ADHD Symptomatology, Self-Regulated Learning and Academic Performance in First-Year Psychology Students

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Abstract

Young adults that transition from school to a more independent and less structured life at university can struggle with these new changes. For university students with Attention-deficit/hyperactivity disorder (ADHD) this transition is even further hampered due to the executive function problems and poor self-regulation that can impede effective learning and successful performance at the university. Research shows that high ADHD symptomatology leads to worse self-regulated learning strategies and lower performance seen in lower grade-point averages (GPA). It is crucial to know what factors of self-regulated learning are affected to create possible interventions, therefore we investigated the relationship between ADHD symptomatology, self-regulated learning strategies and GPA. Our sample consists of first-year psychology students (N = 215) who completed online questionnaires. Results showed that students with high ADHD symptomatology had lower self-regulation, lower intrinsic goal orientation, higher test anxiety and received lower grades. Worse self-regulated learning was not related to the outcome of higher GPA. I conclude that high ADHD symptomatology negatively impacts on self-regulated learning strategies and performance of the students.

Keywords: ADHD, self-regulated learning, academic performance, university students

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a well-researched disorder manifesting in early childhood including hyperactive symptoms, impulsivity and attention deficits as defined in the DSM-5 (American Psychiatric Association, 2013). Most research is being done on children with ADHD as prevalence rates in children reach from 1,5% in up to over 7% around the world (Magnin & Maurs, 2017). Symptoms of the disorder persist well into adulthood for a high proportion of people as was found to be up to 85% (Lieshout et al., 2016) and research in the past decades revealed a considerable amount of information about the expression of ADHD in adulthood. Emerging adults who are in the process of the transition from adolescence to adulthood and decide to pursue studies in the university context are susceptible to the negative effects of ADHD (Lefler et al., 2021). Despite the mounting problems that are observed in university students with ADHD, little research has been conducted consequently leaving ADHD expression and consequences less well understood for this population. The deficits associated with ADHD can become very problematic for young adults transitioning from school to a much more independent and less-structured everyday life in university and the independent and intensive learning accompanied by this change (Fleming & McMahon, 2012). Research shows that students with ADHD often perform less well in university than their peers and are more likely to engage in risky behavior (Nugent & Smart, 2014). Moreover, it was shown that intelligence does not protect individuals with ADHD from the adverse effects associated with ADHD on several life domains including social, academic and vocational pursuits (Antshel et al. 2009). Referring to the dimensional view of ADHD, high ADHD symptomatology that does not reach the threshold for diagnosis, can still contribute to poor functioning and impairment in several life domains in college students with symptoms of ADHD (Hartung et al., 2019).

ADHD as a Neurodevelopmental Disorder

The neurodevelopmental roots for ADHD are now well-recognized and well documented in research and constitute the basis for lower self-regulation due to a higher focus on the temporal now rather than the past or future (Barkley, 1997). Self-regulation is closely linked to executive functions which are necessary for effective planning and organization, skills that are relevant for successful academic performance. In college students the self-regulatory skills are firstly compromised because of lower executive functioning due to ADHD as well as not yet fully matured executive functions and motivational systems necessary for delaying rewards for example (Fleming & McMahon, 2012). Although these deficiencies contribute to the poor outcomes for university students with ADHD it was found that high executive functioning does not protect students from the detrimental impact of ADHD symptoms on academic performance (Dorr & Armstrong, 2019).

The Effects of High ADHD Symptomatology on Academic Performance

Numerous studies highlight the difficulties college students with ADHD demonstrate relating to academic performance (Frazier et al., 2007). For example, previous research shows that students who have this disorder achieve lower grade-point averages (GPA) and demonstrate higher withdrawal from classes even when study habits do not differ much from average students (Advokat et al., 2011). Examples of study habits included hours studied per week, credits collected for a semester, reading relevant literature before class or reviewing own notes. Moreover, students with ADHD were shown to exhibit higher school disengagement such as skipping classes or not completing homework and experienced more emotional difficulties such as feeling overwhelmed or depressed than their peers (DuPaul et al. 2017). Additionally, previous research showed that students with ADHD preferred a surface rather than a deep study approach as well as a surface motive relating to learning because the student is afraid to fail (Simon-Dack et al. 2016). The students with higher ADHD symptomatology were less likely to engage in collaborative studying with their peers

precluding these students from possible positive experiences in the academic setting as well as important information exchange. These findings highlight the notion that while study habits generally only differ in some aspects and are overall comparable to students without ADHD, less effective learning strategies are applied by students that have ADHD. The study by Reaser et al. (2007) demonstrated that students with ADHD have problems with self-regulation and generally adopt relatively inefficient learning strategies. For the first comparison students with ADHD were compared to students without any disorder. Although the study attitude to do well in university as well as the use of study aids by students with ADHD was similar to that of other students, there were several domains in which differences emerged which include worse time management and concentration, lower motivation and higher anxiety. The researchers also compared students with ADHD to students with learning disabilities (LD) and found that students with ADHD had poorer time management, worse concentration and less self-regulation than students with LD. The findings support the conception that students with ADHD face a number of challenges in the academic setting which are to some extent similar to those of students with LD.

Self-Regulation and Self-Regulated Learning in ADHD

To understand why students with ADHD academically do not perform as well as their peers, several explanations have been presented, one of which concerns the difficulties in self-regulation seen in ADHD independent of age. Due to the difficulties individuals with ADHD including university students with ADHD experience in self-regulating themselves, self-regulative resources related to effective learning are also reduced. As one of the domains of self-regulation theory, self-regulated learning refers to cognitive and metacognitive strategies applied by the individual as well as the motivation to regulate and successfully adjust their behavior to effectively deal with educational material and situations (Pintrich, 1991, 1995). This means that less effective cognitive strategies, relating to factors such as organization and

due to deficient meta-cognition also less effective meta-cognitive strategies, are applied by individuals with ADHD (Butzbach et al. 2021a).

Cognitive strategies include organization, time management, and planning (OTMP) which are also targeted skills of training interventions for students with ADHD (LaCount et al., 2018). Research demonstrates that university students with ADHD experience difficulties in applying these strategies effectively. As previously mentioned, the study by Reaser et al. (2007) revealed that students with ADHD have great difficulties in managing their time properly. Additionally, a study by Weyandt et al. (2013) investigated the differences between university students with and without ADHD concerning various factors including study related organizational skills. On the self-report measures students with ADHD indicated a significant deficiency in planning, organization skills, metacognition, response inhibition, emotional control and self-monitoring in comparison to students without the disorder. These factors are crucial for successful performance as well, consequently students in the ADHD group also received lower grades.

Meta-cognitive self-regulation is comprised of regulation and monitoring. Previous research shows that students with ADHD can display difficulties with each of these processes due to attention and executive functions deficits associated with the disorder. For instance, one study investigated the differences in error monitoring in college students with ADHD compared to students without by using measures of an EEG, a behavioral measure of reaction time and self-reported performance monitoring (Chang et al., 2009). The researchers found that the students had comparable error recognition but lower error processing. This indicates reduced preconscious awareness while actively making an error compared to the control group, as measured by EEG activity. Furthermore, scores on a self-report measure of performance monitoring including self-monitoring and task-monitoring were significantly higher for ADHD students, indicating daily-life struggles of performance monitoring for this

group. The behavioral measure indicated slower reaction times to maintain a correct response for students that have ADHD and also higher reaction time variability which is associated with a lower efficiency to deploy attention. Meta-cognition towards attention was found to be reduced in adults with ADHD as well as regulation of cognition which makes it more difficult to reflect on their cognitive performance (Butzbach et al. 2021b). In this sense they may overestimate their abilities and also overreport their symptoms due to lower insights into their cognitive functioning.

Motivation and Test Anxiety in Students with ADHD

As the third factor of self-regulated learning strategies motivation was found to be a compromised resource in students with ADHD. More specifically, important components of motivation such as lower self-efficacy and test anxiety are often observed in students with ADHD (Newark et al., 2016; Dan & Raz, 2015). Self-efficacy is one of the core components of social cognitive theory (Bandura, 1977) and a core concept of human motivation associated with successful performance in the job as well as in educational settings. It refers to the individuals' beliefs in their own ability and skills to do things well and effectively deal with stressful situations. Resources for a high sense of self-efficacy are often reduced in students with ADHD due to past difficulties or failures that arise in the educational context already in the first school years (Newark et al., 2016). Furthermore, inadequate coping styles that result in avoidance and procrastination only reinforce the beliefs that these individuals have about themselves and prevents self-efficacy enhancing possibilities. Supporting these outcomes, a considerable number of studies show that students with ADHD as well as students who are high in ADHD symptomatology regardless of diagnosis show lower self-efficacy (Schmidt-Barad et al., 2021). Additionally, higher self-efficacy was shown to be associated with higher GPA in students with ADHD in several studies (Stevens et al., 2022).

While high self-efficacy can be a valuable resource for university students with ADHD, poor self-efficacy is negatively related to performance and is often closely related to and found in combination with high test anxiety. An often-occurring comorbidity in ADHD is anxiety and symptoms of these two disorders partly overlap and are also generally highly prevalent among college students (Lefler et al., 2021). Lifetime history of anxiety disorders was found to be two times more likely in students with ADHD and this population is also at higher risk for developing anxiety symptoms in comparison to students who do not have the disorder (O'Rourke at al., 2020). Therefore, it is not surprising that students with ADHD show higher levels of test anxiety compared to their peers and consequently also receive lower grades. A considerable amount of research demonstrates the prevalence of test anxiety in students with ADHD. For example, previous research found that while study habits did not differ subjectively nor objectively for ADHD students compared to those without ADHD, the former felt less prepared for tests, showed significantly higher levels of test anxiety and also had a lower GPA (Lindstrom et al., 2020). Additionally, another study looked at each subcomponent of a test anxiety taxonomy which include a cognitive hindrance of cognitive performance while testing, social derogation fearing the judgment of others if tests are failed and tenseness such as physical or emotional arousal (Dan & Raz, 2015). The researchers found that students with ADHD exhibit greater levels of test anxiety on each of those subcomponents compared to students without the disorder. It is still disputed how test anxiety exerts influence on academic achievement particularly in students with ADHD who despite objectively demonstrating similar study habits were found to be subjectively less prepared or feel that they perform worse. Nevertheless, it is without question that test anxiety hinders optimal performance.

Research on self-regulated learning in relation to ADHD is relatively sparse which makes more research a necessity, contributing to an understanding of consequential self-

regulated learning factors in ADHD associated with lower performance in university. For the current study, three research questions are asked. The first research question is whether there is a relationship between ADHD symptomatology and academic performance. Based on the literature, I formulate my first hypothesis such as that higher ADHD symptomatology is related to lower academic performance reflected in GPA (H1).

The second research question aims to understand the relationship between ADHD symptomology and self-regulated learning overall as well as specific components. Consequently, I hypothesize that higher ADHD symptomatology is related to worse self-regulated learning strategies (H2).

My third research question is whether less self-regulated learners with high ADHD symptomatology perform worse in university. Therefore, I hypothesize that worse self-regulated learning strategies are related to lower academic performance, meaning lower grades (H3) and that high ADHD symptomatology is related to lower GPA which is at least partly explained by worse self-regulated learning strategies (H4).

In order to find self-regulated leaning strategies that are most important for successful performance in the university we will measure factors of the MSLQ that were supported in the literature also in relation to ADHD. These include self-efficacy, self-regulation, effort regulation and test anxiety.

Methods

Participants

This study initially included N = 451 participants which lead to a total of N = 215 participants after data cleaning of which 156 are female and 59 male (as documented on their original birth certificate). The mean age of our sample is M_{Age} = 19.68 years (*SD* = 1.86) and an age range from 18-29 years. All participants were first-year students of either the Dutch or English bachelor psychology program of the University of Groningen (UG). A majority of the

respondents had Dutch (*n* = 111) or German (*n* = 67) as their first language. Other first languages included English (*n*= 8), French (*n*= 3) or Polish (*n* = 2), for example. Few students indicated a diagnosis of ADHD (*n* = 3) who also take medication for ADHD. Beside these students, some had other previous diagnoses such as anxiety, depression or other (*n* = 25). Participation was voluntary and was compensated with credits necessary for completion of a course of the program.

Data cleaning was done to each dataset of the two questionnaires separately before merging the datasets. A detailed description of the procedure for exclusion of the participants can be found in the Appendix (Appendix A).

This research was approved by the Ethical Committee of Psychology from the Faculty of Behavioural and Social Sciences at the University of Groningen (2021-s-0054).

Measures

Respondents of our final sample completed two questionnaires. One that measures ADHD symptomatology and another one that measures learning strategies and motivation as well as the student's adjustment to college and executive functioning. Lastly, they were asked for consent to request their grades collected throughout the year from the student administration.

ADHD Symptomatology

ADHD symptomatology was assessed by using the Conners' Adult ADHD Rating Scales (CAARS) by Conners et al. (1999) which is a standard measure for ADHD symptomatology in adults and is used for screening purposes as well. It is a self-report questionnaire composed of 66 items assessing different dimensions of ADHD symptoms including inattention/memory problems, hyperactivity/restlessness, impulsivity/emotional lability and problems with self-concept. Subscales for symptoms based on the DSM-IV classification of ADHD and an overall ADHD index as well as an inconsistency index are

also included, embedded within these 66 items. An additional 12 items are used for calculation of an infrequency index (Suhr et al. 2011). Respondents had to indicate in what frequency/intensity they experienced statements such as ‘‘I don’t plan ahead‘‘ to measure inattention or ‘‘My moods are unpredictable‘‘ to measure impulsivity. Scoring was done on a 3-point Likert scale ranging from 0= *not at all/never to* 3= *very much/ very frequently*. As can be taken from the CAARS manual, reliability of the questionnaire and its items is overall quite high demonstrating good internal reliability (α =.83 for the ADHD index) and good test-retest reliability (Conners et al., 1999). Additionally, goodness of fit indicates adequate validity for this questionnaire and good sensitivity and specificity (above .7) was found for the ADHD index. Cronbach’s alpha in my dataset indicated acceptable internal consistency α =.79 for the ADHD index.

Self-Regulated Learning Strategies

I assessed self-regulated learning strategies with the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich et al. (1991). This 81 item self-report scale consists of two overall domains which each have one or more subscales. These domains are motivation including self-efficacy and test anxiety and learning strategies which are divided into cognitive and metacognitive strategies scales and resource management strategies scales. Example items include ‘‘I believe I will receive an excellent grade in this class‘‘ for motivation and ‘‘When I become confused about something I’m reading for this class, I go back and try to figure it out‘‘ for metacognitive strategies. All items were answered in the context of one of the first courses of the program ‘Introduction to Psychology’. Items were scored on a 7 -point Likert scale ranging from 1 = *not at all true for me* to 7= *very true of me.* According to the MSLQ manual, the questionnaire demonstrates reasonable predictive and factor validity. Internal reliability values range from .52 up to .93, although most scales show good internal consistency (Pintrich et al. 1991). Cronbach’s alpha in my dataset was overall in

the acceptable range for most subscales between .7 and .8. Some indicated lower internal consistency below .6, which include intrinsic and extrinsic goal orientation. For test anxiety I found a value in the unacceptable range α = .35.

A study by Hilpert at al. (2013) examined the latent factor structure of the MSLQ. Through confirmatory factor analysis, the researchers determined a more parsimonious factor structure which may be useful for this project as well as the new factors are relevant for academic achievement. The new model comprises only 6 of the original 15 subscales which leads to the following structure: The first scale Expectancy consists of self-efficacy and control of learning beliefs. Value constitutes the second scale, including intrinsic goal orientation and task value. Lastly, the third Self-regulation consists of metacognitive self-regulation and effort regulation. In the study of Hilpert at al. (2013) Cronbach's alpha for the factors in these new scales was in the acceptable to excellent range. For example, Cronbach's alpha for control of learning beliefs was α = .79 and for self-efficacy α = .94. In my dataset Cronbach's alpha was in the acceptable range for the first two scales, α = .76 for Expectancy and α = .79 for Value. Cronbach's alpha indicated good internal consistency for Self-regulation (α = .82).

Academic Performance

To assess academic performance, participants were asked to give consent for their grade list to be requested from the student administration including all courses and resits from the first year. The grade list included courses which were evaluated as either pass or fail due to online teaching in times of the COVID-19 pandemic. I excluded these courses from the calculation of GPA which is also common practice of the university. Contrary to common practice, grades from failed courses for which a grade was received were included as this might also be indicative of worse study strategies. Students who only completed a total of three exams for which grades were received, were excluded from the analysis. To determine

the number of exams we looked at the graded courses in the dataset and used the frequency function to determine which students completed less than three exams.

Procedure

Data collection was done prior to this study by a group of bachelor students for the academic years 2020-2021. Students were able to access the study online via the Qualtrics application and received credits necessary for the completion of a mandatory course of the bachelor program. Access and credits were granted by the SONA system and the questionnaires were offered in Qualtrics. Their study consisted of two parts. The first part presented the CAARS and students afterwards were invited to take part in the second part which included the MSLQ. The Student's Adjustment to College Questionnaire (SAQ) as well was the Executive Function Index (EFI) were also part of the study but were not used for our purposes, hence they were excluded in our study. Participants were asked for giving consent and further filled out their demographics such as gender, language and current job and Sona or student numbers. Additionally, they were able to indicate whether they were previously diagnosed with any medical or psychological condition and whether they are currently taking any medication which they could explicitly elaborate on as a comment.

Statistical Analysis Plan

The analysis of our data will include overall descriptive and correlational outcomes as well as multiple regression to investigate the relationships between our constructs ADHD symptomatology, learning strategies and motivation and academic performance (GPA). First correlational information will be obtained. Next, for the first multiple regression analysis self-regulated learning strategies including the scales Expectancy, Value, Self-Regulation, and test anxiety will be used as predictor variables and ADHD symptomatology will function as the outcome variable. I will use a stepwise regression for this analysis. The second analysis will include a stepwise multiple regression as well, with the same self-regulated learning strategies

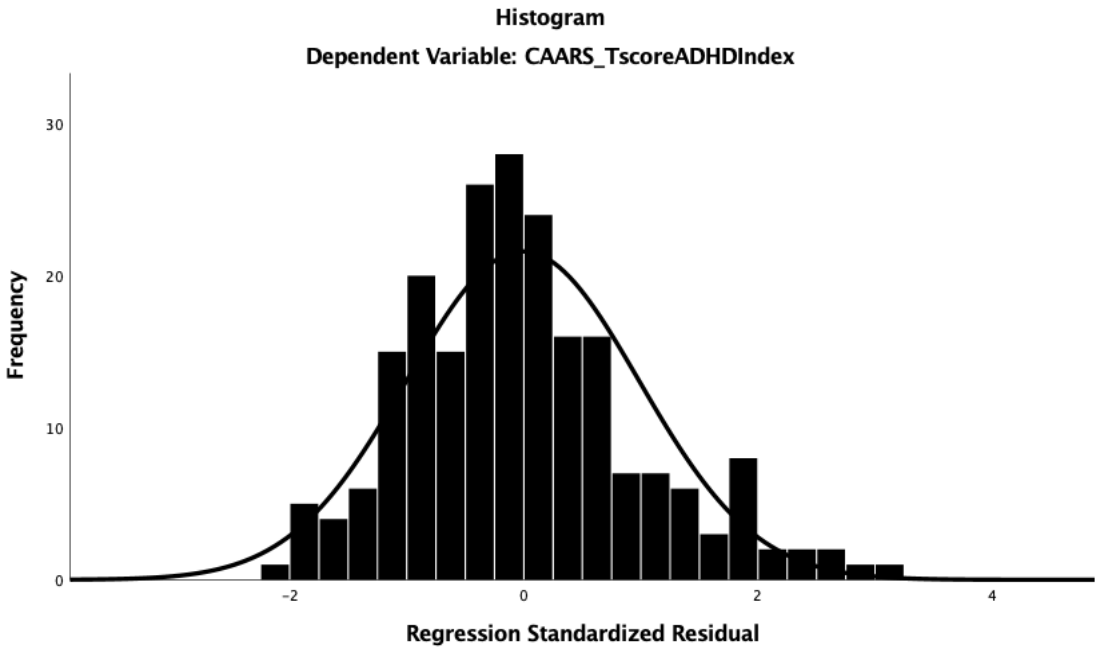
as in the first regression as predictor variables and GPA as the outcome variable. Possibly a mediation analysis will be conducted with ADHD symptomatology as predictor, self-regulated learning strategies as mediator and GPA as the outcome variable. For all statistical tests I will use an alpha level of .05. If outliers are detected, their significance will be evaluated. The analyses will be conducted with SPSS. Assumption checks were completed which do not give any concern to violations (see Appendix B).

Results

As can be taken from the descriptive statistics (see Table 1), ADHD T-scores are in the normal range, based on the CAARS manual. Students differ to some extent on the intensity of ADHD symptomatology as the variation for T-scores is relatively high which means that some students also fall into the range of above and below average (see Figure 1). Conversely, only three students scored in the range of clinically significant ADHD, in this case a T-score of 70 or above. The students who scored in this range indicated a previous diagnosis of ADHD, ADD or that ADHD runs in the family. Means for the MSLQ factors are generally high (above $M = 3.5$) which suggests that students overall perceive themselves to possess good learning strategies. Based on the mean for the factor self-regulation which is the highest out of all MSLQ factors and its high standard deviation it seems that students have overall good self-regulative strategies, but scores vary considerably throughout the sample. Additionally, test anxiety has a high standard deviation but as the mean is relatively low, on average the students in our sample experience low to moderate levels of test anxiety. Students overall achieved good grades as the mean grade can be considered a good pass. Variation for GPA is also relatively high. While most students achieved overall good grades, a considerable number of students also scored close to the cutoff for passing of 5.5.

Figure 1

Distribution of ADHD T-scores



Correlations between the variables can be taken from Table 1 below. ADHD symptomatology is negatively related to all self-regulated learning variables except for test anxiety meaning that the more ADHD symptoms the students have, the worse their self-regulated learning strategies seem to be. MSLQ Expectancy, Value, Self-Regulation and GPA were all negatively related to ADHD symptomatology although correlation to the first variable is not significant. Only test anxiety was positively related to ADHD which is the expected outcome. Self-regulation has the strongest relationship out of the MSLQ factors with ADHD T-scores while Expectancy has the lowest correlation. Lastly, correlations among the MSLQ factors show that Expectancy and Value are highly and negatively correlated. Self-regulation has high correlations with Expectancy and Value which are positive. As expected, ADHD and GPA are negatively related, and this correlation is significant as well although low in strength. This finding supports my first hypothesis (H1). None of the correlations between the MSLQ factors and GPA reached significance, hence hypothesis 3 (H3) is not supported. Correlations for Self-regulation and Expectancy with GPA are positive while Test Anxiety and Value are negatively related to GPA. The direction of the relationships was expected except for Value and GPA.

Table 1

Descriptive Statistics and Pearson correlation coefficient for all constructs

Variable	*n*	*M*	*SD*	1	2	3	4	5	6
1. ADHDT	215	48.56	8.71	-					
2. Expect.	215	4.21	0.57	-.13	-				
3. Value	215	3.92	0.73	-.17*	-.49**	-			
4. Self-reg.	215	4.52	0.88	-.38**	.35**	.45**	-		
5. TA	215	3.31	1.10	.22**	-.21**	-.08	-.10	-	
6. GPA	172	7.39	1.03	-.19*	.03	-.08	.13	-.03	-

Note: ADHDT: ADHD T scores, Expect.: MSLQ Expectancy scale, Value: MSLQ Value Scale, Self-reg.: MSLQ Self-regulation scale, TA: MSLQ Test anxiety, GPA: Grade-Point Average. * indicates p < .05. ** indicates p < .01.

The Relationship between ADHD symptomatology and Self-Regulated Learning Strategies

Based on the outcome of the stepwise multiple regression, self-regulation is the best predictor of ADHD symptomatology b = -3.73, $t(213) = 22.602$, $p < .001$ and it explained a significant proportion of variance explained in ADHD symptomatology, $R^2 = .142$, $p = <.001$. Adding test anxiety lead to a significant increase in explained variance of self-regulated learning strategies on ADHD symptomatology, $R^2 = .174$, $F(2,212) = 22.317$, $p = <.001$. The factors Value and Expectancy did not add any significant increase in variance explained. Based on these findings, Hypothesis 2 is supported.

The Impact of Self-Regulated Learning Strategies on GPA

I did not find support for our Hypothesis 3. Correlations between the MSLQ factors and GPA did not reach the significance threshold of $p = <.05$, hence I do not conduct further analyses.

ADHD Symptomatology Impact in the Relationship between Self-Regulated Learning strategies and GPA

The relationship between MSLQ factors and GPA did not reach significance which makes the use of a mediation model redundant. No further analysis was conducted. I conclude that hypothesis 4 is not supported.

Discussion

The purpose of this study was to get a better understanding of the relationship between high ADHD symptomatology and self-regulated learning strategies as well as academic performance. The first research question concerned the relationship between ADHD symptomatology and academic performance as measured with GPA. The corresponding hypothesis that higher ADHD symptomatology is related lower GPA was supported based on the correlation that was obtained. This outcome is in line with previous literature that generally found students with high ADHD symptomatology to perform worse in university (Advokat et al., 2011; Nugent & Smart, 2014).

The second research question regarding the relationship between ADHD symptomatology and self-regulated learning strategies resulted in the hypothesis that students with high levels of ADHD apply worse self-regulated learning strategies. This hypothesis was supported as ADHD was negatively related to all corresponding MSLQ factors which included the Expectancy, Value and Self-Regulation scale. The correlation with test anxiety was positive. Higher test anxiety is related to higher ADHD symptomatology which translates to worse self-regulated learning strategies as students with high test anxiety are more likely to perform worse, therefore the findings are also in line with the literature (Lindstrom et al., 2020; Reaser et al., 2007).

Results of the stepwise regression supported our hypothesis as well and revealed that self-regulation has the strongest relationship with ADHD T-scores out of all scales for self-

regulated learning strategies. Based on what was presented in the literature review and the properties of ADHD, poorer self-regulation was to be expected for students with higher symptomatology (Fleming & McMahon, 2012). The students who reported poor self-regulation perceive themselves to be worse at adapting their learning strategies when the learning material is confusing or difficult to understand and are more likely to quit learning because the material is not interesting to them. Test anxiety was the only variable that explained a significant amount of variance when added to the model while Value and Expectancy did not add any significant change in variance explained. Students with higher ADHD symptomatology reportedly feel more anxious before exams or are more afraid of failing the exams.

Nonetheless, it does not correspond to the findings that were presented in the literature review which emphasize that poorer self-efficacy, which is part of the Expectancy scale, is related to higher ADHD symptomatology in university students (Schmidt-Barad et al., 2021). It needs to be pointed out that self-efficacy in the referred study was measured with a short scale assessing general self-efficacy. The MSLQ measures self-efficacy for learning and performance which asks questions relating specifically to one course, which may not be particularly low while general self-efficacy may be. This can partly explain the unexpected finding. Another explanation could be that students that made it this far meaning getting accepted to a relatively highly regarded program such as psychology, overall possess high self-efficacy even for students with ADHD. The high means and relatively low standard deviations for the Expectancy scale and the two components individually, indicate that this may indeed be the case in our sample as there are a lot of high scorers compared to low scorers. Additionally, a positive illusory bias of self-efficacy beliefs may affect the students rating of items of the Expectancy scale for students with high ADHD symptomatology (Prevatt et al., 2012). Consequently, they may overestimate their self-efficacy beliefs in that

they report to belief in their abilities more than they do realistically which in turn may bias our findings.

Lastly, the third research question relates to the relationship between self-regulated learning and GPA and the role of ADHD symptomatology in that relationship. The respective hypotheses were that worse self-regulated learning strategies and motivation are related to lower GPA and that this relationship is explained by high ADHD symptomatology. None of the hypotheses were supported. Firstly, none of the MSLQ factors were significantly related to academic performance which is an unexpected and contradicting finding. According to the literature I presented, components of self-regulated learning strategies such as higher self-efficacy, higher self-regulation and lower test anxiety are all associated with better academic performance in students with and without ADHD. A meta-analysis adds to these claims using the MSLQ for large samples of students indicating that factors such as effort regulation and task value are in fact related to lower performance in addition to the factors mentioned above (Credé & Phillips, 2011). Nonetheless, there is some literature that does not find significant correlations between self-regulated learning strategies and academic performance. For example, two studies investigating self-efficacy in first-year students before the start of their studies found no significant correlation between self-efficacy and performance in the first year (van Herpen et al., 2017; Fokkens-Bruinsma et al., 2021). The researchers hypothesized that this finding could be explained by the student's motivation and belief in the beginning to succeed in the program because otherwise they would have not applied for the program but later the expectations that the students had before their studies were not met. As self-regulated learning strategies including self-efficacy were assessed for the first course in the beginning of the program this explanation may apply to my study as well. The students in my sample may similarly had high expectations of the program and were disappointed over time which may have led to a lower performance. Furthermore, a meta-analysis that investigated learning

strategies in relation to GPA in students up to 12th grade only found weak correlations between factors such as self-regulation and academic performance (Dent & Koenka, 2016). The method of calculating GPA possibly contributes to the unexpected results and is further discussed in the limitations.

Nevertheless, certain strengths of this study can be pointed out. One of these concerns the size of the sample. Overall, with over 170 participants for all variables I have a considerable amount of reliability and power to my results. The questionnaires that I used have been proven to be valid and reliable measurements for the variables investigated (Conners et al., 1999; Pintrich et al., 1991). The CAARS has become a widely used and reliable inventory for screening of ADHD symptoms in adults. The MSLQ, which is an internationally used study strategies questionnaire, as an alternative to the Learning and Study Strategies Inventory (LASSI) for example, was shown to have good reliability and validity as well. The internal consistencies that I found mostly support this, except for the Cronbach's alpha for test anxiety. Additionally, by applying the dimensional approach of ADHD I investigated the effects of symptoms of the disorder in the context of university through a wider lens. This allows to detect potential consequences of ADHD symptoms that do not reach clinical significance, providing a clearer picture of ADHD symptoms in relation to self-regulated learning and academic performance generally. Support for the use of the dimensional approach comes from recent literature which found this approach to be useful for psychopathy, and ADHD (Ahmad et al., 2021; Steinert et al., 2021). Symptoms of these disorders were found to be dimensionally present across the population with different outcomes and consequences depending on the severity of the symptoms which do not necessarily reach a threshold for a diagnosis. Especially in ADHD, diagnosis is not necessarily stable over time concerning childhood to adulthood assessments and subthreshold ADHD still has a significant impact on functioning (Balázs & Keresztény, 2014). Such

findings urge research to investigate the consequences of high ADHD symptomatology generally. Lastly, because there is information about medication use and diagnosis of other disorders, confounding effects can be ruled out as there are only few students who reported them and exclusion of these students did not significantly affect the results.

Limitations and Further Directions

An important limitation of this study concerns the use of self-report measures only. Recent literature suggests that students with ADHD exhibit positive illusory bias in reporting their own abilities in that they tend to overestimate themselves to enhance motivation and retain a more positive self-view (Prevatt et al., 2012; Butzbach et al., 2021). The students in my study who display high ADHD symptomatology may have also overestimated the effectiveness of their self-regulated learning strategies, for example reporting better self-regulative strategies as well as higher self-efficacy and having more intrinsic goal orientation than they realistically have. Consequently, this can have diminished the results for the relationship between ADHD and the factors for self-regulated learning strategies. In terms of future research, it would be useful to include another measure to show possible discrepancies between the perception of the self-regulated learning strategies of the student and that of a peer or family member or actual observed behavior.

Moreover, the method of calculating GPA needs to be critically reviewed here. Contrary to the standard way of measurement, I had to calculate the GPA of the whole first year with just a few grades also including ‘fails’ because most courses were only graded either pass or fail due to the COVID-19 crisis. Results may have differed a great extent if all courses were graded numerically and only included passed courses. Future studies which are not restrained by such circumstances may be able to obtain different and more reliable results regarding GPA. Related to this, the first course ‘Introduction to Psychology’ was graded pass/fail as well which is the course that the MSLQ concentrates all questions on. I think it

may be advisable to either measure MSLQ related to the whole year generally or to measure it twice, once before the start of the studies and later such as after the first year when the students gained some experience and may be able to better reflect on their way of learning and their performance.

Another shortcoming of this study concerns the indifference regarding the various ADHD symptoms related to the different subtypes. For example, results possibly differ if I tested our hypotheses with ADHD total scores, Inattention or Hyperactivity scores relating to ADHD with predominantly inattentive or predominantly hyperactive symptoms or combined ADHD, respectively. Previous literature emphasizes that high ADHD symptomatology relating to inattention is a crucial factor underlying underachievement in university students with ADHD (Henning et al., 2022). Prospective studies may benefit from using more ADHD scales of the CAARS and especially inattention in their analysis of ADHD symptoms in relation to self-regulated learning and GPA.

As a last point it is important to notice that because of the nature of correlational studies, I cannot make any claims about causality. This implies that ADHD symptoms do not necessarily cause students to perform less well or apply worse learning strategies. There are many factors that can play a role for developing sufficient self-regulated learning skills which includes previous way of education in school as well as at home. The COVID-19 crisis adds to the complications that the students encountered in adapting to the new university environment by being hindered in their possibilities for exchange and learning with other students. Being tied to their room most of the time and learning on their own in addition to a loosely structured daily life, students were confronted with several challenges to find an effective way of learning and keeping up with the material by themselves.

Implications

The findings of this study highlight the notion that higher ADHD symptomatology is related to lower or wore self-regulated learning strategies. Although this outcome was not translated into lower grades possibly for reasons explained earlier, more research is needed on ADHD symptomatology that does not reach a clinically significant level because it can still impact the student's way of learning and dealing with the daily struggles that the life at university entails. As the findings regarding self-regulated learning strategies and ADHD contradicts the literature the way of calculating GPA here and the focus of the MSLQ may need some revision. Additionally, ADHD symptomatology in university students needs to be looked at in relation to academic performance related to grades but also in possible dropouts. Our study added to previous literature that self-regulation indeed goes hand in hand with ADHD symptomatology, but it is of further investigation whether self-efficacy is lower in students with higher ADHD symptomatology and whether this are any poor outcomes connected to it as was found in previous studies.

As a practical implication, students who struggle with self-regulated learning or do not perform that well may be advised to meet with a study advisor who should investigate possible symptoms of ADHD. Interventions that address learning in people with ADHD may be applied and or additionally a referral to a psychologist may be initiated to professionally screen for ADHD symptoms and measure their severity. Interventions may target the OTMP skills or how the students can become better at regulating themselves which may also prevent students from dropping out.

Conclusion

The important message that can be taken from this study is that high ADHD symptomatology is associated with self-regulated learning and performance for first-year university students. This implies that having more ADHD symptoms can already negatively

impact the way these students are able to implement effective learning strategies and deal with the new academic environment. Students with higher ADHD symptomatology that does not reach threshold for diagnosis are at risk for applying worse self-regulated learning strategies such as worse self- and effort regulation and being more anxious in testing situations and receiving lower grades. We need to keep track of university students' performance throughout the year to possibly detect ADHD related problems that hinder successful performance at university and guide them to effective interventions.

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Appendix A

Participant exclusion

In the first dataset containing the CAARS, 10 participants were excluded because they were not in the age range of 18-29, seven participants had overall missing scores. Two participants were excluded because they had invalid ADHD index scores, 73 exceeded the cutoff on the CAARS inconsistency index and 11 exceeded the cutoff on the infrequency index, these participants were excluded as well. In the dataset of the MSLQ, 12 respondents had missing values, 6 did not complete the questionnaire and 3 indicated having not responded honestly. Lastly, for merging the datasets another 117 participants were excluded because they only completed one of the two questionnaires and another 3 participants had to be excluded because their scores could not be matched based on student or Sona number.

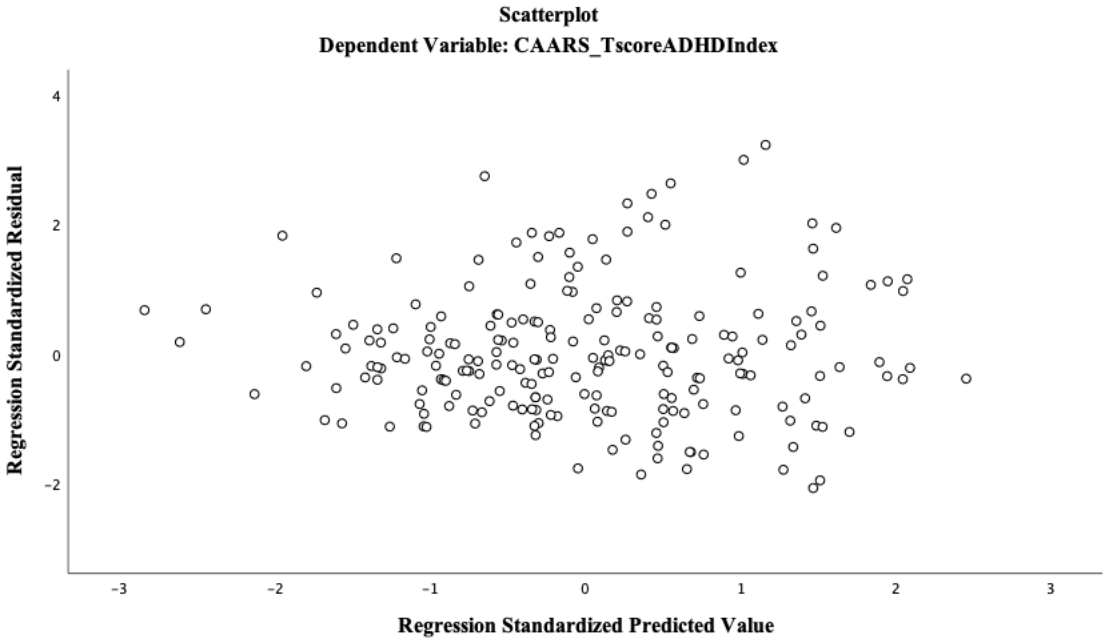
Appendix B

Assumption checks

Assumption checks were conducted for the multiple regression of self-regulated learning strategies on ADHD. The distribution of ADHD T-scores and GPA scores does not give any concern as to a violation of normality (see Figure 1). The assumptions of linearity and homoscedasticity were not violated which can be seen by looking at the distribution of residuals in the partial scatterplots and residual plots, respectively (see Figure 2 and Figure 3). Moreover, the assumption of multicollinearity was not violated as indicated by VIF scores which all fall below *VIF* = 2. Among the variables, MSLQ Self-Regulation has the highest score with *VIF* = 1.48 and Test Anxiety the lowest with *VIF* = 1.05. Independence of observations was checked by calculating the Durbin-Watson statistic = 1.78 (H2) and =1.93 (H3) which indicated no violation. We found one outlier in both analyses, but results were not significantly affected by the inclusion of the outlier.

Figure 2

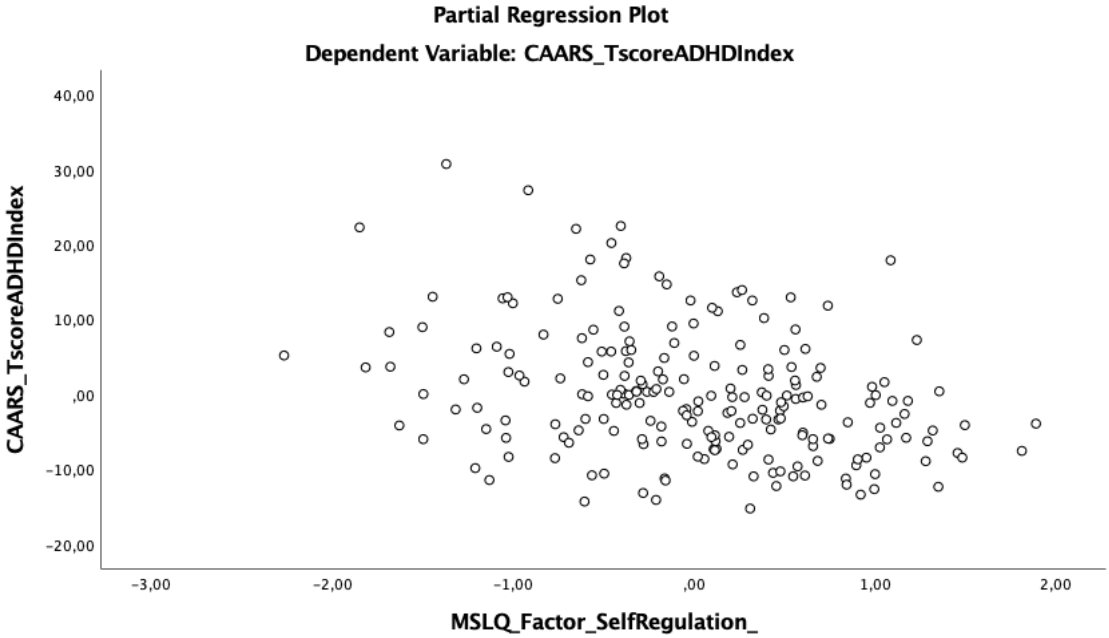
Scatterplot of standardized residuals of ADHD T-scores



Note: This scatterplot was used to check for the assumption of homoscedasticity.

Figure 3

Partial regression plot between ADHD T-scores and Self-Regulation



Note: This scatterplot was used to check for the assumption of linearity.