CHALLENGING THE ATTENTION-DEFICIT HYPERACTIVITY DISORDER AND
INTERNALIZING DISORDER SUBTYPE: EVIDENCE FROM FUNCTIONAL
IMPAIRMENT

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
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To my mom and dad for being a compass to my life journey

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Researchers have postulated that youth with Attention-Deficit Hyperactivity

Disorder (ADHD) and an internalizing disorder represent a unique subtype of ADHD that

has differential treatment and functional outcomes; however, results are inconclusive as

researchers have not differentiated types of internalizing disorders. Fifty-nine youth with

a diagnosis of solely ADHD (n = 34), ADHD with a mood disorder (n = 15) or ADHD with

an anxiety disorder (n = 10) were included. Participants were recruited in a

psychological assessment clinic. Parents filled out questionnaires examining their

youth's ADHD symptom severity, quality of life, adaptability, and executive functioning.

As part of the assessment, clinicians also provided Global Assessment of Functioning

scores for all youth. Multivariate analyses indicated that youth with ADHD and a mood

disorder had significantly greater functional impairment across both parent and clinician

rated measures compared to youth with ADHD and an anxiety disorder or youth with

solely ADHD. This difference in functional impairment maybe the result of anxiety

symptoms attenuating ADHD symptoms and subsequently the functional impairment

caused by the addition of an Anxiety Disorder diagnosis. Results support an "ADHD-

Mood Dysregulation Type" rather than an ADHD and an Internalizing Disorder subtype.

CHAPTER 1
INTRODUCTION

Excessive Comorbidity in ADHD

Currently, the *Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition, Text Revision* (*DSM-IV-TR*) describes three subtypes of ADHD, specifically ADHD-Combined Type, ADHD-Predominately Inattentive Type, and ADHD-Predominantly Hyperactive-Impulsive Type (American Psychiatric Association, 2000). However, youth with ADHD often have several comorbid disorders. A recent national study found that 46 percent of youth with ADHD had a Learning Disorder (7.79 higher realitive risk than national sample) 27 percent had Conduct Disorder (12.58 higher realitive risk), 18 percent had an Anxiety Disorder (7.45 higher realitive risk), 14 percent had Depression (8.04 higher realitive risk), and 12 percent had an Expressive Language Disorder (4.42 higher realitive risk) (Larson, Russ, Kahn, & Halfon, 2011). This excessive comorbidity in ADHD supports that ADHD is a heterogeneous clinical construct and suggests that ADHD may be comprised of numerous subtypes with unique clinical outcomes. This study will investigate one of the possible subtypes: ADHD with a comorbid internalizing disorder.

Several problems have been identified with the current ADHD classification system that provides additional indication that the *DSM-IV-TR* ADHD subtypes could be improved with reclassification. The current subtypes have poor temporal stability, with children often qualifying for multiple different subtypes as they age from preschool through elementary school (Lahey, Pelham, Loney, Lee, & Willcutt, 2005). These subtypes also vary greatly in severity based off of presenting comorbid symptoms (e.g., Hurtig et al., 2007), likely a result of symptom overlap with other disorders (e.g.,

inattentiveness and internalizing symptoms), further complicating the diagnostic picture.

Therefore, research is warranted investigating the validity of the several new subtypes

of ADHD that have been suggested in the literature.

Possible ADHD Subtypes

Jensen and colleagues (2001) investigated possible subtypes of ADHD that have

been previously suggested in the literature to better explain the wide variety of symptom

presentations in ADHD. Using cross sectional and longitudinal data collected from 570

children as a part of the National Institute of Health Multisite Multimodal Treatment

Study of Children With Attention-Deficit/Hyperactivity Disorder (MTA), investigators

concluded that validational evidence (see Cantwell, 1995) only supported two possible

additional subtypes of ADHD: ADHD with a co-occurring Disruptive Behavior Disorder

and ADHD with a co-occurring Internalizing Disorder. Numerous additional subtypes for

ADHD have been posited over the past two decades of research, such as ADHD with

executive functioning deficits (Nigg, Willcut, Doyle & Sonuga-Barke, 2005), ADHD with

Autism (Mulligan et al., 2009), etc. However, the majority of attention has been given to

the first of the two proposed subtypes by Jensen and colleagues (2001): ADHD with

Disruptive Behavior Disorder (e.g., Banaschewski et al., 2003; Hurtig et al., 2007) and

little research has investigated the proposed ADHD with an Internalizing Disorder

subtype.

ADHD with an Internalizing Disorder Subtype

Roughly 33% of children with ADHD have a comorbid Internalizing Disorder (MTA

Cooperative Group, 1999b) and thus identification of a possible ADHD with a comorbid

Internalizing Disorder subtype could have diagnostic and treatment implications for up

to one-third of children with ADHD. The focus of the literature on this topic has been

regarding a possible ADHD with a comorbid Anxiety Disorder subtype. Previous meta-analysis reviewed the majority of research on this topic before 1997 and concluded that partial (4/8) criteria for the validation of ADHD with an Anxiety Disorder was met (Jensen, Martin & Cantwell, 1997), using the validational criteria of Cantwell (1995) which assess multiple domains such as impairment, symptom presentation, treatment response, etc. The inconclusiveness of these findings regarding the validity of an ADHD and Anxiety Disorder subtype is echoed in the literature that is highlighted below.

ADHD with an Anxiety Disorder

Support for an ADHD with a comorbid Anxiety Disorder subtype is exemplified by research which has shown that these children have a different response to medication (e.g., Buitelaar, Van der Gaag, Swaab-Barneveld & Kuper, 1995). For example, the researchers of a double-blind placebo controlled trial of Methylphenidate found that children with ADHD and lower levels of anxiety improved more on inattention and hyperactivity than peers without a comorbid Anxiety Disorder (Buitelaar, Van der Gaag, Swaab-Barneveld & Kuper, 1995). Children with ADHD and a comorbid Anxiety Disorder also differ on psychological treatment response. Work by the MTA Cooperative Group (1999a) and March and colleagues (2000) found that having a comorbid Anxiety Disorder related to improved outcome on ADHD and internalizing symptoms after behavioral therapy. These results were not moderated by having Oppositional Defiant Disorder or Conduct Disorder and were replicated by Jensen and colleagues (2001). In terms of functioning, children with ADHD and a comorbid Anxiety Disorder show greater social (Mikami, Ransone, & Calhoun, 2011) and cognitive functioning impairment (Carlson & Mann, 2002; Tannock, Schachar, & Logan, 1995) compared to their peers with solely ADHD.

On the other hand, some research posits that ADHD and Anxiety Disorders are independently expressed and have little additional impact when presenting comorbidly (Hammerness et al., 2009). Contrary to previous findings, having co-occurring anxiety did not impact response to Methylphenidate in the MTA Cooperative Group study, and the researchers posit that this is the result of a carefully titrated dose regimen (March et al., 2000). In this vein, results from the MTA Cooperative Group which suggested that anxiety was a moderator of treatment outcome, was contradicted when Owens and colleagues (2003) reexamined the outcome data using a more sensitive statistical analysis (Receiver Operating Characteristics with multiple moderators analyzed simultaneously). Researchers defined a more clinically meaningful outcome measure of "excellent response" to therapy (composite score of quantity of symptoms that were reported by parents or teachers to have decreased to minimal severity) and found that anxiety *did not* impact treatment outcome. Highlighting a common limitation of several studies in the literature, research by Newcorn and colleagues (2004) found that after controlling for a comorbid diagnosis of Conduct Disorder, youth with ADHD and an Anxiety Disorder did not differ in social or behavioral functioning compared to peers with solely ADHD (e.g., aggression, delinquency). Regarding cognitive functioning, Oosterlaan and Sergeant (1998) conducted a meta-analysis of research on children with ADHD's performance on the stop task (measures behavioral regulation of an already initiated task) and found that anxiety had no effect on response inhibition. Thus, the impact on treatment outcome and general functioning of having a comorbid Anxiety Disorder diagnosis remains unclear as a result of the inconsistent findings in the literature.

ADHD with a Mood Disorder

Despite presenting comorbidly with ADHD more often than Anxiety Disorders (Wilens et al., 2002), substantially less research has been conducted on children with ADHD and a comorbid Mood Disorder. To date, no treatment outcome trials have been conducted to identify if comorbid depression moderates response to behavioral therapy. However, pharmacological therapy is thought to be overall less effective for ADHD when comorbid depression is present (Spencer, Biederman, & Wilens, 1999). Additionally, research by Biederman and colleagues (1992) found that children with a Major Depressive Disorder diagnosis at baseline had worse psychosocial functioning, a higher rate of hospitalizations and increased interpersonal difficulties four years later than their peers with solely ADHD. Similarly, youth with ADHD and a co-occuring Mood Disorder are more likely to be defined as "socially disabled" than their peers without a Mood Disorder (Greene et al., 1996; Blackman, Ostrander, & Herman, 2005). Impairment in metacognition and other aspects of executive functioning is also compounded in youth with ADHD and a comorbid Mood Disorder (Shear, DelBello, Rosenberg, & Strakowski, 2002; Shear, DelBello, Rosenberg, Jak, & Strakowski, 2004), as is academic functioning (Blackman, Ostrander, & Herman, 2005).

As with anxiety, the existing research on how comorbid Mood Disorders impact ADHD presentation and outcome is contradictory. Some researchers suggest manic symptoms or Bipolar Disorder, which are highly comorbid with pediatric ADHD, may stem from an overlap in symptomology and an "artificial subdivision of syndromes" (Youngstrom, Arnold, & Frazier, 2010). While comorbid Mood Disorders increase the severity and course of ADHD (Faraone, Biederman, Mennin, Wozniak, & Spencer, 1997), some would argue that ADHD is distinct from Mood Disorders and as such

reflects a true comorbidity because both these disorders respond to their standard separate treatments (Scheffer, Kowatch, Carmody & Rush, 2005). However, as Youngstrom and colleagues (2010) illustrate, this may just represent "targeting different branches of the same tree." To the best of the author's knowledge, no exisiting literature indicates that comorbid Mood Disorders may *not* hinder standard pharmacological therapy for ADHD or decrease functioning in ADHD.

Functional Impairment in ADHD

Improving the nosology of ADHD would facilitate more detailed clinician communication, more strategic treatment planning, increased treatment outcome, and an overall more comprehensive understanding of ADHD. Following the validity criteria of Cantwell (1995), a new subtype would require changes in multiple facets of the disorder (e.g., clinical phenomenology, identified overlap in etiology, etc). One of the eight criteria proposed is functional impairment (referred to as psychosocial correlates) and thus the functional impairment outcome variables chosen for this study have important implications for ADHD classification. While an ADHD with an Internalizing Disorder subtype has been suggested for over ten years, only one study has directly compared ADHD with a comorbid Anxiety Disorder versus ADHD with comorbid Mood Disorder in terms of functional impairment. Karustis, Power, Rescorla, Eiraldi, and Gallagher (2000) compared youth with ADHD and depression to peers with ADHD and anxiety and found that co-occurring self-reported anxiety was predictive of parent reported social problems above that of self-reported depression. However, for teacher reported social problems, self-reported depression was more predictive than anxiety of social functioning. Regarding academic functioning, youth with ADHD and depression had more problems with completing homework than youth with ADHD and anxiety. Taken together, these

results highlight the lack of literature on how specific internalizing comorbidities in youth with ADHD impact functioning and subsequently, one key criteria for determining a new subtype related to comorbid internalizing disorders has yet to be thoroughly investigated.

Summary

ADHD is a heterogonous clinical construct for which multiple subtypes have been proposed in lieu of or in addition to the current *DSM-IV-TR* ADHD subtypes. Data collected from the MTA Cooperative Group, a multi-site ADHD treatment outcome research study, suggested that out of all the proposed subtypes, ADHD with an Internalizing Disorder and ADHD with Oppositional Defiant Disorder/Conduct Disorder had the most empirical support in their study. Since these findings were reported, little research has investigated ADHD with an Internalizing Disorder as a new subtype. What research that has been conducted has found mixed findings regarding the impact of a comorbid Anxiety Disorder or Mood Disorder on treatment outcome and functional impairment. Only one study has directly compared comorbid anxiety and depression and underscores the need for more research in this area. Functional impairment is a worthy outcome to investigate due to its relevance to subtype classification.

Study Aims

The first aim is to investigate if the presence of a comorbid Anxiety or Mood Disorder impacts functional impairment. It is hypothesized that youth with ADHD and a comorbid Internalizing Disorder will have worse functional impairment than youth with solely ADHD as the result of the additive effect of the internalizing symptoms. The second aim of this study is to determine if there are any differences in functional impairment between children with ADHD and a comorbid Anxiety Disorder versus

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children with ADHD and a comorbid Mood Disorder. It is believed that youth with a comorbid Mood Disorder will have worse impairment on psychosocial wellbeing, as a consequence of hindered social functioning, and global clinician-rated functional impairment as a result of the trait-like nature of depression as opposed to anxiety which is often situationally based. The third aim is to capture any interaction between internalizing symptoms and ADHD subtypes. It is thought that there will be an interaction between depression with ADHD-Inattentive Type as a result of the difficulties in concentration commonly observed in depressed youth.

CHAPTER 2
METHODS

Procedure

This study was a secondary data analysis from a larger study and only participants who were administered the included measures and met diagnostic criteria for this study were included in the sub-sample. Participants parents provided consent to participate in the study at a large university hospital in the Southeastern United States. Diagnostic inclusion criteria included having a diagnosis of solely ADHD (any type), or ADHD plus any Mood Disorder, or any Anxiety Disorder (not both). The only exception to this criterion was that youth were allowed to have a comorbid diagnosis of any Learning Disorder, Enuresis/Encopresis, or an Expressive Language Disorder because research has suggested that these disorders may not increase impairment beyond that of ADHD (e.g., Biederman et al., 2006). Diagnosis was determined by a clinical consensus between two licensed psychologist who reviewed both objective and subjective data gathered from an hour interview with the patient and their family and a full battery of intellectual, emotional and behavioral assessments and questionnaires. The supervising clinician than assigned a Global Assessment of Functioning (GAF) score for each child based off the collected and observed data.

Participants

Fifty-nine participants were included in this sub-sample, which was 75% male and 25% female. A predominately male sample is common in psychological assessment clinics, due to the higher rate of behavior disturbances in male youth (Biederman et al., 2002). Youth's ages ranged from six to 17 years of age. In terms of ethnic composition, the sample was comprised of 69% Caucasian, 17% Hispanic, and 14% African

American. The majority of the youth in this sample were referred from a psychiatrist (66%), while other major referral sources were from a pediatrician (14%), self-referral (14%) or from another professional (6%).

As stated above, this study only included youth with a diagnosis of ADHD or ADHD with a comorbid anxiety or mood disorder. Of the total sample of 59 youth, 33 had just a diagnosis of ADHD, 16 had a diagnosis of ADHD with a comorbid Mood Disorder (Major Depressive Disorder or Mood Disorder NOS), and 10 had a diagnosis of ADHD with one comorbid Anxiety Disorder (Generalized Anxiety Disorder, Obsessive-Compulsive Disorder, Separation Anxiety Disorder or Panic Disorder).

Youth with the following disorders were not excluded: any Learning Disorder, Enuresis/Encopresis, and/or an Expressive Language Disorder. There were three youth with a comorbid Reading Disorder, 10 with a comorbid Mathematics Disorder, eight with a Written Expression Disorder, one with a Learning Disorder Not Otherwise Specified, four with Enuresis, one with Encopresis, and two with Mixed Receptive-Expressive Language Disorder. In terms of ADHD subtypes, over half the sample (53%) had a diagnosis of ADHD-Combined Type and most of the remaining sample had ADHD-Inattentive Type (42%) with a few having a diagnosis of ADHD-Not Otherwise Specified (5%). The lack of youth with an ADHD-Hyperactive-Impulsive Type is common in research studies due to the failure of children to meet complete criteria for this diagnosis (Greene, Beszterczey, Katzenstein, Park, & Goring, 2002).

Measures

Apart from collecting data on ADHD symptom severity, the following measures were utilized to capture functional impairment (or an aspect of functional impairment) from two different informants: the parents of the child and the supervising clinician.

Global Assessment of Functioning (GAF)

The GAF score is a clinician-rated item where the clinician provides an estimate of how well the child is functioning, using a one to 100 point scale where every ten points represents a range of functioning generally seen in individuals with certain types of symptoms. Higher scores on this rating scale represent better levels of functioning. For example, 61-70 reflects "mild symptoms," 51-60 indicates "moderate symptoms" and 41 to 50 represents "serious symptoms" (American Psychiatric Association, 2000). The GAF score is reliable for analyzing group-level differences in functioning (Söderberg, Tungström & Armelius, 2005).

Conners, 3rd Edition (Conners-3)

The Conners-3 (Conners, 2008) was administered to assess youth's current ADHD symptoms. The parent-report version used in this study is for youth ages 6-18 years and contains 108 items. A large, representative national sample was used to standardize the *DSM-IV-TR* ADHD-Inattentive and ADHD-Hyperactive/Impulsive symptom scales used in this study. This allows for each youth's score to be compared to national averages using standardized T-Scores. The Conners-3 has strong psychometric properties, such as well-established internal consistency, reliability and validity (Conners, 2008). In this sample, strong internal consistency for the ADHD-Inattentive (α = .83) and ADHD-Hyperactive/Impulsive symptom (α = .86) scales were observed, consistent with the .83-.94 ranges observed in the national sample. For the Conners-3, higher scores reflect increased ADHD severity.

Behavior Rating Inventory of Executive Functioning (BRIEF)

The BRIEF (Gioia, Isquith, Guy, & Kenworthy, 2000) was administered to assess youths' executive functioning, specifically their cognitive self-management and problem

solving abilities captured by the Metacognition scale of the BRIEF. Overall, the BRIEF provides an estimate of how the youth's executive functioning abilities present in real-world situations that often occur at home, school, etc. The Behavioral Regulation scale was not included in this analysis due to its inherent overlap with ADHD symptomology that is already captured with the Conners-3 (McCandless & O'Laughlin, 2007). The parent-report version of the BRIEF is an 86-item survey for youth ages 5-18 years of age that asks parents to rate the frequency that their child displays certain behaviors (e.g., "Cannot stay on the same topic when talking"). The BRIEF has well-established internal consistency, reliability and validity in both community and clinical samples (Gioia et al., 2000; Gioia, Isquith, Retzlaff, & Espy, 2002). The Metacognition scale of the BRIEF collected for this study echoed the findings of these larger community and clinical samples, with a Cronbach's alpha of .74. For the BRIEF in this study, lower scores reflect more impairment in Metacognition (reversed scored for consistency with other measures).

Behavior Assessment System for Children, 2nd Edition (BASC-2)

The BASC-2 (Reynolds & Kamphaus, 2004) is a widely used multidimensional assessment that was administered to measure youth's behavioral functioning. The parent-report version used for this study is for youth ages 6-21 and contains 148 items; each is rated on a four-point scale with respect to the frequency of occurrence (never, sometimes, often, and almost always). The Adaptability scale of the BASC-2 was used in this study to assess how youth handle unpredictable changes in their environment, such as adjusting to a new teacher at school. The BASC-2 has well-established psychometric properties, such as internal consistency, convergent validity, etc. (Reynolds & Kamphaus, 2004). Internal consistency for the Adaptability subscale in this

study was .79. Similar to the BRIEF, the BASC-2 provides a nationally normed T-Score for each child in this study. For the BASC-2, lower scores represent more impairment in adaptability.

Pediatric Quality of Life Inventory, Version 4.0 (PEDSQL)

The PEDSQL (Varni, Seid, & Rode,1999) was administered to assess youth's quality of life, specifically emotional (five items), social (five items) and school functioning (five items) that is captured by the Psychosocial scale used in this study. Items are rated on a 5-point scale and lower scores on the PEDSQL indicate more impairment in psychosocial functioning. Developed from focus groups, cognitive interviews, and pilot testing, the 23-item, parent-report PEDSQL has displayed strong reliability and validity in both healthy and patient populations (Varni, Burwinkle, Seid, & Skarr, 2003; Varni, Seid, & Kurtin, 2001). For this study, strong internal consistency was observed for the Psychosocial scale (.87).

Statistical Analysis

All data analysis was conducted using the Statistical Package for the Social Sciences, version 19.0 and 20.0 (SPSS 19.0/ 20.0). All data entry was conducted by the members of the research team and supervised by the first author. Procedures were conducted to check for accuracy. For the measures used, there was no missing data for the clinician-rated GAF scores and no more than 2% missing for any of the parent-report measures per participant. This low quantity of missing data and the nature of the data collection in which parents were waiting for their child to be tested and thus had no time constraints, extra expenses (e.g., gas) or other factors that may contribute to identifiable patterns of missing data, support that this data is missing completely at random and thus is justifiable to estimate. For estimation, multiple imputation with 10

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imputations was conducted, which is sufficient to accurately estimate the data for this small sample size (Rubin, 1987).

For preparatory analyses, all variables were checked to ensure they met all normality assumptions, as well as any specific assumptions required to conduct a Multivariate Analysis of Covariates (MANCOVA). A MANCOVA was then conducted to investigate the hypotheses proposed in the first chapter. The main goal of a MANCOVA is to test whether mean differences among the groups (independent variable) on a combination of dependent variables are likely to have occurred by chance, while simultaneously controlling for extraneous variables. This is accomplished by forming a single dependent measure from a combination of all dependent measures that maximizes the between group differences. By including more than one dependent variable, the chance of discovering what more clearly defines the groups is increased.

There are several reasons for conducting a MANCOVA instead of multiple Analysis of Covariance (ANCOVA). First, MANCOVA takes into account the pattern of covariation among the dependent measures that often can greatly skew results if ignored and generally increases power if addressed (Tabachnick & Fidell, 2001). Additionally, conducting a broad MANOVA reduces family-wise error by allowing the researcher to identify significant ANCOVAS for multiple dependent variables in one analysis. While Hummel and Sligo (1971) suggest that a MANCOVA "protects" additional analyses from family-wise error, several flaws in this widely cited study have been suggested (Bray & Maxwell, 1982), and thus each post-hoc analysis was conducted using a Bonferroni correction.

For the MANCOVA, GAF, Metacognition, Adaptability, and Psychosocial scores were entered as dependent variables and diagnosis type (ADHD, ADHD+ Anxiety Disorder, or ADHD+ Mood Disorder) was entered as the independent variable. ADHD symptom severity for hyperactivity/impulsivity and inattentiveness, as captured by the two symptom scales of the Conners-3, were entered as covariates to control for differences in ADHD severity.

Preliminary Analyses

In order to conduct a MANCOVA, several sample assumptions must be met, specifically 1) the homogeneity test of variance/covariance, 2) the linearity of dependent variable relationships, 3) absence of singularity, 4) multivariate normality, and 5) adequate sample size.

Homogeneity Test of Variance/Covariance

Box M's test of the equality of variance/covariance was conducted as a result of the unequal group sizes. Box M's test was non-significant ($p = .170$). Thus, the hypothesis that the covariances are not homogeneous was rejected and the assumption of homoscedasticity is upheld.

Linearity of the Dependent Variable Relationships

In order to test this assumption, all relationships between dependent variables and/or covariates were checked by conducting line plots. Visual inspection suggests that all variables are best represented by a linear relationship as the worst fitting line between two variables had an R-Squared of .06.

Absence of Singularity

Singularity refers to the covariance between the dependent variables and tests if redundancies between the variables may lead to missed significant effects in the conducted MANCOVA. Singularity is tested by investigating residual correlation between the dependent variables, and correlations above .70 indicate that the variables share more than 50% of their variance and may be better treated as one variable. In this

sample, the highest correlation observed was between adaptability and psychosocial functioning, with a correlation of .442.

Multivariate Normality

There is no direct test for multivariate normality when conducting a MANCOVA in SPSS. However, it can be assumed that if the variables in the sample meet univariate normality, then linear combinations of these variables may meet multivariate normality. As seen in Table 3.1, all the variables in this MANCOVA analysis meet the univariate normality tests of skewness and kurtosis.

<div align="center">

Results for Aim One

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Aim one examined how having ADHD or ADHD and a comorbid Anxiety or Mood Disorder impacted both global and domain specific functioning across three archetypes of functional impairment which assesses impairment in ability to adjust in new circumstances (Adaptability), impairment in social, emotional and school functioning (Psychosocial), as well as cognitive functioning (Metacognition). A global clinician assessment of functioning was also used (GAF).

ADHD versus ADHD and an Anxiety Disorder

Across all four measures of functional impairment, only one significant difference occurred between youth with solely ADHD and youth with ADHD and a comorbid Anxiety Disorder. The one exception being on the adaptability index, youth with solely ADHD functioned significantly better then youth with ADHD and a comorbid Anxiety Disorder (p <.01). This difference between these two means was over a standard deviation difference in functioning. Additionally, youth with ADHD and a comorbid Anxiety Disorder also functioned slightly worse across Psychosocial, Metacognition and

GAF measures, although none of these comparisons were significantly different. These results can be observed in Table 2.

ADHD versus ADHD and a Mood Disorder

Youth with solely ADHD consistently functioned better than youth with ADHD and a comorbid Mood Disorder. Youth with ADHD had significantly higher global functioning than their peers with ADHD and a comorbid Mood Disorder on GAF (p < .000). The difference observed in GAF scores was over 10 points. This implies that children with solely ADHD (mean = 63) generally were having mild difficulties in school and social functioning while children with ADHD and a comorbid Mood Disorder (53) were having moderate difficulties in school and social functioning (American Psychiatric Association, 2000). This subjective clinician observed discrepancy in functioning can be observed in scores on the Psychosocial scale from the PEDSQL, which asks parents to describe how their children are functioning with friends, at school, and emotionally. For this measure, youth with solely ADHD scored over one standard deviation higher (better functioning) than their peers with ADHD and a comorbid mood disorder (p < .000). This relationship was found for Adaptability (p < .000) and Metacognition scores (p < .000), where youth with ADHD and a comorbid Mood Disorder functioned 1-2 standard deviations worse than their ADHD peers (see Table 2).

<div align="center">

Results for Aim Two

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Aim two investigated how having ADHD and a comorbid Anxiety or Mood Disorder impacted functioning across a subjective clinician assessment of global functioning and three archetypes of functional impairment (Adaptability, Psychosocial, and Metacognition). In general, youth with ADHD and a comorbid Mood Disorder functioned worse than youth with ADHD and a comorbid Anxiety Disorder.

GAF

On clinician rated GAF scores, youth with ADHD and a comorbid Mood Disorder were rated an average of 10 points lower than youth with ADHD and a comorbid Anxiety Disorder ($p < .01$), indicative of "some difficulty" in functioning compared to "moderate" impairment" (American Psychiatric Association, 2000).

Adaptability

Similarly, parents reported that youth with an ADHD and comorbid Anxiety Disorder diagnosis function an average of seven points higher than youth with ADHD and comorbid Mood Disorder ($p < .05$). While less than a standard deviation, it is notable since Adaptability was the one aspect of functioning where youth with a comorbid Anxiety Disorder scored significantly lower than youth with solely ADHD.

Psychosocial

As with Adaptability ratings, parents rated youth with ADHD and a comorbid Mood Disorder almost one standard deviation lower on Psychosocial functioning than youth with ADHD and a comorbid Anxiety Disorder ($p < .05$).

Metacognition

In terms of cognitive self-management and daily problem solving, parents rated children with ADHD and a comorbid Mood Disorder as functioning nine points lower than children with ADHD and a comorbid Anxiety Disorder ($p < .05$). This is almost one standard deviation difference and thus reflects a significant deviation in functioning.

Results for Aim Three

Aim three inspected the interaction effect between comorbidity status and ADHD subtype. More specifically, the aim was to investigate if having a certain ADHD subtype influenced the relationship between comorbidity status and functional impairment.

Because of sample size limitations, only ADHD-Combined Type and ADHD-Inattentive Type could be compared. Hotelling's Trace Multivariate F-Test for the interaction between comorbidity status and ADHD subtype was non-significant ($p < .067$). While non-significant across impairment measures, an interaction between a Mood Disorder comorbidity and ADHD-Inattentive Type appeared to be trending, as highlighted below.

GAF

In terms of GAF scores, youth with a comorbid Anxiety Disorder or solely ADHD had similar GAF scores regardless of ADHD subtype. However, children with a comorbid Mood Disorder had lower clinician-rated functioning by 5.4 points if they had ADHD-Inattentive Type compared to ADHD-Combined Type, although this difference in means was not significant ($p = .136$).

Adaptability

As with GAF scores, youth with a comorbid Mood Disorder were more impaired in Adaptability if they had a diagnosis of ADHD-Inattentive Type compared to ADHD-Combined Type. There was a half a standard deviation discrepancy between these subtypes but this difference was not significant ($p = .105$). Notably, children with a comorbid Anxiety Disorder were 8 points lower in parent ratings if they had ADHD-Inattentive Type versus ADHD-Comorbid Type ($p = .059$).

Psychosocial

Psychosocial scores were on average 2.2 points lower for youth with a comorbid Mood Disorder who had ADHD-Inattentive Type compared to ADHD-Comorbid Type ($p = .787$). While not significant, this difference mirrors the larger discrepancies in GAF and Adaptability scores.

Metacognition

Youth with a comorbid Mood Disorder who had a diagnosis of ADHD-Inattentive Type scored 2.5 points lower in Metacognition compared to youth who had a diagnosis with ADHD-Combined Type (p = .597).

Summary

Overall, youth who have ADHD and a comorbid Mood Disorder have more functional impairment than youth with ADHD and a comorbid Anxiety Disorder or youth with just solely ADHD. All three archetypes of functional impairment displayed this discrepancy (see Figure 3-1., 3-2., and 3-3.), observed as a "V" pattern in these figures. The "V" pattern was observed because, with the exception of Adaptability (Figure 3-2.), youth with ADHD and a comorbid Anxiety Disorder had similar levels of impairment to those with just a diagnosis of ADHD. Finally, no significant interaction effects between comorbidity type and ADHD subtype was observed, although a slight trend towards an interaction between a Mood Disorder and Inattentive subtype was observed.

Table 3-1. Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Z Statistic Skewness	Kurtosis
GAF[a]	59	40.00	80.00	59.92	8.49	.582	.080
Hyperactive/ Impulsive[b]	59	40.00	121.00	72.29	18.18	.961	.507
Inattentive[c]	59	52.00	104.00	76.44	12.91	.527	.974
Adaptability[d]	59	20.00	65.00	42.09	11.00	1.15	.600
Metacognition[e]	59	44.00	89.00	68.85	10.57	.466	1.79
Psychosocial[f]	59	31.67	96.67	64.85	17.56	.524	1.78

Note: Significant Skewness or Kurtosis is indicated by a Z statisitic greater than 1.96. [a] Global Assessment of Functiong, [b] Conners-3 ADHD-Hyperactive/Impulsive Type, [c] Conners-3 ADHD-Inattentive Type, [d] BASC-2 Adaptability, [e] BRIEF Metacognition, [f] PEDSQL Psychosocial

Table 3-2. Mean comparisons for youth from three diagnoses groups

Dependent variable	Group (I)	Group (J)	Mean difference (I-J)
GAF[a]	ADHD	ADHD-MD	10.93***
		ADHD-AD	.871
	ADHD-MD	ADHD-AD	-10.01**
Adaptability[b]	ADHD	ADHD-MD	17.41***
		ADHD-AD	10.40**
	ADHD-MD	ADHD-AD	-7.01*
Psychosocial[c]	ADHD	ADHD-MD	19.92***
		ADHD-AD	3.24
	ADHD-MD	ADHD-AD	-16.67***
Metacognition[d]	ADHD	ADHD-MD	10.58***
		ADHD-AD	1.34
	ADHD-MD	ADHD-AD	-9.25*

Note: This table displays the mean differences between youth with ADHD, ADHD and a comorbid Mood Disorder (ADHD-MD), and ADHD with a comorbid Anxiety Disorder (ADHD-AD). [a]Global Assessment of Functiong, [b]BASC-2 Adaptability, [c] PEDSQL Psychosocial, [d] BRIEF Metacognition. Significance is represented as follows: $p < .05*$, $p < .01**$, $p < .001***$.
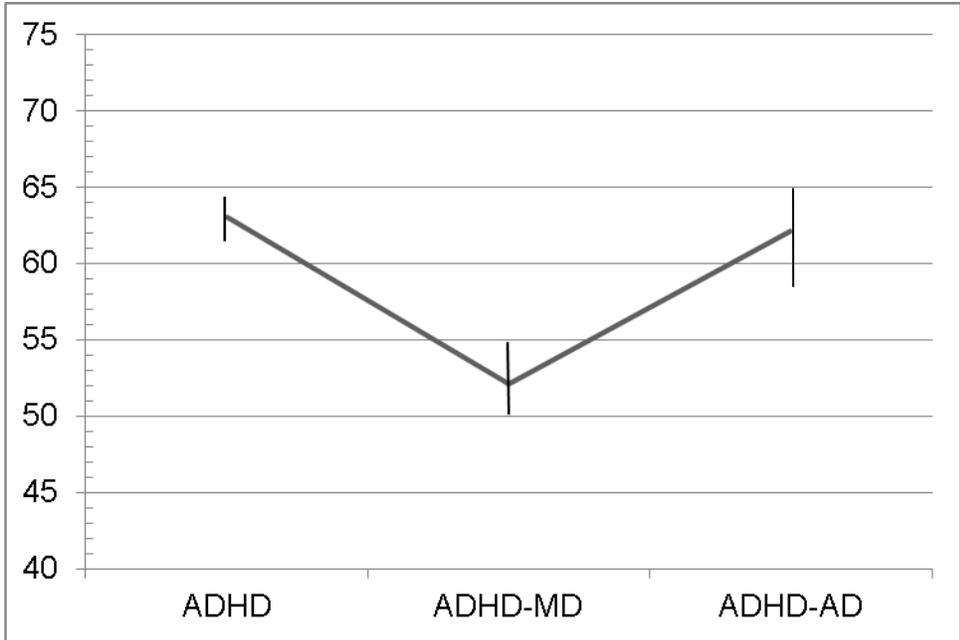
Figure 3-1. Graph of GAF means for the three diagnostic groups. In this graph, "MD" represents a comorbid Mood Disorder and "AD" represents a comorbid Anxiety Disorder. The X-axis displays different comorbid subgroups and the Y-axis reflects score on functional impairment measure.
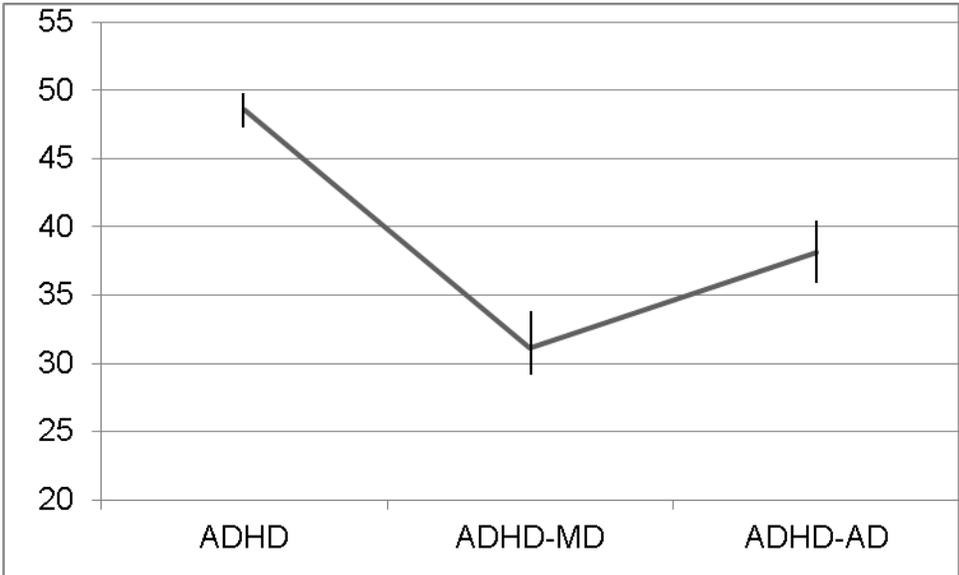
Figure 3-2. Graph of Adaptability means for the three diagnostic groups. In this graph, "MD" represents a comorbid Mood Disorder and "AD" represents a comorbid Anxiety Disorder. The X-axis displays different comorbid subgroups and the Y-axis reflects score on functional impairment measure.

Figure 3-3. Graph of Psychosocial means for the three diagnostic groups. In this graph, "MD" represents a comorbid Mood Disorder and "AD" represents a comorbid Anxiety Disorder. The X-axis displays different comorbid subgroups and the Y-axis reflects score on functional impairment measure.

Figure 3-4. Graph of Metacognition means for the three diagnostic groups. In this graph, "MD" represents a comorbid Mood Disorder and "AD" represents a comorbid Anxiety Disorder. The X-axis displays different comorbid subgroups and the Y-axis reflects score on functional impairment measure.
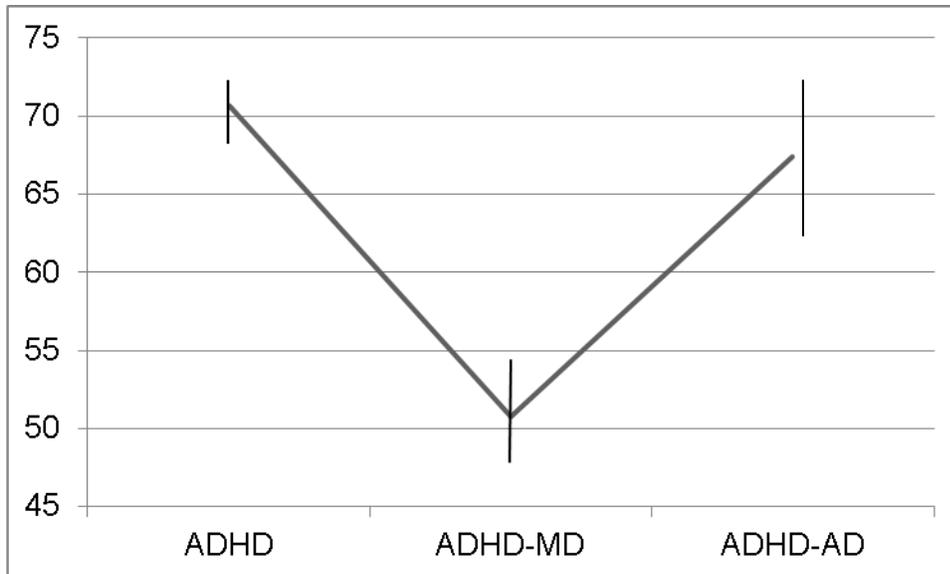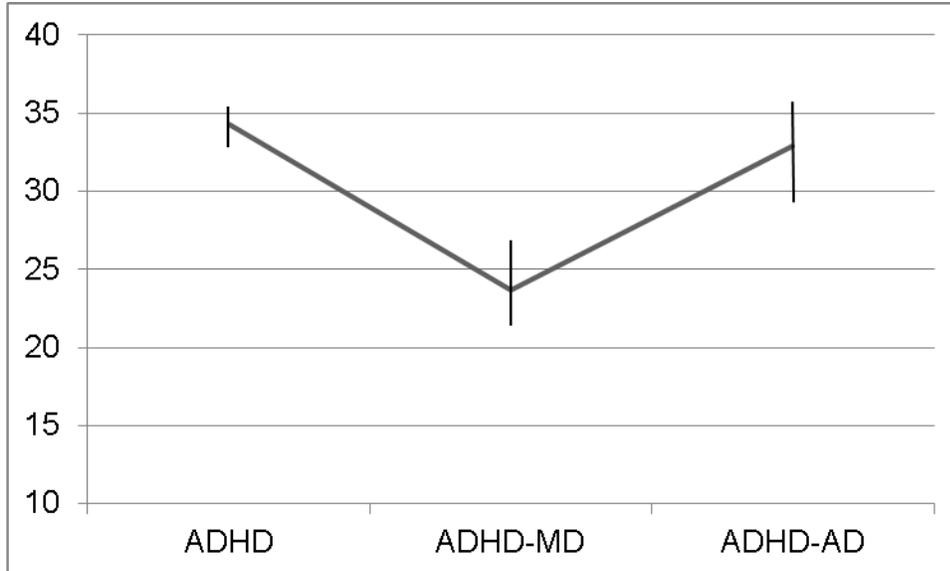
CHAPTER 4
DISCUSSION

Implications for Subtype Classification

Results support that youth with a comorbid Mood Disorder present with significantly higher impairment than their peers with a comorbid Anxiety Disorder, suggesting that if an ADHD with an Internalizing Disorder subtype were developed, it may be better classified as an "ADHD-Mood Dysregulation Type." Genetic research supports this possible classification; depression may stem from the same genetic vulnerability as ADHD, rather than being the emotional sequela of untreated ADHD (Wilens et al., 2002; Biederman, Faraone, Keenan, & Tsuang, 1991). Biederman and colleagues (1991) found that having ADHD and a comorbid Mood Disorder did not increase the liklihood of their realitives developing a Mood Disorder, although Mood Disorders alone have a strong genetic link (see Sullivan, Neale, & Kendler, 2000). Research has also found that Mood Disorders present comorbidly with ADHD before the age of five years-old in a sample of preschool and elementary aged children with ADHD (Wilens et al., 2002), and preliminary research suggests that treatments typically used for ADHD may also be efficacious for treating depression in children of a similar age range (Lenze, Pautsch, & Luby, 2010). Taken together, this literature supports that these two disorders sometimes have a similar etiological pattern and may represent a unique form of ADHD.

As highlighted in the introduction, there is a lack of literature on how psychological treatment for ADHD is impacted by a comorbid Mood Disorder, although it appears comorbid depression may hinder the effectiveness of pharmacological therapy (Spencer, Biederman, & Wilens, 1999). The findings of the present study echo previous

literature that has found elevated functional impairment in children with ADHD and a comorbid Mood Disorder (Biederman et al., 2002; Greene et al., 1996; Shear, DelBello, Rosenberg, & Strakowski, 2002; Shear, DelBello, Rosenberg, Jak, & Strakowski, 2004). Taking into account the similar genetic vulnerability, negative impact on pharmacological therapy, and the clear increase in functional impairment across multiple domains (psychosocial, cognitive, etc.) found in this study, it appears an "ADHD-Mood Dysregulation Type" warrants additional research.

Interaction of ADHD Subtype and Internalizing Disorders

Results of this research did not observe any significant interaction between ADHD subtypes (ADHD-Combined Type and ADHD-Inattentive Type) and Internalizing Disorders (Anxiety Disorders or Mood Disorders) in how they impact functional impairment. This parallels past research that has failed to find a discrepancy in anxiety or depression symptoms between ADHD subtypes (Mayes, Calhoun, Chase, Mink & Stagg, 2009; Power, Costigan, Eiraldi, & Leff, 2004).

Attenuating Effects of Anxiety on ADHD

A noteworthy finding is the nearly identical scores between youth with ADHD and a comorbid Anxiety Disorder and youth with solely ADHD across the functional impairment measures utilized in this study. In three out of four impairment indices, youth in these two subsamples were not significantly different, with the one exception being Adaptability scores. While children with an Anxiety Disorder consistently had worse reported impairment, the discrepancy between the means of the two groups often differed by just a few points.

One possible explanation for this discrepancy could result from the attenuating effect of anxiety on ADHD symptoms that has been documented often in the literature

for over twenty years (Pliszka, 1989). Schwartz and Rostain (2006) conducted a review that concluded that comorbid anxiety in ADHD may inhibit impulsivity while making inattention symptoms worse. While not directly collecting data on functional impairment, it could be posited that this decrease in impulsivity and increase in inattentiveness as a result of comorbid anxiety may result in no net overall change in functioning, as observed in this study.

Limitations

One limitation of this study is a small sample size. Our sample had 33 youth with a diagnosis of solely ADHD, 16 with a diagnosis of ADHD with a comorbid mood disorder and 10 with a diagnosis of ADHD and a comorbid anxiety disorder. Researchers disagree regarding the sample size needed to obtain reliable MANCOVA results (VanVoorhis & Morgan, 2007). One consistent convention for conducting a MANOVA is that for each cell (dependent variables x independent variable) there are more participants than dependent variables. With four dependent variables for each cell, this basic requirement is easily achieved (Tabachnick & Fidell, 1996). With this criteria met, a minimal sample size suggested in the literature is 7 participants per cell, with a minimum of three cells and a medium effect size of .50 (Kraemer & Thiemann, 1987). The effect size for the Hotelling's Trace Multivariate F-Test was .484 and the lowest number of participants per cell for the first two aims was 10. For aim three, the lowest frequency was 5 individuals per cell and thus, these results are preliminary and may have become significant with increased power. Other limitations include reliance on mostly parent report data, a predominately male sample and cross-sectional data permitting any analysis of causality between internalizing symptoms and functional impairment our sample of youth with ADHD.

Future Directions

These findings stand with the findings of Karustis, Power, Rescorla, Eiraldi, & Gallagher (2000) as the only research investigating differences in functional impairment between youth with ADHD and an Anxiety Disorder versus those with a comorbid Mood Disorder. Results of this study indicate that youth with ADHD and a comorbid Mood Disorder have substantially more impairment in their functioning compared to peers with ADHD and an Anxiety Disorder. Future research should investigate what contributes to this discrepancy in impairment, beginning by exploring which aspects of depression contribute to the additional impairment, such as anhedonia or decreased energy. The lack of research investigating the classification criteria of Cantwell (1995) needs to be addressed before a new subtype of ADHD with a comorbid Mood Disorder could be established. These findings addressed one component of this criteria (functional impairment), thus, research examining other aspects such as treatment outcome is warranted and would help move the field closer to better classifying ADHD. Likewise, research, following preliminary work of Mick and colleagues (2005), regaurding how these children could be identified based on clinic presentation is also needed to help clinicians quickly recognize these youth and adjust their treatment plan accordingly.

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BIOGRAPHICAL SKETCH

Adam Michael Reid was born in Titusville, Florida. The youngest of three, he spent the majority of his childhood in Gainesville, Florida and graduated from Buchholz High School in 2007. He then attended the University of Florida for his undergraduate education and graduated a year early with a Bachelor of Science in Psychology. During these three years, he maintained a 4.0 Psychology G.P.A. while volunteering in three research labs and two community health centers. He spent a summer in Australia doing an internship at the University of Sydney Brain and Mind Research Institute and worked 10 hours a week administering psychological assessment batteries at an internship at the Behavioral Health Unit at Shands Hospital. Adam was awarded the University Scholars Award which provided funding for him to conduct two senior theses: one on the impact of sleep on Obsessive-Compulsive Disorder (OCD) and a second which developed the first measure of insight for children with OCD. As a result of his academic achievement, he graduated with highest honors in 2010.

Adam currently is in his second year of his doctoral training in Clinical and Health Psychology at the University of Florida, under the mentorship of Dr. Gary Geffken. His first two years have been spent treating a variety of patients, from youth with OCD to adults with Bipolar Disorder. His research interests include treatment augmentation for youth with OCD and improved classification of Attention-Deficit Hyperactivity Disorder and pediatric Anxiety Disorders. He has submitted a National Research Service Award to the National Institute of Health which he hopes will fund his dissertation that aims to develop a new classification system for Anxiety Disorders. Adam is an avid Gator fan and enjoys traveling around the world.