

2021

EXECUTIVE FUNCTIONING IN COLLEGE STUDENTS WITH COMORBID ANXIETY AND DEPRESSION SYMPTOMS

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EXECUTIVE FUNCTIONING IN COLLEGE STUDENTS
WITH COMORBID ANXIETY AND DEPRESSION
SYMPTOMS

BY
LAUREN THOMPSON

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN
INTERDISCIPLINARY NEUROSCIENCE

UNIVERSITY OF RHODE ISLAND

2021

MASTER OF SCIENCE THESIS

OF

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2021

ABSTRACT

Few studies have investigated how comorbidity, the presence of two or more distinct disorders in an individual, is related to executive functioning impairments. Executive functioning consists of cognitive processes that control planning and goal-oriented behavior and contribute to perceived quality of life, physical health, and job performance. Impairments in executive functioning in young adults are associated with poorer academic performance and psychological disorders, such as depression and anxiety. The present study investigated whether A) college students with symptoms characteristic of comorbid major depressive disorder and anxiety would self-report impaired executive functioning and a lower grade point average (GPA) compared to those with symptoms of either depression or anxiety alone, and B) college students with singular or comorbid symptoms would report impaired executive functioning and a lower GPA than those without symptoms of anxiety and/or depression. A sample of 77 undergraduate college students completed self-report measures of executive functioning, anxiety symptomatology, depression symptomatology, and GPA. A multivariate analysis of variance (MANOVA) was conducted to test hypotheses A and B. Results supported that executive functioning was significantly different between symptomatology groups, with comorbid disorder symptoms resulting in greater executive functioning impairments compared to singular disorder symptoms or no symptoms. There was no significant difference in grade point average between groups based on symptomatology.

ACKNOWLEDGMENTS

There are many people I would like to recognize for their help and support. First, I would like to thank my major professor, Dr. Lisa Weyandt. I deeply appreciate your guidance and teaching throughout my time at URI and especially during this process. I would also like to thank my committee members, Dr. Alycia Mosley Austin and Dr. Aaron Piepmeier, for their encouragement and willingness to aid in my academic growth. Thank you to Dr. Mark Hartman for joining and chairing my committee. Thank you to all the members of the Weyandt lab, and the faculty, staff, and students of the INP. Last (but certainly not least), thank you to the family and friends who watched me take this journey and encouraged me every step of the way.

PREFACE

This thesis is in Manuscript Format.

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PUBLICATION STATUS

The current study has not yet been submitted for publication but is currently being prepared for submission to *Journal of Affective Disorders*.

INTRODUCTION

Executive functions (EFs) allow for conscious modification of cognition and behaviors in order to plan for and achieve goals (Diamond, 2013; Weyandt, 2009). Although there is not a universally accepted designation of EF domains, a set of three EF domains originally proposed by Miyake et al. (2000) is broadly used in the literature as a group of core functions from which higher-order EFs may be constructed (Diamond, 2013; Friedman & Miyake, 2017; Lehto et al., 2003). These three core EF domains include 1) inhibition, 2) set shifting, and 3) updating/working memory. Inhibition refers to the ability to suppress a prepotent response in favor of a more desirable action or behavior. Set shifting—also called cognitive flexibility—is the ability to switch between different mental tasks or “sets”. Updating/working memory involves the ability to hold and manipulate information even when the stimulus for it is no longer perceptually present (Diamond, 2013; Friedman & Miyake, 2017; Miyake et al., 2000).

EFs are vital for many aspects of daily life including physical health, increased job success, and greater perceived quality of life (Bailey, 2007; Brown & Landgraf, 2010; Crescioni et al., 2011; Davis et al., 2010). The physiological substrates of EFs involve multiple brain regions including the prefrontal cortex (Munro et al., 2018; Weyandt et al., 2020). Among college students, research supports the role of EFs as predictors of academic adjustment, including qualitative measures such as students’ confidence in their academic abilities and their belief that they are keeping pace with their

coursework (Sheehan & Iarocci, 2015) and quantitative measures such as grade point average (GPA) (Biederman et al., 2006; Cirino & Willcutt, 2017; Munro et al., 2017). Collectively, these findings suggest that college students with EF impairments are less likely to achieve academic success than students without EF impairments.

In addition to negatively affecting academic success, EF impairments are associated with a variety of disorders, such as major depressive disorder (MDD) and anxiety disorders (Airaksinen et al., 2005; American Psychiatric Association [APA], 2013; Gulpers et al., 2018; Snyder, 2013; Weyandt, 2009). MDD is characterized by the presence of five (or more) symptoms during the same two-week period; at least one of the symptoms is either depressed mood or loss of interest or pleasure. Other symptoms may include significant weight loss or gain or change in appetite; insomnia or hypersomnia nearly every day; and recurrent thoughts of death or suicidal ideation (APA, 2013). Depending on symptom severity, patients with MDD may suffer from reduced quality of life (Lin et al., 2014) or be unable to attend to basic self-care needs (APA, 2013). Anxiety disorders share attributes of excessive fear, anxiety, and related behavioral disturbance, but differ in the types of situations or settings that induce these symptoms (APA, 2013). Functional consequences range from decreased well-being, elevated school drop-out rates and decreased work productivity, and impaired interpersonal relations (APA, 2013; Kessler et al., 2006; Patel et al., 2002; Stinson et al., 2007). In Spring of 2019, 24.0% of undergraduate students surveyed in the United States by the American

College Health Association (ACHA) had been diagnosed or treated for anxiety in the past year; 20.0% had been diagnosed or treated for depression, and 16.6% had been treated for both (ACHA, 2019). A study by Jarrett (2016) investigating college students with ADHD and anxiety symptoms found that students who displayed symptoms of both disorders reported greater deficits in self-regulation and self-organization/problem solving than those with symptoms of only one disorder. These studies support that it is important to understand not only how disorder symptomatology individually interact with EFs, but also how comorbidity, the presence of more than one distinct condition in an individual (Valderas et al., 2009), is related to EFs.

Prior research supports the relationship between MDD and EF impairments. For example, meta analytic evidence has reported participants with MDD experience impairment across a broad range of EF measures, with some evidence supporting greater impairment of inhibition relative to other domains (Ahern & Semkovska, 2017; Snyder, 2013). Studies of out-patient populations, including young adults, reported both domain-specific and broad EF impairments (i.e., spatial working memory and set shifting) (Porter et al., 2003; Taylor Tavares et al., 2007; Yang et al., 2018). Bredemeier et al. (2016) found that past and current depressive symptoms were associated with EF impairments in college students with MDD. Past depressive episodes were associated with impaired set shifting, while current symptoms were associated with impaired inhibition. Furthermore, a study by Wingo et al. (2013) found that behavioral regulation and metacognition measures of EF (measured by the

Behavioral Rating Inventory of Executive Functioning-Adult version) and depression symptoms were significantly related to problems with academic adjustment in female college students. Preliminary studies therefore support a relationship between both depression symptoms and impaired EFs, as well as between impaired EFs and academic performance. However, current research is needed to understand the extent of impairment and whether specific EF domains are affected.

The relationship between EF impairment and anxiety disorders is less clearly delineated than the relationship between EF impairment and depression. Two longitudinal population-based studies found that anxiety was negatively related to EFs, but when assessed by anxiety type, only certain groups exhibited significant levels of impairment (Airaksinen et al., 2005; Gulpers et al., 2018). For example, Airaksinen et al. (2005) found that panic disorders—with or without concurrent agoraphobia—and obsessive-compulsive disorder (OCD) resulted in impairments in episodic memory and EF tested using a word recall task and the Trail-Making Test (TMT) parts A and B. Gulpers et al. (2018) found that only agoraphobia was associated with impaired figural fluency, measured using the Ruff Figural Fluency Test (RFFT). Generalized anxiety disorder (GAD) and social phobias displayed some EF impairment on the RFFT but did not meet the requirements for statistical significance. A study by Leonard and Abramovitch (2019) of college students with GAD found no difference in EF domains between students with anxiety and non-anxiety controls as assessed by the NeuroTrax Computerized

Psychological Test Battery. However, Snyder et al. (2014) found that college students with high levels of anxious symptoms performed significantly worse on tasks of verbal selection, and a study of students with diagnosed anxiety disorders in Ontario community colleges were found to be twice as likely to face academic challenges related to memory and EF performance compared to peers with mood disorders (Holmes & Silvestri, 2016). Given these mixed findings, further research is warranted to explore the relationship between anxiety and EFs, particularly in the college student population.

Although several studies have investigated the relationship between either depression or anxiety disorders and EFs, there is a paucity of research regarding the relationship between comorbid anxiety and depression symptoms and EFs. Furthermore, the available limited literature on this subject has produced mixed or contradictory findings. For example, Kizilbash et al. (2002) found that comorbid depression and anxiety had a greater negative effect on working memory function than depressive symptoms alone in a sample of military veterans. Using the TMT parts A and B, Basso et al. (2007) examined inpatients with depression, and found that while depressive symptoms were associated with worse memory function, depression with comorbid anxiety resulted in executive dysfunction. Alternatively, a study with patients from an outpatient psychiatric unit found that deficits in common EF measures such as the Wisconsin Card Sorting Test (WCST), TMT parts A and B, Controlled Oral Word Association (COWA) and the Letter-Number Sequencing subtest of the Weschler Adult Intelligence Scale III (WAIS-III)

were only minimally related to self-reported depression and anxiety (Smitherman et al., 2007).

Similarly, few studies have addressed the relationship between comorbid depression and anxiety and EF impairments in college students. Snyder et al. (2014) found that anxiety and depression had opposite effects on EFs during verbal fluency tasks; anxiety was associated with decreased selection performance while depression was associated with enhanced performance. However, verbal fluency was the only EF domain tested in this study, and it is unknown whether these results would apply to other EF domains. Other studies show partial support for the compounded effect of comorbidity. Holmes and Silvestri (2016) found that students with a diagnosed mental health disorder (unspecified) experienced significantly more academic performance challenges related to alertness/attention and memory/EF than their peers; those with dual diagnoses reported more academic performance challenges than those with a single diagnosis. Eisenberg et al. (2007) reported that depression was a significant indicator for lower GPA and higher probability of dropping out among college students, and that the association between depression and academic outcomes was highest among students that also displayed anxiety symptoms. The study by Eisenberg et al., however, did not address EF impairment, while the study by Holmes and Silvestri investigated EF impairment as only one of several factors related to mental illness and academic performance. Further research focused on the relationship between comorbid depression and anxiety and EFs remain necessary. It would be

helpful to determine whether students with comorbid symptomatology face EF impairments above and beyond those experienced by students with anxiety or depression alone, and whether intervention may be necessary for students to succeed academically.

Given that previous research has found EF deficits and impaired academic performance in college students with mental health disorders, the primary purpose of the present study was to investigate the relationship between comorbid anxiety and depressive symptoms, EFs, and GPA in college students. The current study hypothesized that A) students with symptoms characteristic of comorbid major depressive disorder and anxiety would self-report impaired EFs and a lower GPA compared to those with symptoms of either depression or anxiety alone, and B) students with singular or comorbid symptoms would self-report impaired EFs and a lower GPA than those without symptoms of anxiety and/or depression.

METHOD

Participants

Participants were recruited from the undergraduate population of a public university in the Northeast region of the United States via online class announcements/flyers and through social media groups/messaging applications. Participants were all over the age of 18, full-time undergraduate students, and able to comprehend written English.

A total of 77 participants submitted the online survey, but not all participants answered every item of the study measures. Participants with missing data were removed from the relevant analysis (e.g., if a participant did not report GPA but completed all other measures, they were excluded from the primary analysis but included in the secondary analysis). The number of participants included in the analyses ranged from 69 (in the primary analysis) to 74 (in the secondary analysis) after exclusion.

Participants ranged from 18 to 25 years of age ($M = 20.26$ years, $SD = 1.509$). Most participants self-identified as white (87.0% of responding participants; see Table 1 in Appendix A for full demographic information) and female (81.6%). Almost half of the participants identified as college seniors (46.7%); first year (freshman) students accounted for 18.7% of the participant group, sophomores for 14.7%, and juniors for 20.0%.

Measures

The demographic questionnaire contained questions regarding a participant's age, sex, ethnicity, mental health disorder diagnoses, year in school, college or department affiliation, and GPA. Self-reported GPA was used as a dependent measure of academic performance in the primary statistical analysis.

The Barkley Deficits in Executive Functioning Scale (BDEFS) is a rating scale designed to assess EFs in adults aged 18 to 81 years; it contains 89 items within five subscales that correspond to EF domains: self-organization/problem-solving, self-management to time, self-restraint, self-regulation of emotion, and self-motivation (Barkley, 2011). In addition to providing scores for individual subscales, the BDEFS provides a total EF summary score. The BDEFS has good internal consistency (Cronbach's alpha = 0.91-0.95 across scales) and test-retest reliability (0.62-0.90 across scales, 0.84 for the total EF summary score) (Barkley, 2011; Kamradt et al., 2019). The total EF summary score was used as a dependent measure of overall EF ability in the primary analysis, and all subscale scores were used as dependent measures in the secondary analysis.

The Major Depression Inventory (MDI) is a 10-item self-report questionnaire designed to screen for symptoms of mild to severe depression (Bech et al., 2001). The MDI has good sensitivity (0.86-0.92) and specificity (0.82-0.86); reported internal validity is also high (Cronbach's alpha = 0.94) (Bech et al., 2001). Possible scores range from 0-50; a threshold score greater than 25—indicating moderate to severe levels of depression—was used to

determine the presence of significant depression symptoms and a participant's group for the symptomatology variable used in the primary and secondary analyses.

Finally, the Generalized Anxiety Disorder screener (GAD-7) is a 7-item self-report scale; although it was originally created to diagnose GAD, it has also demonstrated good sensitivity and specificity as a screening tool for panic, social anxiety, and post-traumatic stress disorder (PTSD) (Kroenke et al., 2007; Spitzer et al., 2006). In a large clinical sample population, the GAD-7 demonstrated excellent internal consistency (Cronbach's alpha = 0.92), and a good test-retest reliability (intraclass correlation = 0.83) (Spitzer et al., 2006). Possible scores range from 0-21; a threshold score of 10 or greater—indicating moderate to severe levels of anxiety—was used to determine the presence of significant anxiety symptoms and a participant's group for the symptomatology variable used in the primary and secondary analyses.

Procedure

All study procedures were approved by the relevant Institutional Review Board. Participants were recruited through classroom announcements and collegiate groups on social media/messenger applications. The recruitment flyer contained a link to the online survey platform. Before completing the online survey, all recruited students were presented with an online consent form detailing their rights as participants in the current study. All participants selected that they had read the consent form and agreed to participate in the

study before being advanced to the survey measures. At the end of the survey, participants could submit an email address to be entered in a drawing for a \$15 gift card as compensation for their participation. Data were collected between September 2020 and February 2021, but each participant completed and submitted the measures at a single time point.

Statistical Analyses

Data were analyzed using SPSS 26.0. Before analyses were conducted, data were inspected to ensure they met the requirements for multivariate normality using a Shapiro-Wilks test. Total EF summary score met criteria for normality across all symptomatology groups. Self-reported GPA data did not meet normality criteria due to the presence of outliers. The data were Winsorized to remove outliers (Salkind, 2012). After Winsorization, self-reported GPA data met normality criteria across two symptomatology groups according to a Shapiro-Wilks test, and were within accepted skew and kurtosis value ranges across all groups (George & Mallery, 2010). No other transformations were conducted.

Before the primary and secondary analyses were conducted, variables were checked for correlation to determine whether analyses of variance (ANOVAs) or multivariate analyses of variance (MANOVAs) should be used. Total EF summary score and self-reported GPA were found to be significantly correlated ($r = -0.577, p < 0.01$), and therefore a MANOVA was used in the primary analysis to test hypotheses A and B. The EF subscale scores were

also significantly correlated ($r = 0.387-0.727, p < 0.01$; see Table 2), and therefore a MANOVA was used for the secondary analysis to investigate differences in individual EF domains between symptomatology groups.

RESULTS

The current study investigated differences between groups of students based on their reported symptomatology. Symptomatology served as the independent variable in the primary and secondary analyses and had three groups: “none”, in which participants had no significant symptoms (scores < the designated threshold scores for both the GAD-7 and the MDI); “singular”, in which participants had significant symptoms of a single disorder \geq the threshold score on either the GAD-7 or the MDI); and “comorbid”, in which participants had significant comorbid symptoms (scores \geq the designated threshold scores for both the GAD-7 and the MDI) (see Figure 1 in Appendix B for a visual representation of the group assignment process). Group means have been described in Tables 3 and 4.

Self-reported GPA and the total EF summary score of the BDEFS were used as the primary dependent variables. However, summary scores may not always accurately reflect group differences, as low scores in some domains may be masked in the composite score by high scores in other domains (Maroof, 2012). Therefore, all BDEFS subscale scores were used as secondary dependent variables.

Primary Analysis: MANOVA Using Total EF Summary Scores and Reported GPA

To test hypotheses A and B, a primary MANOVA was conducted using total EF summary score and GPA as dependent variables and

symptomatology group (with levels of none, singular, or comorbid) as the independent variable. Results revealed that there was a significant difference in total EF summary score ($F = 23.865, p < 0.001$; see Tables 3 and 4). These findings indicated that EF impairments were significantly related to level of symptomatology. A post hoc Tukey test confirmed this result, revealing significant differences between all symptomatology group pairs. However, this trend was not observed in GPA. Although the mean self-reported GPA was lowest in the comorbid symptoms group and highest in the no symptoms group, the MANOVA was nonsignificant ($F = 1.912, p = 0.156$; see Table 3).

Secondary Analysis: MANOVA Using BDEFS Subscales

A secondary MANOVA was conducted to investigate whether differences in BDEFS scores between groups were consistent across all EF domains, or due to a functioning difference in only some domains. The five BDEFS subscale scores were used as dependent variables, and symptomatology group served as the independent variable. Results revealed that there was a significant difference between groups in all five subscales/EF domains: self-management to time ($F = 11.594, p < 0.001$; see Table 5), self-organization/problem-solving ($F = 17.463, p < 0.001$), self-restraint ($F = 14.606, p < 0.001$), self-motivation ($F = 15.900, p < 0.001$), and self-regulation of emotions ($F = 18.501, p < 0.001$).

DISCUSSION

The present study investigated whether college students with symptoms characteristic of comorbid major depressive disorder and anxiety would self-report impaired EFs and a lower GPA compared to those with symptoms of either depression or anxiety alone, and whether college students with singular or comorbid symptoms would report impaired EFs and a lower GPA than those without symptoms of anxiety and/or depression. While previous studies have investigated the relationship between various comorbid mental health disorders and EF impairments, the present study was the first to specifically examine the relationship between EFs and comorbid anxiety and depression symptoms in college students. This is an important area to address, as depression and anxiety are the most commonly reported mental health disorders in the U.S. undergraduate population (ACHA, 2019). According to data collected by the ACHA in 2019, anxiety was the most common mental health disorder, with 24.0% of respondents reporting that they had been diagnosed or treated by a professional within the last 12 months. Depression was the second most common disorder reported (20.0%).

Results provided mixed support for the study hypotheses. For example, a negative relationship was found between EFs and level of symptomatology, i.e., as level of depression and anxiety symptomatology increased, EF abilities decreased/impairment increased. The results also demonstrated that students with comorbid symptomatology faced EF impairments above and beyond those experienced by students with anxiety or depression alone. Students with

singular symptoms (of either anxiety or depression) reported marginal EF impairments while students who reported significant comorbid symptoms of depression and anxiety reported moderate EF impairments, notably the highest level of impairment seen in this study. Results also reveal that while any level of symptomatology was related to EF impairments, students that did not meet the threshold for significant symptoms (i.e., were part of the no symptoms group) reported no significant EF impairments.

A handful of previous studies have investigated how comorbid symptomatology or disorders are related to EFs in college students. Results from those studies revealed the same general trend observed in the present study: comorbidities were related to greater EF impairments (Jarrett, 2016; Weyandt et al., 2017). It is important to note, however, that these previous studies have investigated the relationship between ADHD with comorbid disorders and EFs, not comorbid anxiety and depression and EFs.

In contrast to expectations, results did not support the hypothesized relationship between comorbid anxiety and depression and lower GPA, despite the highest mean GPA occurring in the no symptoms group and the lowest mean GPA occurring in the comorbid symptoms group. This finding is contrary to previous research that has found that the presence of either mental health disorders or EF impairments were significantly related to lower GPA in college students. For example, Hysenbegasi et al. (2005) investigated the relationship between depression and academic productivity among college students and found that a depression diagnosis was associated with a

decrease in GPA equal to approximately half of a letter grade. Similarly, Eisenberg et al. (2009) found that depression was a significant predictor of lower GPA; this association was strongest when co-occurring anxiety was also present. Other studies have reported a negative relationship between EF impairments and academic performance in college students (e.g., Baars et al., 2015; Knouse et al., 2014; Ramos-Galarza et al., 2019).

A plausible explanation for the lack of a significant relationship between symptomatology and GPA is that most participants ($n = 70$) completed the survey during the Fall 2020 semester, and their reported GPA would be based on their academic performance during the previous school year. In the case of first year (freshman) students, it is possible that they do not yet have a collegiate GPA to report and are reporting a high school GPA. Therefore, it is possible that the symptoms students reported and observed EF impairments would be reflected in their GPA if data were collected after the end of the semester and the release of updated academic performance information. Several universities across the U.S. introduced alternative grading schemas because of COVID-19 (Salmi, 2020). The unexpected absence of significant academic performance differences between groups may be a result of these modified grading schemas, as universities and colleges try to accommodate students experiencing more stress and decreased academic performance during unprecedented times.

Although the present study focused on broad EF impairments, a secondary analysis was conducted to investigate whether significant

differences in EFs were due to differential functioning in specific domains. Results indicated that EF impairments occurred across multiple domains. All the domains included in the BDEFS (self-organization/problem-solving, self-management to time, self-restraint, self-regulation of emotion, and self-motivation) reached significance in the secondary analysis. This pattern of broad impairments was consistent with results from a recent study by Warren et al. (2021) that investigated the structure of EF deficits associated with anxiety and depression in a population of undergraduate students. Warren et al. (2021) found that depressed mood and anxious arousal were related to EF deficits in all domains of interest (shifting, updating working memory, and inhibition) and suggested that this may be due to a deficit in an underlying EF ability shared between domains, referred to as “common EF” by Miyake and Friedman (2012). The broad pattern of impairment seen in the current study may lend additional support to this conclusion, although results cannot be directly compared as different EF measures were used.

Future Directions

The results of the current study suggest that there is a negative relationship between anxiety and depression symptoms and EFs. Although available literature also supports a negative relationship between mental health disorders and GPA, the current study did not support this relationship. Future research should continue to investigate mental health, academic performance, and EFs in order to better understand how these areas are

interrelated. Research should also address whether interventions targeted to improve one of these areas also provide benefits to others. Understanding whether interventions have singular or multiple benefits is important, as the knowledge could be applied to create more effective strategies for improving college students' mental health and academic performance. For example, Hysenbegasi et al. (2005) found that a diagnosis of depression was associated with a 0.49 point decrease in college GPA; however, depression treatment had a protective effect of 0.44 points. Likewise, Schwitzer et al. (2018) found that college students that received mental health support and treatment and remained in counseling were more likely to experience GPA increases than their peers that did not continue counseling after their first visit or were referred to a clinic off-campus. Research also suggests that EF interventions could potentially provide benefits for students' mental health and EF functioning. Specifically, Bettis et al. (2017) found that college students that underwent a 6-week cognitive training program reported significant differences in EF difficulties, and improved significantly more in a measure of ADHD symptoms than a comparison group that participated in a coping skills training program. Future research should continue to investigate the efficacy and benefits of different intervention approaches.

Limitations

There were several limitations to the present study. First, while this study was sufficiently powered to detect a medium effect size, it was underpowered

to detect a small effect size. Second, the demographic make-up of the participants in this study may not reflect the U.S. undergraduate student population as a whole, and given the rather small sample size, it was not possible to examine gender difference nor possible differences among students from various backgrounds.

Additionally, the analyses did not account for other mental health disorder symptoms or diagnoses that may be present in the study population. Specifically, aside from anxiety and depression diagnoses, participants in this study ($n = 43, 55.8\%$) disclosed diagnoses of attention-deficit/hyperactivity disorder (ADHD), bipolar disorder, eating disorders, misophonia, and specific learning disorders (see Table 6). These participants were not excluded, as doing so would result in an underpowered analysis. Therefore, although anxiety and depression symptoms were the focus of this study and analyses, participants may have experienced symptoms of an additional disorder (or additional comorbidities) that contributed to EF impairments (Cotrena et al., 2020; Crisci et al., 2021; Cury et al., 2020; Pignatti and Bernasconi, 2013; Weyandt et al., 2017). Additionally, participants with diagnosed disorders did not provide information regarding treatment or medication status. It is unknown what effect treatment may have had on group assignment, EFs, or academic performance in the current study.

Lastly, this study collected data regarding depression and anxiety symptoms during the ongoing COVID-19 pandemic. Initial research indicates that students have reported increased stress, anxiety, and depressive

thoughts due to COVID-19 (Son et al., 2020). Therefore, national and global events occurring during the data collection period may have influenced participants' self-reported symptoms, and it is possible that different patterns of group membership would be seen if data were collected under different conditions.

CONCLUSION

Results of the present study revealed that anxiety and depression symptoms are significantly related to EF impairments in college students. Importantly, the present study found that comorbid symptomatology was related to compounded impairment; students who reported comorbid anxiety and depression symptoms reported greater EF impairments than students with singular symptoms (of either anxiety or depression). The present study also found that any degree of symptomatology resulted in greater impairment than no symptomatology, as students that reported no symptoms of anxiety or depression also reported unimpaired EFs. Anxiety and depression symptoms were related to lower GPA, but the relationship was nonsignificant. Despite limitations, the present study contributes to the current available knowledge regarding mental health symptoms, impaired EFs, and academic performance in college students. Future studies are needed to further understand how these variables are interrelated, and whether interventions targeted to one of these areas may have broader applications and benefits. Ideally, longitudinal studies, rather than the present study's cross-sectional design, would be employed to investigate the relationship between EFs and mental health symptoms. Lastly, well-powered studies are needed to explore whether the relationship between EF and depression and anxiety symptoms differ among students from marginalized groups and whether interventions need to be tailored to meet the needs of students from various backgrounds.

APPENDIX A. TABLES

Table 1.

Participant demographic make-up: number of participants that responded to each item is listed by item

Demographic Item	Percentage (%)
Sex (<i>n</i> = 76)	
Female	80.6
Race/Ethnicity (<i>n</i> = 77)	
White	87.0
Hispanic or Latino	3.9
Black or African American	1.3
Asian	1.3
Asian/White	1.3
Black or African American/Hispanic or Latino	1.3
Hispanic or Latino/White	1.3
White/Middle Eastern	1.3
Cape Verdean	1.3
Year in School (<i>n</i> = 75)	
First year (freshman)	18.7
Sophomore	14.7
Junior	20.0
Senior	46.7
	<u><i>M (SD)</i></u>
Age	20.26 (1.509)

Table 2.
Correlation of BDEFS subscale scores

	Self-man- age- ment to time	Self-or- ganization/ problem- solving	Self-re- straint	Self-moti- vation	Self-regula- tion of emo- tions
Self-management to time	1.000				
Self-organization/ problem-solving	0.628*	1.000			
Self-restraint	0.538*	0.790*	1.000		
Self-motivation	0.727*	0.683*	0.665*	1.000	
Self-regulation of emotions	0.387*	0.598*	0.680*	0.444*	1.000

*Indicates significance of $p < 0.01$

Table 3.
MANOVA results examining the difference in GPA and EF Summary scores by symptomatology group

	No symptoms ($n = 24$)		Singular symp- toms ($n = 23$)		Comorbid symp- toms ($n = 22$)		<i>F</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
GPA	3.5338	0.36760	3.4443	0.40654	3.2645	0.61804	1.912
EF Sum- mary Score	136.33	30.345	170.48	39.301	218.27	49.736	23.865*

*Indicates significance of $p < 0.001$

Table 4.
Mean EF summary score by symptomatology group. The percentile or percentile range and the corresponding level of impairment is also reported based on the scoring system established by Barkley et al. (2011)

Group	<i>n</i>	<i>M</i>	<i>SD</i>	Percentile	Impairment Level
No symptoms	24	136.33	30.345	51 st -75 th	None
Singular symptoms (anxiety or depres- sion)	23	170.48	39.301	79 th	Marginal
Comorbid symptoms	22	218.27	49.736	96 th	Moderate

Table 5.
MANOVA results examining the difference in EF subscale scores by symptomatology group

	No symptoms (n = 25)		Singular symptoms (n = 25)		Comorbid symptoms (n = 24)		F
	M	SD	M	SD	M	SD	
Self-management to time	37.56	11.244	44.24	16.050	56.58	14.301	11.594*
Self-organization/ problem-solving	38.80	9.734	46.84	12.912	60.54	15.770	17.463*
Self-restraint	26.12	6.547	32.16	9.339	41.25	12.797	14.606*
Self-motivation	16.72	5.668	19.92	8.144	28.63	8.767	15.900*
Self-regulation of emotions	19.64	5.816	28.00	8.968	33.13	8.415	18.501*

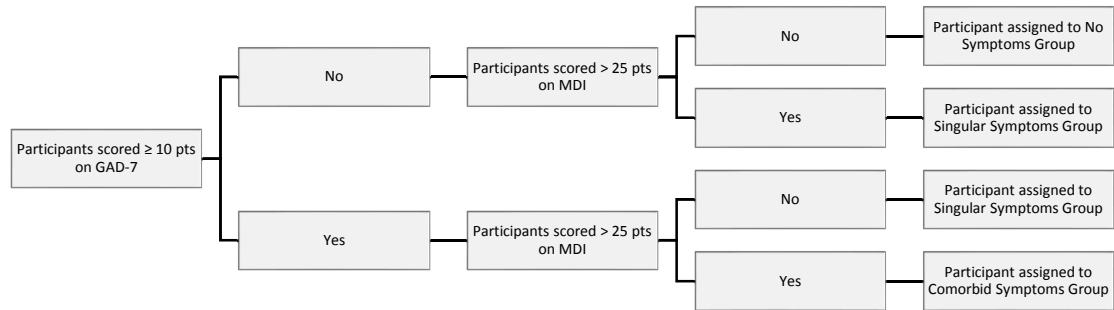
*Indicates significance of $p < 0.001$

Table 6.
Participant response to demographic item regarding psychological disorder diagnosis

Response/Diagnoses	Number of Participants
Did not respond to item	32
Responded with non-diagnosis	2
<u>Responded with diagnosis</u>	<u>43</u>
Anxiety	9
Anxiety/Bipolar disorder	1
Anxiety/Depression	9
Anxiety/Depression/ADHD	6
Anxiety/Depression/ADHD/Bipolar disorder	1
Anxiety/Depression/ADHD/Specific learning disorder	1
Anxiety/Depression/Eating disorder	6
Anxiety/Depression/Misophonia	1
Anxiety/Depression/Specific learning disorder	1
Anxiety/Eating disorder	3
ADHD	2
Depression	1
Depression/ADHD	1
Eating disorder	1

APPENDIX B. FIGURES

Figure 1. *Determining participant group membership*



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