attention Breaks.** Given the inability to attend to multiple things at once, it is possible that the role of fidget aids on attention may be relevant through other routes. Movement in general, as well as small breaks in attention from target stimuli have been proposed as practices for attention restoration. For example, breaking attention from the target stimuli may allow attentional resources to “re-charge,” therefore helping the student attend more when they shift their attention back to the target stimuli. This effect has been studied in the context of long-term sustained attention; such is necessary with college lectures. Attention, is a resource that can be depleted when sustained over time, as demonstrated by poorer performance on attention tasks over time. This effect is labeled the vigilance or sensitivity decrement effect (e.g., See et al., 1995). When dividing college lectures into early and late periods, students show greater memory of information presented in the earlier portion, and increased mind wandering in the later
session; suggesting that students’ attention is depleting throughout the course of a lecture (Farley et al., 2013).

Switching tasks briefly during sustained attention tasks, can decrease the vigilance decrement effect, improving attention performance over long task time period (Ariga & Lleras, 2011). These mental breaks can take different forms, resulting in different effects on attention and learning. It is possible that a fidget aid, when briefly attended to, may serve as an opportunity for students to shift tasks throughout the course of a class period, restoring their attention abilities, resulting in ultimately more learning than may naturally occur throughout the course of a long lecture. This theoretically could be the case even if small amounts of information are not attended to throughout the course of the lecture.

**Development of Attention**

Different aspects of attention develop at different points throughout the lifespan. Rueda and Posner (2013) discuss the development of the three key brain regions associated with the development of attention: the alerting network, orienting network, and executive network. In infancy, children begin to develop the ability to alert to stimuli. Orienting, or the ability to intentionally direct attention, is also present in infancy, but matures, reaching adult levels in middle-childhood. Executive attention is the ability to self-regulation attention using self-monitoring and inhibition strategies. Executive attention begins to emerge in early childhood and experiences a huge period of growth in development during the preschool years. During this period of time, children’s brains are rapidly developing and they begin to develop the ability to inhibit primary responses as well self-monitor and sustain attention for longer periods of time. Children continue to
show executive attention improvements on a variety of attention measures, including decreased errors and increased performance throughout middle-childhood. The brain undergoes another period of concentrated growth during pre-adolescence, in which the brain networks associated with executive control continue to develop and mature. Youth continue to demonstrate improvement in attentional abilities and awareness of errors into late adolescence (Segalowitz & Davies, 2004). Yet, the most significant differences are between young children (age seven and eight) and older children or adults. Changes continue to occur after late adolescence; however, these improvements have less practical significance and are rarely the point of interest in scientific literature (e.g., Rueda & Posner, 2013).

Considering the developmental aspect of attention is useful when evaluating the effect of fidgets across the lifespan. Many of the literature discussing the effect of both facilitated and natural fidgeting on attention and learning evaluates students ranging from elementary school to college. While these examinations of fidgeting clearly do not serve as a direct comparison of each other, understanding the relative stability of attention abilities following pre-adolescence helps generalize the effect of fidgets on attention. College students do have improved attention compared to those in middle childhood, but in many ways their attention abilities are similar to those of late middle school and high school age. Understanding the role of attention development, it is possible to better generalize the effect of facilitated fidgeting on different ages of students. Elementary age students would likely be the most negatively impacted by facilitated fidget use due to their development of executive attention, while those in late middle school and high
school would likely experience a similar effect on attention and learning as young college students based on the development of the attention networks within the brain.

**Cognitive Load Theory**

Attention, while important and imperative for learning remains only one aspect of the cognition necessary in learning. The effect of fidget aids and attention can also be understood within the larger context of Cognitive Load Theory (CLT; Choi et al., 2014). Cognitive load refers to the amount of work an individual’s working memory is able to process, given the demands of the task and the environment (Choi et al., 2014). Each person has a finite amount of cognitive processing capacity (Sweller, 1988). When a learner gathers a new piece of information, he or she must hold it in her working memory and attempt to find schemas to attach the new information or to find a sufficient response to the problem. The organization and consolidation of this information enables individuals to engage in complex problem solving relatively quickly and efficiently (Choi et al., 2014). Depending on the complexity of the task, this encoding process may occur quickly or slowly. If intrinsic and extrinsic demands exceed a person’s working memory capacity, they may not be able to complete the task (Choi et al., 2014).

Extrinsic factors related to cognitive load include elements such as the volume of a classroom, lighting, desk arrangement, and the presence of other people. These elements can affect cognitive load through cognitive, physiological, and affective means which are mediated through the learner and tasks (Choi et al., 2014). A poorly designed environment may result in extra irrelevant stimuli occupying working memory, reducing the amount of available cognitive resources to process a given task. Working memory (WM) resources may also be taxed by background noise (Choi et al., 2014) and excessive
visual stimuli (Doherty-Sneddon & Phelps, 2005). Working memory, therefore, is a cognitive ability that can be used up, or freed up with extraneous information. The more “freed-up” an individual’s working memory, the more useful it is in completing a task. While there are many physical environmental demands in any given learning situation, fidget aids may contribute to these demands. Fidget aids may negatively affect attention through the following pathways.

**Perceptual Load**

Within the overarching cognitive load model there are several components. One of these components is perceptual load, or the amount of available information an individual perceives. This includes task relevant information, such as the textbook a student is reading, as well as irrelevant information, such as sights, sounds, smells, and distracting visual information, as well as internal thoughts and mind wandering (Lavie & Dalton, 2014). According to Load Theory, perceptual processing can only become selective when the limits of an individual’s perceptual capacity have been reached (Lavie & Dalton, 2014). Therefore, tasks perceptual demands have a direct impact on the ability to ignore distractors and selectively attend to target information. Tasks with lower demands result in longer reaction times and poorer performances compared to higher demand tasks.

This has been demonstrated in several experiments ranging from measuring participants reaction time identifying the letters “X” or “N” from distractor letters in either low demand (few distractors) or high demand (many similar distractor) situations (Lavie & Cox, 1997). Others have included distractors manipulated based on color, shape, or position (Lavie & Dalton, 2014), as well as including high priority distractors of
bright, colorful cartoon characters (e.g., Spiderman) (Forster & Lavie, 2008). Regardless of the distractors, researchers have found that individuals perform better on tasks with high demands compared to low demands.

This has important implications when considering student learning in the classroom. The first conclusion that can be drawn is that all students are better able to ignore distractors when presented with tasks with higher demands, regardless of their baseline abilities with distractibility (Forster & Lavie, 2008). Students who are more distractible on a regular basis also do better when presented with high tasks demands. Secondly, it is possible that students may be better equipped to ignore the distraction of a fidget aid when presented with a more difficult task demand. Also, it may be that when students are completing low-demand tasks in the classroom a fidget aid may provide the sufficient level of extra perceptual/sensory information to “fill” the perceptual load, effectively kicking in the student’s ability to then selectively attend to information and limiting the effects of other environmental or internal task-irrelevant distractors. The fidget aid may essentially provide the necessary perceptual information to increase the perceptual demands of the task to cue the need for more selective perceptual processing.

Assuming the need for selective perceptual processing is met, the student must then choose to selectively attend to the desired target stimuli (e.g., educational material) rather than the fidget aid itself. This process then places demands on executive control abilities. Executive control is the top-down processing by which individuals are able to cognitively prioritize processing of relevant information. As demands on executive control go up, however, this has the opposite effect of perceptual load. Too much executive control load and individuals become more easily distracted. The cognitive
“sweet spot” involves just enough perceptual load with just enough executive control load, a state of being that is more easily speculated on than produced in any given moment.

The “sweet spot” also differs based on individual abilities and development. Perceptual load develops throughout childhood and declines later in life, leaving children and adults with lower levels of perceptual load capacity (Lavie & Dalton, 2014). Because of this, however, children and older adults are less distracted by task-irrelevant stimuli compared to young adults (Lavie & Dalton, 2014). This could suggest that the presence of a fidget aid may be less distracting to a young child than to a young adult. This effect, however, is purely speculative because so many variables effect the interaction and attention diverted to the fidget aid and how it is used. Also, the effect of growing up using digital media has been speculated to negatively impact attention spans, with a study by the Microsoft Corporation claiming the average adult attention span has shrank from 12 – to eight seconds in the past decade (McSpadden, 2015). The statistics connected to the study, however, were pulled from an additional website and have been criticized for lacking clear citations and methods as to how they were derived (Maybin, 2017).

Regardless, it is difficult to hypothesize the impact this may have student’s attention abilities, fidget aid use, and overall learning as the young children develop into young adults attending college lectures.

*Split Attention*

When an individual is completing a task, such as reading, their attention and working memory are ideally devoted to the task. When a fidget aid is introduced, small amounts of working memory need to be devoted to its appropriate use, whether that is
spinning a fidget spinner, clicking buttons on a fidget cube, or squeezing a stress ball. The available cognitive processing and attention is then split between the intended task, in this instance reading, and the attention necessary to maintain fidgeting with the given object. The limited working memory abilities become even more limited when divided between the two tasks. Not only does the task of using the fidget aid create additional cognitive load, it also provides an additional competing stimulus in the environment for both the individual and surrounding peers.

**Competing Sensory Input.** Fidget aids can produce noise, such as the sound of the fidget spinner spinning around its ball bearing. The noise not only adds to the WM load of the individual using the spinner, but also to the WM load of other students and teachers within a classroom. Additionally, colorful designs provide extra visual stimuli that may demand cognitive attention from the student and peers. Even if a student is not using a distracting fidget aid herself, her classmate’s use of a fidget spinner or stress ball may be distracting and may reduce the amount of working memory available. This scenario is assuming the spinner is being used individually and appropriately. However, even if a child is successfully inhibiting her desire to look at another student playing with a toy or is trying to exhibit self-control, she is still using cognitive resources. Self-control, emotional control, behavioral control, as well as physical and cognitive effort place demands on the working memory (Kahneman, 2011). Thus, requiring a student to resist the temptation of a toy may make an academic task too difficult.

Based on CLT, negative environmental distractions should be eliminated, reducing the strains of WM, and lightening the overall cognitive load to achieve optimal problem solving. Within this model, fidget toys are negative environmental effects for
both the individual as well as the classroom. This contrasts with the sensory processing model, in which spinners may provide a level of sensory stimulation for individuals with higher sensory thresholds to enable optimal learning.

**Comparing Theories**

Dunn’s (2007) Sensory Processing Theory as well as theories around attention and cognitive load (e.g., Choi et al., 2014; Ormrod, 2016) present conflicting logical arguments on the possible effect of fidgets on attention and learning. Dunn’s (2007) theory is limited by a lack of research outside of her own investigations. Her studies tend to lack experimental rigor, rely on self-report, and purport overly generalized findings. Attention is a diverse construct with many different theories; yet all theories support that adding an additional, irrelevant, stimuli to cognitive processing would likely lead to distraction, diverted attention, and resulting negative effects on learning (e.g., Berti & Schroger, 2001; Choi et al., 2014; Franconeri & Simons, 2003; Ormrod, 2016). Attention theories also rely on more scientifically sound measures, such as eye tracking, or other direct measures of attention (e.g., Liu & Heynderickx, 2011). When compared to the scholarship on Sensory Processing Theory, scholarship on attention theories is completed by more researchers using different paradigms and experimental measures, and often produces clear, specific conclusions related to the findings of their work. The limitation of much of the research on attention is that it is often limited to such direct and specific findings. Overall conclusions on the nature of attention are often the synthesis of the specific findings, rather than testing a full model. Even given this limitation, however, theories of attention and cognitive load have greater empirical support compared to
Sensory Processing Theory. Therefore, attention and cognitive load theory should be given greater weight in considering the effect of fidget aids on attention and learning.

**Fidgeting and Attention Disorders**

Several researchers have proposed a difference in the neurobiology of individuals with ADHD compared to other, neurotypical, individuals, which may alter the relationship between fidgeting and attention specifically for this population. Individuals with ADHD demonstrate decreased firing of the locus coeruleus-norepinephrine system, resulting in decreased cortical arousal and poor attention performance (Cohen et al., 2018). The brain is theoretically not receiving enough of the neurotransmitter to “wake-up” and pay attention. This baseline under-arousal of the brain is the theoretical reason underlying why stimulants are often prescribed to individuals with ADHD. Little is definitively known about the exact mechanisms of action facilitated by psychostimulant medication; however, it is hypothesized to increase cortical arousal. A meta-analysis of MRI findings showed enhanced activation in bilateral inferior frontal cortex (IFC)/insula in children diagnosed with ADHD who were taking psychostimulant medication (Rubia et al., 2014). The stimulant medication was correlated with greater brain activation. The use of psychostimulants has also been demonstrated to improve attention in individuals with ADHD (Greenville, 2001).

Some have proposed the fidgeting effectively achieves a similar consequence as the psychostimulant medication discussed above (Cohen et al., 2018). Fidgeting, in fact, has been argued as helping individuals with ADHD through both stimulating and calming properties (Rotz & Wright, 2005). Specifically, natural fidgeting has been proposed as playing a role in maintaining attention with hyperactive children, acting as a
compensatory behavior (Sarver et al., 2015). Students with ADHD may be fidgeting naturally as a means of increasing their arousal or brain activation, similar to proposed resulting effects stimulant medication. The physical movement effectively stimulates the brain. Physical fidgeting has also been found to contribute to improved test performance in individuals with ADHD (Hartanto et al., 2016). Specifically, Hartanto and colleagues conducted a study of children between 10 to 17 years old who were either typically developing (n=18), ADHD-combined type, or ADHD inattentive type (total ADHD group, n=27). Participants completed an Eriksen flanker task, in which they were instructed to respond with a button press of their left or right hand given a prompting stimulus that was either incongruent or congruent with the correct direction (left or right). Participants physical movement was measured using a Motionlogger device. The ADHD group demonstrated significantly higher movement during correct trials than the control group. The authors argue this is evidence that students with ADHD have enhanced cognitive control with more intense activity.

Within-task stimulation is an additional route explanation by which fidgeting (natural or facilitated) could improve task performance. The within-task stimulation intervention for students with ADHD proposes that student improvement on academic task can be improved through increasing stimulating properties within a given tasks, such as through changing the color of materials or print, or requiring the physical pressing of a button to respond (Raggi & Chronis, 2006). For example, when students with ADHD were asked to press a button for a repetitive response activity, their impulsive errors, talking, noise making, and hyperactivity became reduced to that demonstrated by their non-ADHD peers (Zentall & Meyer, 1987). Therefore, given these proposed mechanisms
of effectiveness and the differences in neurobiology and need for greater biological arousal, it is possible the effect of fidget aids may be different for those with ADHD compared to those without.

Unlike psychostimulant medication, fidgets are accessible and marketed to all individuals, regardless of their diagnosis. Attention difficulties experienced by an individual with a diagnosis of ADHD may be related to different causal mechanisms than attention difficulties experienced by those without ADHD. The consequence of fidget use, therefore, could also be different across groups. Further, despite the purposed action pathway of fidgeting on the ADHD brain, there is no scientific evidence that fidgets increase brain activation in such a manner that overall focus is improved, or that students are more capable of attending to and learning academic material. In evaluating the effects of fidgets on attention and learning it is important to evaluate the general population, as they are targets of the fidget marketing and consumers of fidgeting products, while also accounting for those who may have a diagnosis of ADHD. All group differences between ADHD and general population groups are based on theoretical constructs but lack biological or experimental evidence to explain the effects of fidgeting.

In order to recommend best practices regarding fidget use it is necessary to understand how they affect the attention and learning of all students, while also accounting for possible differences in ADHD groups. This also informs practice as school psychologists, teachers, occupational therapists, other school staff, and students can discern who may or may not benefit from fidget use and use these tools accordingly. This differs from the approach of allowing fidget use by any student who can use them non-disruptively, regardless of the effect on their academic performance.
Review of Fidget Aids in Practice

The body movement of fidgeting is generally associated with inattention (Carriere et al., 2013; Farley et al., 2013). Carriere et al. (2013) found that inattentiveness and spontaneous mind wandering were uniquely predictive of fidgeting when observing college students, suggesting a strong association between self-reported fidgeting behavior and decreased attention and mind wandering. A tendency to daydream has also been found to positive correlate with an inclination to fidget, using self-report and objective observation, also based on a study with college students (Mehrabian & Friedman, 1986). In these instances, fidgeting is the consequences or byproduct of already lost attention or mind wandering, rather than associated with the desired outcome of maintaining attention. This suggests fidgeting itself could be the distractor, rather than the enhancer of attention. There is some evidence, however, to suggest that the causal path is actually reversed.

Some researchers advocate that fidgeting, when done in a way that is not intrusive, may improve attention and cognitive performance (Carson et al., 2001; Levine et al., 2000; Stalvey & Brasell, 2006). For example, sixth-grade students displayed some improvement in academic writing scores, as well as decreased display of distraction behaviors when using stress balls while receiving direct writing instruction, compared to their behavior without the stress balls (Stalvey & Brasell, 2006). Further, in a conference presentation, Slater and French (2010) presented on their finding that fidget toys may help refocus college student’s attention to class material and away from in-class distractions. These examples remain the only available empirical findings of positive effects of fidget aid use available in extant literature. It is difficult to rule out these
positive findings, however small and scientifically lacking they are, because there is also little counterevidence of fidgets leading to neutral or negative outcomes.

In an unpublished thesis, Grodner (2015) found that when college student participants were instructed to use an unspecified fidget toy, they performed significantly worse on an easy version of a Stroop task compared to when they had no instructions for fidget use. While not a significant difference, the participants also performed worse on the easy Stroop task when instructed to use the fidget compared to when they were told to simply hold the fidget toy and not move. A study by Kriescher and colleagues (2018) found evidence of negative effects of fidget aid use. The authors evaluated the effect of fidget spinners on behavior and academic achievement in two subjects (math and reading) in a third-grade classroom. They found that in both math and reading, students showed a significant increase in off-task behavior when using fidget spinners compared to when they were not using fidget spinners with corresponding medium and large effect sizes (math Hedge’s g = 0.525; reading Hedge’s g = 1.033). Students also performed significantly worse on a grade appropriate math worksheet when they were permitted fidget spinner use as compared to when they were not, with a small effect size (Hedges g = -0.25) (Hulac et al., in press). The authors did not directly evaluate the effect of using fidget spinners on attention.

An additional study examined the effect of fidget spinners on attention and movement of young children diagnosed with ADHD. Graziano and colleagues (2018) implemented an A-B-A-B design to monitor the attention and movement related redirections of 48 children (mean age = 4.86 years) with and without the use of fidget spinners during an intensive evidence-based behavioral treatment program. The
researchers also measured overall physical activity levels using accelerometers. The researchers found that students moved slightly, but significantly, less during their first fidget spinner use, but not during their final fidget spinner use period, suggesting a possible habituation effect. During the first period of fidget spinner use, the students also demonstrated fewer “area” (movement) violations. The authors do note that the fidget spinner use did not have an effect on the other students’ behavioral and attentional functioning, as measured by class “area” or “attention” rule violations. During both fidget spinner use periods, students using the fidget spinners demonstrated significantly greater “attention” violations compared to their baseline period, suggesting fidget spinner use had a negative effect on attention. This study is limited by its setting in an intensive behavioral program as well as participants were majority male and majority Hispanic. Therefore, when students diagnosed with ADHD engaged in facilitated fidgeting using a fidget spinner, thereby increasing within-task stimulation and overall sensory information, they still demonstrated worsened attention and classroom behavior compared to when they did not use the fidget spinners.

Recently, Soares and Storm (2020) evaluated the effect of fidget spinners on college student memory and self-reported attention lapses. The researchers completed two studies. The first study was a between groups design in which college students watched a video lecture in small groups. Participants \( n = 98 \) were assigned either the fidget spinner condition, using fidget spinner while watching the lecture, a fidget spinner present condition, being present while others used a fidget spinner, or a no fidget spinner control condition. After watching the lecture participants completed a short multiple-choice test on lecture content and self-reported attention lapses. The authors found that
individuals with the fidget spinner performed significantly worse on the memory test following the lecture compared to the other two groups, but no significant difference reported for attentional lapse. There was no difference between the fidget spinner present condition and control condition on any task.

In the second study the researchers used a within participant experimental design \((n = 48)\). Participants watched two video lectures. During one lecture participants used a fidget spinner and during the other they used no fidget device. The researchers also asked participants about their attitudes regarding fidget use and performance. Participants performed worse on the memory measures as well as reported increased attentional lapses when using the fidget spinner. There was no significant effect on attitudes of fidget use on results.

As previously mentioned, these studies range the developmental spectrum and therefore are not perfect comparisons. Yet they remain the only studies on fidget use and therefore serve as the only comparison and basis for understanding the possible effect of facilitated fidgeting. Even in light of the given specific examples, the evidence on fidget aid use remains sparse, conflicting, and non-conclusive. Based on the available research, using fidget aids may lead to decreased on-task behavior in some circumstances \((\text{Graziano et al., 2018; Kriescher et al., 2018})\), decrease math CBM performance \((\text{Hulac et al., in press})\), and may improve writing scores in other circumstances \((\text{Stalvey & Brasell, 2006})\), yet the effect on attention is all together unknown. Additionally, each fidget toy is unique in the shape, structure, and intended use. Their unique effects on behavior, attention, or academics, however, has yet to be compared and evaluated scientifically. More research is needed to determine the effect of different fidget aids on
attention. The effect of facilitated fidgeting on different ages or developmental stages is also unknown. Attention is an essential aspect of fidget aid use to explore because, in most instances, these fidget aids are being marketed and recommended based on hypothesized ability to improve attention in students of all ages.

**Gaps in the Literature**

Relatively few studies exist explicitly evaluating the effect of fidget aids on relevant outcomes for students, such as attention, learning, and behavior. Those that do exist possess several limitations. Broadly speaking, claims that fidgets may benefit student’s attention lack methodological rigor, peer review, and have never been replicated. Student success and learning has been broadly defined and self-reported. The present study will improve upon these areas by operationally defining the learning process through attention, inhibition, working memory, and reading and listening comprehension. The measures in this study are direct measures based on participants’ performance, not their self-reported beliefs about fidgeting, inattention, and the benefits of fidget aids.

Studies that have claimed possible negative effects of fidget aids also have several limitations. Grodner (2015) did not define type of fidget used. Based on how attention is affected by features such as motion, novelty, animation, and intensity, type of fidget may be a major contributor to results. Additionally, Grodner failed to demonstrate a significant effect of the fidget toy on any other outcome variable other than performance on an easy Stroop task. The present study would improve on Grodner’s (2015) work through evaluating two different and popular fidget aids, stress balls and fidget spinners. This study will also evaluate more relevant outcome measures. Additionally, by
manipulating the Stroop task, Grodner experienced a floor effect on the easy version of the task, the same task that they claimed to have found a significant effect of fidget aid use.

Further, research by Kriescher and colleagues (2018) on the behavioral off-task outcomes related to fidget aids was unable to control for confounding variables such as task difficulty and group membership. Future research would benefit from random assignment of participants to groups and direct measurement of attention and learning task. The Hulac and colleagues (in press) study measured the effect of fidget aid use on relevant educational performance measure, math curriculum-based measures (CBMs). Again, however, this did not indicate how fidget aids affected attention and learning, but rather performance on an assessment. Future research would benefit from exploring broader measurements of learning, in addition to assessment performance. While test performance is a significant variable of interest in schools and should be considered, learning loss because of fidget aid use has significant additive consequences.

Current Study

Given the conflicting theories and limited existing scholarship, it is possible that fidget spinners and other fidget toys could have either a positive or a negative effect on attention and learning. There is stronger scholarship and evidence supporting the negative effects on additional stimuli and attention, compared to the benefits of sensory-based interventions for typically developing individuals. However, scholarship on the direct effect of fidget aids on attention and learning is limited and largely unknown. The current study evaluated the effect of no fidget aid use, fidget spinner use, or stress ball use on
variables relevant to attention and learning of college students, including simple attention, inhibition, working memory, and reading and listening comprehension.

Examining college students in an experimentally rigorous way serves as the beginning of answering the many research questions associated with facilitated fidgeting. As previously mentioned, college students are a subpopulation of the total consumers of fidget aids and their selection of use may differ from the methods employed by schools to aid students; yet, there are also many similarities in terms of attention abilities, seeking tools to improve academic performance, availability of accommodations provided by institutions, and concerns about student performance. Current literature on the topic is spread throughout the developmental span on childhood through early adulthood. The current study will serve to inform college students on the effects of fidget use on their attention and learning performance and provide a methodologically rigorous basis for pursuing these research questions across the developmental span.
CHAPTER III

METHODOLOGY

Participants

College students enrolled in psychology classes at a mountain western region university town were recruited through the university’s participant recruitment pool. Based on sample size estimates for a MANOVA design with three groups (no fidget, fidget spinner, and stress ball), and six dependent variables, estimating a medium effect size, with a power of .80, the minimum participants needed for the study was 66 participants, 22 per group (Lauter, 1978). Effect size estimate was based on medium to large effect sizes ($Hedge’s \ g = 0.525 – 1.033$) in previous research on the effect of fidget spinners on on-task behavior (Kriescher et al., 2018), alpha and beta estimates are best practice for social sciences research (Cohen, 1988). A fixed effects design was selected to assess performance of each of the three groups (no fidget aid, fidget spinner, and stress ball) on different learning related tasks.

In order to qualify for participation in the study, all participant reported they were free of any documented motor impairments of the arms or hands to control for motor difficulties that may have confounded and prevented fidget use. Participants were compensated with two class credit through the university recruitment SONA system, for their participation, in accordance with the University policy. The study was approved by the University’s Institutional Review Board before implementation (see Appendix A). All
participants were given written informed consent and debrief forms following termination of their participation in the study.

A total of 66 participants completed the study. The participants were relatively equally divided between male and female (female $n = 36$, male $n = 29$, transgender $n = 1$) and had an average age of 19.6 ($SD = 2.7$). The demographics of the sample are representative of the mountain western university (69.7% White ($n = 46$), 24.2% Hispanic or Latino ($n = 16$), 3% Black ($n = 2$), 3% Asian ($n = 2$)). Majority (53%) of participants reported they were in their first year of college, followed by second year college students (25.8%), and third year college students (16.7%) and those attending their fourth year (1.5%). Across groups average self-reported graduating high school GPA was 3.44 ($SD = 0.48$), average current GPA was 2.95 ($SD = 0.74$).

**Measures**

**Demographic Survey**

Participants were given a brief demographic survey, eliciting information about age, ethnicity, gender, college major, self-reported high school GPA and current college GPA, and year in college (see Appendix B). The demographic form also included information on participant familiarity with fidgets, including if participants had recently (within the past year) used a stress ball or fidget spinner to help with their attention in school, and reported levels of perceived improvement related to fidget use, from 1 (not at all improved) to 4 (a lot improved) Likert scale.

**Adult Attention Checklist**

The Adult Attention Deficit/Hyperactive Disorder Self-Report Checklist (ASRS) is an 18-item self-report screener for Attention Deficit/Hyperactive Disorder (ADHD)
that takes approximately five minutes to complete (see Appendix C). The ASRS was
developed by the World Health Organization to align with the Diagnostic and Statistical
Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria for ADHD (Kessler et al.,
2005). The measure includes subscales for attention difficulties and functional
impairment. When compared to measures of independent raters, the self-report scores on
the ASRS have been in high agreement (Cronbach’s alpha = 0.89), as well as there has
been high internal consistency demonstrated within the rater’s self-report (Cronbach’s
alpha = 0.88), supporting the assessment as a valid and reliable measure (Adler et al.,
2006). The ASRS has also been supported as a sensitive screener in identifying ADHD
(sensitivity 84%, specificity 66%), when comparing scores of the ASRS to those of the
Conner’s Adult Diagnostic Interview, a gold standard for ADHD diagnosis (Glind et al.,
2013). Further, it has been used to identify ADHD symptoms with a college population
(Gray et al., 2014). The ASRS was selected as a measure to approximate self-perceived
attentional difficulties in college students.

While the ASRS was originally formed based off the DSM-IV-TR, the DSM-5
poses few major changes to the ADHD diagnosis. Symptoms included in Criterion A
remain the same, with further description of how these symptoms may manifest in
adolescence and adulthood. Additionally, the number of symptoms that must be met for a
diagnosis of ADHD in older adolescents and adults changed from six to five (Epstein &
Loren, 2014). Considering the symptoms themselves have not changed the purpose of the
ASRS is simply to screen for the possibility of ADHD, these changes are not at a
significant level as to undermine the validity of the ASRS.
Wechsler Adult Intelligence Scale
Fourth Edition, Digit Span Task

The Digit Span task of the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV) is believed by many neuropsychologists to assess attention and working memory (Strauss et al., 2006); it is also part of the WAIS-IV Working Memory Index. For this study, two of the trials of Digit Span were administered, Digit Span-Forward and Digit Span-Backward. For Digit Span-Forward, participants were read a list of numbers ranging from three to eight total numbers at a rate of one number per second and asked to repeat the numbers back to the examiner in the same order. This task is considered a more basic task of auditory attention because participants are only required to hear the numbers and repeat them back. Once participants responded incorrectly to two test items of the same length, the task is discontinued. The Digit Span-Backward task is similar, except participants were asked to repeat the items back in the reverse order. This task requires more working memory, as participants must hold the numbers in their memory, organize them backward, and repeat them. In order to be successful with the task participants must have paid attention to the information being presented verbally, retained the numbers in their working memory, and repeated the numbers back to the experimenter.

In all the tasks participants were awarded one point for correct answers. The total points were summed. This produced two outcome scores, a total score for Digit Span-Forward (Dsf), and a total score for Digit Span-Backward (Dsb). Standard scores are available to correct for age for all scores, according to WAIS-IV standardized scoring protocol; however, raw scores were used for the purpose of this experiment. The relevant research question was not how participants compared to a nationally standardized and
normed sample of other same-age individuals, but rather how their scores compared across groups within the local experiment.

The WAIS-IV standardization sample includes 2450 people between the age of 16- to 89-years-old, included to match demographic information from the 1995 U.S. Census. The Full-Scale IQ (FSIQ) score is largely considered the most valid and reliable outcome from the WAIS-IV (Canivez & Watkins, 2010; Wechsler, 2008). Bifactorial models with subset loading into an overall “g” factor as well as their subtest domains, however, suggest that the digit span task reliably moderately loads (.44) on to the Working Memory Index (WMI) on the WAIS-IV (e.g., Gignac & Watkins, 2013). Given this and other factorial models, the digit span task may load onto the general “g” intelligence factor best, however, it also loads onto working memory. Additionally, the task has face validity for measuring attention and working memory, as both attending to numbers and remembering them is necessary for completing the task. Successful performance on the task may also tap into cognitive abilities and intelligence above working memory ability, but attention and working memory are necessary for task completion. The digit span task has been critiqued for not adequately capturing working memory because of its neglect of a visual working memory task (Egeland, 2015). For the purpose of this study, however, the use of Digit Span is to measure auditory attention and working memory; therefore, it is still an appropriate measure. Digit Span also reflects more realistic, everyday methods of working memory than highly sensitive computerized tasks.

The Digit Span task has also been used to assess working memory in a variety of experimental tasks (e.g., Bull & Scerif, 2001; Conway et al., 2005; Gathercole et al.,
1994; Pisoni & Geers, 2000), has shown sensitivity and differentiating working memory ability with individuals with different subtypes of ADHD (Pasini et al., 2007), and has been demonstrated to predict attention and executive functioning problems in children (Rosenthal et al., 2006). The Digit Span task has also been used in studies to be sensitive to changes in attention level after an intervention (e.g., evaluating the effects of nicotine in patients with Alzheimer’s disease; Sahakian et al., 1989). Digit Span also has evidence as a reliable subtest, with 0.93 internal consistency (Schleicher-Dilks, 2015). Some practice effect is present upon repeated administration of the task within a year time period (Estevis et al., 2012). However, for the sake of this experiment, the task was only administered once.

**Stroop Task**

The Stroop Task is considered to be a measure of executive functioning that assess inhibition, fluid ability, and speed (Strauss et al., 2006). The Stroop test is also one of the top ten most commonly used tests of executive functioning, believed to uniquely capture this combination of skills (Strauss et al., 2006). The Stroop task is also widely used in clinical research. The task requires attention; however, builds upon attention demands with additional executive function tasks. This is similar to what students experience in a classroom. Not only must they attend to material, but at times they are required to inhibit irrelevant information and complete tasks quickly. The original Stroop task was developed by Stroop in 1935. The paradigm proposed by Stroop (1935) has since been adapted and implemented in many research studies as well as applied practice (e.g., Bench et al., 1993; MacLeod, 1991; Logan, Zbrodoff, & Williamson, 1984; Verhaeghen & De Meersman, 1998). The Stroop Task, at its core, contains congruent and
incongruent stimuli. For the congruent stimuli, words are presented in the same color as their semantic meaning (e.g., the word, “Red,” printed in red ink). For the incongruent stimuli, words are presented in a different color than indicated by their semantic meaning (e.g., the word, “Red,” being printed in green ink). Participants are then instructed to state the color of the ink of the word. On these incongruent trials, participants must inhibit their initial response of reading the word’s semantic meaning, and instead report the printed color.

Often, Stroop tasks begin with participants completing a basic color identification trial, followed by a word trial, in which they read the semantic words, and ending with the color-word interference trial (e.g., MacLeod, 1991; Stroop, 1935). Other paradigms simply present the Stroop task with a variation of congruent to incongruent words (i.e. some words are printed in the same color as their semantic meaning indicates – congruent, while others are not – incongruent). The percentage of congruent to incongruent words in the task can be manipulated to adjust the difficulty of the task (e.g., Grodner, 2015; Logan et al., 1984). Participants are timed when completing the task and corrected when answering incorrectly. For example, if a participant responded that the color was “blue” because the semantic word was “blue”, but the ink was yellow, they would be corrected by the experimenter who would say “yellow”. MacLeod’s (1991) review on the Stroop Effect documents a wide variety of variations on the initial Stroop Task in which stimuli are presented at different points in time, different positions (e.g., vertically versus horizontally), and administered to groups at a time. He also documents studies employing different methods of adapting the words and colors of the stimuli to include different vocabulary or different hues of colors.
For the purposes of this study, the Stroop task was modified to include a 100% congruent block, followed by 100% incongruent block consisting of 40-word trials each (see Appendix D). Total time for the block was recorded for each block as well as number of errors. The congruent block acted as a measure of simple visual attention – are participants able to attend to and read the color words printed in ink quickly and accurately? The incongruent block assessed participants’ ability to inhibit their dominant response and respond correctly. The Stroop effect has been demonstrated in several different types of experimental paradigms (MacLeod, 1991). The current study extended upon this research, adapting the task to be an appropriate difficulty and length to detect differences in group performance. Because the Stroop task is timed, the forty words in each trial provided participants adequate opportunity to have their performance evaluated in each condition, while remaining sensitive to variance in group performance. The Stroop tasks remains widely used in research and clinical assessment (Strauss et al., 2006).

Previous research demonstrates the ability to manipulate performance on a Stroop task with fidget aid use. Participants performed significantly worse on an easy version of the Stroop task when they were told to play with a fidget aid; however, this finding was not apparent in the hard version of the task (Grodner, 2015). Performance on the Stroop task has also been found to be related to third grade students’ math abilities (Bull & Scerif, 2001) adult ADHD symptoms (King et al., 2007), and other executive impairments in disorders such as Schizophrenia and depression (Moritz et al., 2002). Across instances, better performance on the Stroop task was associated with improved math performance and less executive functioning impairments across disorders.
**Reading Comprehension Maze Task**

Maze passages are a commonly used form of curriculum-based measurement (CBM) of reading comprehension. Maze CBMs indicate current level of comprehension and are more predictive of future reading performance for students in grades 4 and higher than oral reading fluency probes (Hosp et al., 2016). Reading maze tasks are created by selecting a passage of 300 words or less. In adapting this to college students, longer passages helped alleviate the possibility of a ceiling effect. In maze tasks, every seventh word is deleted. Participants are then given three words to select for the missing word, the correct answer and two foils. The three choices are presented in random orders throughout the task. To complete the task, the researcher times the participant once they begin reading silently. The participant selects the correct word to restore the meaning of the sentence every time they come to a response item in the passage. The participant is given 120 seconds to complete the task. After 120 seconds, the researcher stops the participant and records the stopping point in text. Reading maze CBMs have demonstrated strong criterion validity when compared to commercial reading test (Fuchs & Fuchs, 1992), as well informal measures of reading ability, such as cloze completion, recall of passages, and question answering (Fuchs & Fuchs, 1992; Fuchs et al., 1988).

A reading maze task was created for this study using Intervention Central’s Test of Reading Comprehension – Maze Passage Generator. The generator constructs a reading passage in accordance to the earlier mentioned specifications (omits every seventh word and participants must select from three choices, one correct word and two foils). Foils were words selected randomly from the passage. This was done to control for passage tone and word difficulty. The passage selected was selected from recommended
reading passages for ninth through twelfth grade students, according to Scholastic (Scholastic, 2020). Overall reading ability for college freshman students has been estimated to be between fifth grade and twelfth grade reading level (Olney et al., 2017). The readability of the selected passage, based on common readability estimates, from John Muir’s *My First Summer in the Sierra*, titled “To the High Mountains,” based on ranged from seventh grade level (Dale-Chall, Lix Formula) to twelfth grade level (Automated Reading Index, Fox Index), with a Lexile score of 1420L. Participants were given two minutes to read and answer as far as they were able within the 850 word passage (Experimenter Copy, Appendix E; Participant Copy, Appendix F). This specific passage was selected due to the content and difficulty, as established through pilot testing. When administered to 24 college freshmen, participants scored an average of 14.71 (SD = 3.22) words correct during the allotted two-minute time frame. The results of the pilot tasks support task validity for the current study.

In addition to the Stroop Task and Digit Span, the maze reading comprehension task provided an approximation of how fidget aids are affecting students on higher level tasks relevant to performance in the classroom. The Stroop task provided a sample of how students’ visual attention and inhibition are affected while the reading comprehension maze task built upon the visual attention and inhibition ability to assess how students perform on a task relevant to their overall learning and comprehension of written materials.

**Wechsler Individual Achievement Test -Third Edition Task**

The Wechsler Individual Achievement Test – Third Edition (WIAT-III) is a standardized achievement test for children and adolescents, with expanded norms for
individuals up to age 50, intended to access academic capabilities in several domains including, reading, writing, and arithmetic. The Listening Comprehension subtest specifically is intended to measure an individual’s ability to listen to tasks and select the correct answers. For the Oral Discourse Comprehension task, used for the purposes of this study, participants listened to a CD recording of sentences and passages followed by comprehension questions and orally provided the correct answer based on their ability to make inferences from the context of and remember details about the sentence(s) and/or passages.

The Listening Comprehension task had strong split half reliability when measured in the standardization sample in both fall \( r = 0.84 \) and spring \( r = 0.83 \) semesters. Test-retest reliability was also adequate \( r = 0.75 \) (Lichtenberger & Breaux, 2010). The WIAT-III has also demonstrated validity, with moderate to high correlations with indices on the WIAT-II and WIAT-III \( r = 0.76-0.93 \) (e.g., Canivez, 2013). The WIAT-III also correlates moderately with other tests of cognitive ability (e.g., WISC-IV, WAIS-IV, and WNV) \( r = 0.60 - 0.82 \). These correlations also suggest divergent validity, as the WIAT-III is measuring similar, but different constructs than measured by intelligence test, such as that including the Digit Span task. The WIAT-III was also able to differentiate between different ability levels of students and identify students who are gifted and talented, students with a mild intellectual disability, students with an expressive language disorder, and students with learning disabilities in the areas of Reading, Written Expression, and Mathematics, and typically achieving peers (Lichtenberger & Breaux, 2010).
Compared to other age-normed tests of oral expression, reading comprehension, and written expression, the Listening Comprehension task explains unique individual variance across fifth and seventh graders (Berninger & Abbott, 2010). This suggests that the Listening Comprehension subtest uniquely captures listening comprehension abilities outside of general academic ability, intelligence, or reading ability and written expression. The WIAT-III Listening Comprehension subtest has also been used in studies as a unique measure of listening comprehension (Berninger & Abbott, 2010), suggesting validity for the subtest evaluating listening comprehension abilities outside of the overall validity of the WIAT-III. Kim (2016) also found the construct of listening comprehension is predicted by several components including working memory, attention, vocabulary, grammatical knowledge, inference, theory of mind, and comprehension monitoring. Therefore, listening comprehension tasks measure components relevant to learning across domains (e.g., attention and working memory), but also components specific to the task of listening and comprehending (e.g., grammar and comprehension monitoring).

**Materials**

**Fidget Spinner**

A plain white fidget spinner was provided to the participants in the fidget spinner condition. The fidget spinner contained three one-inch prongs rotating around a one-inch center with a covered ball bearing. Each prong contained an uncovered black ball bearing at the end that could also be used for spinning the device (see Appendix J).

**Stress Ball**

A plain white round foam stress ball, two and a half inches in diameter was provided to the participants in the stress ball condition (see Appendix J).
Research Design

The data evaluating attention and fidget aid condition were analyzed using a 3x6 Multiple Analysis of Variance (MANOVA). All outcome dependent variables are theoretically related on a similar construct (cognitive processes related to learning) and dependent upon one-another (e.g., comprehension is dependent on working memory and working memory is dependent on attention and inhibition). This analysis is appropriate because participants will be divided into three groups and will have their performance on individual tasks compared across groups. Aligning with requirements for MANOVA use, there are multiple independent variables (no fidget, fidget spinner, and stress ball group) being compared on multiple (more than two) dependent criterion variables simultaneously (Bray & Maxwell, 1985). Using the MANOVA as opposed to separate ANOVA analyses for each outcome variable allows for evaluating the relationships among the outcome variables and the potential underlying theoretical construct of learning processes effected by fidget use. Through examining multiple theoretically related variables together, the MANOVA is theoretically more powerful statistic tests than conducting individual ANOVAs, creating a higher ability to detect an effect and reduced likelihood of making a Type II error (false negative) and Type I error through running fewer overall statistical analyses (Bray & Maxwell, 1985).

Huang (2020) recently critiqued the MANOVA procedure, arguing the MANOVA as a complicated, often inaccurately applied, outdated, less useful statistical procedure often overused in the fields of psychology and education. When considering Huang’s critiques, the MANOVA remains an appropriate method of analysis for this study. The present study poses dependent variables and research questions that are
multivariate in nature. As detailed above the primary inquiry of this study is how do different types of fidget use effect student learning, as measured through the different, theoretically related tasks of attention, inhibition, working memory, and reading and listening comprehension. This relationship can be evaluated using a correlation matrix (see Results section). Evaluating assumptions also ensures the data do not violate necessary requirements for the MANOVA (see Results section). Given these assurances, the argument of using a differing method of analysis over the MANOVA becomes less about factually wrong or right and more a matter of subjective opinions about interpretability which have yet to be fully debated within the field given the recency of Huang’s critiques. Additionally, as Huang highlights in his critique, MANOVA’s are widely used across psychological and educational research, arguably improving the ability for a variety of researchers to interpret, compare, and consume research findings produced by this method of analysis.

Demographic and self-reported attention problems were compared using 3 x 1 ANOVAs to ensure no statistically significant differences existed between groups (e.g., difference in number of males and females will be compared across groups, participants’ ages, and number of reported ADHD symptoms.)

The independent variable of the study is type of fidget aid used (no fidget aid, fidget spinner, stress ball). The dependent variables being measured are visual attention and inhibition, as measured by the Stroop Task, auditory attention and working memory, as measured by Digit Span, Reading Comprehension, as measured by the Maze reading task, and Listening Comprehension, as measured by the WIAT-III Listening Comprehension Oral Discourse task (see Figure 2).
Participants attended an hour testing session. Before arriving, participants were randomly assigned to either the no fidget, fidget spinner, or stress ball conditions. Upon arriving, participants signed informed consents (Appendix G). Each participant then completed the visual attention and inhibition task (Stroop Task), auditory attention and working memory task (Digit Span) and reading and listening comprehension task (Reading Maze and Listening Comprehension, Oral Discourse). Tasks were counter-balanced across participants to protect against order effects. At the beginning of the study, participants received a short set of directions regarding the fidget use in their condition, as follows:
No fidget aid: Complete the following task.

Fidget spinner: During the following tasks, hold this fidget spinner and use it on the activity.

Stress ball: During the following tasks, hold this stress ball and use it on the activity.

In Fidget Spinner and Stress Ball Condition participants were provided a short visual demonstration and prompts by the experimenter describing appropriate use. If participants put down any items over the course of an activity, they were prompted to keep it in their hand throughout the task, using the prompt, “Hold the [insert object] and use it to help you complete the task.” In the no fidget condition, participants were not permitted to hold any items in their hand. If they picked up an item before or during the course of the task, they were prompted, “Please put down the [insert object] and continue to complete the task.” The exception to this being holding a pencil while completing the Reading Maze task. After completing each individual task, participants were given a brief mandatory break, up to two-minutes, to allow for attention restoration between tasks.

No fidget aid was selected as a suitable control condition for the study for several reasons. This investigation focuses on the effect of facilitated fidgeting as a unique construct compared to natural fidgeting. As previously mentioned, facilitated fidgeting encompasses fidgeting behaviors that are enabled through specific objects intended to elicit fidgeting behaviors (such as a fidget spinner or stress ball). Through introducing specific objects, natural fidgeting is inherently altered. Certain natural fidgeting behaviors, such as simple finger tapping have been demonstrated to have no attentional
cost (e.g., Kane & Engle, 2000). The same has not been demonstrated with any type of facilitated fidgeting to date. Therefore, while no fidget aid is not a perfect control, as some movement or natural fidgeting may occur, it is a suitable control when comparing types of facilitated fidgeting. Researchers noted observational anecdotal data on natural fidgeting in the control condition to contribute to the discussion of the research.

After completing the test tasks, the participant completed the ASRS followed by the demographic survey. Completing these items after test activities have been completed reduced the possible priming effects of drawing a participant’s attention to their self-reported attention abilities, academic performance, attitudes of fidgets, or other variables that may have influenced their performance. Following completion of the survey, participants were given a debrief explaining the nature of the study as well as an opportunity to ask any questions before leaving (Appendix H). Participants were awarded two credits on the online participant recruitment system for their participation.

If participants arrived to participate in the study and were visibly intoxicated or unable to engage with experimental tasks for other reasons, experimenters were instructed to thank them for their time, award the study credit, and tell them they could leave. No participants were turned away throughout the course of the study for these reasons. All data were analyzed to determine and remove outliers indicating unusually off-task or compromised responding. Outliers were determined by visually inspecting distribution of findings across all measures. Data were checked for illogical outcomes (numbers or results that were not possible based on the nature of the task), and extremes (data separated from the remaining data by two or more standard deviations). Data points of concern were examined within the context of the full participant performance (e.g.,
high or low data points on one task were compared to performance across other tasks based on theoretical relatedness of DVs). Experimenters were also given the opportunity to note any concerns about specific participant’s performance. No significant outliers were identified and therefore no data removed from analysis. Data for one participant’s Stroop task were misplaced and therefore not included in analyses.

**Data Analysis**

The first research question addressed how use of different fidget aids (stress ball or fidget spinner) compares to a no fidget aid control on different measures of attention, memory, and learning. This question was analyzed through a 3x6 MANOVA. The three groups were compared on all six outcome variables. The rationale for selecting a MANOVA procedure is detailed above. In order to conduct the MANOVA, the data must meet assumptions of independence of observations, homogeneity of variance, and normality. Equal number of participants were randomly assigned to each group for the study and completed testing sessions independently, therefore meeting the assumption of independence of observations. Before conducting the MANOVA, data were also analyzed using histograms to check for normal distribution, a correlation matrix between DV variables to evaluate relationship between outcome variables, and the Leven’s univariate tests and Box’s M-test to test for homogeneity of variance.

Group similarities were also assessed through 3x1 ANOVAs evaluating any significant differences across gender distribution (number of males and females), age, high school GPA, and self-reported ADHD symptoms. The ANOVAS also met assumptions of normality, equal distribution across groups, and independence of observations.
The second research question addressed total self-reported ADHD symptoms and the relationship between type of fidget used and attention and learning performance across all six outcome measures (basic auditory and visual attention, working memory, inhibition, and visual and auditory comprehension). This question was analyzed using a 3x6 MANCOVA with total ADHD symptoms as the covariate. The significance of the interaction term was considered significant if the p-value is at or below $p = 0.05$. 
CHAPTER IV
RESULTS

Participants were divided across three groups, no-fidget ($n = 22$), fidget spinner ($n = 22$), and stress ball ($n = 22$). The majority (83.3%) of the sample reported not using fidgets, including over 90% reporting they do not use fidgets when completing academic tasks. Majority (61%) of participants believed using fidgets lead to little or no improvement in academic performance. Within the past year 40.9% of participants reported they had used a fidget spinner once with 31.8% reporting they have used a fidget spinner two-to-three times. Within the past year 54.5% of participants reported using a stress ball once for any purpose, followed by 24.2% reporting they have used a stress ball two-to-three times. Based on these responses, majority of the sample was familiar with the fidgets utilized in the study; however, did not use them often, or to aid in academic tasks.

Eight participants self-reported having been diagnosed with ADHD from a medical professional at some point in their lives: the age of diagnosis ranging from between age six to 21, with majority of diagnoses (75%) occurring before age 10. All participants also completed an ADHD screener questionnaire, ASRS. The average total score on this measure was 30.38 ($SD = 10.631$). According to the ASRS screener guidelines, a score of 24 or higher suggests an individual is at high risk of having ADHD. Forty-nine participants obtained total scores at the 24-score cutoff or higher (74.24%). While few individuals reported clinical diagnoses of ADHD, the high average and
number of participants endorsing total scores above the 24-score cutoff on the screener indicates several participants were experiencing perceived attention difficulties. This may have been an artifact of a majority of college students being first year students and attentional and stress demands associated with school as well as the sensitivity and specificity of the measure. Mean, standard deviation, and ranges for ASRS scores as well as other relevant study variables are included in Table 1.

**Table 1**

*Descriptive Statistics for Study Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>M (SD)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASRS Total</td>
<td>66</td>
<td>30.38 (10.63)</td>
<td>10</td>
<td>58</td>
</tr>
<tr>
<td>Digit Span Forward</td>
<td>66</td>
<td>9.92 (1.77)</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Digit Span Backward</td>
<td>66</td>
<td>8.55 (1.75)</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Stroop Time 1</td>
<td>65</td>
<td>18.82 (4.85)</td>
<td>10.98</td>
<td>35.00</td>
</tr>
<tr>
<td>Stroop Time 2</td>
<td>65</td>
<td>38.10 (7.78)</td>
<td>26.36</td>
<td>65.81</td>
</tr>
<tr>
<td>Stroop Difference</td>
<td>65</td>
<td>19.28 (7.98)</td>
<td>3.36</td>
<td>47.06</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>66</td>
<td>19.38 (3.59)</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Reading Maze</td>
<td>66</td>
<td>18.33 (4.96)</td>
<td>7</td>
<td>29</td>
</tr>
<tr>
<td>Reading Maze Error</td>
<td>66</td>
<td>1.18 (1.29)</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

To evaluate possible relationship between demographic variables and task performance, mean comparisons were conducted across dependent variables based on
gender, ethnicity, and year in college. There were no significant differences across all dependent variables based on year in college and gender. Performance on the Reading Maze task was significantly different across groups based on ethnicity ($F_{(3,62)} = 5.28, p < 0.01$). Based on a Tukey’s post-hoc analysis, individuals who reported White ethnicity performed significantly higher on the reading maze task than individuals who reported Hispanic/Latino ethnicity ($p < 0.01$).

Additional analyses were conducted to assess for differences in experimenter on outcome measures. Performance on the Reading Maze tasks was also significantly different across groups based on experimenter ($F_{(2,62)} = 8.451, p < 0.01$). A Tukey’s post-hoc analysis for experimenter groups found those in the second experimenter’s group performed differently on Reading Maze than those in the first or third group. One possible explanation for this is that experimenter two ran fewer participants ($n = 6$) than both experimenter one ($n = 43$) and experimenter three ($n = 16$), leading to non-normal distribution within experimenter two’s participant group.

**Research Question One**

**Q1** How does using different fidget aids (stress ball or fidget spinner) compare to not using a fidget aid on the Stroop Task, Digit Span forward and backward, Reading Maze, and Listening Comprehension Task? Are there differences between high movement fidget (fidget spinner) and low movement fidget (stress ball)?

A 3x6 MANOVA was conducted examining the three conditions (no fidget, stress ball, fidget spinner) across six outcome measures (Digit Span Forward, Digit Span Backward, Stroop time 1, Stroop difference, Listening Comprehension total, and Reading Maze total) (see Table 3).
Assumptions

The necessary assumptions for conducting a MANOVA include multivariate normal distribution, homogeneity of variance across groups, and independent observation of data (O’Brien & Kaiser, 1985). The data for this study met these assumptions in the following ways: visual analysis of histograms supports assumptions of normal distribution across variables. Box’s Test of Equality of Covariance Matrices (Box’s $M = 61.34, p = 0.172$) indicate no concerns for equal variance across dependent variables. No variables were found to be significant on Levine’s Test of Equality of Error Variance, also supporting no evidence of violating the assumption of equal variance.

To address the level of dependency between outcome variables, a correlation matrix was conducted with outcome variables (see Table 2). Huang poses DV’s should poses moderate to strong correlations to create the necessary linear composite for a meaningful MANOVA analysis.

Table 2

*Correlations Between Dependent Variables*

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Digit Span Forward</td>
<td>-</td>
<td>0.47**</td>
<td>0.18</td>
<td>-0.15</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>2. Digit Span Backward</td>
<td>-</td>
<td>-0.03</td>
<td>-0.12</td>
<td>0.20</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>3. Stroop Time 1</td>
<td>-</td>
<td>-0.34**</td>
<td>0.01</td>
<td>-0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Stroop Difference</td>
<td>-</td>
<td></td>
<td>-0.09</td>
<td>-0.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Listening Comprehension</td>
<td>-</td>
<td></td>
<td></td>
<td>0.30*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Reading Maze</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01
Results suggest some small significant correlations between outcome variables, including a significant relationship between Digit Span Forward and Digit Span Backward ($r = 0.47$, $p < 0.01$), Stoop Time 1 and Stroop Difference ($r = -0.34$, $p < 0.01$), and Listening Comprehension and Reading Maze ($r = 0.30$, $p = 0.013$). No correlations, however, meet Huang’s (2020) suggested $r = 0.6$ cutoff for moderate to large effect sizes, ensuring true interrelatedness between outcome variables, thereby supporting the multivariate aspect of the MANOVA. While some significant correlations exist between DV’s all variables are not significantly related and even those that are, are not to a moderate or large effect. Based on the results of the correlation matrix, additional post-hoc analyses were conducted, including separate ANOVAs for each DV. Post-hoc analyses can further explore the effect of fidget aid on DV’s. The level of interrelatedness of dependent variables is of interest. For further discussion on the implications of these findings, see Discussion chapter.

**Main Effects**

There were no significant differences in any of the dependent variables based on condition (Wilk's Lamda = 0.77 ($F_{(12, 114)} = 1.35$, $p = 0.20$) (see Table 2). Partial Eta Squared for the dependent variables indicate a small effect size, however, because all findings are insignificant the small effect sizes likely would not generalize beyond this study.
Table 3

*MANOVA Results for Research Question 1 Main Effects*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Partial Eta Squared</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digit Span Forward</td>
<td>2.04</td>
<td>1.02</td>
<td>0.32</td>
<td>0.01</td>
<td>0.73</td>
</tr>
<tr>
<td>Digit Span Backward</td>
<td>6.84</td>
<td>3.42</td>
<td>1.12</td>
<td>0.04</td>
<td>0.33</td>
</tr>
<tr>
<td>Stroop 1 Time</td>
<td>99.52</td>
<td>49.76</td>
<td>2.20</td>
<td>0.07</td>
<td>0.12</td>
</tr>
<tr>
<td>Stroop Difference</td>
<td>194.43</td>
<td>97.22</td>
<td>1.55</td>
<td>0.05</td>
<td>0.22</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>51.78</td>
<td>25.89</td>
<td>2.10</td>
<td>0.06</td>
<td>0.13</td>
</tr>
<tr>
<td>Reading Maze</td>
<td>35.63</td>
<td>17.82</td>
<td>0.71</td>
<td>0.02</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Note: *Df* = 2.

The non-significant MANOVA results indicate there was no significant difference between fidget groups. Though non-significant, the means of the no fidget group trended higher (see Table 4). Higher values indicate better performance apart from scores on the Stroop Task.
Table 4

Descriptive Statistics for Study Variables by Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>No Fidget</th>
<th>Stress Ball</th>
<th>Fidget Spinner</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>ASRS Total</td>
<td>32.91 (8.99)</td>
<td>27.77 (10.32)</td>
<td>30.45 (12.20)</td>
</tr>
<tr>
<td>Digit Span Forward</td>
<td>10.23 (1.69)</td>
<td>9.73 (1.64)</td>
<td>9.82 (1.99)</td>
</tr>
<tr>
<td>Digit Span Backward</td>
<td>8.41 (1.99)</td>
<td>8.23 (1.66)</td>
<td>9.00 (1.54)</td>
</tr>
<tr>
<td>Stroop Time 1</td>
<td>18.65 (4.94)</td>
<td>20.39 (5.50)</td>
<td>17.40 (3.66)</td>
</tr>
<tr>
<td>Stroop Time 2</td>
<td>39.78 (10.90)</td>
<td>37.38 (5.22)</td>
<td>37.23 (6.31)</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>20.18 (3.50)</td>
<td>18.27 (3.55)</td>
<td>19.68 (3.60)</td>
</tr>
<tr>
<td>Reading Maze</td>
<td>19.27 (5.51)</td>
<td>17.73 (4.20)</td>
<td>18.00 (5.16)</td>
</tr>
<tr>
<td>Reading Maze Error</td>
<td>1.27 (1.35)</td>
<td>1.32 (1.04)</td>
<td>0.95 (1.46)</td>
</tr>
</tbody>
</table>

Note: All sample sizes equal 22 with the exception of the no fidget condition Stroop tasks (n = 21).

Post-Hoc Analyses

Due to lack of moderate to strong correlations across dependent variables, additional post-hoc analyses are appropriate to analyze for possible test effects given the independence of DV’s. Six ANOVAs were conducted to test the effect of fidget group across each DV of interest. Using the Bonferroni adjustment to reduce the likelihood of Type I Error the alpha is divided by number of test (6), meaning results must be significant at the $p = 0.008$ level (0.05 divided by six). Based on these criteria type of fidget group did not have a significant effect on any DV, including Digit Span Forward ($F_{(2, 63)} = 0.49, p = 0.613$), Digit Span Backward ($F_{(2, 63)} = 1.18, p = 0.31$), Stroop Time 1
$F_{(2, 62)} = 2.198, p = 0.12$, Stroop Difference $F_{(2, 62)} = 1.55, p = 0.22$, Listening Comprehension $F_{(2, 63)} = 1.71, p = 0.19$, and Reading Maze $F_{(2, 63)} = 0.602, p = 0.55$.

**Research Question Two**

Q2 Does total self-reported ADHD symptoms significantly affect the relationship between type of fidget used and attention and learning performance?

To address this research question, I conducted a 3x6 MANCOVA in which I covaried total self-reported attention difficulties (as reported on the ASRS) with the three condition groups and six dependent variables. When covaried self-reported ADHD symptoms were non-significant in the MANCOVA model (Wilk’s Lambda = 0.076 ($F_{(6, 56)} = 0.916, p = 0.535$)) (see Table 5).

**Table 5**

**MANCOVA Covarying ASRS Scores**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type III Sum of Squares</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Partial Eta Squared</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digit Span Forward</td>
<td>3.81</td>
<td>1.27</td>
<td>0.40</td>
<td>0.02</td>
<td>0.76</td>
</tr>
<tr>
<td>Digit Span Backward</td>
<td>10.46</td>
<td>3.49</td>
<td>1.15</td>
<td>0.05</td>
<td>0.34</td>
</tr>
<tr>
<td>Stroop 1 Time</td>
<td>103.66</td>
<td>34.55</td>
<td>1.51</td>
<td>0.07</td>
<td>0.22</td>
</tr>
<tr>
<td>Stroop Difference</td>
<td>194.53</td>
<td>64.84</td>
<td>1.02</td>
<td>0.05</td>
<td>0.39</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>57.79</td>
<td>19.26</td>
<td>1.55</td>
<td>0.07</td>
<td>0.21</td>
</tr>
<tr>
<td>Reading Maze</td>
<td>60.174</td>
<td>20.06</td>
<td>0.80</td>
<td>0.04</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Note: $Df=3$

**Post-Hoc Analyses**

To further evaluate the effect of self-reported ADHD symptoms on participant performance on tasks of attention and learning regardless of type of fidget used, I
conducted an independent samples t-test equal variance assumed, comparing those individuals who endorsed ADHD symptoms at or above the screener cutoff, compared to those below the cutoff on all outcome measures (see Table 6). There were no significant differences between those scoring at or above the ADHD indicator cutoff compared to those scoring below on any outcome measure (see Table 7).

**Table 6**

*Descriptive Statistics for ADHD Indicated and Non-ADHD Indicated Groups*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-AHDH Indicated</th>
<th>ADHD Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M (SD)</td>
</tr>
<tr>
<td>ASRS Total</td>
<td>17</td>
<td>17.76 (3.25)</td>
</tr>
<tr>
<td>Digit Span Forward</td>
<td>17</td>
<td>10.06 (2.02)</td>
</tr>
<tr>
<td>Digit Span Backward</td>
<td>17</td>
<td>9.12 (2.03)</td>
</tr>
<tr>
<td>Stroop Time 1</td>
<td>17</td>
<td>17.92 (5.67)</td>
</tr>
<tr>
<td>Stroop Time 2</td>
<td>17</td>
<td>35.66 (6.34)</td>
</tr>
<tr>
<td>Stroop Difference</td>
<td>17</td>
<td>17.74 (6.80)</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>17</td>
<td>18.71 (3.92)</td>
</tr>
<tr>
<td>Reading Maze</td>
<td>17</td>
<td>18.29 (4.07)</td>
</tr>
<tr>
<td>Reading Maze Error</td>
<td>17</td>
<td>1.35 (1.22)</td>
</tr>
</tbody>
</table>
Table 7

*T-test for ADHD Indicated vs ADHD Non-Indicated Performance*

<table>
<thead>
<tr>
<th>Variables</th>
<th>$T$</th>
<th>$p$-value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digit Span Forward</td>
<td>0.36</td>
<td>0.72</td>
</tr>
<tr>
<td>Digit Span Backward</td>
<td>1.59</td>
<td>0.12</td>
</tr>
<tr>
<td>Stroop Time 1</td>
<td>-0.87</td>
<td>0.38</td>
</tr>
<tr>
<td>Stroop Difference</td>
<td>-0.93</td>
<td>0.36</td>
</tr>
<tr>
<td>Listening Comprehension</td>
<td>-0.90</td>
<td>0.37</td>
</tr>
<tr>
<td>Reading Maze</td>
<td>-0.4</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Note: $Df = 64$ for all variables, except Stroop tasks ($Df = 63$), Equal Variance Assumed
CHAPTER V
DISCUSSION

Fidget Devices: Helpful or Harmful?

In individually administered, short, blunt tasks of attention and learning, fidgets were neither helpful nor harmful in college student performance. The findings of this study must be interpreted within the context of the instrumental precision as well as the experimental setting. In aiming to measure constructs of learning such as attention, working memory, inhibition, and comprehension, experimental tasks exist on a spectrum of precision. The more specific the construct of learning (e.g., attention), the more levels of instrumental precision (e.g., reaction time on computer tasks). Additionally, the constructs of learning may perform differently in different experimental settings, such as individual administration, small group administration, and large group/classroom administration. Therefore, when comparing the findings of this study to existing literature and deducing generalizability it is necessary to consider and compare the level of instrumental precision and experiment setting in addition to the study findings.

Precision & Setting

The most precise experimental measures of attention and memory as relevant to fidget use could be different computerized reaction time tasks and/or visual tracking. These tasks detect small “micro” changes in response times, allowing for detection of much more subtle changes in performance; however, they may not translate to changes in performance on more “blunt” tasks, such as Digit Span (utilized in this study), ability to
perform on a pop quiz, or general comprehension of taught concepts. At this time, no studies have specifically evaluated the outcome of fidget use using this level of precision in instruments. Given the findings of the present study, it is possible that fidget use may have had an effect on attention or working memory, but that this effect was so small that the instruments utilized were unable to detect it. To address this question, additional studies would need to utilize more precise instruments.

The tasks in this study were short, domain-specific, and administered individually, similar to the tasks utilized by Grodner (2015). Grodner found mixed effects, with fidgeting leading to an improvement in performance on in the difficult Stroop tasks. Grodner’s study, however, utilized movement suppression as a control condition, leading to an imperfect comparison to the present study. Given that consideration, the results were generally similar. Fidget devices did not consistently lead to an improvement or decrease in attention and memory skills with the college student population. These replicated findings provide support that at this level of precision, in the individually administered setting with college students, fidget devices have no significant effect.

The next step up in experimental precision would be to look at the effect of fidget devices on test or work output. Fidgets can be used during tests, such as the use of fidget spinners and stress balls while completing comprehension reading maze probes in this study, or using fidget spinners while completing curriculum-based math probes (Hulac et al., in press). They can also be used during learning of academic material and then later evaluated using test or work samples, such as a short quiz following watching a video lecture while using a fidget spinner (Soares & Storm, 2020), or creative writing output
after having access to stress balls during writing times (Stalvey & Brasell, 2006). Fidget use while completing a clear test of performance of already learned material has led to no effect on reading comprehension for college students when individually administered. Conversely, in a full class setting, third graders performed worse on math CBMs when using fidget spinners compared to performance when using no fidget device. (Hulac et al., in press). These serve as imperfect comparisons because of the difference in content (reading versus math) as well as developmental difference (third graders compared to college students). However, this leaves an unclear conclusion of how fidget use affects performance on these specific tasks at this level of precision. The setting also serves as an imperfect comparison. During individually or small group administered tasks, students may perform better than when completing tasks in large groups, as evidenced by increased performance on academic measures when completed in small group compared to full group (e.g., Hart et al., 2011).

Other studies measuring tests and work outputs have also led to inconclusive findings. On a multiple-choice test following a video lecture, college students performed worse when using fidget spinners (Soares & Storm, 2020); however, sixth graders performed better on creative writing after using stress balls (Stalvey & Brasell, 2006). Again, however, Stalvey & Brasell’s findings are problematic due to the limitations in their study already discussed, and the two studies serve as imperfect comparisons (e.g., differences in developmental level as well as content).

The broadest level of experimental precision for attention and memory is observational data, such as on-task/off-task observations (Kriescher et al., 2018) or recording of attention or movement violations (Graziano et al., 2018). This level of
precision relies on behavior approximations of attention and may fail to detect true cognitive attention. However, this possesses strong validity as it relates to student behavior in the classroom. In all instances of observed behaviors, use of fidget has led to increased off-task behaviors and/or attention violations. At this level of measurement precision and setting (full group) several studies have aligned, suggesting the negative effect of fidget devices on student performance.

The true effect of fidget devices must be understood and interpreted within the context of the precision and settings it has been evaluated. The measurements and settings may strongly affect the relationship between fidgeting and performance. An overview of studies evaluating the effect of fidgets across the contexts remains inconclusive on their effects; however, it is important to note that more recent published studies with improved experimental methods trend towards the negative effect of fidget devices on different student learning and behavior outcomes across age levels (e.g., Graziano et al., 2018; Hulac et al., in press; Soares & Storm, 2020).

**Fidget Devices & Attention Disorders**

In individually administered, short blunt tasks of attention and learning, degree of self-reported attention difficulties did not significantly affect the relationship between type of fidget or no fidget use and task performance with college students. Further, college students who reported ADHD indicated level of attention difficulties on the ASRS ADHD screener did not perform different than those who reported non-ADHD indicated levels of attention difficulties on individually administered, short blunt tasks of attention and learning. These conclusions from the present study can be understood
within the context of the instrument’s psychometric properties as well as the level instrumental precision and experimental setting.

With only eight participants reporting medical diagnoses of ADHD and 49 participants falling above the ASRS screener ADHD-indicated cut-off, the measure clearly led to an overrepresentation of ADHD-indicated individuals within the sample. Several factors may have contributed to this. The Sensitivity (84%) and Specificity (66%) of the ASRS compared to the gold-standard ADHD measurement, the Conner’s inventory (Glind et al., 2013) helps explain the high number of false-positives, or those without a true diagnosis of ADHD who were labeled as ADHD-indicated according to the screener. According to the psychometric features, the screener was only able to successfully identify the true-negatives, or those who do not have ADHD, roughly 6 out of 10 times. The measure cast a wide-net, leading to many individuals being inaccurately identified as ADHD-indicated. Considering the items on the ASRS, individuals may have been reporting attention difficulties that may be related to a wide range of other factors relevant to college student life, such as attention difficulties related to lack of sleep, stress, etc., as opposed to those with true medical and/or psychological concerns due to ADHD.

The screener, therefore, did not serve as a good differentiating measure between those with and without ADHD, convoluting the study outcomes. While the screener may have been accurate at detecting the level of perceived attention difficulties, it is unlikely these difficulties related to real ADHD diagnoses for most participants. Given the theories behind ADHD and fidget use, such as Sensory Processing Theory (Dunn, 2007), and the lack of cortical arousal hypothesis (e.g, Cohen et al., 2018), presence of a real
medical diagnosis of ADHD may relate uniquely to the effect of fidget devices on outcomes as opposed to general attention difficulties. To truly evaluate the effect of fidget devices on performance in students with ADHD, more rigorous ADHD criteria would need to be implemented, such as only accepting those with a documented medical diagnosis of ADHD or conducting a diagnostic interview and using more valid and precise measures of assessment for ADHD.

**Precision & Setting**

Regardless of presence of ADHD, however, it may be anticipated that those who reported greater attention difficulties would perform worse on attention tasks, regardless of fidget grouping. The lack of this finding may also be related to precision and setting. As previously discussed, smaller group sizes have been related to increased on-task behavior (e.g., Hart et al., 2011). The nature of the individually administered task eliminated many factors that may have affect attention or cognitive load leading to less competing information to attend to. Participants only had to attend to the performance tasks presented in the study, as opposed to having to selectively attend to the tasks in the presence of other individuals with attention grabbing elements, such as other sounds, sights, social awareness, etc. When given less information to attend to and clear performance criteria, it is possible that even individuals who feel they have attention difficulties are able to successfully direct and sustain attention for short durations of time, as was expected with the tasks utilized in this study.

Other studies evaluating the effect of fidget spinners using observational measures in full-group settings found that fidget spinners led to decreased attention with young children with ADHD (Graziano et al., 2018). Attention during full group activities is
likely more of a concern due to the additional distracting factors contributing to overall cognitive load detailed above. Therefore, Graziano’s findings may have more significant real-world applicability. Graziano also used participants with a clear medical diagnosis of ADHD. Based on these factors fidget spinners are likely an ineffective intervention for individuals with ADHD, especially within the full-group classroom context; however, additional studies across development would provide more substantial support for this finding.

**Findings Within Their Theoretical Context**

**Sensory Processing Theory**

Sensory Processing Theory (Dunn, 2007) describes individuals as having different sensory needs in order to reach their personal optimal level of arousal, therefore enabling optimal learning. Everyone falls on a spectrum of sensory need and passive or active approaches to fulfilling those sensory needs. If the results of this study were to show evidence of Dunn’s theory, we would expect that using a fidget would lead to an improvement in performance on these learning tasks. Afterall, individuals were equipped with the tool and given instructions to use it to help them on the experimental tasks. While all individuals followed the task instructions, the exact use of the fidget varied from individual to individual, with some consistently spinning the fidget spinner or squeezing the stress ball, while others would hold the stress ball and squeeze it before or after providing an answer, or hold the fidget spinner and occasionally spin it. This variation in performance does serve as a confounding variable in the results; yet, this falls within Dunn’s (2007) reasoning. Those who needed more sensory input likely would use the fidget tools at a greater frequency or in a method that would produce greater sensory
input. Those who did not have as great of sensory needs would likely only fidget occasionally. Therefore, regardless of fidget tool use, we would expect to see an improvement in overall performance compared to the no fidget group. This, however, was not the case. There was no significant difference across no fidget, stress ball, or fidget spinner groups. Other factors may have also influenced individual fidget use, such as the participants adherence to rules (e.g., feeling the need to fulfill the requirement of using the fidget) or general attitudes about performance (e.g., how much they cared about doing a good job on the tasks). Familiarity with fidgets may have also been a contributing factor to overall use; however, as indicated in the demographic survey, majority of participants had some familiarity with all types of fidgets.

It is also a possibility that individuals in the no fidget group still engaged in some natural, non-facilitated fidgeting, such as tapping their foot, that may have provided additional sensory information even for the no fidget condition. This study does not provide comprehensive data to rule out this possibility and the hypothesis warrants further inquiry. Regardless, if natural, non-facilitated fidgeting was to blame for the lack of significant differences across groups, this provides further evidence that facilitated fidgeting through the use of fidget tools provides no added benefit above and beyond students’ natural, unconscious abilities to seek and provide sensory input. The tools themselves remain unnecessary and come with additional monetary costs, create clutter, and may still create problems or serve as distractions to others in the classroom. Across age levels fidget tools must be monitored for appropriate use. In college students, ideally this monitoring is a self-monitoring process by which college students are aware of when their fidget use is no longer a tool, but shifting to that of a toy (e.g., performing tricks
with a fidget spinner, throwing a stress ball into a waste bin). At younger levels, however, this task of monitoring and feedback often falls on adults working with the students, adding an additional demand brought about by fidget tool use, and increasing the time cost of facilitated fidgeting through fidget tools as compared to natural fidgeting.

**Attention & Cognitive Load Theory**

The other theories proposed to provide a framework in predicting and understanding the effect of facilitated fidgeting through use of fidget toys on attention and learning were attention theories and Cognitive Load Theory (CLT; Choi et al., 2014). According to this theory, learning is accomplished through a series of cognitive steps by which information is attended to and incorporated into long-term memory. The cognitive load of a given learning task is determined by a variety of factors within the individual, the task, and the environment. The more extraneous factors, the greater the load, the more cognitive energy a given task may take, which can lead to poorer performance. It may be useful to think of a body builder at a gym. The “load” of a cognitive task can be likened to the amount of weight the body builder is attempting to pick up. As additional extraneous factors are added that may interrupt attention, such as a loud environment, a cluttered desk with brightly colored papers or objects, a video containing animate objects (such as the Snapchat video of peers) on a friend’s phone, extra “weight” is added to the overall cognitive load of the tasks, thereby making it more difficult to attend to and incorporate all essential information into long-term memory to facilitate learning. Using the framework of this theory, the use of a facilitated fidget may also add to the overall load. Therefore, we would expect individuals’ performance on attention and learning tasks would be worse if they were using a fidget tool compared to the no fidget control.
This, however, was also not supported by the findings of this study. There were no significant differences across stress ball, fidget spinner and no fidget conditions.

Under CLT these findings could be interpreted in several ways. The first possibility is that facilitated fidgeting through use of stress ball or fidget spinner has no effect on overall cognitive load and therefore did not affect attention and learning. Because of the ample evidence in support of CLT and several well-developed empirical studies providing support for CLT, this is likely not the case. It is more likely that the attention and learning task in this study did not provide the level of sensitivity in measurement to detect small changes in attention and memory performance that one may expect from adding to an individual’s cognitive load. Importantly, however, even if there were small changes in attention and working memory that went undetected by the measures in this study, there were no differences on tasks reflecting broader learning, such as listening comprehension and reading comprehension. This stands to support that facilitated fidgeting through fidget tools does not hurt nor help overall academic performance.

It is also possible that other confounding variables in the study may have made it more difficult to detect the small variance caused by type of fidget or no fidget use. Within CLT we understand that the cognitive load of a given task is determined by many different factors, as previously mentioned. For example, the time of day, the amount of sleep an individual had the night before, how recently they’ve eaten, any sounds made in the hallway outside the room, and their own emotional state may all influence the cognitive load of a task. Therefore, in the absence of controlling for all these variables, it may be difficult to parse apart the small effect of fidget tools on cognitive load, especially
given the broader measures of attention and learning utilized in this study. However, due to the randomization of participants across conditions, the effects of these potentially confounding variables should have remained equally distributed and therefore not significantly altering results.

**Limitations**

An additional limiting confounding variable that may have affected performance is the language load of different tasks. While the consent form for the study included the constraint that English must be the primary language for participants, it is possible that this question was interpreted differently or overlooked by some participants. This may serve as a possible explanation for the significant difference in performance on the reading comprehension task (Reading Maze) between participants who reported White ethnicity versus Hispanic/Latino. Further studies should contain more controls to ensure for similarities in language ability or less language-heavy experimental tasks.

The type of facilitated fidgeting that occurs within the research lab may also not align with facilitated fidgeting in more naturalistic settings, such as the classroom. More research is needed to monitor how facilitated fidgeting effects performance when under less strict experimental instruction. In this study, as well as several others examining the effect of facilitated fidgeting on learning (e.g., Grodner, 2015; Hulac et al., in press; Kriescher et al., 2018), participants are given explicit instructions to use their fidget tools while completing tasks. While the verbiage and constraints on these instructions may vary from experiment to experiment, this likely differs from typical use of fidget tools outside the experimental setting. Especially in cases such as this study where the instructions are left relatively short and simple, application of the instructions is left, in
part, to the individual’s interpretation. This is done to allow for appropriate individual variation and reducing the cognitive demand of following explicit strict instruction (e.g., squeeze the stress ball every 20 seconds, spin the fidget spinner at the start of each item); however, it also introduces variability that requires greater analysis and observation to understand and interpret. In the absence of experimental instruction, students may engage with fidgets in methods that feel more natural and less prescriptive. Few studies have evaluated when fidgets were used within the classroom setting as opposed to the experimental setting and have found both negative effects (e.g., Hulac et al., in press; Kriescher et al., 2018; Soares & Storm, 2020) and positive effects (Stalvey & Brasell, 2006) of fidget use. More robust inquiry, however, is needed to further address this question.

The findings of this study are also limited by the sample size. A-priori analysis based on the literature (Lauter, 1978) indicated 66 participants were necessary to detect a large effect size. The estimated large effect size was based on earlier studies which found that fidget spinners had a large effect on off-task behavior and academic performance (Kriescher et al., 2018). This estimate, however, was based on research conducted with younger students. It is possible that estimated effect size of fidgets with a college population may be smaller, indicating the number of participants in the present study was not sufficient to detect the small effect. This aligns with the non-significant small effect sizes found in the main analyses of this experiment. However, prior to collecting data, with the absence of robust previous research, there was no evidence to suggest a smaller effect size. Despite this limitation, none of the main effects of the study were approaching significance, suggesting the lack of significant findings was not solely an artifact of the
sample size. Further research should examine if the results are replicated in larger sample sizes.

The lack of interrelatedness between dependent variables also has important implications to the findings of the study. Tasks measuring auditory attention (Digit Span forward) and working memory (Digit Span backward) were not related to visual attention (Stroop Time 1), inhibition (Stroop Difference), or reading (Reading Maze) and listening comprehension (Listening Comprehension). This finding is likely less related to overall theoretical relationship between these different cognitive processes and more related to the specific tasks selected for this study to measure them. Future studies would benefit from further defining dependent variables and selecting more precise measures to ascertain the specific effect on cognitive processes. The tasks selected for this study, however, have practical importance, especially in the world of school psychology.

The tasks included within the study are commonly used to measure and evaluate different aspects of student functioning in schools (e.g., WISC-V, WIAT-III, CBMs). How the field interprets the findings of these assessments in regard to student functioning and abilities can directly affect programming, goals, and supports puts into place. Often practitioners may interpret subtests scores to have direct implications to specific skills, such as Digit Span performance being related to a working memory skill or deficit. The very names of the subtest imply greater knowledge of specific cognitive abilities. The lack of relationship between these commonly used intelligence and learning tasks highlights the importance of not over interpreting results or over generalizing performance on subtests as single point indicators of need. When an auditory attention and working memory task is not related to a listening comprehension task on assessments
commonly applied and interpreted within schools, this should cause pause and increased caution in interpreting test results to specific areas of need, especially in the absence of a robust body of evidence.

**Implications**

Despite the limitations of the present study and need for further inquiry, the findings of this study remain important in several ways. Given the wide-spread popularity of fidgets and extensive pseudoscientific claims (e.g., Best, 2017), the present study provides a structured scientific inquiry into the effectiveness of these devices on different aspects of learning. Additionally, this is the first study to compare fidgets from different fidget categories (low-movement, stress balls) and high movement (fidget spinners) to a no fidget control group. This study also further broke down the learning output into more specific tasks of attention, memory, and comprehension compared to earlier inquiries looking at broader work output, such as writing assignments (e.g., Stalvey & Brasell, 2006) or behavioral related factors, such as attention redirections for when students are displaying off-task behavior (e.g., Kriescher et al., 2018). The processes and measures of this study can be improved upon in future studies; however, the study provides an essential step forward in the field in differentiating between types of fidgeting and linking this to direct measures in an experimental fashion.

This study also provides evidence that facilitated fidgeting does not appear to negatively or positively effect broader measures of attention and learning in college students. Therefore, college students who are seeking assistance with their attention and learning should consider other, more empirically based, interventions. If, however, a
college student should want to use a fidget tool in class, it is unlikely (based on the findings of this experiment) that the fidget tool poses a risk to their performance.

In seeking to improve student outcomes, invested personnel such as administration, school psychologists, occupational therapists, teachers, parents, and students themselves are bombarded with pseudoscientific “tools” painted in fun and inviting colors, promising to solve problems (e.g., Biel, 2017; Tornio, 2017). Fidgets are purchased and distributed within schools and by college students as interventions lacking empirical backing. Previous scientific attempts to address the effectiveness of these “tools” have been conflicting, flawed, limited by sample sizes or lack of definitions and/or fidgets used, and/or not replicated (e.g., Grodner, 2015; Hulac et al., in press; Kriescher et al., 2018; Slater & French, 2010). Schools push for evidence-based interventions (Kratochwill et al., 2004), yet this is often ignored when school personnel or others provide fidgets to students in the absence of evidence of effectiveness with hopes of improving varying ranges of outcomes. The claims of fidget effects need to be narrowed and empirically explored. The present study cannot conclusively answer the questions of effectiveness; however, it provides an imperative stepping block in the scientific inquiry of fidget devices though defining natural and facilitated fidgeting, comparing high and low movement fidget devices, and through evaluating the effect of fidget use on specific, highly defined outcome measures.

Importantly, however, it can be said based on the results of this study that facilitated fidgeting is not helpful or harmful in improving attention, memory, and learning and it remains less cost effective than natural fidgeting. Further, in integrating the results of this study within the broader context of the evidence on fidget devices,
facilitated fidgeting is not an evidenced-based intervention and should not be implemented as such.

Applications

Defining Fidgeting

The current state of the field reflects broad and differing definitions of fidgeting, with definitions ranging from small or large body movements (Farley, Risko, & Kingstone, 2013), to doodling (Andrade, 2010), or chewing gum (Tucha et al., 2004). I propose that future inquiry adopts the terms “facilitated fidgeting” and “natural fidgeting.” Facilitated fidgeting encompasses any fidgeting that is enabled through use of an object. Natural fidgeting encompasses fidgeting behaviors that humans naturally engage in without tools or objects to enable their use. See Table 8 for examples of each.
<table>
<thead>
<tr>
<th>Category</th>
<th>Facilitated Fidgeting</th>
<th>Natural Fidgeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Any fidgeting that is enabled through use of an object.</td>
<td>Fidgeting behaviors that humans naturally engage in without tools or objects to enable their use.</td>
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<tr>
<td>Examples</td>
<td>Fidgeting using…</td>
<td>Tapping one’s leg/foot</td>
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<td></td>
<td>Stress balls</td>
<td>Tapping fingers on a table</td>
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<td></td>
<td>Putty</td>
<td>Twirling hair/Running fingers through hair</td>
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<td>Fidget spinners</td>
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<td>Fidget cubes</td>
<td>Rubbing/wrangling hands</td>
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<td>Tapping a pencil</td>
<td>Snapping</td>
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<td>Clicking a pen</td>
<td>Cracking knuckles</td>
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<td>Rubbing a worry stone</td>
<td>Rolling neck</td>
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<td>Stretching</td>
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<td>Biting nails</td>
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<td>Crossing/uncrossing legs</td>
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<td></td>
<td></td>
<td>Standing up/sitting back down</td>
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<td></td>
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<td>Adjusting one’s clothing</td>
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This table is not comprehensive; however, it provides a useful starting point to develop consistency within the knowledge base on fidgeting. Nor is the purpose of the table to state every human movement engaged in during a learning activity done for the explicit purpose of fidgeting or completed under conscious awareness. There may be biological or other reasons as to why someone may engage in physical movement during a learning activity. However, regardless of the “why” of the movement, the movement inherently involves sensory input which has theoretical consequences on attention and learning. The field needs to differentiate where fidgeting behaviors fall and how to experimentally define and measure them. Only through this process can the resulting research be interpreted, compared, and applied across a broader range of ages, settings, and resulting outcomes.

**Recommendations for Using Fidgets in Schools**

Synthesizing the present knowledge of the effectiveness of fidget devices on student learning, I pose the following recommendations for using fidgets in schools.

1. Be intentional about purpose.

Why is the fidget device being recommended? There is no evidence that fidget devices are useful in improving attention or behavior. Fidget devices may have some utility in improving emotion regulation or serving as a positive reinforcement tool to award students following completion of a desired behavior.

2. Be intentional about when allowing students fidget devices.

There is no evidence that fidget devices are effective during full-group instruction. Fidget devices may either lead to no improvement, or decreased performance on tests or performance tasks. They may be appropriate for use during breaks. In these
instances, however, their utility should be compared to that of other activities, such as larger movement breaks or social breaks.

3. Be deliberate about monitoring fidget device use.

For older students and adults this is may be accomplished through self-monitoring. Unless explicit skills and strategies are taught, however, the task of monitoring for appropriate use will likely fall on others, primarily supervising adults. This may add an undue burden to a classroom teacher to ensure appropriate fidget device use. Without appropriate monitoring, however, it is likely fidget device use can regress from appropriate, to unhelpful, to detrimental.
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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER
DATE: December 6, 2018  
TO: Stephanie Kriescher  
FROM: University of Northern Colorado (UNCO) IRB  

PROJECT TITLE: [1347493-1] Attention and Learning of College Students  
SUBMISSION TYPE: New Project  
ACTION: APPROVED  
APPROVAL DATE: December 6, 2018  
EXPIRATION DATE: December 6, 2019  
REVIEW TYPE: Expedited Review

Thank you for your submission of New Project materials for this project. The University of Northern Colorado (UNCO) IRB has APPROVED your submission. All research must be conducted in accordance with this approved submission. This submission has received Expedited Review based on applicable federal regulations. Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document. Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure. All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of December 6, 2019. Please note that all research records must be retained for a minimum of three years after the completion of the project. If you have any questions, please contact Nicole Morse at 970-351-1910 or nicole.morse@unco.edu. Please include your project title and reference number in all correspondence with this committee.
APPENDIX B

DEMOGRAPHIC SURVEY
Birthdate: ______________________

Age: ____________________

Gender (circle one):
   a. Female
   b. Male
   c. Transgender
   d. Non-binary
   e. Other
      a. Specify: _______________

Ethnicity (circle all that apply):
   a. White
   b. Hispanic or Latino
   c. Black
   d. Native American
   e. Asian
   f. Pacific Islander
   g. Other
      a. Specify: _______________

Year in college (circle one):
Freshman  Sophomore  Junior

High School Graduating GPA: __________  Current GPA: ________________

College Major: ________________________

Do you use fidgets (e.g., fidget spinners, stress balls, fidget cubes)? (circle one):

Yes  No

Do you use fidgets when completing academic tasks such as reading, writing, or listening to lectures? (circle one):

Yes  No

Do you think using fidgets improves your academic performance? (circle one):

Not at all  Very little  Somewhat  A lot

Within the past year, have you used a fidget spinner for any purpose?

Once  2-3 times  4-5 times  5-6 times  6-10 times  10+ times

Within the past year, have you used a stress ball for any purpose?

Once  2-3 times  4-5 times  5-6 times  6-10 times  10+ times

Have you ever received a diagnosis of ADHD from a medical professional (e.g., doctor or psychologist)?

Yes  No

   If yes, approximately how old were you when you received this diagnosis?

   ________
APPENDIX C

ADULT ATTENTION DEFICIT/HYPERACTIVITY

SELF-REPORT SCALE
Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page. As you answer each question, place an X in the box that best describes how you have felt and conducted yourself over the past 6 months. Please give this completed checklist to your healthcare professional to discuss during today’s appointment.

1. How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?
2. How often do you have difficulty getting things in order when you have to do a task that requires organization?
3. How often do you have problems remembering appointments or obligations?
4. When you have a task that requires a lot of thought, how often do you avoid or delay getting started?
5. How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?
6. How often do you feel overly active and compelled to do things, like you were driven by a motor?
7. How often do you make careless mistakes when you have to work on a boring or difficult project?
8. How often do you have difficulty keeping your attention when you are doing boring or repetitive work?
9. How often do you have difficulty concentrating on what people say to you, even when they are speaking to you directly?
10. How often do you misplace or have difficulty finding things at home or at work?
11. How often are you distracted by activity or noise around you?
12. How often do you leave your seat in meetings or other situations in which you are expected to remain seated?
13. How often do you feel restless or fidgety?
14. How often do you have difficulty unwinding and relaxing when you have time to yourself?
15. How often do you find yourself talking too much when you are in social situations?
16. When you’re in a conversation, how often do you find yourself finishing the sentences of the people you are talking to, before they can finish them themselves?
17. How often do you have difficulty waiting your turn in situations when turn taking is required?
18. How often do you interrupt others when they are busy?

*Exact form to be used can be provided upon request.
APPENDIX D

STROOP TASK
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Congruent Trail

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Incongruent Trial
APPENDIX E

READING MAZE PASSAGE
EXPERIMENTER COPY
John Muir was one of the foremost American conservationists. In 1869 he went with a group of shepherds who were taking a flock of sheep to summer pasture in the Sierra Nevada mountains. In this passage, the shepherds try to get the sheep to cross a river. The man named Don, who Muir also calls “the Don,” is the sheep owner, Don Delaney. “Don Quixote” is a nickname Muir uses for Delaney. Don Quixote was a character in a Spanish novel who was famous for fighting imaginary enemies.

July 14, 1869

The drivers and dogs had a lively, laborious time getting the sheep across the creek, the second large stream thus far that they have been compelled to cross without a bridge; the first being the North Fork of the Merced near Bower Cave. Men and dogs, shouting and barking, drove the timid, water-fearing creatures in a close crowd against the bank, but not one of the flock would launch away. While thus jammed, the Don and the shepherd rushed through the frightened crowd to stampede those in front, but this would only cause a break backward, and away they would scamper through the stream-bank trees and scatter over the rocky pavement. Then with the aid of the dogs the runaways would again be gathered and made to face the stream, and again the compacted mass would break away, amid wild shouting and barking that might well have disturbed the stream itself and marred the music of its falls, to which visitors no doubt from all quarters of the globe were listening. "Hold them there! Now hold them there!" shouted the Don; "the front ranks will soon tire of the pressure, and be glad to take to the water, then all will jump in and cross in a hurry." But they did nothing of the kind; they only avoided the pressure by breaking back in scores and hundreds, leaving the beauty of the banks sadly trampled.

If only one could be got to cross over, all would make haste to follow; but that one could not be found. A lamb was caught, carried across, and tied to a bush on the opposite bank, where it cried piteously for its mother. But though greatly concerned, the mother only called it back. That play on maternal affection failed, and we began to fear that we should be forced to make a long roundabout drive and cross the wide-spread tributaries of the creek in succession. This would require several days, but it had its advantages, for I was eager to see the sources of so famous a stream. Don Quixote, however, determined that they must ford just here, and immediately began a sort of siege by cutting down slender pines on the bank and building a corral barely large enough to hold the flock when well pressed together. And as the stream would form one side of the corral he believed that they could easily be forced into the water.

In a few hours the enclosure was completed, and the silly animals were driven in and rammed hard against the brink of the ford. Then the Don, forcing a way through the compacted mass, pitched a few of the terrified unfortunates into the stream by main strength; but instead of crossing over, they swam about close to the bank, making desperate attempts to get back into the flock. Then a dozen or more were shoved off, and the Don, tall like a crane and a good natural wader, jumped in after them, seized a
struggling wether, and dragged it to the opposite shore. But no sooner did he let it go than it jumped into the stream and swam back to its frightened companions in the corral, thus manifesting sheep-nature as unchangeable as gravitation. Pan with his pipes would have had no better luck, I fear. We were now pretty well baffled. The silly creatures would suffer any sort of death rather than cross that stream. Calling a council, the dripping Don declared that starvation was now the only likely scheme to try, and that we might as well camp here in comfort and let the besieged flock grow hungry and cool, and come to their senses, if they had any. In a few minutes after being thus let alone, an adventurer in the foremost rank plunged in and swam bravely to the farther shore. Then suddenly all rushed in pell-mell together, trampling one another under water, while we vainly tried to hold them back. The Don jumped into the thickest of the gasping, gurgling, drowning mass, and shoved them right and left as if each sheep was a piece of floating timber. The current also served to drift them apart; a long bent column was soon formed, and in a few minutes all were over and began baaing and feeding as if nothing out of the common had happened. That none were drowned seems wonderful. I fully expected that hundreds would gain the romantic fate of being swept into Yosemite over the highest waterfall in the world.
APPENDIX F

READING MAZE PASSAGE PARTICIPANT COPY
John Muir was one of the foremost American conservationists. In 1869 he went with a group (would, of, require) shepherds who were taking a flock (near, of, grow) sheep to summer pasture in the (Sierra, beauty, desperate) Nevada mountains. In this passage, the (quixote, shepherds, named) try to get the sheep to (cross, had, each) a river. The man named Don, (haste, rank, who) Muir also calls “the Don,” is (the, laborious, about) sheep owner, Don Delaney. “Don Quixote” (is, imaginary, banks) a nickname Muir uses for Delaney. (Dogs, Don, Nevada) Quixote was a character in a (wild, under, Spanish) novel who was famous for fighting (globe, imaginary, make) enemies.

July 14, 1869

The drivers and dogs (calls, cross, had) a lively, laborious time getting the (eager, while, sheep) across the creek, the second large (stream, siege, falls) thus far that they have been (group, compelled, tried) to cross without a bridge; the (first, brink, however) being the North Fork of the (john, Merced, like) near Bower Cave. Men and dogs, (shouting, building, over) and barking, drove the timid, water-fearing (creatures, rocky, pitched) in a close crowd against the (seized, see, bank), but not one of the flock (sort, would, went) launch away. While thus jammed, the (Don, mother, senses) and the shepherd rushed through the (gain, hard, frightened) crowd to stampede those in front, (driven, pretty, but) this would only cause a break (scores, backward, time), and away they would scamper through (the, play, well) stream-bank trees and scatter over the (rocky, men, sadly) pavement. Then with the aid of (the, enough, hold) dogs the runaways would again be (gathered, sierra, but) and made to face the stream, (in, and, pan) again the compacted mass would break (owner, away, we), amid wild shouting and barking that (form, and, might) well have disturbed the stream itself (and, must, roundabout) marred the music of its falls, (could, to, got) which visitors no doubt from all (quarters, taking, baaing) of the globe were listening.

"Hold (them, out, leaving) there! Now hold them there!" shouted (the, made, north) Don; "the front ranks will soon (shepherds, take, tire) of the pressure, and be glad (shepherd, way, to) take to the water, then all (hungry, will, forced) jump in and cross in a (hurry, starvation, barely)." But they did nothing of the (kind, tied, try); they only avoided the pressure by (rather, breaking, go) back in scores and hundreds, leaving (manifesting, the, those) beauty of the banks sadly trampled.

(Through, Calling, If) only one could be got to (bridge, cross, pell-mell) over, all would make haste to (enclosure, trampled, follow); but that one could not be (muir, terrified, found). A lamb was caught, carried across, (and, trees, disturbed) tied to a bush on the (current, farther, opposite) bank, where it cried piteously for (its, man, merced) mother. But though greatly concerned, the (amid, mother, now) only called it back. That play (them, on, now) maternal affection failed, and we began (stream-bank,
animals, to) fear that we should be forced (than, to, suffer) make a long roundabout drive and (few, cross, began)the wide-spread tributaries of the creek (in, its, scheme) succession. This would require several days, (their, but, after) it had its advantages, for (slender, was, one) eager to see the sources of (scatter, carried, so)famous a stream. Don Quixote, however, (determined, then, sheep) that they must ford just here, (more, cried, and) immediately began a sort of siege (struggling, failed, by) cutting down slender pines on the (so, bank, minutes) and building a corral barely large (enough, right, -------------------------------) to hold the flock when well (sooner, pressed, an) together. And as the stream would (that, form, good) one side of the corral he (let, believed, in) that they could easily be forced (into, unchangeable, trampling) the water.

In a few hours (greatly, against, the) enclosure was completed, and the silly (get, pines, animals) were driven in and rammed hard (yosemite, wide-spread, against) the brink of the ford. Then (companions, the, foremost) Don, forcing a way through the (side, compacted, hurry) mass, pitched a few of the (scamper, terrified, listening) unfortunates into the stream by main (nickname, strength, piece); but instead of crossing over, they (corral, swam, likely) about close to the bank, making (desperate, is, apart) attempts to get back into the (hours, and, flock). Then a dozen or more were (comfort, being, shoved) off, and the Don, tall like (a, that, drift) crane and a good natural wader, (jumped, common, jump) in after them, seized a struggling (creatures, mass, wether), and dragged it to the opposite (shore, follow, breaking). But no sooner did he let (jammed, if, it) go than it jumped into the (delaney, stream, where) and swam back to its frightened (pressed, none, companions) in the corral, thus manifesting sheep-nature (seems, bent, as)unchangeable as gravitation. Pan with his (pipes, bower, piteously) would have had no better luck, (found, I, dripping) fear. We were now pretty well (itself, feeding, baffled). The silly creatures would suffer any (unfortunates, sort, stream) of death rather than cross that (a, stream, concerned). Calling a council, the dripping Don (dragged, declared, he) that starvation was now the only (shore, likely, ranks) scheme to try, and that we (crane, might, death) as well camp here in comfort (of, water-fearing, and) let the besieged flock grow hungry (crossing, expected, and) cool, and come to their senses, (sheep-nature, backward, if) they had any. In a few (have, minutes, maternal) after being thus let alone, an (vainly, adventurer, natural) in the foremost rank plunged in (and, making, gasping) swamp bravely to the farther shore. (Then, Though, Timber) suddenly all rushed in pell-mell together, (trampling, we, ford) one another under water, while we (vainly, timid, column) tried to hold them back. The (Don, any, days) jumped into the thickest of the (into, gasping, character), gurgling, drowning mass, and shoved them (lively, right, river) and left as if each sheep (was, far, romantic) a piece of floating timber. The (current, launch, when) also served to drift them apart; (did, a, pressure) long bent column was soon formed, (gurgling, but, and) in a few minutes all were (bank, there, over) and began baaing and feeding as (believed, swept, if) nothing out of the common had (immediately, the, happened). That none were drowned seems wonderful. (Cave,
Across, I) fully expected that hundreds would gain (the, just, gravitation) romantic fate of being swept into (off, fully, Yosemite) over the highest waterfall in the (left, uses, world).
APPENDIX G

PARTICIPANT CONSENT FORM
CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH
UNIVERSITY OF NORTHERN COLORADO

Project Title: Attention and Learning of College Students
Researchers: Stephanie L. Kriescher, MA
E-mail: stra3486@bears.unco.edu
Faculty Sponsor: David M. Hulac, PhD, David.hulac@unco.edu, (970)351-1640
Department: School Psychology

Thank you for your interest in our study. We are evaluating college students’ performance of different attention and learning tasks when provided different tools. As part of this research, you will be asked to complete a series of four cognitive tasks as well as brief questionnaires about some personal information. These tasks may involve listening to instructions, reading material, and providing back written or verbal responses. Your participation in this study is entirely voluntary and you can stop at any time. The only requirement for participating in this task is you must be free of any motor impairments of the hands or arm.

All tasks you complete will be de-identified so that your performance while not be linked to your name. Risks to you are minimal and no greater than you typically experience in school. You may feel some pressure to perform well on cognitive tasks or slight embarrassment associated with more challenging cognitive tasks. However, you should not feel pressure about how well you do because your answers will not be linked to you specifically. Tasks range from easy to difficult for all participants. The important thing is to try your best. The benefits to you include earning 2 SONA credits.

Participation is voluntary. You may decide not to participate in this study and if you begin participation, you may decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any question,

You may keep this form for future reference. If you have any concerns about your selection or treatment as a research participant, please sign below if you would like to participate in this research. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or participation as a research participant, please contact the IRB Administrator, Office of Resesarch, Kepner Hall, University of Northern Colorado Greeley, CO 80639: (970)351-1907; research@unco.edu.
APPENDIX H

PARTICIPANT DEBRIEF FORM
Debrief

Thank you for completing the study! We were interested in evaluating the effect different fidgets (fidget spinners and stress balls) on attention and learning compared to not using any fidget. Your participation in this study is helping inform research on the effects of fidgets which can then help students and teachers make informed decisions about their use in the classroom. You will also be awarded 2 SONA credits for your participation in our study.

We are also interested in evaluating if and how attention problems alter the relationship between fidgets and attention and learning. Some attention difficulties are normal for students in college. If you feel your attention difficulties are impacting your daily life, or if you are concerned about your attention abilities, you can seek additional resources at the University Counseling clinic and/or at the University Health Clinic, or by speaking to your general physician.

If you have any further questions or concerns about this study, you can contact the principal investigator or faculty advisor. Thank you.

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Campus Resources

UNC Counseling Center
(970)351-2496
Cassidy Hall
Second Floor
www.unco.edu/counseling-center

UNC Student Health Center
(970)351-2412
Cassidy Hall
First Floor
www.unco.edu/student-health-center
APPENDIX I

EXPERIMENTAL PROTOCOL
Experimental Protocol

**Introduction & Informed Consent**
Before beginning, ensure the participant you are talking to is the same one listed on the SONA website for the timeslot.

Experimenter: “Thank you for coming in today.”

Introduce Informed Consent form.

Experimenter: “Before we begin, here is the informed consent form. This explains the general purpose of our study. We are looking at how students perform on different cognitive tasks. If you agree to participate, the risk you experience is no greater than the general emotional reaction to challenging readings, homework assignments, or test in your everyday experience as a college student. If you chose to participate, you will be awarded 2 SONA credits for your participation. Your participation is entirely voluntary, and you can choose to stop at any time. You can take a minute to read over the consent form and let me know if you have any questions.”

Give the participant time to read over the form.

Experimenter: “As mentioned in the consent form, in order to participate you must not have any motor impairments in your dominant hand or arm. In other words, you don’t have any illness that would result in a limited range of motion in your hand or arm and/or you do not currently have any injuries such as broken or sprained wrist or fingers that may result in you not being able to use your hand to its fullest ability. Do you have any conditions that would limit your ability to participate in this study?”

If participant answers, “No,” continue.
If participant answers, “Yes,” state, “Thank you for coming in today. Unfortunately, you do not qualify for our study. Because this is due to regulations on our side of things, we will still award you the two SONA credits. Thank you again.”

Experimenter: “If you want to participate in the study, go ahead and sign and date the bottom of the form, here.”

Have the participant sign on the designated line. Sign and date on the designated researcher line.

Experimenter: If the participant consents, “Great! We are going to do several different activities today. Some tasks may be easy, while others may be difficult for you. The important part is to try your best.”
If the participant does not consent, “Thanks for coming in today!”
Place the signed consent form in the confidential manila envelope. This will be returned to the locked filing cabinet.

Assign the participant a participant number, based on the participant number spread sheet.

**Write the participants first and last name next the next available number. Write your initials and date in the corresponding columns.**

This is the number that you will write on all their answer sheets. DO NOT write the participants name on any other document. Place the participant number spread sheet in the corresponding confidential manila envelope. This will also be returned to the locked filing cabinet.

**Experimental Tasks Assignment**
Refer to the Participant Task Order Key to determine the order of the experimental tasks for that participant. All participants will finish with the ASRS, Demographic Survey, and Debrief. This spreadsheet will also indicate what condition a participant is assigned to…

- N – No fidget
- S – Stress ball
- F – Fidget Spinner

Based on participant condition, administer the following prompt after handing the participant the object.

- N – “**Complete the following tasks.**”
- S – “**Use this when completing the following tasks.**”
- F – “**Use this when completing the following tasks.**”

Give participants approximately 30 seconds – 1 minute to become familiar with the fidget tool while organizing the correct order for tasks.

If at any point completing experimental tasks the participant puts down their designated fidget item, prompt them to pick up the item, stating, “**Use the [object’s name] and use it to complete the task.**”

*The participant must be holding the fidget in their hand during all experimental tasks, even if they are not using it.*

Proceed to the correct task in the experimental protocol according to the order designated by the task order sheet.

**Digit Span**
Administer WAIS Digit Span task based on standardized administration protocol. Read digits at the rate of 1 digit per second. Record participant responses.

**Digit Span Forward**
Experimenter: “Now I’m going to say some numbers. Listen carefully, I can only say them one time. When I am through, I want you to say them back to me in the same order. Just say what I say.”
Begin with item 1.
Record item responses. Do not repeat any item.
Stop when the participant has missed two consecutive items of the same length.

Digit Span Backward
Experimenter: “Now I am going to say some more numbers, but this time when I stop, I want you to say the numbers backward. If I say 7-1, what would you say?”
If participant responds correct, “That’s right.”
If participant responds incorrectly, “That’s not quite right. I said 7-1, so to say them backward, you should say 1-7.”
Continue, “Let’s try another one. Remember to say them backwards. 3-4.”
If correct, “That’s right. Let’s try some more.”
If incorrect, “That’s not quite right. I said 3-4, so to say them backward, you should say 4-3. Let’s try some more.”
Begin with item 1.
Record item responses. Do not repeat any item.
Stop when the participant has missed two consecutive items of the same length.

Once the participant finishes, give them a two-minute break. During this time, they may check their phone, get up and stretch, or use the bathroom or get a drink.

Stroop Task
First present the congruent trial in which semantic words are written in the same color ink as their meaning indicates (i.e. the word “RED”, printed in red ink.).

**Trial 1:** Experimenter: “When I say go, read these words from left to right. When you finish the first row, move to the second row and so on until you have read all the words. Go.”
Start timing immediately when you say, “Begin.”
If the participant makes any mistakes, interrupt immediately and state the correct answer while pointing to the word. (“That is incorrect. [Correct word]. Continue.”)
When the participant finishes reading all the words, stop the timer. Record the participant time.

**Trial 2:** Experimenter: “This time, when I say go say the color of the ink the word is written in, not the written word. For example, here the word ‘Red’ is written in blue ink, so you should say, ‘Blue.’ Any questions? Go.”
Start timing immediately when you say, “Begin.”
If the participant makes any mistakes, interrupt immediately and state the correct answer while pointing to the word. ("That is incorrect. [Correct word]. Continue.")
When the participant finishes reading all the words, stop the timer. Record the participant time.

Once the participant finishes, give them a two-minute break. During this time, they may check their phone, get up and stretch, or use the bathroom or get a drink.

**Listening Comprehension Oral Discourse**
Administer WIAT Listening Comprehension Oral Discourse according to standardized administration protocol.

Experimenter: “Now I will play some recordings. You will hear different things, like stories, commercials, and people talking to teach other. Listen carefully because I cannot play them again. After each one, I will ask you questions about what you heard.”

Play the audio recording, pausing after each item to ask the participant the corresponding question. **Begin on Track 7, item 6.**
If participant responds incorrectly on any of the first 3 items (receives a 0), administer preceding items in reverse order until 3 consecutive scores of 1.

Follow experimental protocol for correct audio recording and corresponding questions for each track. Discontinue when the participant has scored 4 consecutive scores of 0.

Once the participant finishes, give them a two-minute break. During this time, they may check their phone, get up and stretch, or use the bathroom or get a drink.

**Reading Maze**
Experimenter: “You will be reading a passage that is missing words. In each place a word is missing, there are three possible words that could complete the sentence in the passage. Circle the word that best completes the sentence and fits the passage. Begin when I say go and stop when I say stop. Do you have any questions?”

Allow the participant to ask any clarifying questions. Answer all questions in order to ensure the participant understand the task.

Hand the participant the reading passage with their participant ID number and a pen.
Experimenter: “**Begin.**”
Begin the timer for two minutes.
If the participant makes a mistake and goes back to fix it say, “It’s ok. Keep going.”
After two minutes say, “**Stop.**”
Collect the reading passage.
Once the participant finishes, give them a two-minute break. During this time, they may check their phone, get up and stretch, or use the bathroom or get a drink.

**ASRS**
Give the participant the ASRS with their participant ID written in the patient name spot. Read the directions.

> “Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page. As you answer each question, circle the correct number that best describes how you felt and conducted yourself over the past 6 months. If the statement never applies to you, circle 0, rarely, circle 1, sometimes, circle 2, often, circle 3, and very often, circle 4. [Motion to area of scale that shows the never, rarely, sometimes, often, very often, scale.] Only circle one number per question. Do you have any questions?”

Answer any questions the participant has to be sure they understand the task.

> “Let me know when you are done.”

When the participant is done, hand them the demographic survey. They do not need a break between the ASRS and survey unless they request it.

**Demographic Survey**
Hand the participant the demographic survey with their participant number written on the appropriate line.

> “Complete this to the best of your ability and let me know if you have any questions.”

When the participant is done, move directly to debriefing them.

**Debrief**
Experimenter: “Thank you for participating in our study. Here is a debrief form that explains a little bit more about the research we are doing.”

Give the participant the debrief form.

> “We are looking at how different types of fidgeting effect attention and learning. If you have any more questions about the research study you can ask me know or contact the principal investigator or faculty advisor, here-“

Point to the contact information.

> “We also were interested in how attention difficulties may change the relationship between fidgets and attention and learning. Some level of attention difficulties are typical, but if you feel like your struggles with attention are effecting your everyday, here are some resources you can go to for more information or to get help-“

Point to clinic information.

> “You’ll be awarded to the two SONA credits online for your participation today. Do you have any other questions for me?”
Answer any questions before the participant leaves. If they have questions you can’t answer tell them they can contact one of the people on the debrief form.

**SONA Credit**

Once the participant has left, log on to your SONA account and award the participant 2 credits. If a participant does not show up, they do not get any SONA credits. Make sure you log-on and record their no-show through the SONA platform.
APPENDIX J

FIDGET IMAGES
Fidget Spinner

Stress Ball