Abstract

ADHD is a common and impairing mental health disorder associated with academic underachievement, among other negative developmental outcomes. Individuals with ADHD experience significant stigma, as ADHD is associated with negative stereotypes such as laziness, carelessness, and lack of intelligence. Given the negative stereotypes associated with ADHD, students with ADHD are at risk for experiencing stereotype threat related to their academic performance. Testing accommodations such as extended time are commonly provided to students with ADHD in academic settings. Although these accommodations are intended to make tests more accessible for students with ADHD, they may also serve as a salient, proximal reminder of students' stereotyped identity, and thus may hinder their performance on academic tests. No previous study has examined the potential of testing accommodations to induce stereotype threat in students with ADHD. The present study examined this question through a 2 (ADHD vs. no ADHD) by 2 (stereotype threat vs. no stereotype threat condition) between-subject experimental design. Participants were 178 college students (41 with ADHD, 137 without ADHD), who were randomized to participate in a simulated standardized testing situation under either stereotype threat or control conditions. Results revealed that test performance did not significantly differ by group (ADHD vs. no ADHD) or condition (stereotype threat vs. no stereotype threat). There were no significant moderation or mediation effects on the relationship between stereotype threat and test performance. While findings were not consistent with a stereotype threat effect, the present study had several limitations that may help explain why such an effect may not have been observed. Implications and directions for future research are explored.

DO TESTING ACCOMMODATIONS HAVE THE POTENTIAL TO INDUCE
STEREOTYPE THREAT IN STUDENTS WITH ADHD?

by

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Table of Contents

Do Testing Accommodations have the Potential to Induce Stereotype Threat in

Students with ADHD?

ADHD is the most commonly diagnosed mental health disorder among youth in the

United States, with prevalence rates estimated at 8 – 11%.[1,2] ADHD is characterized by cross-

situational symptoms of hyperactivity, impulsivity, and/or inattention that are developmentally

inappropriate and cause impairment in major areas of functioning.[3] In childhood, ADHD is

associated with disruptive behavior, social rejection, and academic problems which significantly

impact functioning in the school environment.[3,4] For many individuals with ADHD, these

challenges persist through adolescence and young-adulthood, and compile and cascade into

significant problems across the lifespan, including higher rates of school disciplinary referrals

and drop-out,[5-8] increased substance use and conduct problems,[9] higher rates of job loss and

lower earnings,[7] poorer overall health,[10] and even decreased life expectancy.[11]

While individuals with ADHD are less likely to graduate from high school and attend

college compared to their peers,[12] the number of students with ADHD attending college has been

increasing in recent years, with students with ADHD now making up an estimated 3-8% of

college students in the United States.[13] Students with ADHD who attend college experience

significant difficulty adjusting to the college setting, have lower GPA's, are more likely to be on

academic probation, struggle socially, experience greater psychological and emotional distress,

have higher rates of substance use, and are less likely to graduate from college.[13] Given the

growing number of students with ADHD seeking college degrees, and the significant challenges

faced by students with ADHD on college campuses, research aiming to increase our

understanding of how to best support college students with ADHD is of great importance.

Due to their significant academic problems, many students with ADHD receive school-based services and accommodations.[14] In fact, individuals with ADHD are more likely to receive services at school than to access clinical care.[15] However, while extensive research has established a solid evidence base for several clinical treatments available for ADHD,[16,17] both pharmacological and psychosocial, far less research has been conducted to examine the effectiveness of school-based services, such as academic accommodations, which are often the only services provided to college students with ADHD.[14,18]

Academic accommodations are intended to reduce the impact of a disability on an individual's ability to access tests and assignments and demonstrate their knowledge.[19] The most common accommodation provided to students with ADHD is extended time for testing.[20] Approximately 88% of students with ADHD who receive academic accommodations receive extended time accommodations.[21] Yet, findings of studies examining the effectiveness of extended time accommodations for college students with ADHD have been mixed. Some studies suggest that while college students with ADHD or ADHD symptoms certainly benefit from extended time accommodations, they do not benefit as much as students without ADHD or students with fewer symptoms.[22,23] One study found that while both students with and without ADHD attempted more test items with extended time, there was no effect of extended time on the number of items answered correctly, or percent accuracy for either group.[24]

Additionally, students with ADHD report mixed attitudes toward accommodations. While many students with ADHD report feeling that accommodations are helpful, one study found that two-thirds of students with ADHD were ambivalent to receiving accommodations and cited concerns that receiving test accommodations would negatively impact how others perceive them.[25] Two other studies reported that receiving accommodations led some students to feel

embarrassed and unintelligent.[26,27] In other words, many students with ADHD experience public and internalized stigma related to their use of testing accommodations, which may dampen the effectiveness of these accommodations.

There is significant stigma associated with the diagnosis of ADHD,[28] and this stigma causes additional stress and threatens well-being beyond the direct impact of ADHD itself.[29] Common stigmatizing beliefs about ADHD include perceiving individuals with ADHD to be careless, dangerous, more likely to get in trouble, and less intelligent compared to their typically developing peers. Stigmatizing views of ADHD are prevalent among parents, teachers, and peers of all ages, and individuals with ADHD themselves report feeling that others view them negatively, perceive them as "stupid," and treat them differently because of their ADHD.[28] Stigma may prevent individuals with ADHD from seeking treatment and school-based services, which may increase the likelihood of negative outcomes.[30,31] Stigma may also increase vulnerability to stereotype threat.[32,33]

Stereotype threat is a well-documented phenomenon in stigmatized groups, experienced when an individual finds themselves at risk for confirming a negative stereotype about their group identity.[32] Stereotype threat is associated with reduced performance on stereotype-relevant tasks, and thus likely contributes to the academic underachievement of marginalized groups.[34-36] For example, women have been found to perform worse on math tests when reminded of their gender identity,[37] and black students have been found to perform worse on standardized academic tests when reminded of their racial identity prior to testing.[32] Few studies to date have examined stereotype threat related to mental health or disability status.[33,38] However, it is likely that individuals with mental health disorders such as ADHD also experience stereotype threat related to their stigmatized identity. The negative stereotypes associated with ADHD (i.e.,

laziness, carelessness, and lack of intelligence)[28] are highly relevant to the academic domain. Thus, academic testing situations may put students with ADHD at risk for confirming negative stereotypes about ADHD, and may induce stereotype threat that compromises academic performance.

Surprisingly, only one previous study has examined stereotype threat in ADHD.[33] This study examined stereotype threat among college students with ADHD by randomly assigning participants to complete GRE test questions under stereotype threat and control conditions. Those in the stereotype threat condition completed an ADHD symptom checklist prior to testing, while those in the control condition completed testing prior to completing the ADHD symptom checklist. Results revealed that participants with ADHD who were exposed to stereotype threat performed significantly worse on the GRE than participants with ADHD who were not exposed to stereotype threat.[33] The findings of this study suggest that ADHD-based stereotype threat can be induced in academic testing situations and can negatively impact student performance.

Although one study has examined stereotype threat in ADHD, no previous study has examined the potential of testing accommodations to induce stereotype threat. The testing accommodations frequently provided to students with ADHD may serve as a salient, proximal reminder of the negative stereotypes associated with students' ADHD identity prior to testing. Thus, despite being intended to help, these accommodations may actually have an unintended negative impact on the academic performance of students with ADHD. Given the academic impairments associated with ADHD, the frequency with which testing accommodations are recommended by clinicians and provided by schools, and the lack of clarity in terms of the benefits of these accommodations, determining the real impact of accommodations on student

performance is crucial, and will have important practical implications for supporting students with ADHD in academic settings.

The overall objective of the present study was to examine whether the provision of testing accommodations could induce stereotype threat among students with ADHD, to explore the mechanism(s) by which stereotype threat impacts test performance, and to explore who is most vulnerable and/or resilient to its impact. To examine this, college students with and without ADHD were recruited to participate in a simulated standardized testing situation and randomized into stereotype threat and control conditions. This was the first study to examine the potential of testing accommodations to induce stereotype threat, and only the second study to examine ADHD-related stereotype threat. The specific aims of the study were as follows:

AIM 1: To determine whether a stereotype threat induction based on testing accommodations would reduce test performance in college students with ADHD. Stereotype threat was induced via oral and written statements, explaining that students with ADHD have been found to underperform on the GREs, and thus would be receiving extended time to complete a GRE test section. In past stereotype threat research, reduced performance among stigmatized group members exposed to threat has served as evidence that stereotype threat was successfully induced.[34] It was hypothesized that students with ADHD who were exposed to this stereotype threat would perform worse on the GRE test section, answering fewer total items correctly, compared to students with ADHD who were not exposed to stereotype threat. It was also hypothesized that students without ADHD would perform better than students with ADHD overall, and would not be impacted by the stereotype threat.

AIM 2: To identify moderators of the relationship between stereotype threat and test performance. Understanding who is most vulnerable and who is most resilient to the impact

of stereotype threat is important for mitigating its negative effects, as some of the factors that determine vulnerability may be malleable, and thus may be harnessed to promote resilience. Previous stereotype threat literature has identified several moderators of the relationship between stereotype threat and test performance, including an individual's level of awareness of the stereotypes associated with their identity, how much they personally identify with the stereotyped group, and self-efficacy for stereotype-relevant tasks.[39] Individuals who are more aware of the stereotypes associated with their identity, who identify more with the stereotyped group, and who have lower self-efficacy have been found to be more vulnerable to stereotype threat.[39] While not examined in previous studies, the present study also sought to examine processing speed and high school/college GPA as potential moderators of stereotype threat. Processing speed deficits are common among individuals with ADHD and relevant to the need for extended time accommodations.[40] Linear regression was utilized to examine all potential moderators (stereotype awareness, identification with stereotyped group, self-efficacy, processing speed, and GPA) of the relationship between stereotype threat and test performance. It was hypothesized that the test performance of students with lower academic self-efficacy, processing speed, and GPA and higher stereotype awareness and identification with the stereotyped group would be more vulnerable to the negative impact of stereotype threat on GRE test performance.

AIM 3: To identify mediators of the relationship between stereotype threat and test performance. Understanding the mechanism by which stereotype threat impacts test performance would allow for better understanding of this phenomenon, and might also help inform changes to the delivery of accommodations to mitigate the effects of stereotype threat. Previous studies examining race- and gender- based stereotype threat have identified

performance-avoidance goals, anxiety, and reduced working memory capacity as potential

mediators of the relationship between stereotype threat and test performance.[39] One of the

primary ways in which stereotype threat has been theorized to impact test performance is through

increased anxiety. However, this finding has been inconsistent in previous studies using self-

reports of anxiety, and it has been suggested that this may be due to presentation effects on self-

report measures of anxiety.[41] It is widely known that individuals with ADHD display a positive

bias in their self-reporting of symptoms and competence,[42-44] thus presentation effects are a

concern when studying this population. The present study utilized both self-report and

physiological measures of anxiety in order to explore this further. The literature also suggests

that stereotype threat may promote the adoption of performance-avoidance goals (i.e., the goal to

avoid failure), because it motivates students to avoid confirming negative stereotypes, rather than

more adaptive performance-approach or learning goals (i.e., the goal to perform well or to master

material).[45] Performance avoidance goals have been found to be associated with maladaptive

learning strategies, such as more superficial study strategies, preference for easier tasks, less

persistence on challenging tasks, and poor response to failure, which are all associated with

poorer academic performance.[46] Finally, stereotype threat has been found to impact test

performance through reduced working memory capacity, by distracting students from the task at

hand.[47] Given that working memory deficits are already common among individuals with

ADHD, this mediator was important to examine for this population.[48] The literature suggests that

these mechanisms may differ across different stereotyped groups,[39] thus it was important to

examine this within an ADHD population.

Path analysis was utilized to examine the potential mediating effects of anxiety,

performance-avoidance goals, and working memory capacity in the relationship between

stereotype threat and test performance. It was hypothesized that all proposed mediators would be significant mechanisms by which stereotype threat impacts GRE test performance, after accounting for baseline levels of each mediator.

METHOD

Participants.

Participants were 178 college students (41 with and 137 without ADHD) recruited from several sources, including: the Syracuse University SONA research participant pool, summer undergraduate psychology courses, and the Center for Disability Resources. College students were chosen as the participants for the present study because 1) most previous stereotype threat research has been conducted within a college population, 2) standardized testing performance is highly salient for this population, and 3) greater feasibility of recruitment.

Eligibility. All full-time enrolled, English-speaking college students between the ages of 18 and 25 were eligible to participate. Individuals with and without ADHD were not excluded based on the presence of other psychiatric comorbidities. ADHD rarely occurs in the absence of comorbid conditions, thus electing to exclude participants with ADHD based on the presence of comorbidities would result in a sample that does not represent the general population of individuals with ADHD. Common comorbidities (anxiety, learning disability) were instead screened for and considered as potential covariates in analyses.

ADHD Status. ADHD status was reported by participants on the baseline survey in the present study. All participants who reported having an ADHD diagnosis were included in the ADHD group. While ADHD diagnosis was not further confirmed in the present study, sample characteristics support the validity of this group. Specifically, the majority of participants with ADHD reported receiving academic accommodations in the college setting, which would require

them to have undergone an approval process through the Center for Disability Resources. Additionally, participants with ADHD in the present study were more likely to report common comorbidities associated with ADHD, higher levels of ADHD symptoms, and were more likely to be male (aligning with gender differences commonly observed in ADHD) compared to participants who did not report a previous ADHD diagnosis. Participants without ADHD who report highly elevated ADHD symptoms (defined as a total score of 45 or higher on the ASRS) were excluded from analyses. This included 10 participants without ADHD, bringing the number of participants without ADHD included in analyses down to 127, and total participants to 168.

Power Analysis. A priori power analyses for Aims 1 and 2 were conducted using G-Power. For Aim 1, a sample size of 126 was determined from the power analysis for two-way ANOVA, assuming four groups, 0.8 power, medium effect size,[34] and 0.05 error. Although the collected sample of 168 would be sufficient, uneven distribution of the sample across groups (ADHD vs. non-ADHD) is likely negative impacting power for this aim. For Aim 2, a sample size of 77 was determined from the power analysis for multiple linear regression, assuming three test variables, 0.8 power, medium effect size,[34] and 0.05 error. Given the collected sample size of 41 participants with ADHD, Aim 2 analyses utilizing only the ADHD sample (analyses examining stereotype awareness and identification with the stereotyped group) were underpowered. However, Aim 2 analyses utilizing the total sample (analyses examining GPA, academic self-efficacy, and processing speed) were well-powered. For Aim 3, sample size was determined using published guidelines for path analysis using a percentile bootstrapping test of mediation, and based on effect sizes (standardized coefficients) for paths from stereotype threat to mediators of interest (*a* paths), and from mediators of interest to test performance outcome (*b* paths) found in previous studies.[49] The *a* path coefficients reported in previous literature ranged

from 0.30 to 0.52, and *b* path coefficients ranged from 0.33 to 0.58,[45,47,50-52] suggesting effects in the medium range. According to the published guidelines, 78 participants would be required to detect medium effects for both *a* and *b* paths.[49] Given the collected sample size of 41 participants with ADHD, Aim 3 analyses were underpowered. Bias-corrected bootstrapping was utilized to help address power concerns for this aim.

Procedures.

Recruitment. The opportunity to participate in this study was posted through SONA and the Center for Disability Resources at SU, as well as provided as an extra-credit opportunity for summer undergraduate psychology courses. Recruitment materials did not state the true purpose of the study, as awareness that the study was examining ADHD-based stereotype threat could have biased decisions to participate as well as influenced survey responses and test performance. Instead, the study was presented as examining predictors of GRE performance broadly.

Study Design. Students who registered to participate in the study were asked to complete a baseline survey and then to participate in a virtual testing session. For the virtual testing session, participants were randomized into stereotype threat and non-stereotype threat group conditions, resulting in a two-by-two between-subject study design (ADHD vs. no ADHD; stereotype threat vs. no stereotype threat). Among the 41 participants with ADHD, 22 were assigned to the stereotype threat condition, and 19 to the non-stereotype threat condition. Among the 127 participants without ADHD, 61 were assigned to the stereotype threat condition, and 66 were assigned to the non-stereotype threat condition.

Baseline Survey. The baseline survey asked participants to complete measures related to current ADHD symptoms, measures of the five moderators of interest (academic self-efficacy, GPA, stereotype awareness, ADHD identification, and processing speed), and baseline measures

of the mediators of interest (anxiety, working memory, and goal orientation). Participants were required to complete the survey on a computer or laptop to ensure reliable and valid administration of the included processing speed and working memory tasks. Survey measures were ordered carefully to reduce biased responding and potential stereotype threat during the baseline period, by placing the more performance-based measures at the beginning of the survey, and placing measures related to ADHD symptoms, comorbidity, and stereotypes at the end of the survey. Demographic questions were also placed at the end of the survey in order to avoid potential interference from stereotype threat based on gender, race, or other minority identity.

Virtual Testing Session. Participants were asked to participate in a virtual testing session via zoom one to two weeks following completion of the baseline survey, in which they were administered a GRE verbal reasoning section. One to two participants were included in each virtual testing session. Additionally, one to two confederates were included in order to increase the authenticity of the testing situation. Participants were asked to keep their cameras on throughout testing so that the proctor could see them as they worked. They were also asked to utilize the "split screen" function on their computer in order to have both the testing window and the zoom session open and visible on their computer simultaneously, so that participants were aware of the other students' presence during testing, also to increase the authenticity of the testing situation. All participants were informed that their name would be entered into a drawing for a $100 Amazon gift card based on the number of GRE items they answered correctly, in order to provide additional motivation for participants to put adequate effort into their performance. The stereotype threat manipulation was delivered through the task instructions provided to participants upon signing into the virtual testing session.

For all participants, testing was divided into one 20-minute period, and then a second 10-minute period, with measures of the mediators of interest (working memory, anxiety, goal orientation) administered in between. Consistent time for testing was provided across conditions to allow for the effect of the stereotype threat induction to be isolated from the effect that actual differences in time allotted for testing might have had on performance. A pool of items from two GRE verbal reasoning sections was utilized so that participants would be unlikely to run out of items to complete during the testing periods, which would reduce the chances of ceiling effects for test performance. Items administered during the first 20-minute testing period were independent from items administered during the second 10-minute testing period. Thus, regardless of whether participants attempted all items included in the 20-minute testing period, they were presented with the same new items during the following 10-minute testing period. Heart rate variability data was collected via a personal heart rate monitor throughout the testing session as a physiological measure of anxiety. Participants retrieved and returned heart rate monitors via a remote pick-up procedure.

Confederate Behavior. Confederates acted as though they were participants completing the virtual testing session. They were instructed to log into the testing session at the same time as participants, and to appear confident and focused on their computer screen during testing. Although the amount of time provided to participants to complete the testing was consistent across stereotype threat and non-stereotype threat conditions, confederates were instructed to announce that they had completed each section of testing more quickly in the stereotype threat condition (e.g., 16 minutes into the 20 minute section), in order to simulate the experience many students with ADHD have in in-person testing situations, whereby others are finishing and turning in their tests more quickly, while students with ADHD are still working. Confederates

were then allowed to leave the virtual testing session after announcing they had completed the second section of testing, leaving participants to finish testing with the proctor.

Debriefing. When testing was complete, participants were asked about their perceptions of their performance and of the testing situation and their awareness of the study purpose. They were then debriefed about the true purpose of the study and the deception involved (i.e., this was a study about ADHD-based stereotype threat; the test was introduced differently to different participants in order to induce threat for some participants and not others; the same amount of time was provided to all students to complete testing). Participants were given the opportunity to ask the researcher any questions they may have had regarding their participation in the study.

Stereotype Threat Manipulation. Stereotype threat was induced via oral instructions prior to testing, as well as via written statement presented on participants' computer screens immediately prior to testing.

Stereotype Threat Script: *"The GRE is a test students are often required to take before entering graduate school. The GRE is diagnostic of your ability to perform well in higher education settings. So, even if you have no interest in graduate school, your performance on this test will relate to your ability to perform well in your undergraduate studies. Students with ADHD have been found to perform significantly worse on the GRE than students without ADHD. This is likely due to their increased distractibility, difficulty focusing, and difficulty organizing their thoughts to effectively solve problems and answer questions. Because of this, we will be giving students with ADHD extended time accommodations to complete today's testing. You'll see a timer in the top corner of your screen to remind you of how much time is remaining throughout the testing session. When you have completed the testing, we will provide you with feedback about how your performance compares to other college students your age."*

No Stereotype Threat Script: *"The GRE is a test students are sometimes required to take before entering certain graduate school programs. For the purposes of today's testing, all participants will be receiving a little more time than is typically provided to complete this testing. Your performance data will be recorded."*

Measures.

Demographics and Educational/Psychiatric History. Participants were asked to report on their age, race, ethnicity, and gender, as well as their year in school, and current GPA (or high school GPA for students in their first semester of college). Participants were also asked about their history of academic accommodation use, learning disability status, and medication status. These variables were considered as potential covariates for primary study analyses. GPA was examined as a potential moderator of the relationship between ADHD-based stereotype threat and test performance. Due to possible differences in college vs. high school GPA's, z-scores were calculated for high school GPA's and college GPA's separately, and then these GPA z-scores were utilized in analyses.

Adult ADHD Rating Scale (ASRS). The ASRS is an 18-item self-report measure assessing current symptoms of ADHD, including the nine symptoms of inattention and nine symptoms of hyperactivity/impulsivity listed in the *DSM-5*. Participants responded to items on a five-point scale from *never* to *very often*. Total scores on the ASRS range from a minimum score of 0 to a maximum score of 72. The ASRS has been validated for use with young adults, and has been found to have good internal consistency (Cronbach's alpha = .75 – .82).[53] This measure was used in the present study to help characterize and validate the ADHD and non-ADHD participant samples. Internal consistency in the present sample was .82 for inattentive symptoms and .83 for hyperactive/impulsive symptoms.

Motivated Strategies for Learning Questionnaire (MSLQ) Self-Efficacy Scale. The MSLQ was designed to measure post-secondary students' motivation and learning strategies for college courses.[54] The overall questionnaire consists of fifteen different scales which can be administered together or separately. For the purposes of the present study, only the Self-Efficacy scale was administered. The self-efficacy scale consists of eight items measuring students' beliefs about their academic ability. Participants were asked to respond to items on a seven-point scale from *not at all true of me* to *very true of me*. The items were modified slightly for the purposes of this study to refer to the students' self-efficacy for their college courses in general, rather than for a specific course (example item: "I'm certain I can master the skills being taught in my college courses"). Total scores on the MSLQ Self-Efficacy scale range from a minimum score of 0 to a maximum score of 48. The MSLQ Self-Efficacy scale has been found to have good internal consistency (Cronbach's alpha = .93).[54] This was examined as a potential moderator of the relationship between ADHD-based stereotype threat and test performance in the present study. It was hypothesized that participants with greater academic self-efficacy, as measured by the MSLQ, would be more resilient to the impact of stereotype threat. Internal consistency in the present sample was .90.

Adapted Stigma Consciousness Questionnaire (SCQ). The SCQ is a 10-item measure of stereotype awareness which has previously been customized and validated for use with LGBT populations and women.[55] This measure was adapted for the present study to measure ADHD-related stereotype awareness (example item: "Stereotypes about ADHD/ADD have not affected me personally"). The adapted measure included 14-items. Participants responded to items on a five-point scale from *strongly disagree* to *strongly agree*. Total scores on the adapted scale range from a minimum score of 0 to a maximum score of 56. The Cronbach's alpha for the SCQ for

Women was .72 and the Cronbach's alpha for the SCQ for Gay and Lesbian men and women was .81.[55] Both measures showed construct validity when compared to relevant sexism and homophobia related scales. ADHD stereotype awareness was examined as a potential moderator of the relationship between ADHD-based stereotype threat and test performance in the present study. It was hypothesized that participants with greater awareness of ADHD-related stereotypes, as measured by the SCQ, would be more vulnerable to the impact of stereotype threat. Internal consistency for the adapted SCQ utilized in the present sample was .90.

   Adapted Collective Self-Esteem Identity Subscale. The Collective Self-Esteem Scale is a 16-item measure of social group identity, which includes four subscales – *membership* esteem, *private* perceptions of the social group, perceived *public* evaluation of the social group, and importance of the social group to *identity*.[56] The four-item identity subscale was adapted for the present study to assess the perceived importance of ADHD to self-concept (example item: "Having ADHD/ADD in an important part of my self-image"). Participants responded to items on a five-point scale from *strongly disagree* to *strongly agree*. Total scores on the adapted scale range from a minimum score of 0 to a maximum score of 16. The original scale was found to have good internal consistency (Cronbach's alpha = .85 for the total scale, and .76 for the identity subscale). The identity subscale has previously been adapted in a similar manner to measure the importance of gender to the identity of women, and also displayed good internal consistency (Cronbach's alpha = .70).[57] The importance of ADHD to self-identity was examined as a potential moderator of the relationship between ADHD-based stereotype threat and test performance in the present study. It was hypothesized that participants who identify more strongly with ADHD as part of their identity, as measured by the CSE Identity scale, would be

more vulnerable to the impact of stereotype threat. Internal consistency for the adapted identity subscale utilized in the present sample was .65.

Symbol-Digit Coding. The symbol digit coding task is a normed, computerized test of processing speed, comparable to the WAIS-IV coding task. The symbol digit coding task asks participants to link numbers to corresponding symbols, with the goal being to type as many correct numbers as they can in a two-minute time frame. Normative data suggests the average college-aged individual is able to complete 61-65 items correctly in the two-minute administration period.[58] Performance on the computerized symbol digit coding task correlates strongly with performance on the WAIS-IV coding task ($r = .79$) and shows strong test-retest reliability ($r = .82$).[58] The symbol digit coding task was administered within the baseline survey. This was examined as a potential moderator of the relationship between ADHD-based stereotype threat and test performance in the present study. It was hypothesized that participants with slower processing speed, as measured by the Symbol-Digit Coding task, would be more vulnerable to the impact of stereotype threat.

State-Trait Anxiety Inventory. The state-trait anxiety inventory (STAI) is a widely used measure of anxiety in psychological research. The 20-item trait anxiety subscale of the STAI was utilized to examine participant anxiety in the baseline survey in the present study. Participants responded to items on a four-point scale from *almost never* to *almost always*. Total scores on this subscale range from a minimum score of 0 to a maximum score of 60. The STAI has been found to have good internal consistency (Cronbach's alpha = .86-.95).[59] The trait subscale was utilized in the present study to provide a baseline measure of participant trait anxiety, and was utilized as a covariate for the Aim 3 path analysis. Internal consistency for the present sample was .90.

Corsi Block Tapping Task. The Corsi Block Task is a computerized test of non-verbal working memory.[60] Similar to the digit span task of the WAIS-IV, the Corsi Block Task asks participants to remember and repeat an increasing sequence of presented visual stimuli. In the computerized task, nine blocks are presented on the computer screen, and participants are asked to remember the sequence with which particular blocks are highlighted or "tapped" on the screen, and then tap the blocks in the same order as presented. Normative data for the Corsi Block Task suggests an average Corsi Block Span x Total Correct score of 60.0 for healthy 18-20-year-olds.[61] The Corsi Block Task was administered as part of the baseline survey, as well as during the virtual testing session itself. Previous studies have found moderate test-retest reliability and minimal practice effects for the Corsi Block Task, suggesting that retesting after a one-to-two-week period does not result in significant improvement in scores.[62] Working memory, as measured by Corsi Block Span x Total Correct sequences was examined as a potential mediator of the relationship between ADHD-based stereotype threat and test performance in the present study. It was hypothesized that stereotype threat would be associated with reduced working memory capacity, as measured by performance on the Corsi Block Tapping task at the time of testing, which in turn would be associated with reduced GRE test performance.

Achievement Goal Questionnaire. The achievement goal questionnaire is an 18-item scale designed to measure students' mastery, performance-approach, and performance-avoidance goals. The measure consists of three 6-item subscales representing these three achievement goal orientations. Participants responded to items using a seven-point scale from *not at all true of me* to *very true of me*. Total scores for each subscale ranged from a minimum score of 0 to a maximum score of 36. Average scores among college students, from the original study

developing this measure were 20.0 for performance-approach, 15.8 for performance-avoidance, and 27.2 for mastery goals.[63] The three subscales of the achievement goal questionnaire have been found to have good internal consistency (Cronbach's alpha = .77 – .91).[63] This measure was administered as part of the baseline survey, and then again during the virtual testing session to measure achievement goals for the specific task at hand. When administered in the baseline survey, items were modified slightly to ask about goal orientation for college courses in general, rather than for a specific course (example item: "I just want to avoid doing poorly in my classes"). When administered during the study visit, items were modified to ask about the specific testing situation (example item: "I just want to avoid doing poorly on this GRE test"), as has been done in previous stereotype threat research.[45] The performance avoidance subscale was examined as a potential mediator of the relationship between ADHD-based stereotype threat and test performance in the present study. It was hypothesized that stereotype threat would be associated with greater performance avoidance goals, as measured by the adapted achievement goal questionnaire at the time of testing, which in turn would be associated with reduced GRE test performance. The internal consistency of the performance avoidance subscale for the present sample was .80 at baseline, and .90 during the virtual testing session.

Worry-Emotionality Scale. The worry-emotionality scale is a 10-item measure designed specifically to examine anxiety related to testing situations.[64] The scale includes five items capturing the worry component of test anxiety, and five items capturing the emotionality component. Participants responded to items on a five-point scale from *this statement does not describe my present condition* to *this statement describes my present condition very well*. Total scores on this scale ranged from a minimum score of 0 to a maximum score of 40. The average score among college students, from the original study developing this measure was 12.6.[64] This

scale has been found to have good internal consistency (Cronbach's alpha = .81 for the worry

subscale, and .86 for the emotionality subscale).[64] This scale has been utilized with college

students in previous stereotype threat research to capture anxiety around test performance. This

measure was examined as a potential mediator of the relationship between ADHD-based

stereotype threat and test performance in the present study. It was hypothesized that stereotype

threat would be associated with greater anxiety, as measured by the worry-emotionality scale at

the time of testing, which in turn would be associated with reduced GRE test performance.

Internal consistency in the present sample was .88.

Physiological Anxiety. Heart rate variability (HRV) data was collected via heart rate

monitor as a physiological measure of anxiety. Anxiety and worry have been associated with

significant reductions in HRV in previous studies.[65] HRV was examined as a potential mediator

of the relationship between ADHD-based stereotype threat and GRE performance in the present

study. Participants were asked to retrieve heart rate equipment via a contactless pick-up

procedure and then proceeded to wear a Polar heart rate monitor and linked actigraph unit

throughout the virtual testing session. The Polar heart rate monitor has been found to accurately

and reliably measure heart rate during laboratory tasks designed to induce physical or mental

stress and shows strong convergent validity with electrocardiagraphy (ECG) heart rate measures

(average within subjects correlation between Polar monitor and ECG measures of heart rate $r =$

.98).[66] Data from the heart rate monitors were recorded and stored through a linked actigraph

unit, and downloaded using ActiLife software following the virtual testing session. Kubios HRV

software was then utilized to process the data and produce HRV summary variables to utilize in

analyses. For each participant who was able to participate in this component of the study ($n =$

101), a 5-minute time increment falling within the first 20-minute period of GRE testing (10min

- 15min mark) was utilized for HRV analysis, in order to capture a physiological measure of anxiety during the testing period. A medium beat correction was utilized to ensure data quality and remove any artifacts in the data. Twenty-nine data files were invalid due to insufficient data captured or due to over 10% of beats requiring correction when the medium correction threshold was applied. These cases were removed from analyses, resulting in 72 cases with valid HRV data. HRV analysis produces several different variables representing different ways of measuring and examining HRV. Previous HRV research suggests that frequency-domain measures are best suited for short-term data such as the 5-minute increment utilized in the present study. Amongst the frequency domain measures, LF/HF ratio, a measure indicating the balance between sympathetic and parasympathetic nervous system activation, was selected for examination in the present study, as this is the most frequently reported frequency-domain factor in previous HRV studies examining participant response to a stressful situation.[67] Normative data from the Task Force of the European Society of Cardiology and the North American Society of Pacing Electrophysiology suggests an average LF/HF ratio of 1.5 – 2.0 for a stationary period of five minutes.[68] Greater LF/HF ratio would indicate greater sympathetic activation compared to parasympathetic, or greater anxiety in the testing situation. It was hypothesized that stereotype threat would be associated with greater physiological anxiety, as measured by LF/HF ratio, which in turn would be associated with reduced GRE test performance.

GRE verbal reasoning section. The Graduate Record Examination (GRE) is a standardized test required for entrance into many graduate school programs in the U.S.[69] The verbal reasoning section of the GRE was chosen as the academic test for the present study because performance on this test was likely to be responsive to ADHD-based stereotype threat. Meta-analyses reveal that the largest discrepancy in academic performance between students

with and without ADHD is in verbal reasoning.[70] Because stereotype threat is likely to be

induced during challenging tasks that are salient to the stereotyped group, it was thought that

performance on the GRE verbal reasoning section would be responsive to stereotype threat. The

verbal reasoning section of the GRE includes three types of questions: reading comprehension,

text completion, and sentence equivalence. Reading comprehension items come in sets based on

a passage, and are often multiple choice. Text completion and sentence equivalence items are

independent of one another, and involve filling in blanks in a sentence or small passage with

correct vocabulary words to complete the sentence/passage with the appropriate meaning.

Reading comprehension items were included at the beginning of each timed testing period, with

quicker response items following, so that participants were unlikely to run out of time in the

middle of a question set, and to ensure that scores were able to capture subtle differences in

participant performance. For the purposes of the present study, items from two GRE verbal

reasoning practice tests were utilized, including 45 total items; thus total scores could range from

a minimum of 0 to a maximum of 45. The number of items answered correctly on the GRE

questions administered was the primary dependent variable of interest in the present study.

Statistical Analyses.

Preliminary Analyses: Descriptive statistics and bivariate correlations were conducted in

IBM SPSS Statistics Version 29 to examine data for non-normality. If normality concerns were

present, normalizing transformations and/or robust maximum likelihood estimation would be

utilized. T-tests and chi-square tests were then utilized to examine the impact of demographic

variables on the dependent variable of interest, and to examine group differences (e.g., between

ADHD and non-ADHD participants, and between stereotype threat and no-stereotype threat

conditions) in order to identify potential covariates to be included in primary analyses.

AIM 1: Two-way ANOVA was conducted in SPSS to examine whether the accommodations-based stereotype threat induction impacted the GRE test performance of participants with ADHD. A significant ADHD status by stereotype threat interaction, such that stereotype threat was associated with poorer test performance only for participants with ADHD, would suggest that the provision of extended time accommodations induced ADHD-based stereotype threat that negatively impacted academic test performance. Eta-squared was utilized as a measure of effect size, representing the percent of the total variance in test performance explained by each of the main effects and the interaction effect in this two-way ANOVA.

AIM 2: A series of multiple linear regression analyses were conducted in SPSS to test potential moderators of the relationship between ADHD stereotype threat and test performance. For moderators: GPA, academic self-efficacy, and processing speed, the full sample of participants with and without ADHD was utilized. Test performance was regressed on main effects of stereotype threat, ADHD status, and the moderator of interest as a first step, the two-way interaction terms between each of these variables as a second step, and the three-way interaction between stereotype threat, ADHD status, and the moderator of interest as a third step in the regression models. A significant three-way interaction would suggest significant moderation, or that the relationship between stereotype threat and test performance differs as a function of ADHD status and the moderating variable. For moderators: ADHD stereotype awareness and identification with the stereotyped group, regression models included only participants with ADHD, as only participants with ADHD completed these measures. Test performance was regressed on main effects of stereotype threat condition and the moderator of interest in step one, and the two-way interaction between these two variables in step two of these

models. R^2 increase from the addition of the interaction term to the regression model was utilized as a measure of effect size.

AIM 3: Path analysis was conducted in *Mplus* Version 8.8[71] to examine proposed mediators of the relationship between stereotype threat and test performance. Path analysis provided an efficient method for examining the mediation relationships of interest in the present study, as it allowed for the estimation of multiple relationships between variables simultaneously within a single model. More specifically, this path model examined the mediating role of anxiety (M_1), working memory (M_2), and performance avoidance goals (M_3) in the relationship between stereotype threat (X) and GRE test performance (Y), among participants with ADHD. Correlations among the mediating variables were estimated, and baseline levels of anxiety, working memory, and goal orientation were accounted for within this model. In order to allow *Mplus* to handle missing data on baseline (X) variables, variances for these variables were specified in the Model command, allowing *Mplus* to handle missing data the same way it does for Y variables, utilizing FIML procedures. Significance testing of the mediating effects was conducted using 95% confidence intervals generated from 10,000 bias-corrected bootstrapped samples. Mediation effects were considered significant if the 95% confidence interval did not include 0 within it. Standardized regression path coefficients and proportion of total effect mediated by each mediating variable were utilized as measures of effect size. Analyses for this aim included data from participants with ADHD only.

RESULTS

Preliminary Analyses.

T-tests and chi-square tests were utilized to examine group differences between participants with and without ADHD. These analyses indicated a significant gender difference

between the ADHD and non-ADHD groups ($X^2(1) = 16.3$, $p < .001$), such that the non-ADHD group had significantly more females than the ADHD group (86% vs. 56%). There was also a significant difference in terms of race ($X^2(1) = 10.9$, $p < .01$), such that the ADHD group had significantly more white, non-Hispanic individuals than the non-ADHD group (77% vs. 50%). ADHD and non-ADHD groups also differed significantly in terms of year in school ($X^2(4) = 24.3$, $p < .001$), such that there were significantly more freshmen in the ADHD group, and more juniors and seniors in the non-ADHD group. Participants with ADHD were also significantly more likely to have been diagnosed with a learning disability ($X^2(1) = 23.2$, $p < .001$), anxiety disorder ($X^2(1) = 10.4$, $p < .001$), or depressive disorder ($X^2(1) = 10.0$, $p < .001$), compared to participants without ADHD, and were significantly more likely to be receiving academic accommodations in the college setting ($X^2(1) = 40.27$, $p < .001$), supporting the external validity of this data to the general population of college students with ADHD. Amongst the baseline, mediating, and outcome variables of interest, the only significant group difference was with regard to ADHD symptoms, with those in the ADHD group, as would be expected, displaying significantly more frequent ADHD symptoms (Hedge's $g = 1.60$, $p < .001$). There were no significant group differences in terms of how participants perceived the testing situation (i.e., how realistic and stressful they found the testing situation to be) or how they perceived their performance (i.e., percent of items participants thought they answered correctly). See Table 1 for descriptive data for all demographic and major variables of interest broken down by participant group.

T-tests and chi-square tests were also utilized to examine possible group differences based on study condition (i.e., stereotype threat vs. non-stereotype threat) for all major variables of interest. Analyses revealed only one significant group difference, with regard to baseline

performance approach goals. Specifically, participants in the non-stereotype threat condition displayed greater performance approach goals than participants in the stereotype threat condition (Hedge's $g = 0.35$, $p < .05$). Participants in stereotype threat vs. non-stereotype threat conditions did not differ in terms of any other demographic, baseline, mediating, or outcome variables, or on any variables related to perceptions of the testing situation.

All variables for which there were significant group differences between ADHD and non-ADHD or between stereotype threat and non-stereotype threat condition (i.e., gender, race, LD, anxiety, depression, year in school, academic accommodations, and baseline performance approach goals) were examined to determine if they were significantly associated with the outcome variable of GRE performance. None were significant (all p's > .05); thus, none of these variables were added as covariates in primary analyses.

Correlations between variables of interest were also analyzed. Academic self-efficacy, as measured by the MSLQ was positively associated with GPA ($r = 0.16$, $p < .05$), mastery and performance approach goals ($r = 0.57$ and $r = 0.26$, respectively, both p's < .001), and GRE test performance ($r = 0.25$, $p = .001$), and negatively associated with STAI trait anxiety ($r = -0.31$, $p < .001$). GPA was positively associated with performance approach goals ($r = 0.31$, $p < .001$) and working memory, as measured by the Corsi Block task at the time of test administration ($r = 0.19$, $p < .05$). Processing speed, as measured by the Symbol Digit Coding task was positively associated with working memory at baseline and at the time of test administration ($r = 0.29$ and $r = 0.30$, respectively, both p's < .001). Performance approach goals were positively associated with both mastery and performance avoidance goals at baseline ($r = 0.26$ and $r = 0.32$, respectively, both p's < .001), as well as with performance approach goals at the time of test administration ($r = 0.44$, $p < .001$). Performance avoidance goals were positively associated with

both baseline trait anxiety ($r = 0.40$, $p < .001$) and state anxiety as measured by the WES at the time of test administration ($r = 0.27$, $p = .001$), as well as performance avoidance goals at the time of test administration ($r = 0.39$, $p < .001$). Trait anxiety was positively associated with ADHD symptoms as measured by the ASRS ($r = 0.31$, $p < .001$), as well as state anxiety at the time of test administration ($r = 0.44$, $p < .001$), and both performance approach and performance avoidance goals at the time of test administration ($r = 0.24$, $p < .01$ and $r = 0.36$, $p < .001$, respectively). Working memory at baseline was positively associated with working memory at the time of test administration ($r = 0.42$, $p < .001$). Self-reported state anxiety at the time of test administration was positively associated with both performance approach and performance avoidance goals at the time of test administration ($r = 0.48$ and $r = 0.68$, respectively, both p's < .001) and with heart rate variability (LF/HF ratio) at the time of test administration ($r = 0.30$, $p < .05$). Performance approach goals at the time of test administration were positively associated with performance avoidance goals at the time of test administration ($r = 0.60$, $p < .001$), as well as with GRE test performance ($r = 0.20$, $p < .05$).

Among participants with ADHD, greater ADHD symptom severity was associated with greater identification with ADHD as part of one's identity ($r = 0.45$, $p < .01$). Greater identification with ADHD was associated with greater state anxiety ($r = 0.33$, $p = .05$) and greater performance approach goals ($r = 0.40$, $p < .05$) during test administration. Additionally, greater awareness of ADHD-related stereotypes was associated with greater state anxiety ($r = 0.43$, $p = .01$), performance approach ($r = 0.55$, $p < .01$), and performance avoidance goals ($r = 0.50$, $p < .01$) during test administration. See Table 2 for correlations between all major variables of interest among the total sample.

Finally, variables of interest were also examined for potential non-normality. Skewness and Kurtosis for all major variables of interest fell within acceptable ranges of -2.0 to +2.0 for Skewness and -7.0 to +7.0 for Kurtosis, suggesting no significant departures from normality that would require special handling of the data.[72]

Primary Analyses.

AIM 1: A two-way ANOVA was conducted to examine the impact of stereotype threat condition and ADHD status on GRE test performance. Results indicate that there was no significant interaction effect for ADHD and stereotype threat ($F(1, 159) = 0.1$, $p = .75$). Simple main effects analysis revealed that the main effects of stereotype threat condition and ADHD status on GRE test performance were also not significant (p's > .05). See Table 3 for ANOVA table and Figure 1 for a visual representation of findings.

AIM 2: A series of multiple linear regression analyses were conducted to test potential moderators of the relationship between stereotype threat and test performance. The first potential moderator examined was GPA. Test performance was regressed on main effects of stereotype threat condition, ADHD status, and GPA in step one, the two-way interactions of each of these variables in step two, and finally the three-way interaction between stereotype threat, ADHD, and GPA in step three. The overall model was not significant ($R^2 = .04$, $F(7, 155) = 1.01$, $p = .43$). There were no significant main effects or interaction effects associated with GRE test performance within this model.

Next, academic self-efficacy was examined as a potential moderator, following the same three-step regression process described above. Again, the overall model was not significant ($R^2 = .07$, $F(7, 153) = 1.72$, $p = .11$). However, step one of the model, including only main effects, was

28

significant ($R^2 = .07$, $F(3, 157) = 3.99$, $p < .01$), with a significant main effect of academic self-efficacy on GRE performance ($B = 0.25$, $p < .01$). No interaction effects were significant.

The next potential moderator examined was processing speed, as measured by performance on the symbol-digit coding task at baseline. The same three-step regression process described above was utilized for this model. The overall model examining processing speed as a potential moderator was not significant ($R^2 = .03$, $F(7, 152) = 0.74$, $p = .64$). There were no significant main effects or interaction effects associated with GRE test performance within this model.

For the remaining two potential moderators, ADHD stereotype awareness and identification with the stereotyped group, regression models included only participants with ADHD, as only participants with ADHD completed these two measures. Test performance was regressed on main effects of stereotype threat condition and the moderator of interest in step one, and on the two-way interaction between these two variables in step two of these models. Both models were non-significant ($R^2 = .08$, $F(3, 36) = 0.97$, $p = .41$ for identification with the stereotyped group, and $R^2 = .10$, $F(3, 35) = 1.31$, $p = .29$ for ADHD stereotype awareness). Of note, these analyses are quite underpowered due to small sample size.

AIM 3: Path analysis was conducted in *Mplus* Version 8.8[71] to examine proposed mediators of the relationship between stereotype threat and test performance. Although four mediating variables were initially proposed: self-reported anxiety, physiological anxiety (HRV), working memory, and performance avoidance goals, sample statistics revealed a collinearity problem between performance avoidance goals and self-reported anxiety at the time of testing within the ADHD sample ($r = 0.77$), which interfered with model convergence. To address this problem, self-reported anxiety was removed from the model, as anxiety was still captured

through the heart rate variability variable, and this would allow all proposed constructs to still be examined within the model. The updated model was a fully-saturated path model with all paths estimated, which examined the mediating role of physiological anxiety (M_1), working memory (M_2), and performance avoidance goals (M_3) in the relationship between stereotype threat (X) and GRE test performance (Y), among participants with ADHD. See Table 4 for correlations between all variables included in this model within the ADHD sample.

The path model revealed no significant effects of any baseline or proposed mediating variables on GRE test performance (all p's > .05). There was a significant effect of baseline trait anxiety on performance avoidance goals at the time of testing (B = 0.58, $p < .05$), whereby individuals with greater trait anxiety endorsed more performance avoidance goals related to the virtual testing session. Additionally, there was a significant relationship between baseline trait anxiety and baseline performance avoidance goals (B = 40.53, $p < .05$), whereby individuals with greater trait anxiety also endorsed more performance avoidance goals in general for their college classes. Finally, there was a significant relationship between performance avoidance goals and physiological anxiety at the time of testing (B = 9.40, $p < .05$), suggesting individuals who were more anxious (i.e., had greater sympathetic nervous system activation) at the time of testing endorsed more performance avoidance goals related to the virtual testing session. Indirect effects from stereotype threat to GRE test performance through each of the three proposed mediating variables were examined using 95% confidence intervals generated from 10,000 bias-corrected bootstrapped samples. All indirect effects were found to be non-significant, as the confidence intervals for all three examined mediators included 0 within them. Thus, performance avoidance goals, working memory capacity, and physiological anxiety at the time of testing do not appear to mediate the relationship between stereotype threat condition and GRE test

performance. See Table 5 for a summary of the direct and indirect effects from stereotype threat to GRE test performance. See Figure 2 for a visual summary of the path model.

DISCUSSION

The present study sought to examine the potential of testing accommodations to induce ADHD-based stereotype threat in academic testing situations, and to examine potential mediators and moderators of the relationship between stereotype threat and test performance. This was only the second study to examine ADHD-based stereotype threat and the first to examine the potential of testing accommodations to induce stereotype threat in college students with ADHD.

Aim 1: Stereotype threat and test performance in college students with ADHD

Aim 1 sought to determine whether a stereotype threat induction based on testing accommodations would reduce test performance in participants with ADHD. It was hypothesized that participants with ADHD in the stereotype threat condition would perform worse on the GRE test section, answering fewer total items correctly, compared to students with ADHD in the non-stereotype threat condition, and compared to students without ADHD regardless of stereotype threat condition. However, results indicated that there were no significant differences in GRE test performance based on ADHD status or stereotype threat condition, with both main effects and the interaction effect between ADHD status and stereotype threat condition being non-significant. As previous studies have determined the success of the stereotype threat induction based on whether task performance was negatively impacted,[34] the lack of significant findings in the present study suggests that stereotype threat may not have been successfully induced.

Previous stereotype threat literature has reviewed the conditions under which stereotype threat is activated, suggesting a few key factors, including relevance of stereotypes to the performance domain, the extent to which individuals identify with and value the performance

domain, and task difficulty and demand.[34,39] While the GRE is certainly a challenging test, as demonstrated by the low mean for total items correct in the present sample (11.5 for participants with ADHD, 10.4 for participants without ADHD, out of 45 total items) and low percent accuracy out of attempted items (32% for participants with ADHD, 28% for participants without ADHD), and should be relevant to negative stereotypes associated with ADHD (e.g., lack of intelligence),[28] it is possible that the GRE is not sufficiently salient as a performance domain to participants of the present study. Specifically, the GRE may not feel very salient or threatening for undergraduate students who do not intend to apply to graduate school, or who simply are not aware of or thinking about graduate school and entry exams yet. This may be particularly relevant in the present study, as there were significantly more first-year students in the ADHD sample, for whom the GRE is likely less salient, and more upper-classmen in the non-ADHD sample, for whom the GRE may be somewhat more salient. Although year in school was not significantly related to GRE test performance, it is possible that this contributed to lack of stereotype threat activation among participants with ADHD in the present study.

In addition to including more first-year students, the ADHD sample in the present study also differed from the non-ADHD sample in terms of racial composition. Specifically, the ADHD sample included more white, non-Hispanic participants, while the non-ADHD sample included more participants with racial/ethnic minority backgrounds. Although there was no intentional stereotype threat induction for identities other than ADHD in the present study, it is important to note that individuals of minority racial backgrounds are vulnerable to experiencing stereotype threat in academic testing situations, and thus their performance on the GRE test section may have been impacted. Previous research suggests that even subtle cues from the environment, without any explicit mention of group identity, can be enough to induce stereotype

threat for some individuals.[32,34] Again, although race/ethnicity was not significantly associated with GRE test performance, it is possible that stereotype threat induced based on other group identities interfered with test performance, impacting findings of the present study.

Students with ADHD attend college at lower rates than students without ADHD.[7,12] This makes students with ADHD who attend college a unique subsample in some ways compared to the larger population of individuals with ADHD, as they have been able to achieve academic success despite the challenges associated with their ADHD diagnosis. It is possible that this unique subsample of individuals with ADHD is less likely to experience stereotype threat, as they have performed well enough academically to attend college. However, many previous stereotype threat studies have also studied populations who have had to persevere in the face of challenges in order to access a college education (e.g., racial minority college students) and these groups have still been found to experience stereotype threat in the college setting, resulting in underperformance, despite their resilience.[35] Another possibility is that students with ADHD who have historically received accommodations may have grown used to them by the time they are in college, may be more desensitized to the stigma associated with them, and therefore may be less vulnerable to potential stereotype threat related to them. However, once again, many of the populations found to experience stereotype threat in previous studies also have historical experience with stigma in academic settings prior to attending college, and yet continue to be impacted by stereotype threat in the college setting in spite of this. [35] Additionally, individuals with ADHD who attend college likely identify more strongly with the academic domain than individuals with ADHD who do not attend college, and previous research suggests this should make them more vulnerable to the impact of stereotype threat.[34,39]

The stereotype threat induction in the present study was designed to activate stereotype threat for participants with ADHD by making test performance relevant to their stereotyped identity. However, the induction may also have activated participants with ADHD to put more effort into their performance and to take the test more seriously than participants without ADHD, for whom the testing situation may not have generated the same level of motivation or effort to perform well. In this case, the stereotype threat induction may actually have worked in the favor of participants with ADHD. There is some previous stereotype threat research suggesting that stereotype threat may be more likely to occur in situations with more subtle stereotype-related cues, and that situations that are overly explicit may produce a different response, termed *stereotype reactance*, that may actually result in enhanced performance by motivating individuals to prove the stereotype wrong.[73] It is possible that in attempting to create a strong manipulation, the stereotype threat induction in the current study was too explicit, resulting in conscious efforts by participants to disprove ADHD-based stereotypes, rather than allowing the more subtle, subconscious mechanisms of stereotype threat to unfold. Interestingly, the one previous study examining stereotype threat in ADHD, which did find an impact consistent with stereotype threat, induced threat by having participants complete an ADHD symptom checklist prior to testing,[33] which was likely more subtle than the present study's stereotype threat manipulation, and may help explain the inconsistent findings of the present study.

Aim 2: **Moderators of the relationship between stereotype threat and test performance**

Aim 2 of the present study sought to explore potential moderators of the relationship between stereotype threat and test performance, in order to understand factors that contribute to vulnerability and/or resilience to the impact of stereotype threat. Previous stereotype threat literature suggests individuals with lower self-efficacy for stereotype relevant tasks, who are

more aware of the stereotypes associated with their identity, and who identify more strongly with the stereotyped group, are more vulnerable to the impact of stereotype threat on task performance.[39] However, results of the present study indicate no significant moderation effects for these variables. There was a significant main effect of academic self-efficacy on GRE test performance, whereby individuals with greater academic self-efficacy at baseline performed better on the GRE test section. However, there was no interaction effect whereby higher academic self-efficacy was protective against the impact of stereotype threat or lower academic self-efficacy made one vulnerable to the impact of stereotype threat on test performance.

Importantly, analyses examining the potential moderating roles of stereotype awareness and identification with the stereotyped group were underpowered, as these analyses included only the ADHD sample. This may have impacted our ability to detect potentially significant relationships. Additionally, the measure for identification with the stereotyped group that was adapted for use in the present study did not have good internal consistency (Cronbach's alpha = .65; likely impacted by this being only a 4-item scale, with 2 items reverse-coded, and used in a small sample),[74] which reduces confidence that the items of the scale captured a unitary construct. Interestingly, correlational data from the present study suggests both of these proposed moderating variables were related to proposed mediating variables of the relationship between stereotype threat and GRE test performance. Specifically, greater identification with ADHD was associated with greater state anxiety during test administration, and greater awareness of ADHD-related stereotypes was associated both with greater state anxiety and with greater performance avoidance goals during test administration. Additionally, correlational data suggests that individuals with greater ADHD symptom severity tended to identify more strongly with ADHD as part of their identity. As it is likely that students with ADHD who are able to attend college

experience less severe symptoms and/or less impairment than the general population of individuals with ADHD,[7] college students with ADHD may perceive their identity as it relates to ADHD differently than the larger population of individuals with ADHD. This may impact their susceptibility to stereotype threat. It is possible that a more symptomatic sample that identifies more strongly with ADHD may be more vulnerable to the impact of stereotype threat.

The present study also examined two potential moderators not examined in previous studies – GPA and processing speed. It was hypothesized that individuals with higher GPA's may be less vulnerable to the impact of stereotype threat, operating similarly to academic self-efficacy. It was hypothesized that individuals with slower processing speed may be more vulnerable to the impact of stereotype threat in the present study, as the stereotype threat induction here was based on need for extended time accommodations, potentially making it more salient for individuals with slower processing for whom extended time accommodations are more relevant. Aim 2 results indicate no significant moderation effects with GPA or processing speed, suggesting the relationship between stereotype threat condition and GRE test performance did not differ based on participants' GPA or processing speed. It is interesting that there was no main effect of GPA on GRE test performance in the present study either, as GPA has been found to predict GRE performance in past research.[75] Once again, this could suggest that participants may not have extended the same level of effort into test performance in the context of this study compared to true high-stakes testing situations.

Aim 3: Mediators of the relationship between stereotype threat and test performance

Aim 3 of the present study sought to examine potential mediators of the relationship between stereotype threat and test performance, in order to understand the mechanism(s) by which stereotype threat impacts test performance. Previous stereotype threat literature has

identified increased anxiety, adoption of performance avoidance goals, and reduced working memory capacity as mediators of the relationship between stereotype threat and test performance.[39] The present study examined each of these variables as potential mediators, and sought to address a gap in the previous literature by utilizing a physiological measure of anxiety.[41] However, results of the path analysis conducted for Aim 3 revealed no significant direct effect from stereotype threat condition to GRE test performance, and no significant indirect effects through any of these proposed mediators. The only significant relationships in the path model were significant relationships between trait anxiety and performance avoidance goals both at baseline and at the time of testing, and between physiological anxiety and performance avoidance goals at the time of testing for participants with ADHD. This suggests that anxiety is related to the adoption of performance avoidance goals, as would be expected;[45] however, neither anxiety nor performance avoidance goals were significantly associated with GRE test performance. Again, this suggests that the stereotype threat induction may not have been successful, as it did not result in expected changes in proposed mediating variables or in expected changes in test performance. Alternatively, it might suggest that individuals with ADHD do not experience or react to stereotype threat in the same way that individuals with other stereotyped identities do.

Implications.

While the present study did not find evidence for a stereotype threat effect based on testing accommodations for students with ADHD, it also does not necessarily provide support for the alternative – that stereotype threat has no effect for these students. Thus, psychologists and schools should continue to proceed with caution in recommending and providing such accommodations to students with ADHD until future research can shed further light on this

issue. Providers and educators should be aware of and consider the potential impact of stigma when making recommendations and/or serving students with ADHD, as there is literature suggesting that some students with ADHD do feel singled out and stigmatized in the process of acquiring and utilizing accommodations such as extended time for testing or a separate testing environment.[25-27] In general, applying a universal design approach to the provision of academic accommodations may be most beneficial for increasing access while also reducing the stigma associated with different learning needs.[76-77] Additionally, given that the only significant predictor of GRE test performance in the present study was academic self-efficacy, this may be a valuable point for intervention. Academic self-efficacy has been found to predict academic performance above and beyond previous academic achievement and ability.[78] Thus, promoting academic self-efficacy broadly may be beneficial for promoting academic resilience and achievement for students with ADHD, whether or not stereotype threat is at play.

Limitations.

The present study has several limitations worth noting. First, recruitment of college students with ADHD proved challenging, and led to a smaller sample size than required to have sufficient power for several of the statistical analyses conducted in the present study. Specifically, the moderation analyses examining identification with the stereotyped group and awareness of ADHD-based stereotypes, as well as the path analysis examining potential mediators of the relationship between stereotype threat and GRE test performance, which included only the ADHD sample, were underpowered. Additionally, despite having a sufficient total sample size, the power for Aim 1 was negatively impacted by unequal group sizes. Low power may have reduced our ability to detect potentially significant relationships between variables. Future research in this area should certainly seek to recruit a larger sample of students

with ADHD. Conducting an ADHD-only study may also have helped with statistical power and allowed the research team to put more resources and effort into recruitment of participants with ADHD; however, this would have meant it was not possible to compare the impact of the stereotype threat induction on participants with ADHD to participants without ADHD to determine whether the effect was only present for the ADHD group. Also of note, a priori power analyses were conducted utilizing effect sizes based on effects found in previous stereotype threat studies; however, these studies examined stereotype threat in different populations than the current study was examining. Thus, it likely would have been more prudent to assume a smaller effect size, given that estimated effect sizes for stereotype threat differ across populations,[34] and may have been different for the population examined here (i.e., college students with ADHD).

Another notable limitation is that the present study did not include a manipulation check to verify that the stereotype threat induction had the intended effect on participants, relying on the dependent variable of GRE test performance to determine the success of the manipulation. Future research should include a manipulation check in order to determine whether stereotype threat was successfully induced independently of how stereotype threat may impact test performance. Additionally, while ADHD medication use was not significantly associated with GRE test performance in the present study, future studies should consider including a stimulant wash-out period prior to testing in order to ensure that medication use does not interfere or muddy potential relationships between constructs of interest.

Importantly, the present study's procedures were modified in order to conduct this research safely during the COVID-19 pandemic. Thus, all measures and tasks were administered virtually, and most importantly, the GRE testing simulation took place virtually as well rather than in-person. While procedures were developed to maintain some of the characteristics of a

true in-person testing situation (e.g., use of trained confederates), it is possible that virtual testing, in which participants were not in the same room together, often completing testing from the comfort of their dorm rooms, impacted the testing environment in a way that was less conducive to inducing stereotype threat.

In attempting to create a strong stereotype threat manipulation, the present study incorporated multiple components in its' stereotype threat induction, which may ultimately have made the threat too explicit and too complex, making it difficult to determine if any one incorporated component may have had an effect. Future research should seek to address this limitation by examining the impact of these simple components separately. For example, the statement about the test being diagnostic of ability, the statement about students with ADHD performing worse than students without ADHD on the GRE, the statement that students with ADHD would receive extended time accommodations, and even the presence of confederates, might be examined separately to determine the unique contributions that each component may or may not have to the experience of stereotype threat.

Finally, although previous stereotype threat research has used the GRE as the performance domain of interest, it is possible that GRE test performance was not relevant or important enough to the present sample of undergraduate students to activate stereotype threat, especially given the large number of first-year students in the ADHD group. Future research may benefit from recruiting from a pool of students who are actually planning to take the GRE in order to apply to graduate school, and who may be interested in participating in a practice test. This would likely provide stronger motivation, elicit greater effort, and would have the potential to be more threatening to participants.

Future Directions.

Although evidence for ADHD-based stereotype threat was not found in the present study, additional research addressing the limitations of the current study and examining this construct in different situations is warranted. One important direction for future research would be to further explore the concept of stereotype reactance,[73] and whether this might explain the lack of significant findings regarding ADHD-based stereotype threat in the present study. This could be examined by designing a study that compares the impact of different stereotype threat inductions that vary in terms of how subtle versus explicit they are. The stereotype reactance hypothesis suggests that a more explicit induction could result in enhanced test performance, because it might lead to conscious efforts to disprove the stereotype, while a more subtle induction would result in reduced performance, because it might lead to subconscious processes that undermine performance, such as those that have been found to mediate the impact of stereotype threat in previous studies (e.g., increased anxiety, reduced working memory capacity).[39] This is also an important next step, given that the stereotype-related cues students with ADHD actually receive in real academic testing situations are likely to be more subtle in nature. Understanding the impact of subtle cues that students actually receive in real academic testing situations is important for understanding the everyday experiences of students with ADHD in academic settings and determining how best to support these students.

Another direction for future research might seek to better understand the relationship between anxiety and performance avoidance goals in the context of academic achievement, as this could provide insight into possible points of intervention to promote more adaptive goal orientations and academic achievement among students with ADHD. Although neither anxiety nor performance avoidance goals were associated with reduced GRE test performance in the

present study, past research suggests that performance avoidance goals are associated with maladaptive learning strategies.[46] Thus, better understanding how such goals are developed by students with ADHD, and how anxiety might play a role in this, could be beneficial for promoting their academic success.

Future research should also seek to examine the potential impact of stereotype threat on younger students with ADHD. This is important because students with ADHD are at-risk for poor academic performance throughout their school careers, which precludes college attendance for many individuals with ADHD altogether.[12] Thus, understanding how current academic accommodation practices are impacting younger students with ADHD is important for promoting academic success and other positive developmental outcomes. This is also an important direction for future research, as it is possible that younger students with ADHD may have some characteristics that could make them more susceptible to the impact of stereotype threat. Namely, previous stereotype threat research suggests that individuals who identify more strongly with the stereotyped group are more likely to experience stereotype threat,[39] and in the present study, participants with greater ADHD symptom severity were found to identify more strongly with the stereotyped group. Given that the population of individuals with ADHD who attend college are likely less symptomatic compared to the general population of individuals with ADHD who attend high school, future research examining stereotype threat in a younger student population may produce different results.

Ultimately, future research should aim to develop and examine less stigmatizing methods of providing school-based services to students with ADHD, in order to promote their academic success and well-being without potential inadvertent negative consequences.

Table 1.

Participant Demographics and Descriptive Data for Major Variables of Interest

Demographics	ADHD (N = 41)	Non-ADHD (N = 127)	Hedges' g
Age (mean(SD))	19.7	20.1	0.28
Gender (% female)	56%	86%***	
Race/Ethnicity (% white non-Hispanic)	77%	50%**	
Year in School (% freshman)	42%	9%***	
(% sophomore)	20%	26%	
(% junior)	22%	34%	
(% senior)	13%	29%	
(% 5th year)	3%	2%	
Learning Disability	34%	6%***	
Anxiety	51%	24%**	
Depression	39%	16%**	
ADHD medication (% current use)	40%	---	
(% past use)	40%	---	
Academic Accommodations	73%	20%***	
(% extended time)	71%	11%***	
(% separate testing location)	51%	5%***	
Parent Education (% less than HS)	2%	1%	
(% HS diploma/GED)	2%	9%	
(% some college)	2%	5%	
(% associates degree)	0%	4%	
(% bachelors degree)	37%	31%	
(% graduate degree)	57%	50%	
Baseline Measures			
MLSQ academic self-efficacy	35.0 (8.2)	34.0 (7.1)	0.14
AGQ performance approach goals	20.6 (10.0)	23.1 (8.0)	-0.29
AGQ mastery goals	28.4 (5.8)	28.7 (5.3)	-0.07
AGQ performance avoidance goals	26.5 (7.0)	27.0 (6.5)	-0.08
STAI trait anxiety	29.7 (10.4)	26.9 (9.2)	0.30
ASRS total ADHD symptoms	43.4 (10.5)	28.9 (8.5)***	1.60
Corsi working memory	61.1 (18.2)	59.5 (21.2)	-0.08
Symbol-Digit processing speed	62.0 (18.0)	65.0 (16.8)	0.18
GPA z-score	-0.3 (1.3)	0.1 (0.9)	-0.42
CSEI identification with stereotyped group	8.4 (3.6)	---	
SCQ stereotype awareness	21.4 (11.4)	---	

Potential Mediating Variables			
Worry-Emotionality scale	17.3 (8.8)	17.3 (7.2)	0.01
Heart Rate Variability (LF/HF)	2.2 (1.6)	1.9 (1.1)	-0.24
Adapted AGQ performance avoidance goals	20.6 (13.0)	22.9 (10.0)	-0.24
Corsi working memory	67.1 (23.7)	69.3 (24.3)	0.09
Outcomes			
GRE total items correct	11.5 (7.2)	10.4 (5.5)	0.18
GRE total items attempted	37.4 (8.8)	38.2 (8.0)	0.10
GRE total correct / total attempted	0.32 (0.18)	0.28 (0.14)	-0.25
Perceptions of Testing Situation			
Realistic-ness of testing (% not at all/ not very)	28%	31%	
(% somewhat/ very)	72%	69%	
Stressfulness of testing (% not at all/ not very)	29%	35%	
(% somewhat/ very)	71%	65%	
Perceived % of items answered correctly	41.8 (23.0)	36.3 (18.8)	

Note: *** $p < .001$, ** $p < .01$, * $p < .05$

Table 2. *Correlation Matrix with Total Sample*

	MSLQ	GPA	CSEI	SCQ	Symbol-Digit	AGQ_Pap	AGQ_Mas	AGQ_Pav	STAI	ASRS	Corsi Block 1	WES	AAGQ_Pap	AAQG_Pav	Corsi Block 2	HRV
GPA	.159*	--														
CSEI	.078	-.011	--													
SCQ	-.035	.210	.244	--												
Symbol-Digit	.035	.107	-.027	.020	--											
AGQ_Pap	.256***	.310***	.070	.081	.090	--										
AGQ_Mas	.566***	-.055	.050	-.044	.052	.263***	--									
AGQ_Pav	-.068	.007	.231	-.114	.074	.322***	.146	--								
STAI	-.307***	-.040	.108	.217	.058	.024	-.127	.398***	--							
ASRS	.018	-.079	.452**	.221	-.022	-.011	-.098	.055	.305***	--						
Corsi Block 1	-.023	-.027	-.091	-.272	.285***	-.034	.035	.018	.139	.122	--					
WES	-.093	.111	.334*	.434**	.115	.009	-.079	.266**	.440***	.060	-.083	--				
AAGQ_Pap	.039	.146	.404*	.554**	.038	.438***	.046	.160	.235**	.039	-.010	.483***	--			
AAGQ_Pav	-.043	.128	.321	.497**	.125	.139	-.008	.391***	.356***	-.031	-.024	.683***	.599***	--		
Corsi Block 2	.034	.186*	-.122	-.007	.299***	.028	.035	-.054	.111	.043	.417***	-.038	.021	-.041	--	
HRV	-.202	.009	-.349	-.011	.116	.000	-.203	-.082	.183	.087	-.152	.302*	.072	.174	.114	--
GRE	.250**	.120	.145	-.014	.028	.118	.040	-.111	.034	.096	.003	-.011	.204*	.004	.051	-.149

Note: *** $p < .001$, ** $p < .01$, * $p < .05$.

Acronyms: MSLQ = Motivated Strategies for Learning Questionnaire (baseline measure of academic self-efficacy); GPA = Grade Point Average; CSEI = Collective Self-Esteem Identity subscale (baseline measure of importance of ADHD to once's identity); SCQ = Stigma Consciousness Questionnaire (baseline measure of awareness of stigma/stereotypes associated with ADHD); Symbol-Digit = Symbol Digit Coding Task performance (baseline measure of processing speed); AGQ-Pap = Achievement Goal Questionnaire – Performance Approach subscale (baseline measure of performance approach goals); AGQ-Pav = Achievement Goal Questionnaire – Performance Avoidance subscale (baseline measure of performance avoidance goals); AGQ-Mas = Achievement Goal Questionnaire – Mastery subscale (baseline measure of mastery goals); STAI = State-Trait Anxiety Inventory – Trait subscale (baseline measure of trait anxiety); ASRS = Adult ADHD Self-Report Scale (baseline measure of ADHD symptoms); Corsi Block 1 = baseline Corsi Block Task Performance (baseline measure of working memory); WES = Worry-Emotionality Scale (measure of state anxiety at time of testing); AAGQ-Pap = Adapted Achievement Goal Questionnaire – Performance Approach subscale (measure of performance approach goals at the time of testing); AAGQ-Pav = Adapted Achievement Goal Questionnaire – Performance Avoidance subscale (measure of performance avoidance goals at the time of testing); Corsi Block 2 = Corsi Block Task Performance (measure of working memory at the time of testing); HRV = Heart Rate Variability (measure of physiological anxiety at the time of testing, captured by LF/HF ratio); GRE = GRE test performance as measured by total number of items answered correctly (primary outcome variable of interest).

Table 3.

ANOVA table for two-way ANOVA examining impact of ADHD status and Stereotype Threat

condition on GRE test performance.

Predictor	Sum of Squares	df	Mean Square	F	p	Partial eta squared
Intercept	14647.06	3	14647.06	408.27	< .001	.720
ST	25.12	1	25.12	0.70	.40	.004
ADHD	32.39	1	32.39	0.90	.34	.006
ST * ADHD	3.56	1	3.56	0.10	.75	.001
Error	5704.32	159	35.88			

Note. ST = Stereotype Threat

Table 4.

Correlations between Path Model Variables in ADHD-only Sample

	1	2	3	4	5	6	7
1. Stereotype Threat (condition)	--						
2. Performance Avoidance Goals (baseline)	-.091	--					
3. Trait Anxiety (baseline)	.211	**.541****	--				
4. Working Memory (baseline)	.179	.013	-.068	--			
5. Performance Avoidance Goals (mediator)	-.147	**.502****	**.537****	.015	--		
6. Working Memory (mediator)	.159	-.012	-.006	.228	.123	--	
7. Physiological Anxiety (mediator)	.176	-.494	.021	-.372	.198	.099	--
8. GRE test performance (outcome)	.088	.074	.164	.199	-.020	.461	-.381

Note: *** $p < .001$, ** $p < .01$, * $p < .05$.

Table 5.

Path Model of the Mediation of the Relationship between Stereotype Threat and GRE Test

Performance

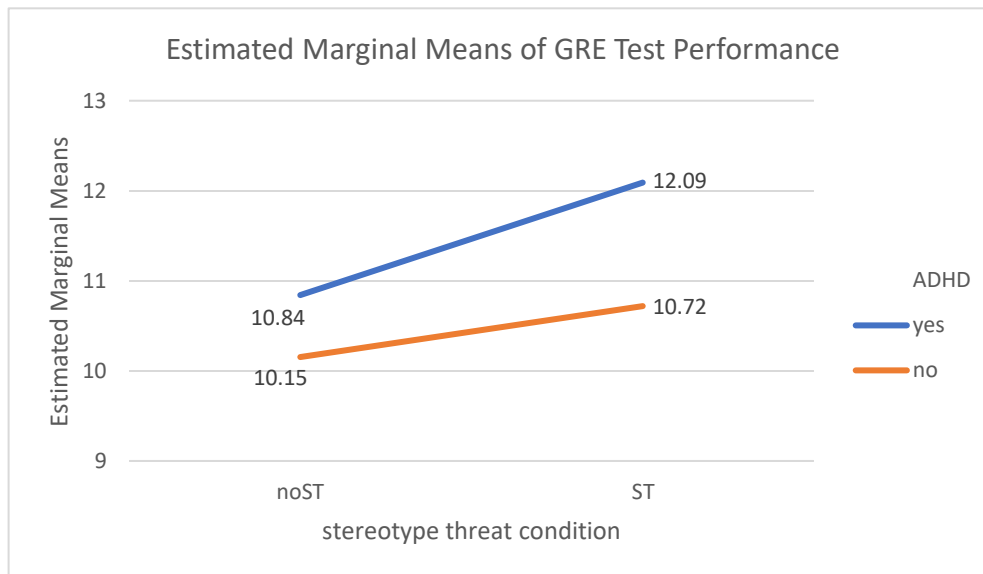| Mediator	Indirect Effect	95% CI of indirect effect[a]	Direct Effect	Total Effect[b]	Proportion Mediated
Performance Avoidance Goals	-1.13	-9.70, 1.92	1.82	2.95	38%
Physiological Anxiety (HRV)	-1.65	-14.05, 3.03	1.82	3.47	48%
Working Memory Capacity	1.03	-1.55, 6.64	1.82	2.85	36%

Note. N = 41. All estimates are unstandardized. Confidence Intervals (CI) were obtained from 10,000 bias-corrected bootstrapped samples. Baseline anxiety, working memory, and performance avoidance goals were accounted for in this model.
[a] 95% confidence interval generated from 10,000 bias-corrected bootstrapped samples.
[b] Total effects were calculated by summing the absolute values of the indirect and direct effects.

Figure 1.

Visual representation of two-way ANOVA findings.

Estimated Marginal Means of GRE Test Performance

Y-axis: Estimated Marginal Means (9, 10, 11, 12, 13)
X-axis: stereotype threat condition (noST, ST)
Legend: ADHD — yes (blue), no (orange)
Data labels: 10.84, 12.09, 10.15, 10.72

Figure 2.

Path Diagram for Mediation Model with Performance Avoidance Goals, Physiological Anxiety,

and Working Memory Capacity Mediating the Relationship between Stereotype Threat and GRE
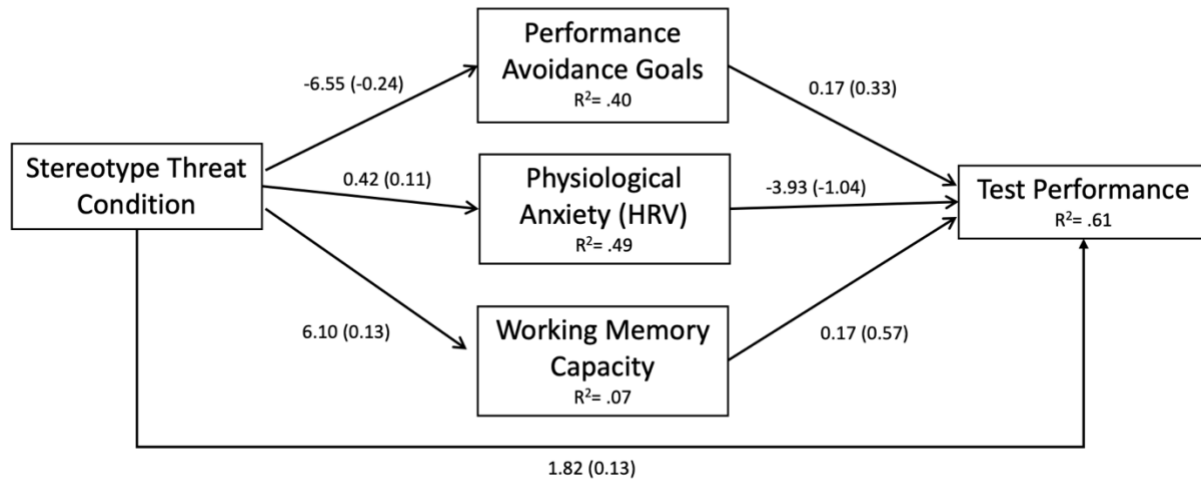
Note. Unstandardized coefficients are presented, with standardized coefficients in parentheses. All coefficients were obtained from a fully saturated path model with N = 41, df = 0. Baseline measures of anxiety, performance avoidance goals, and working memory capacity were accounted for as covariates within this model (covariate paths are not shown in the diagram for simplicity). Correlations among the three mediating variables were estimated (correlation paths are not shown for simplicity).

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