The Association Among Executive Functioning, Self-Efficacy and ADHD with Attitudes Towards Online Learning

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ABSTRACT

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Prior research has shown that worse executive function and lower self-efficacy are associated with learning differences such as ADHD and associated with psychiatric diagnoses. The purpose of this study was to investigate the interaction among executive function, self-efficacy, attitudes towards online learning and learning differences. Fifty-one participants completed a survey which assessed executive function, self-efficacy, attitudes towards online learning and also asked demographic questions. The results indicated that students with learning differences and students with a psychiatric diagnosis had significantly worse executive function than students without a diagnosis. Students with a learning difference were also found to have significantly lower self-efficacy. In addition, students with more effective executive function were also found to have higher self-efficacy.

The Association Among Executive Functioning, Self-Efficacy and ADHD with Success in Online Learning

In March of 2020, Covid-19 began to spread throughout the United States. As a result of the infectious nature of the illness and the growing number of cases, schools were forced to move to online instruction. Colleges and universities along with grade schools, all began conducting classes in an online format. Students had no choice but to begin this new format of learning and while no one had a warning, some students might have been even less prepared than others. Being diagnosed with ADHD or any other psychological disorder, having varying degrees of executive function skills or varying levels of self-efficacy can all potentially impact a student's academic success. A normally structured classroom may present its own difficulties, but when forced to switch and adapt to a new form of learning, a new unique set of challenges is presented. The current study investigated the association among executive functioning, self-efficacy, learning differences and psychiatric diagnoses.

Executive Function is a term that refers to a variety of mental processes. These mental processes allow people to execute everyday tasks that involve planning, organization, self-regulation and attention among others (Goldstein et al., 2014). Dawson and Guare (2016) list the essential twelve executive skills as response inhibition, working memory, emotional control, task initiation, sustained attention, planning (and prioritizing), organization, time management, flexibility, metacognition (awareness of your own thoughts), goal-directed persistence and stress tolerance. It is possible for a person to be strong in some of these areas, but lacking in others and these skills are often developed as a person gets older.

Since executive function first began to be studied in the 1950s, the way that the executive system is visualized and described has evolved (Goldstein et al., 2014). The automatic and controlled processes model, also referred to as the filter model, was one of the first models hypothesized. In this model, a filter, also sometimes visualized as a bottleneck effect, determines which information is important when presented with competing stimuli. The model of cognitive control expanded on the filter model. It stated that in order to control thoughts and emotions, cognitive control is needed. Cognitive control can be used to override automatic responses. Later the central executive model was presented which describes the central executive as a unified system. This model described the central executive as including time-management, selective attention, use of long-term memory and retrieval of information. However, the cross-temporal model does not support the central executive model because it states that there is not one overarching central executive, but it is instead an interaction between short-term memory and attention. This model also hypothesized that the main goal of the executive is organizing behavior. Another recent model, the extended phenotype model, says that executive functioning can be summarized by the term self-regulation and that it is made up of working memory, managing emotions, problem solving and behavioral goals. While researchers may have different opinions on which model accurately describes executive function, it is widely accepted and demonstrated through research that the brain needs the executive system to function effectively.

Executive function develops throughout a person's early life into adulthood, but significant changes related to executive function occur between the ages of two and five years old (Wiebe et al., 2014). Examples of one aspect of executive function, response inhibition, may start to appear in a basic form at around ten months old. Response inhibition can be demonstrated by the A-not-B task. In this task, infants retrieve an object from location A and

then must search for the object when it is hidden at location B. Infants under 10 months old will still search at location A, even though they last saw the object at location B (Zelazo et al., 2003). A more recent interpretation of this error is that the infants cannot inhibit the learned response of reaching towards location A. By the age of three more complex versions of the A-not-B task can be used to assess response inhibition such as a version of the go/no go task which is also used when assessing inhibition in adults (Wiebe et al., 2014). At three years old, deficits are observed in these tasks, but the deficits decrease between the ages of three and five. In addition to the important developmental changes related to response inhibition, there are also important changes in another aspect of executive function, working memory. Working memory is thought to improve because the capacity for working memory improves, meaning that more information can be held at one time. Capacity improves from ages three to five and continues to improve into adolescence. Another aspect of executive function, task switching, can be observed and assessed starting around two years old (Wiebe et al., 2014). Task switching is often assessed by having participants follow a set of rules or goals and then switching them to a new set of rules or goals. An example would be having participants sort objects by color and then having them switch to sorting by shape. At two years old a child can follow one set of rules, but cannot switch to the new set, by three children are able to switch in some tasks and by five children can successfully switch from one set of rules to another.

Executive functioning is believed to be centered in the prefrontal cortex of the frontal lobe (Goldstein et al., 2014). The dorsolateral prefrontal cortex appears to be the location of certain executive functions such as problem-solving, planning and working memory. This area of the brain has many connections to other cortical and subcortical areas. These connections are essential for the integration of information to areas such as the thalamus, basal ganglia and

hippocampus, among others. In addition to the dorsolateral prefrontal cortex, the prefrontal cortex has also been found to be connected with problem-solving as well as planning and decision-making (Goldstein et al., 2014).

Neurodevelopmental changes that are related to executive function have been observed using fMRI. A study investigated the developmental changes in brain connectivity that relate to inhibitory control, an important aspect of executive function (Hwang et al., 2010). The ages of participants in this study ranged from 8-27 and the participants were divided into three age groups: 8-12, 13-17 and 18-27. While an fMRI was being taken of the participants, they performed antisaccade and prosaccade tasks. Antisaccade tasks are tasks in which the participant must try to inhibit their reflexive eye movement and prosaccade are tasks that are meant to trigger eye movement. It was found that the adults' (ages 18-27) inhibitory control was associated with top-down control. The control originated from frontal regions and was connected to cortical and subcortical brain regions. Among the three age groups, a developmental increase in top-down control was observed along with a decrease in the short-range connectivity in the parietal and frontal regions. This study provides evidence that the improvements in inhibitory control that are observed throughout development are due to maturation of local brain function, coupled with better top-down control of the brain (Hwang et al., 2010). Changes in the brain that relate to improvements in executive function are not from a single brain area, but are related to a combination of changes in cortical volume, differentiation in brain structure and neural activation (Wiebe et al., 2014).

Behavior rating scales, completed by parents, teachers or as self-reports, are often used to assess executive function and there is a need for more validated scales. The scales that currently exist have varying levels of reliability and validity. Executive function assessments include the

Behavior Rating Inventory of Executive Function (BRIEF) parent and teacher reports, as well as the BRIEF self-report, the Barkley Deficits in Executive Function Scale-Children and Adolescents (BDEFS-CA), the Delis Rating of Executive Functions (D-REF) and the Comprehensive Executive Function Inventory (CEFI) (Naglieri & Goldstein, 2014). The BRIEF parent and teacher reports focus on the behavioral regulation and metacognitive problem-solving domains of executive function and is meant to assess ages 5-18. The BRIEF self-report is designed for ages 11-18 and focuses on the behavioral shift and cognitive shift areas of executive function. Both of the scales also assess sub-domains of the main areas they measure. The BDEFS-CA is completed by parents for children ages 6-17. This scale measures self-management of time, self-organization/problem-solving, self-restraint, self-motivation and self-regulation. Similar to the other scales, the D-REF is designed for ages 5-18. It consists of three forms: a parent form, a teacher form, and a self-report form. The four areas of executive function that the D-REF assesses are attention/working memory, activity level/impulse control, compliance/anger management and abstract thinking/problem-solving. Each of these scales do report large normative samples, but are not all representative of a diverse population (Naglieri & Goldstein, 2014). The CEFI does report a sample that is representative of the population. This scale can be completed by parents or teachers for ages 5-18 years and there is also a self-report version for ages 12-18. The CEFI assesses nine areas of executive function: attention, emotion regulation, flexibility, inhibitory control, initiation, organization, planning, self-monitoring and working memory. Another assessment that is currently being developed and validated is the Executive Skills Questionnaire (Strait et al., 2019). Similar to the previously described scales, the Executive Skills Questionnaire consists of items relating to plan management, time management, organization, emotional regulation and behavioral regulation (Strait et al., 2019). A

secondary purpose of the current study was to contribute to the normative sample of the Executive Skills Questionnaire.

While behavior rating scales are common measures of executive function and are used to rate behaviors in everyday life, there are some performance-based assessments in which the subjects must complete certain tasks. One such assessment is the Complex Task Performance Assessment (Wolf et al., 2017). In this assessment participants simulate working in a library and must complete a current inventory task and a telephone messaging task. The participants are scored on their inefficiencies, rule breaks, interpretation failures, task failures and tasks not completed. A score of zero is a perfect score, while a higher score indicates more impairment. This assessment was found to have concurrent validity with other cognitive tests of executive function. Another performance-based assessment is the Ruff Figural Fluency Test (RFFT). In this test participants must draw as many unique patterns among 35 five-dot patterns as they can within sixty seconds (Gulpers et al., 2018). There are five parts and each part uses different distractors or patterns. The RFFT tests planning, reasoning, mental flexibility, working memory, inhibition, strategy generation and regulation of action.

Executive function skills have been found to be closely associated with academic success. Even in children as young as preschool age, the executive functioning skills that they have help them attain more information (Fuhs et al., 2014). A longitudinal study followed children from preschool to kindergarten. The children were assessed on executive function and academic achievement three times: fall of preschool, spring of preschool and spring of kindergarten. Results indicated that children's gains in executive functioning skills were related to them making academic gains in kindergarten. This shows that helping children to strengthen their executive functioning skills could help them to succeed academically. An experimental

study further supported this finding (Malekpour & Aghabadabei, 2013). A group of third grade females with spelling learning disabilities were divided into three conditions. One condition received working memory training, the second received response inhibition training and the third was the control group. All three groups were first assessed for executive function using the NEPSY neuropsychology test. This test is a neuropsychological test that can be used to assess executive function/attention, language, sensory motor function, visuospatial processing and memory and learning of children from pre-school to elementary school age. After the two months of training, the children were tested on spelling academic performance. Their executive function was also assessed again using the NEPSY. Similarly, this study found that when a participant's executive function skills improved, their academic performance also improved.

This association between executive function and academic success was seen in young children, but it has also been observed in middle school children and older. Samuels et al. (2016) followed students from 6th grade to 9th grade and measured their executive functioning each year. Teachers and teaching assistants completed a survey to measure each child on executive functioning at the end of each school year and the grade point averages of each child were also reported. The results showed that executive function was a strong predictor of students' grades. If a student had strong executive functioning skills, they were found to have higher GPAs. The effect was seen across the different subject areas. High school students also display the association between executive function and academic success. Mann et al. (2015) studied high school students from three different types of high schools: traditional, alternative and independent learning program. All of the students ranged in age from 14-18 years old. Each participant completed the Behavioral Rating Inventory of Executive Function – Self Report (BRIEF-SR) which generates a Global Executive Composite (GEC) score. Using this scale,

higher scores correspond with worse executive function skills. The GPAs of each participant were also recorded and analyzed with the GEC. It was observed that worse executive function scores were associated with lower GPAs. This association was observed particularly in the inhibition and task completion areas of executive function, meaning that when students had more problems in these areas, they had lower GPAs. Each of these studies contribute to demonstrating the relationship that exists between executive function and academic success.

In college students, executive function has been found to be related to academic procrastination, college adjustment and academic problems. One study investigated the association between academic procrastination and executive function in undergraduate psychology students (Rabin et al., 2011). All of the participants were thirty or younger and each completed six assessments. The Lay General Procrastination Scale was used to assess procrastination, the Beck Anxiety Inventory, the Shipley Institute of Living Scale which assesses general intellectual functioning, the BRIEF-A to assess executive function and the NEO Five Factor Inventory which assesses aspects of adult personality. The results showed that the initiation, planning/organization, organization of materials, inhibition, working memory and task monitoring aspects of executive function were associated with academic procrastination. Participants who had worse executive function procrastinated more. This study found that there was no association between reported depressive symptoms and procrastination.

Another study looked to investigate the association between executive function, depressive symptoms and college adjustment (Wingo et al., 2013). Female students from a university's introductory psychology class participated in the study. They were each assessed using the Wechsler Abbreviated Scale of Intelligence (WASI), the Delis-Kaplan Executive

Function System (D-K-EFS), the BRIEF-A, the College Adjustment Scale (CAS) and the Beck Depression Inventory. The D-K-EFS is an objective measure of executive function that was administered by a trained researcher while the BRIEF-A is a subjective measure of executive function. Participants who reported problems in the executive function areas of planning, organizing, thinking through options and initiating tasks, also reported more academic problems and problems related to long-term career plans. Participants with more depressive symptoms were found to have more interpersonal problems when adjusting to college. This study provided evidence that both depressive symptoms and executive function are related to how a student adjusts to college. As this study does not clearly demonstrate an association between depression and executive function, the current study further investigated the relationship.

Anxiety and depression disorders have been found to be associated with lower levels of executive functioning. One study compared the executive function levels of patients with anxiety and/or depression, neurologically impaired patients and individuals from the general public (Oei et al., 2016). The age range of all three participant groups was from 15 to 72 years old. Executive function was measured using the Dysexecutive Questionnaire (DEX-R) where a greater score is associated with greater dysexecutive function or worse executive function. It was found that the anxious and depressed patients had poorer executive function than both the neurologically impaired patients and the healthy participants. Patients with anxiety demonstrated the greatest executive dysfunction, while the neurologically impaired reported similar levels of executive function to the general public. It was observed that anxious patients had difficulty specifically with the inhibition aspect of executive function. In a patient with anxiety, difficulties with inhibition might present themselves as difficulty preventing a phobic or panic reaction. Problems with volition were observed in both patients with anxiety and patients with depression. Problems

with volition may lead to difficulties in organization and reduced involvement in goal-oriented activities.

Another study that supports these findings separated participants into people with generalized anxiety disorder, people with panic disorder with and without agoraphobia, people with agoraphobia, people with social phobia and people with depressive disorder (Gulpers et al., 2018). Patients' ages ranged from 25 years to 50 years old and each participant completed the Figural Fluency Test in order to assess executive function. This study also reported that anxiety was associated with worse executive function. It was also found that participants with comorbid depression and anxiety as well as depressive disorder had worse executive function than anxiety alone. Both of these studies demonstrate the association among anxiety, depression and executive function.

Psychiatric disorders have also been suggested to be related to a person's academic performance. A study consisting of graduate and undergraduate students investigated the connection between mental health, mental health disorders, suicidal behaviors and academic impairment (Keyes et al., 2012). Each participant completed the Mental Health Continuum (MHC-SF) survey to assess emotional well-being, social well-being and psychological well-being. They also completed the Patient Health Questionnaire (PHQ) to measure anxiety and depression. Participants were asked about suicidal behaviors and how often their academic performance was impacted by mental or emotional difficulties. Results showed that students who had a current mental illness, such as anxiety or depression, were at a greater risk of suicidal behavior as well as a greater risk of academic impairment.

Another diagnosis that often includes executive function disorder is ADHD. Attention deficit hyperactivity disorder (ADHD) is a psychological disorder that is characterized by inattentive and hyperactive-impulsive symptoms (McGough, 2014). ADHD is considered an executive function disorder, but the term executive function disorder can also be applied to other diagnoses (Van Lambalgen et al., 2008) There are a small number of people who believe that ADHD is not a real disorder and that the symptoms are normal aspects of childhood, but it has become one of the most scientifically validated psychiatric disorders (McGough, 2014). The primary symptoms of a person with ADHD are attention problems, time management problems, disorganization, mental restlessness, hyperactivity, mood changes, temper outbursts, impulsivity and sleep disorders (Quinn, 2001). These symptoms can contribute to people with ADHD having difficulty in many areas including educational attainment, social skills, occupational success, personal relationships, parenting, personal safety, and general health (McGough, 2014).

The Diagnostic and Statistical Manual of Mental Disorders (DSM) IV was the first addition to divide ADHD into different subtypes (Rowland et al., 2002). These subtypes were hyperactive and impulsive, inattentive and a combined type for inattentive and impulsive/hyperactive. The diagnosing criteria require that the symptoms of ADHD are present in at least two settings, the most common settings are at school and at home. Parent and teacher reports are commonly used to diagnosis people with ADHD as it has been found that even in adolescents and adults, self-reports are not accurate descriptions of their behavior for diagnosing ADHD. When diagnosing ADHD, the symptoms must be taken in a developmental context meaning that they must be compared to what is developmentally normal at that age. The DSM-V list eighteen symptoms of ADHD: nine inattentive and nine hyperactive-impulsive (McGough, 2014). In order to be diagnosed, an individual must exhibit six out of nine symptoms in either

category, however this is adjusted with age. It has been found that the mean number of symptoms decreases over time, therefore if an adult were to exhibit the same six out of nine symptoms, in order to be diagnosed they would have to differ from the normative population much more than younger children to be diagnosed with ADHD. For this reason, individuals over seventeen only have to exhibit five out of nine symptoms. It is most common for children to be assessed and diagnosed with ADHD in early grade school and some children may be diagnosed as early as preschool.

There are many connections between ADHD and executive functioning. For example, both ADHD and executive functioning are thought to be centered in the frontal lobe (Goldstein et al., 2014; McGough, 2014). The frontal lobe is the area of the brain that is responsible for cognitive skills such as decision making and planning. As dopamine is primarily found in the frontal lobe; it has been found to be connected to executive functioning (Goldstein et al., 2014). Low levels of dopamine are thought to potentially cause motor restlessness, attention problems and poor organization skills (Quinn, 2001). Other neurotransmitters have been found to play an important role in the cause of some of the symptoms of ADHD. Epinephrine, norepinephrine, acetylcholine and serotonin help regulate alertness, attentiveness, sleep patterns, concentration, awareness and retention of information and therefore an imbalance of these neurotransmitters is thought to play a role in ADHD (Quinn, 2001). People diagnosed with ADHD have too many excitatory neurotransmitters which create an alerting response, and not enough inhibitory neurotransmitters which create a calming effect.

Brain imaging techniques, both computerized tomography (CT) and magnetic resonance imaging (MRI) have found differences in patients with ADHD and patients without ADHD (McGough, 2014). Specifically, through these brain imagining techniques, patients with ADHD

have been found to have a smaller total brain size and less white matter compared to patients without ADHD. The frontal cortex, cerebellum and subcortical structures are the areas with the greatest differences. Shaw et al. (2007) conducted a study that demonstrated the delay in maturation of the brains of children with ADHD. A group of children diagnosed with ADHD were compared to children not diagnosed. The thickness of over 40,000 cortical areas were estimated using magnetic resonance scans. The participants were scanned approximately every 2-3 years and the number of times a participant was scanned varied. Based off of these scans, the researchers were able to determine when each group reached peak cortical thickness. It was observed that the patterns of maturation were the same for both groups with the primary sensory areas maturing first. However, the ADHD group reached peak thickness at a mean age of 10.5 years while the non-ADHD group reached peak thickness earlier at a mean age of 7.5 years. The most prominent difference between the two groups was observed in the prefrontal brain regions. Hypoactivation of the brain regions associated with executive function and attention has been observed in children with ADHD, specifically the frontoparietal lobe and ventral attentional networks (McGough, 2014). Hypoactivation of the frontoparietal has also been observed in adults with ADHD, who also exhibit hypoactivation in the visual, dorsal attention and default networks. Given that people with ADHD have abnormal brain activity in the areas that also control executive functioning, there is a strong suggestion that someone with ADHD will not have the same level of executive functioning as someone without it (McGough, 2014).

An association between ADHD and executive function has been demonstrated in adolescents (Toplak et al., 2009). A group of participants, aged 13-18 years old, was divided into two groups. One group consisted of adolescents who had been diagnosed with ADHD, while the other group was the comparative group. The BRIEF was completed by parents and teachers to

measure executive function and the adolescents also participated in various performance-based measures of executive function. Inhibition was measured by the stop task in which stimuli were presented on a computer screen and the participant had to press the corresponding button in response to the stimuli. Set shifting was assessed by the Trail Masking Task in which participants had to connect numbers and letters in sequential order without lifting the pencil from paper. Verbal and spatial memory were assessed using the Digit Span and Spatial Span tasks where participants are read a sequence of numbers and must repeat the list either in the correct order on in reverse order. Finally, planning was measured by the Stockings of Cambridge task. In this task, participants were shown two displays on the computer. One display showed colored balls inside of hanging stockings and participants then had to move the balls on the second display to match the first. The results of this study showed that adolescents who were diagnosed with ADHD had poorer executive function scores than the comparative group in both the performance-based measures and the BRIEF. The results also found that ADHD was better predicted by the BRIEF parent and teacher ratings than the performance-based assessments. Behavioral rating scales are therefore an accurate measure of executive function.

Research has demonstrated that this link between ADHD and executive functioning continues into adulthood. One such study used measures of executive function to test whether ADHD persisted into adulthood (Roselló, 2020). Participants were divided into two groups; one group had been diagnosed with ADHD as children and the other group were typically developing. The people who had been diagnosed with ADHD were further divided into people who still had ADHD (persisters) and people who claimed to no longer have it (remitters). The first data had been collected from 2003-2006, then twelve years later the participants were contacted again. All of the participants had IQs within the normal range and their ADHD

symptoms were measured along with their executive functioning. It was observed that the participants who claimed to be in remittance still displayed hyperactive and restless behaviors. They also lacked planning and organizing skills. This study not only shows that ADHD does persist into adulthood, but also that people diagnosed with ADHD tend to lack some executive functioning skills. Using executive functioning as a measure for whether ADHD persisted shows that the researchers expected people with ADHD to lack those executive functioning skills.

A relation between executive function, ADHD symptoms and functional impairment has been observed in college students (Dorr & Armstrong, 2019). In this study the age range of the participants was from 18 to 25 years old and they were all college students. Each participant was assessed for ADHD symptoms, executive function and functional impairment (the impairment caused by ADHD symptoms). The Executive Function Index (EFI), a self-rating scale, was used to measure executive function. It was found that students who demonstrated higher executive function, demonstrated less functional impairment. Students with high ADHD symptoms level had greater impairment, but students with ADHD symptoms who had higher executive function had less impairment than students who had lower executive function. The study did however find that in students who demonstrated high levels of ADHD symptoms, high executive function did not significantly protect against the functional impairment brought on by their ADHD symptoms. More research would be needed to make a definite conclusion about the relationship among these three variables, but this study does provide evidence of the fact that better executive functioning could help to reduce some of the negative effects of ADHD.

It is common that an individual diagnosed with ADHD will also be diagnosed with another disorder. Of people diagnosed with ADHD, 40% have been diagnosed with another disorder such as anxiety, depression, obsessive-compulsive disorder or other learning disabilities

(Quinn, 2001). A study investigated the possible connection between anxiety and ADHD in children with and without dysthymic disorder (persistent depressive disorder) (Vance, 2003). The sample consisted of children aged 6-12 who were diagnosed with ADHD. The children were rated on a behavior checklist by their parents and their teachers. The results showed that children with ADHD and dysthymic disorder were more likely to be diagnosed with separation anxiety disorder and social phobia, compared to children without dysthymic disorder. This study shows that ADHD is often coupled with various other disorders. Children with ADHD and dysthymic disorder were then also more likely to have other disorders as compared to children without dysthymic disorder. Another study specifically investigated the relation between obsessive compulsive disorder (OCD) and having a comorbid diagnosis (Masi et al., 2006). The participants were children and adolescents between the ages of 8 and 18, who were all diagnosed with OCD. Trained researchers administered the Diagnostic Interview for Children and Adolescents-Revised (DICA-R) to each participant in order to identify other comorbid disorders. The results indicated that 46.8% of participants were also diagnosed with anxiety, 36.2% were also diagnosed with panic disorder and 25.5% were also diagnosed with ADHD. Most participants reported that they had been diagnosed with ADHD prior to being diagnosed with OCD. The participants who were diagnosed with comorbid ADHD demonstrated a significantly higher rate of being diagnosed with other co-occurring disorders. Participants who were diagnosed with OCD were often not aware that some of their impairment might be partly due to comorbid ADHD. This study supports the idea that ADHD often presents along with other psychiatric disorders.

The symptoms of ADHD can often be associated with students' academic performance. Varying effects of ADHD can be seen at different periods throughout the life of a child with

ADHD. In preschoolers, research has shown that children with ADHD display deficits in memory and reasoning as well as general cognitive ability (Daley & Birchwood, 2009). It has been found that both hyperactivity and inattention are negatively associated with achievement in reading (Daley & Birchwood, 2009). School-aged children with ADHD are often more likely to be placed in special education classes or to use academic services compared to children without ADHD. ADHD is associated with lower grades in school than children without ADHD, as well as lower math and reading standardized test scores. The difficulties that accompany ADHD continue into adolescence. It was once thought that children could grow out of the disorder, but it is now accepted that it continues into adulthood (McGough, 2014). Adolescents are also likely to not perform as well in school and receive special education and sometimes counselling. They can often times also have a history of suspension or even expulsion. Many studies that investigate the academic performance of individuals with ADHD control for IQ. This means that the IQ scores of the control group and the individuals with ADHD are equal, but the ADHD group still performs more poorly than the control group. Therefore, the academic underachievement that is observed in people with ADHD is not due to an overall lack of intelligence (Daley & Birchwood, 2009). The symptoms of the disorder are often what are linked to an individual's academic achievement. It seems intuitive that someone who struggles with paying attention and is hyperactive might not excel at school. Furthermore, someone who struggles with impulsivity might be more likely to get into trouble and be suspended or expelled.

It has been observed that people with ADHD have a more negative perception of their academic abilities. A longitudinal study was conducted in order examine the association between ADHD symptoms, academic achievement, self-perception of academic competence and attitudes about the future (Scholtens, Rydell, & Yang-Wallentin, 2013). Data were collected from the

participants during sixth grade, eleventh grade and twelfth grade. The teachers of each participant filled out questionnaires to rate the children on symptoms of ADHD as well as each child's functioning in school. Five years later questionnaires were sent to both parents and children. Children reported their perceptions of their own academic competence and their grades while parents reported on the ADHD symptoms of their children. One year later, students were surveyed about their views on their future education, future employment and current academic performance. It was found that early ADHD symptoms were related to poor academic performance continuing throughout the students' schooling. It was also found that students in twelfth grade with ADHD symptoms had a less positive outlook on their future education. It is evident that the symptoms of ADHD impact students' academic achievement and persist throughout adolescence. Given that students with ADHD symptoms also had less positive outlooks on the future, they might also have less positive attitudes towards other aspects of academics.

An individual's perception of their own abilities could potentially impact their performance in school. Self-efficacy is "people's judgements of their capabilities to organize and execute a course of action required to attain designated types of performances" (Bandura, 1986, p. 391). In other words, self-efficacy is a person's belief in their own abilities to execute tasks and attain goals. If a person believes they are able to successfully execute a task then they have high self-efficacy, but if they do not believe they can do it then they have low self-efficacy. Self-efficacy can be applied to a wide variety of subjects and is often studied in relation to academic performance.

A study conducted by Zimmerman, Bandura and Martinez-Pons (1992) looked into the relationship between self-efficacy, academic goal setting and academic attainment. The

participants of this study were high school students in social studies classes. In order to measure self-efficacy students completed two subscales from the *Children's Multidimensional Self-Efficacy Scales* (Bandura, 1989). The two subscales used were self-efficacy for self-regulated learning and self-efficacy for academic achievement. Students and parents of the students were asked to report the grade they hoped to achieve in the class and what the lowest grade they would find satisfying was. The students' grades in social studies from the past year were also obtained. Self-efficacy was found to be related to an increase in academic attainment. Students with higher self-efficacy scores earned higher grades. Self-efficacy combined with goal setting was found to also be linked to academic attainment. Parents were found to rely on their children's academic history when setting goals for them, while the children were found to rely on their self-efficacy. Parents based their goals for their children on their past grades while children focused on their own beliefs in themselves to set a goal for their grades. This study demonstrates how self-efficacy is related to students succeeding academically. When students have a higher self-efficacy or in other words, believe in their abilities to achieve, they are more likely to do better academically. Given that this is a correlational study, the causal direction of the relationship between self-efficacy and academic achievement cannot be determined. It is possible that students who excel academically develop a higher self-efficacy because their abilities have been demonstrated. It is also possible that when students have a greater confidence in themselves, they are able to succeed in school.

Another aspect of academic success that can be related to self-efficacy is a student's effort. This is demonstrated in a study that looked into the possible relation between college students' self-efficacy and their efforts in a research methods and statistics course (Li, 2012). Participants were students in a department of applied studies who were required to take a

research methods and statistics course. The study points out that many of the students were not used to taking classes in this topic and were often afraid or nervous for it. Participants completed a survey about their attitudes towards research methods, a survey about their attitudes toward statistics, an academic self-efficacy survey, a survey about the effort they put into the course and a survey about their academic achievement. The results showed that all four variables that were measured were positively correlated. It was found that both attitude and self-efficacy could predict the amount of effort that a student put into the course. This study again demonstrates that self-efficacy is related to a student's academic success. It also adds an interesting component by including effort. If a student has higher self-efficacy or believes they will succeed in a course, they will put more effort into it. If a student is put into a learning atmosphere, such as online learning, where they have lower self-efficacy, they are likely to put less effort into it.

Self-efficacy can also help to compensate for a lack of education. A study that shows this connection investigated the association of different cognitive domains, self-efficacy and educational attainment (Zahodne et al., 2014). The participants' ages ranged from 30-85 years old. Participants completed online modules that assessed self-efficacy and cognition. The cognition measures included were effective function, working memory, processing speed, episodic memory, vocabulary and reading. Participants were also asked to report how many years of education they had. The results found that the participants who had fewer years of education, but higher self-efficacy scores, performed similarly to participants with higher education. There was a stronger association between self-efficacy and executive functioning among participants with lower education than among participants with higher education. The findings supported the hypothesis of the study that self-efficacy can buffer against the negative effects that less education can have on executive functioning. However, this study is

correlational so a direction of causation cannot be determined and they results can be interpreted in more than one way. This once again shows that self-efficacy can be an important aspect of a person's ability to succeed. In this study, self-efficacy reduced the difference between people who had less education and people who had more education.

Self-efficacy and executive function have also been found to be related to a person's adherence to an exercise schedule. Participants with a mean age range of 66.44 years were studied in order to see if self-efficacy relates to the interaction between self-regulatory processes, such as executive function, and regular exercise (McAuley et al., 2011). Executive function was assessed using a variety of performance-based measures including the Dual Task in which participants responded to stimuli by pressing the corresponding button and the Stroop Color-Word task in which words were presented either in the color that the word said (BLUE written in blue) or not and participants had to select the correct option. The Flanker Task, when participants have to identify the direction of an arrow when it is flanked by other arrows, the Wisconsin Card-Sorting Test and a task-switching task were also used. Self-regulatory strategies were assessed by the Physical Activity Self-Regulation scale and self- efficacy was measured by the Exercise Self-Efficacy Scale (EXSE), the Barriers Efficacy Scale (BARSE) and the Lifestyle Efficacy Scale (LSE). Finally, adherence to regular exercise was measured by attendance of exercise classes. The results showed that greater use of self-regulatory strategies was associated with higher levels of self-efficacy. It was also found that greater executive function was also associated with higher levels of self-efficacy. This supports the idea that a person with effective executive function will be likely to have higher self-efficacy.

One type of learning that students who lack self-efficacy might have difficulties with is online-learning. There have been conflicting findings on the effectiveness of online-learning and

students' satisfaction with online-learning compared to in-person learning. One study used a sample of university students enrolled in a business law course and compared the students taking the class online to students taking the class in-person (Shelley et al., 2007). All aspects of the course were the same except for the mode of instruction. Students' satisfaction with the course and the students' learning was measured and it was found that there was no significant difference in satisfaction and learning between the two modes of instruction. Another study that compared an online version of a graduate course to the in-person version did observe a difference in satisfaction levels (Johnson et al., 2000). The in-person group reported more positive ratings than the online group for instructor quality and course quality. The in-person students also reported more positive ratings of interaction and support throughout the course. However, there was no significant difference in the quality of the learning between the two groups. It has also been demonstrated that students prefer certain aspects of learning to take place face-to-face instead of online (Kemp & Grieve, 2014). University students each studied two similar topics, but one took place face-to-face while the other was fully online. For each course, participants completed written exercises, a class discussion and a written test. Similar to other studies, no significant difference between test scores in the online class compared to the in-person class were observed. Students did however report that they preferred to complete the various activities in-person instead of online. Specifically, students reported a strong preference for discussions to take place face-to-face.

Self-efficacy is one characteristic that has been found to play an important role in a student's satisfaction with online learning (Shen et al., 2013) and a student's success in web-based instruction (Joo, Bong, & Choi, 2000). In one study five dimensions of online learning self-efficacy were identified: self-efficacy to complete an online course, self-efficacy to interact

socially with classmates, self-efficacy to handle tools in a Course Management System, self-efficacy to interact with instructors and self-efficacy to interact with classmates for academic purposes (Shen et al., 2013). All of the participants were either graduate students or undergraduate students and were enrolled in an online course. The participants were asked to fill out two scales, one to measure self-efficacy and one to measure online learning satisfaction. The results showed that self-efficacy to complete a course was strongly related to the participant's satisfaction with the course. Participants with greater self-efficacy were also found to have greater course satisfaction. While this study does not demonstrate how self-efficacy is related to academic success it does show that if a person does not have confidence in their abilities, they are less likely to feel satisfied with their online course. If a student is less satisfied with their course it could lead to them apply less effort to their course as well.

Another study investigated how self-efficacy predicted success in web-based instruction (Joo et al., 2000). The participants in this study were sophomores in high school. One week before the students were transitioned to web-based instruction they were asked to complete a questionnaire that measured their self-efficacy for self-regulated learning, academic self-efficacy and the strategies they used. The internet self-efficacy of the students was assessed when they began the web-based instruction (WBI). Students completed a written exam on the topics they learned during WBI and they also completed a search test in which they were required to use two different internet sites to answer questions. The results of this study showed a strong relationship between self-efficacy for self-regulated learning and internet self-efficacy. As internet self-efficacy increased, self-efficacy for self-regulated learning also increased. Academic self-efficacy predicted the students' scores on the written test while internet self-efficacy predicted scores on the search test. This study showed that different dimensions of self-efficacy are

important in predicting student success. Once again, it cannot be determined whether the self-efficacy that the students already had allowed them to excel at the tests or if the abilities they knew that they possessed allowed them to succeed on the tests.

Since students with ADHD often have lower academic achievement than students without ADHD and self-efficacy often promotes higher academic achievement it seems important to study the relationship between ADHD and self-efficacy. A study by Major et al. (2013) investigated self-efficacy for self-regulated learning of males and females with ADHD and without ADHD. The participants of this study were 13 to 18 years old. An IQ of 80 or greater was required to be included in either group. The study measured each participant's intelligence, cognitive capacity and academic achievement. The participants also completed a survey that assessed their feelings of depression and anxiety as well as a survey about their self-efficacy for self-regulated learning. Parents and teachers also completed a survey to assess the child's symptoms of ADHD. Similar to the studies discussed earlier, students with higher self-efficacy beliefs also had higher academic achievement. It was also found that females with ADHD had significantly lower self-efficacy for self-regulated learning than females without ADHD. Both males with and without ADHD had higher self-efficacy for self-regulated learning beliefs than females with ADHD. There was no difference in self-efficacy between males with or without ADHD, but males with ADHD did have a significantly lower self-efficacy than females without ADHD.

Lower levels of self-efficacy have also been found to be associated with depression and anxiety A study conducted with doctoral students investigated the association between depression, anxiety, mentor relationship and self-efficacy (Liu et al., 2019). The PHQ was used to measure depression, the Generalized Anxiety Disorder questionnaire was used to measure

anxiety and the Research Self-Efficacy Scale (RSES) was used to assess self-efficacy. The study also included a questionnaire about the students' relationships with their mentors. Overall, depression and anxiety symptoms were found to be common among the doctoral students. It was found that students with worse anxiety and depression had lower self-efficacy. The relationship the student had with their mentor was found to be associated with self-efficacy; if they had a stronger relationship, they also had stronger self-efficacy. It was also found that the correlation between self-efficacy and anxiety and depression was impacted by the mentoring relationship, meaning the correlation was weaker.

The current study expanded on the past research in order to examine the connection among self-efficacy, executive functioning, ADHD and psychiatric diagnoses. Self-efficacy has been found to be correlated with students' academic success and the amount of effort that students put into a course (Li, 2012). Executive functioning has also been found to help improve students' academic achievement (Samuels et al., 2016) and can help to reduce the impact of ADHD symptoms (Dorr & Armstrong, 2019). Students with ADHD have demonstrated lower self-efficacy (Major et al., 2013) and lower academic achievement than students without ADHD (Daley & Birchwood, 2009). Self-efficacy as well as executive functioning can predict a students' academic success which can be applied to online-school. Since students with ADHD often have lower executive functioning, they are likely to have less success in online-school in comparison to students without ADHD and with higher executive functioning.

In the current study, Union College students completed a survey consisting of an executive function questionnaire, a self-efficacy questionnaire and a series of questions about their feelings towards online-learning. Based on Joo et al. (2000), I hypothesized that students with higher self-efficacy would have more positive attitudes towards online learning.

Furthermore, given the findings of Zahodne et al. (2014) and Mann et al. (2015) students with higher self-efficacy and more effective executive function were predicted to report that their grades were higher during online learning compared to students with lower self-efficacy and worse executive function. Students with more effective executive function were hypothesized to have a higher self-efficacy than students with worse executive function (McAuley et al., 2011). It was predicted that students with ADHD would report worse executive function than students without ADHD, similar to the findings of Tolpak et al. (2019). Based on Major et al. (2019), students with ADHD were also hypothesized to have lower self-efficacy scores than students without ADHD. Similar to the hypotheses about students with ADHD, students diagnosed with a psychiatric disorder were hypothesized to have worse executive function than students without a diagnosis (Oei et al., 2016 and Gulpers et al., 2018) and were expected to have worse self-efficacy than students without a diagnosis based on the findings of Lui et al. (2019).

Methods

Participants

Fifty-one participants took part in the study, 6 males and 45 females, all Union College students. Participants were offered class credit or entrance in a raffle for a gift card for participating in the study. The class year of the participants ranged from first-years to senior with 20 first-years, 5 sophomores, 16 juniors and 10 seniors. Majors were divided into four groups according to the convention used at union: arts and humanities (N= 2), social sciences (N = 7), sciences and mathematics (N = 25) and engineering and computer science (N = 4). There were also 10 participants with a double major that consisted of majors in two groups. Forty-four

participants identified as white or European ancestry, 1 identified as black or African American, 1 as Asian, 4 as Latinx and 1 as multiracial. Forty-two participants are currently living on campus, 5 are living off-campus, but nearby and considered on-campus and 4 are living at home or elsewhere and studying entirely remotely.

One participant reported being diagnosed with just ADHD, 2 with another learning difference such as dyslexia, 14 with had a psychiatric diagnosis, 2 had a been diagnosed with a chronic illness. Two participants reported being diagnosed with ADHD and a psychiatric diagnosis, 2 with a psychiatric diagnosis and a chronic illness, and 2 with ADHD and another learning difference. Based off their reported diagnoses, the participants were divided into a learning differences group, a psychiatric diagnosis group and a no diagnosis group. Seven participants were in the learning differences group, 16 in the psychiatric diagnosis group, and 25 in the no diagnosis group. The two participants who were diagnosed with a chronic illness were not include in the analyses.

Materials and Procedure

The survey consisted of four parts; an executive functioning skills questionnaire, a self-efficacy questionnaire, questions related to students' experiences of studying online and demographic questions. The Executive Skills Questionnaire- Revised (ESQ-R) (Strait et al., 2019) was used to assess executive functioning skills. The Cronbach's alpha of this questionnaire was reported to be 0.91, the Guttman split-half coefficient was also reported to be 0.91 and the test-retest reliability correlation was reported to be r =0.70 (Strait et al., 2019). The Cronbach's alpha that was calculated for the current study was 0.90. This was a 25-item, self-report rating scale with a rang of 0 to 3; 0 being "never" and 3 being "very often." The instructions read

"please read each item and decide how often you consider it to be a problem for you using the following scale" (Strait et al., 2019). One item read "I can control my impulses" and participants rated on a scale of 0-3, never to very often. The participants' executive function scores were determined by averaging together their scores on each item. A higher score meant more executive function problems, and a lower score meant more effective executive function.

The *self-efficacy for self-regulated learning* section of the Children's Multidimensional Self-Efficacy Scales (Bandura, 1989) was used to assess self-efficacy. The Cronbach's alpha for this eleven-item section of the scale was reported to be 0.87 and the Cronbach's alpha calculated from the current study was 0.84. Participants were asked to rate their ability to do each item. For example, one question asked "How well can you finish homework assignments by deadlines?" and participants rated themselves on a scale of one, not well at all to seven, very well. Each participant's self-efficacy score was calculated by averaging together their score on each item. A higher score indicated a better self-efficacy while a lower score indicated a lower self-efficacy.

Participants were also asked a series of questions relating to their experience of studying online during the Spring 2020 term and how it related to a normal term with in-person classes. One question included was "In general, compared to in-person classes, during the spring term it was:" and participants were asked to choose from "Much harder than normal for me to focus on school work," "A little harder or me to focus on school work," "About the same for me to focus on school work," "A little bit easier for me to focus on school work" or "A lot easier for me to focus on school work." Each of the questions were structured in a similar way and asked about topics such as organization, effort and grades. The answers were numbered 1-5, with five being more positive attitudes towards online learning and one being more negative views. A principle components analysis was calculated for the six items and the question whether it was harder or

easier to take tests online versus in-person did not load as highly on the first factor as the other questions regarding online-learning. This was reason to remove this question from the computation of the score for this scale. It was instead analyzed separately and the answer options were "much easier than taking tests in-person," "a little easier than taking tests in-person," "about the same as taking tests in-person," "a little harder than taking tests in-person," "a lot harder than taking tests in-person." This question was scored so that a higher score implied that the participant found it easier to take tests online and a lower score indicated that participants found it harder to take test online. The remaining five items were averaged together to create a measure of attitudes towards online learning. A higher score indicated more positive attitudes towards online learning while a lower score indicated more negative views towards online learning. The Cronbach's alpha calculated from the five questions was 0.64. Students were not asked for their specific grades or GPA from the term because students were given the option of taking classes pass/fail.

The last section of the survey asked a series of demographic questions including whether or not they had been diagnosed with ADHD, ADD, executive function disorder, any learning differences, any psychiatric diagnosis or chronic illness. They were also asked for their gender, race/ethnicity, class year, major and current living situation.

The survey was created in a Google form and uploaded to Sona. The link was also sent to various group messages. Informed consent was obtained from participants when they clicked a box that said they consented to participating in the survey (Appendix A). Participants were able to complete the survey any time within a twelve-day period and were able to receive credit for completing the survey or be entered in a raffle to win a $20 gift card. The answers for each

question were automatically recorded in a google spreadsheet. The names of participants were not recorded and the time stamp of the google sheet was removed to ensure anonymity.

The participants were divided into three groups: participants with no diagnoses, participants who were diagnosed with ADHD, executive function disorder, dyslexia or another learning difference and participants who had a psychiatric diagnosis. Students who reported being diagnosed with a learning difference and a psychiatric diagnosis were put in the learning difference group. Two participants had only been diagnosed with a chronic illness and these participants were not included in the analysis as they did not fit in with another group.

Results

The correlations among the three main variables of total executive function, self-efficacy and attitudes towards online learning can be found in Table 1. There was a significant positive correlation of 0.76 between executive function and self-efficacy. The correlation between executive function and attitudes toward online learning was not significant. The correlation between self-efficacy and attitudes toward online learning was also not significant.

The correlations between executive function, self-efficacy, self-reported grades during online learning and attitudes towards test taking during online learning can be found in Table 2. The correlation between executive function and grades was not significant and the correlation between executive function and test taking was also not significant. Similarly, the correlation between self-efficacy and grades was not significant and neither was the correlation between self-efficacy and test taking. Grades and test taking had a significant positive correlation of 0.45.

Table 1: Correlations of executive function, self-efficacy, feelings about online learning, grades during online learning compared to in-person and attitudes towards test taking online.

	1	2	3	4	5
1.) Total EF	1	0.76**	0.13	0.13	-0.15
2.) Self-efficacy		1	0.18	0.19	-0.31
3.) Online learning			1	0.37**	0.52**
4.) Grades				1	0.45**
5.) Tests					1

**p = 0.01

Table 2: Means and standard deviations[i] of three learning groups (learning diagnosis, psychiatric diagnosis or none) and the three variables (executive function, self-efficacy and feelings about online learning)

Variables	No diagnosis	Learning diagnosis	Psychiatric diagnosis
Executive function	2.26(0.38)	1.89(0.46)	1.89(0.46)
Self-efficacy	5.56(0.80)	4.76(1.34)	5.02(0.74)
Online learning	2.26(0.76)	2.00(0.53)	1.93(0.70)
Grades	2.92(1.15)	2.00(1.56)	2.77(1.17)
Tests	2.64(1.19)	3.57(1.40)	2.96(1.32)

[i]SDs are in parentheses

The means and standard deviations of the no diagnosis group, the learning diagnosis group and the psychiatric diagnosis group can be found in Table 2. Three one-way analyses of variance were performed; one for each variable. The analysis of variance for executive function found a significant difference among the three groups, $F(2, 45) = 4.72$, $p = 0.01$. Post hoc tests indicated that the difference between the learning diagnosis group and the no diagnosis group was significant, $p = 0.04$. The no diagnosis group had a higher mean executive function score than the learning diagnosis group (Table 2). There was also a significant difference between the no diagnosis group and the psychiatric diagnosis group, $p = 0.01$. The no diagnosis group had a higher mean executive function score than the psychiatric diagnosis group (Table 2). There was no significant difference between the learning diagnosis and the psychiatric diagnosis groups.

The analysis of variance for self-efficacy found a significant difference among the three groups, $F(2, 45) = 3.25$, $p = 0.05$. Post hoc tests indicated that the difference between the no diagnosis group and the learning diagnosis group was significant, $p = 0.04$. The no diagnosis group had a higher mean self-efficacy than the learning diagnosis group (Table 2). There was no significant difference between the no diagnosis group and the psychiatric group and there was also no significant difference between the learning diagnosis group and the psychiatric diagnosis group.

In relation to attitudes towards online learning, 60.8% reported a two or lower on the question meaning the majority of participants had overall negative feelings towards online learning. The analysis of variance for attitudes towards online learning did not find a significant difference among the three groups, $F(2, 45) = 1.19$, $p = 0.31$. There was also no significant difference among the groups for grades during online learning, $F(2,45) = 1.85$, $p = 0.17$ or for attitudes towards test taking during online learning, $F(2,44) = 1.80$, $p = 0.18$. The relationship among grades, tests and learning group was further analyzed, after an approximate median split, by a X^2. The X^2 was not significant, $X^2(2) = 1.82$.

Discussion

In the current study, college students completed a survey to assess their executive function, their self-efficacy and their attitudes toward online learning during the spring of 2020. Participants were also asked whether they had been diagnosed with ADHD, other learning differences, had any psychiatric diagnoses or any chronic illnesses. There was a significant difference among learning groups and executive function as well as among learning groups and

self-efficacy. There was also a significant correlation between executive function and self-efficacy.

There was found to be a significant difference in executive function among the learning difference, psychiatric diagnosis and no diagnosis groups. However, this association was observed in the opposite direction of what would be expected based on prior research (Tolpak et al., 2019; Oei et al., 2016; Gulpers et al., 2018). It was suspected that participants did not read the instructions of the executive function questionnaire correctly and therefore did not answer the questions accurately. The instructions of the questionnaire stated, "Please read each item and decide how often you consider it to be a problem for you using the following scale: 0-Never, 1-Sometimes, 2-Often, 3-Very often." Then the question would be a statement such as "I can control my impulses" and if the participant responded with a 3 that would mean they had problems controlling their impulses very often. The scoring instructions stated that a 2 or higher meant that was a problem area for the participant and a 0 or 1 was a strength. Participants with no diagnosis had a higher mean score than both participants with a learning difference and participants with a psychiatric diagnosis. This raised the possibility that the participants had answered the questionnaire opposite from how they meant to answer. This executive function scale is still in development so it is possible that there could be some issues that still need to be worked out. After confidentially interviewing five participants it was determined that they had not read the instructions correctly. By responding with a three to the question "I can control my impulses" they believed they were saying that they were able to control their impulses very often. Based off of the results and the interviews with participants, I found it reasonable to interpret the results as though a higher score on the questionnaire was associated with better

executive function skills. A two or three was considered to be a strength, while a lower score was a problem area.

When interpreted in this way, these results support the hypotheses that students with a learning diagnosis would have worse executive function than students with no diagnosis and that students with a psychiatric diagnosis would also have worse executive function than students with no diagnosis. This is important given the strong association between executive function and academic achievement that has been observed in past studies (Mann et al., 2015). Students who have a learning difference, a psychiatric diagnosis or potentially both may struggle with academics, but it is not necessarily related to their overall intelligence. Most studies that are focused on the academic performance of students with ADHD control for IQ meaning that the overall intelligence of the participants with ADHD is the same as the control group (Daley & Birchwood, 2009). Given the fact that these students have worse executive function, if they were struggling in school it would be important to recognize that it could be due to their deficits in executive function, not necessarily their understanding of the actual content that they are being taught. These students could be then given extra support and help in building their executive function skills instead of only focusing on their understanding of course material.

The hypothesis that students with more effective executive function would have higher self-efficacy was supported by a positive significant correlation. This finding is consistent with the findings of McAuley et al. (2011). There are not many previous studies on the relationship between self-efficacy and executive function, therefore this study provides more evidence of the connection that exists between them. This observed correlation could be interpreted in two ways. It is possible that when people have more effective executive function, they are able to complete tasks and succeed in different aspects of their life which allows them to develop a confidence in

their own abilities, giving them a higher self-efficacy. It is also possible that people with a higher self-efficacy are able to develop more effective executive function skills because of the confidence in their own abilities that they already possess. Given that both self-efficacy and executive function are related to academic success this correlation suggests that a person who has more effective executive function and higher self-efficacy would have greater academic achievement than a person who has worse executive function and lower self-efficacy.

The correlation between self-efficacy and executive function and the significant difference found among the three learning groups and executive function help to validate the executive function questionnaire that was used. When the scores were interpreted in reverse, the results were consistent with previous research of the expected interactions among executive function, ADHD, psychiatric diagnoses and self-efficacy. In order for the executive function scale to be further validated, it would be beneficial to reword the directions to be clearer.

The significant difference observed among the three groups and self-efficacy supported the hypothesis that students with ADHD would have lower self-efficacy than students without ADHD. Participants with a learning diagnosis were found to have a significantly lower self-efficacy than the no diagnosis group. This finding is consistent with the results reported by Major et al. (2019). It is possible that students with ADHD, or other learning differences, have a lower self-efficacy because of the functional impairments that they experience due to their diagnosis. If they experience difficulties, they would likely not have great confidence in their own abilities and therefore have lower self-efficacy. Given the correlation between self-efficacy and executive function, it is also conceivable that people diagnosed with a learning difference have a lower self-efficacy due to the fact that they have a worse executive function. Since self-efficacy is

related to academic achievement (Zahodne et al., 2014), these results provide another possible explanation for the lower academic achievement of students with ADHD.

There was no significant difference between the no diagnosis group and the psychiatric diagnosis group which is in opposition of the findings of Lui et al. (2019). This difference could be due to the type of self-efficacy that was measured. Lui et al. measured research self-efficacy while the current study assessed self-efficacy for self-regulated learning. It is possible that individuals with psychiatric diagnoses have deficits in some types of self-efficacy, but not others. In individuals diagnosed with anxiety specifically, it is possible that their anxiety is related to certain activities and not others. If this is the case, they may have a higher self-efficacy in the areas that they do not have anxiety about, but have a lower self-efficacy in areas that make them anxious. Other types of self-efficacy include self-efficacy for academic achievement, self-efficacy for enlisting social resources, self-efficacy for meeting others' expectations and more (Zimmerman et al., 1992). In the current study self-efficacy for self-regulated learning was measured because self-regulated learning was believed to be a good description of what was required during online learning. Even though they were not found to have a lower self-efficacy, participants with a psychiatric diagnosis were found to have worse executive function than students without a diagnosis. A possible explanation of this is that students with a psychiatric diagnosis have developed a higher self-efficacy to compensate for their lack of executive function skills. Even thought they do not have effective executive function skills; they still have confidence in their ability to complete tasks similar to the results of Zahodne et al. (2014).

The hypothesis that students with higher self-efficacy would have more positive attitudes towards online learning was not supported as there was no significant correlation between the two variables. These results contrast the results of Joo et al. (2000) which reported that students

with higher self-efficacy had a more positive opinion of online learning. This difference could be due to the fact that the majority of participants in the current study reported overall negative attitudes towards online learning. Participants in the current study were made to abruptly transition to online learning as the result of the pandemic, while participants in the Joo et al. study took part in online learning as part of their normal schooling. The reasons for which participants entered online learning could have impacted their attitudes towards it. Being transitioned into online learning under negative circumstances could have resulted in participants having more negative attitudes toward online learning and lead them to report more negative attitudes on the survey.

Students with higher self-efficacy and more effective executive function were also predicted to report that their grades were higher during online learning compared to students with lower self-efficacy and worse executive function. This was not supported by the results as there was no significant correlation between self-efficacy, executive function and grades during online learning. Previous research demonstrated that students with more effective executive function had greater academic achievement (Mann et al., 2015) and that students with higher self-efficacy also demonstrated greater academic achievement (Zahodne et al., 2014). The contradictory findings of the current study could be due to the fact that there was no objective measure of academic achievement. Students were asked how their grades during online learning compared to their grades during in-person learning, but their actual GPAs were not reported. This was due to the fact that during online learning students were given the option to pass/fail their courses and not receive a letter grade. If the survey had asked for a report of the participants' GPAs from spring term it most likely would have not been accurate. However, if there was an objective way

to measure academic achievement it is possible that a result similar to previous research would have been observed.

A possible limitation of the current study is that sample may not have been representative of college students. The sample consisted of twenty first-year students and while they are currently in college, they were still in high school during the spring of 2020 and therefore may have had a different experience than the other class years who were enrolled in college courses. The sample also only included six male participants compared to the forty-five female participants. It is possible that male participants could have varying views on online learning. In past research, males have also been found to have higher self-efficacy than females, even when they are diagnosed with ADHD. This could therefore alter the results. Obtaining a larger sample would help to reduce the impact of this limitation.

Another possible limitation of the current study is that the series of questions that were created to assess students' attitudes towards online learning were only found to have a Cronbach's alpha of 0.64. It is possible that using a questionnaire with higher reliability may have resulted in a significant result regarding attitudes towards online learning. In the current study, participants reported an overall negative attitude towards online learning with 60.8% scoring a 2 or below. This could be due to the measure and it could also be due to the students' current situation. Many students are still taking online courses while continuing their college educations. If they are currently not enjoying their online learning experience, their answers regarding the spring 2020 term might have been skewed. This issue could be fixed by only asking students about their experience with online learning once they have transitioned back to in-person learning.

The current study could have also been potentially limited by the online format. If the study were in-person it is possible that executive function could have also been measured by performance-based tasks to further support the questionnaire. This could have provided an even more accurate measure of executive function. Another result of the study being in an online survey format is that it would have been more difficult for the participants to ask questions. If the study was done in-person, the participants could have been verbally told instructions and then if any questions arose throughout the survey, they could ask the research. The email of the researcher was provided for the participants to ask questions after the survey, but it would have been difficult for them to ask a question during the survey to clarify wording of a question or anything else they were confused about. Being able to ask questions could have reduced some of the confusion about the wording of the executive function questionnaire.

The results of the current study may have also been limited by only measuring self-efficacy of self-regulated learning. This area was chosen to be measured because online learning requires self-regulated learning. However, there was not a significant difference found between the psychiatric diagnosis group and the no diagnosis group. It was expected that the psychiatric diagnosis group would have a lower self-efficacy than the no diagnosis group (Lui et al., 2019). It is possible that including measures of more areas of self-efficacy may have shown the expected difference between the psychiatric diagnosis group and the no diagnosis group.

One possible implication of this study relates to the significant difference found among executive function, learning differences and psychiatric diagnoses. Given the fact both the learning difference group and the psychiatric diagnosis group demonstrated worse executive function scores, it would be helpful for a person who falls into one of these groups to be aware. It would also be helpful for educators to be aware that students who fall into one of these groups

might benefit from more support. If a person is aware that they likely have worse executive function, they could seek out assistance or suggestions of how to improve their executive function skills. If educators are aware that a student is likely to struggle with executive function, they could offer more support or resources for the student. Improving these skills would likely help the student in many aspects of their everyday life.

Given the results of this study, a possible direction for future research would be to measure the executive function and self-efficacy of various learning differences (ADHD, dyslexia, auditory processing, etc.) separately in order to see if there is any difference among the various diagnoses. In the current study, learning differences were grouped together for evaluation due to the smaller sample size. If it were possible to obtain a large enough sample of participants with each diagnosis it would be interesting to see how they were associated. It would be expected that ADHD would be associated with poorer scores than the other diagnoses as previous research has demonstrated the strong association between ADHD and executive dysfunction (Tolpak et al., 2019) and given that the symptoms of ADHD are related to executive dysfunction (McGough, 2014).

Another direction for future research would be to further investigate the relationship between self-efficacy and executive function. Previous research has demonstrated that executive function can be improved through training exercises. In a study by Dovis et al. (2015) participants, aged 8 to 12 years old and all diagnosed with ADHD, were assigned to one of three groups; full-active condition, partially-active condition and the placebo condition. All three groups completed online modules of a computerized training for executive functioning. The full-activation group completed sections that helped to train working memory, inhibition and cognitive-flexibility. The second group, partially-active, only completed tasks for inhibition and

cognitive-flexibility in training mode. In the final group, placebo, all three skills were in placebo-mode. Executive function was assessed using performance-based measures such as the digit span and stop task and the BRIEF was also used. The children were rated before and then again after the training sessions. The results showed an improvement in visuospatial short-term-memory, working memory, inhibition and interference control. Therefore, a future study could measure self-efficacy before the participants underwent the training and measure it again after to see if self-efficacy would improve along with executive function.

Research has demonstrated the association between executive function, self-efficacy, learning differences and psychiatric diagnoses. The current study further supported the previous research by demonstrating the correlation between executive function and self-efficacy. It also demonstrated the association among executive function, learning differences and psychiatric diagnoses as well as the association among self-efficacy, learning differences and psychiatric diagnoses.

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Appendix A

Informed Consent:
My name is Alice Sperry, and I am a senior at Union College. I am inviting you to participate in a research project for my senior thesis. Involvement in the study is voluntary, so you may choose to participate or not.
I am interested in looking at how students with different learning styles feel about learning during the covid-19 pandemic. You will be asked a series of questions related to your learning styles and how you felt about online learning in the spring of 2020. This will take approximately 15 minutes to complete. There are no known risks to you participating in this study. If you no longer wish to continue, you have the right to withdraw from the study, without penalty, at any time.
All information will be kept anonymous and confidential.
While the general information of this study has been explained to you beforehand, more specifics about my goals and hypothesis will be provided at the end of the study.
If you have any questions about the research please contact Alice Sperry (sperrya@union.edu) or Professor Stanhope (stanhopl@union.edu). If you have any questions concerning your rights as a research participant that have not been answered by the investigator or if you wish to report any concerns about the study, you may contact the Union College Human Subjects Review Committee Chair Professor Walker (walkerc@union.edu) or the Office for Human Research Protections (https:hhs.gov/ohrp/).
By clicking yes below, you indicate that you understand the above information, and that you wish to participate in this research study.

Debrief:
Thank you for participating in this study! The hypothesis of this study is that high levels of executive functioning and self-efficacy will be associated with academic achievement in online classes and that students with learning differences, such as ADHD, will report more difficulties with online learning during the pandemic. If you have any further questions about this study please email Alice Sperry (sperrya@union.edu).
If you are not completing this survey for class credit and would like to be entered in a raffle to win a $20 gift card please email the code 7199 to sperrya@union.edu to be entered!