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Emily Deubler Date

Exploratory Factor Analysis of DISC-IV Impairment for ADHD Diagnosis

By

Emily Deubler
Master of Science in Public Health

Biostatistics and Bioinformatics

Paul S. Weiss, MS

(Thesis Advisor)

Susanna Visser, DrPH

(Reader)

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By

Emily Deubler

B.S.
University of Scranton
2011

Thesis Committee Chair: Paul S. Weiss, MS
Reader: Susanna Visser, DrPH

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Abstract

Exploratory Factor Analysis of DISC-IV Impairment for ADHD Diagnosis

By: Emily Deubler

Introduction: Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that affects an estimated 6.4 million school-aged youth. Many clinicians rely on the Diagnostic and Statistical Manual of Mental Disorders (DSM) for an ADHD diagnosis. As the diagnosis of ADHD relies on a set of subjective responses to assess objective criteria, ADHD remains complicated to diagnose. As a result, DSM has undergone numerous revisions, the most recent which maintains the symptom and impairment criteria, but drops the multi-axial system which previously suggested a global assessment of functioning for a diagnosis. The goal of this paper is to perform an exploratory factor analysis to investigate the factors of impairment associated with ADHD and the four most common co-occurring mental disorders (generalized anxiety, major depression, CD and ODD) and determine whether a composite scale of impairment would be more valid when assessing the impairment criteria for a diagnosis of ADHD.

Methods: An exploratory factor analysis was performed on the Diagnostic Interview Schedule for Children Version IV (DISC-IV) impairment questions related to ADHD-I, ADHD-H, generalized anxiety, major depression, CD and ODD. Subsequently, a sensitivity analysis was performed to determine the validity of the results by adding a random uniform deviate to create 10 new datasets, and performing ten additional exploratory factor analyses. Empirical 95% confidence intervals of the Cronbach's alpha values for all of the datasets were computed to determine the reliability of the initial results.

Results: The results of the factor analysis illustrated that the factors generally grouped together by condition as there were two ADHD factors, one CD factor, one GA factor, one MD factor and one ODD factor. The results of the sensitivity analysis yielded a mean Cronbach alpha greater than 0.70 for each of the factors, illustrating a reliable scale.

Discussion: The results of this analysis demonstrate the validity of relying on condition-specific criteria for the diagnosis of ADHD, as the factors grouped by condition. These results also support the revision of the DSM criteria from the multi-axial system, suggesting that the multi-axial system may not increase the validity of the diagnosis of certain conditions.

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1: INTRODUCTION

Attention-Deficit / Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that has been diagnosed in an estimated 6.4 million school-aged youth with an increase in prevalence occurring over the past decade (Visser et al., 2014). ADHD is characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development (American Psychiatric Association, 2013). The high prevalence rates of ADHD highlights the importance of the understanding and correct diagnosis of the condition (Bell, 2011). Many clinicians rely on the Diagnostic and Statistical Manual of Mental Disorders (DSM) to assess criteria for a diagnosis (American Psychiatric Association, 2013). However, the diagnosis of ADHD relies on a set of subjective responses to a set of objective criteria. To increase the internal validity of the diagnosis, the DSM has undergone numerous revisions regarding criteria for ADHD. The most recent revision of DSM resulted in a dropping of a multi-axial system, which required a global assessment of functioning for a diagnosis (American Psychiatric Association, 2013).

1.1 Problem Statement

The case definition of ADHD used by the Project Learn about ADHD in Youth (PLAY) study incorporated the National Institute of Mental Health's Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV) to assess functional impairments related to ADHD. However, due to the high prevalence of comorbid conditions associated with those who have ADHD, impairment is often difficult to attribute to ADHD versus other mental disorders. Thus,

assessing only ADHD-specific impairment could potentially lead to an underestimation of prevalence.

1.2 Purpose Statement

The purpose of this paper is to perform an exploratory factor analysis to investigate the factors of impairment associated with ADHD and the four most common co-occurring mental disorders (generalized anxiety, major depression, conduct disorder and oppositional defiant disorder) and determine whether it would be beneficial to use a more composite scale of impairment when assessing the impairment criteria for a diagnosis of ADHD. A factor analysis will be used to determine what disorders and what questions group together, and if common factors occur across different disorders. The goal of the factor analysis is to increase the internal validity of the assessment of impairment regarding an ADHD diagnosis.

1.3 Significance Statement

This paper will provide evidence either for or against the use of a more global indicator of impairment with regards to the diagnosis of ADHD. The newest addition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) has dropped the multi-axial assessment that was previously used in the earlier versions, and thus there is no longer a requirement for a global assessment of functioning. Therefore this paper will also serve as evidence to either support or oppose this new revision.

2: BACKGROUND/LITERATURE REVIEW

Study Topic: Attention-Deficit / Hyperactivity Disorder

2.1 ADHD Overview

Attention-Deficit / Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that has been diagnosed in an estimated 6.4 million school-aged youth (Visser et al., 2014). According to recent research, the prevalence of ADHD has been increasing over the past decade. The nation-wide prevalence of US children 4-17 years old who ever had a diagnosis of ADHD was 7.8% in 2003, 9.5% in 2007, and 11.0% in 2011 (Visser et al., 2014). Though ADHD is usually diagnosed first in childhood, about one in three children with ADHD meet criteria for the disorder into adulthood (Barbaresi et al., 2013). According to the latest version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), ADHD is defined as a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development (American Psychiatric Association, 2013). ADHD can be further divided into subtypes including predominantly inattentive presentation, predominately hyperactive-impulsive presentation, and a combined presentation. Those who have an inattentive presentation may be unable to give close attention to detail, and also may have difficulty sustaining attention at school or at work. Other symptoms include difficulty organizing tasks, being easily distracted, and having trouble following directions and finishing schoolwork. Those who have a hyperactive-impulsive presentation often fidget or squirm, have difficulty waiting his or her turn, and is often on the go. Other symptoms include blurting out answers before questions are being asked, or interrupting or intruding on others. Those who have a combined presentation will include symptoms from both the inattentive and hyperactive-impulsive subtypes (American Psychiatric Association, 2013).

Often times those who are diagnosed with ADHD are also diagnosed with comorbid conditions, most prominently the externalizing conditions of oppositional defiant disorder (ODD) and conduct disorder (CD) (Perou et al., 2013). Perera (2012) performed a cluster analysis of psychometric profiles of an adolescent and child sample of ADHD cases and controls, and found that the adolescent group clustered into those without comorbidity and those with externalizing comorbidity, concluding that there is a distinct pathological entity for those with ADHD and an externalizing comorbid condition (Perera et al., 2012). There are various estimates of prevalence of comorbid conditions among those who have ADHD. For example, a study by Bird et al (1994) estimated that 17.1% of those with ADHD also had CD/ODD, 9.2% of those with ADHD also had an internalizing condition such as anxiety disorder and depression, and 68.5% of those with ADHD also had CD/ODD and an internalizing condition (Bird, Gould, & Staghezza-Jaramillo, 1994). According to Gillberg (2004), 60-100% of those with ADHD also have at least one other DSM condition, the most prominent co-occurring conditions being ODD or CD, with an estimate of about 50-60% of children with ADHD also having ODD. Furthermore, children who have ADHD without the early signs of ODD may present with an internalizing condition, such as anxiety, in adolescence (Gillberg et al., 2004).

2.2 ADHD Diagnosis and DSM

While ADHD remains prevalent in the United States, it is still complicated to diagnose partially due to its behavioral nature, the subjective interpretation of the impact of symptoms, and the high rates of comorbidity that exist among ADHD. The complicated nature of the diagnosis of ADHD is further illustrated in the numerous revisions that have occurred in the Diagnostic and Statistical Manual of Mental Disorders (DSM) which provides criteria for the diagnosis of ADHD (Wolraich, Hannah, Pinnock, Baumgaertel, & Brown, 1996). The first two

DSM editions (DSM-I and DSM-II) were very descriptive in nature. However, there was a shift from a descriptive nature to an approach for a criterion based diagnosis in DSM-III. With regards to ADHD, DSM-III (American Psychiatric Association, 1980) criteria for ADHD conceptualized three different dimensions of ADHD, attentive, impulsivity, and hyperactivity, and two different subtypes: Attention Deficit Disorder with hyperactivity and Attention Deficit Disorder without hyperactivity. The revision of DSM-III to DSM-III-R (American Psychiatric Association, 1987) shifted ADHD from these three dimensional criteria to a unidimensonal criteria. This again changed in the revision of DSM-III-R to DSM-IV (American Psychiatric Association, 1994) where ADHD was classified as a two dimensional condition (inattention and hyperactivity/impulsivity), with three different subtypes: predominantly inattentive, predominantly hyperactive-impulsive, and a combined type (Biederman et al., 1997; Wolraich et al., 1996). DSM-5, the most current revision of the DSM, (American Psychiatric Association, 2013) maintains the two dimensional and three subtype diagnostic criteria for ADHD.

In addition to the changes in the number of subtypes and the dimensions of ADHD, there have also been revisions regarding the overall multi-axial system that was used for previous versions of the DSM. The multi-axial system was introduced in DSM-III and remained until the newest edition of the DSM-5 (Nevid, Rathus, & Greene, 2003). The multi-axial assessment looked at five different axes with regards to diagnosis: 1) general psychiatric disorders; 2) combined mental retardation and personality disorders; 3) general medical conditions, 4) psychosocial and environmental problems; and 5) global assessment of functioning scale. However, the most recent version of the DSM dropped the multi-axial assessment so there is no longer a need for a global assessment of functioning for an ADHD diagnosis.

2.3 Impairment and DISC

While the DSM-5 no longer requires a global assessment of function, it does have strict criteria for the diagnosis of ADHD, which consists of at least 6 or more symptoms of inattention and/or hyperactivity-impulsivity, an onset age prior to 12 years old, symptoms being present in two or more settings, and clear evidence that the symptoms interfere with social, academic, or occupational function (significant impairment) (American Psychiatric Association, 2013). Although there are specific criteria regarding a diagnosis of ADHD, some of these are not always met. For example, Angold (1999) reported that 11.5% of a sample study received a mental health diagnosis without actually having significant impairment (Angold, Costello, Farmer, Burns, & Erkanli, 1999).

Impairment can be measured using a number of tools, one of which is the Diagnostic Interview Schedule for Children (DISC), a diagnostic instrument designed to be used by nonclinicians to assess more than 30 psychiatric disorders occurring in children and adolescents (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). The DISC consists of an introductory module containing demographic information, and then six subsequent modules which contain related diagnoses. The DISC includes questions involving the onset of conditions as well as questions involving the impairment from the symptoms of the conditions. The questions that are asked are uniform across all diagnoses and address the six domains in which the impairment might be present: 1) getting along with parents/caretakers; 2) participating in family activities; 3) participating in peer activities; 4) academic/occupational function; 5) relationships with teachers/boss; and 6) distress attributable to symptoms (Shaffer et al., 2000).

Statistical Method: Factor Analysis

2.4 Overview

Exploratory factor analysis has been widely used in psychological research, although it has been criticized for its lack of contribution to theory development and its application (Fabrigar, Wegener, MacCallum, & Strahan, 1999). The primary purpose of a factor analysis is to describe the covariance relationships among many variables in terms of a few underlying, unobserved factors which are not directly measured (Johnson & Wichern, 1992). This analysis is based on the common factor model which assumes that each of the measured variables is a linear function of one or more common factors and also one unique factor, and this model is able to reflect the fact that most measurements in psychological research contain some random error. The common factors that are produced by an exploratory factor analysis are unobservable, but are presumed to account for the correlations that occur between the measured variables (Fabrigar et al., 1999).

2.5 Methodological Decisions

There are numerous decisions that need to be considered when running a factor analysis, and the decisions can have a large impact on the reliability of results. These decisions include, but are not limited to, what variables to include, the factor extraction methods, the selection of the number of factors, and the rotation method that will be used (Fabrigar et al., 1999; Floyd & Widaman, 1995). With respect to the number of variables, research suggests that at least three to five measurements should significantly load on each factor (Fabrigar et al., 1999) and therefore the number of measurable variables that are selected for the analysis should be at least three times the number of expected common factors. It is also important to consider the psychometric

properties of measurements, with special regard to those measured variables with low communalities because they can cause distortion in results. Low communality can occur when there is low reliability, or when a variable does not have much in common compared to the other measured variables in the factor. Thus, a crucial step of factor analysis is to consider the validity of the measured variables when selecting which ones to include for the analysis (Fabrigar et al., 1999).

With regards to factor extraction, the most commonly used methods are principle factor analysis, which consists of eigenvalue-eigenvector decomposition of a correlation matrix, maximum likelihood factor analysis, which consists of an iterative procedure which finds factors that maximize the likelihood of the data, and unweighted least squares which is a noniterative alternative to the maximum likelihood method (Truxillo & Hamer, 2003). An advantage of the maximum likelihood method is that it allows for statistical significance testing of factor loadings, however it assumes multivariate normality (Fabrigar et al., 1999). On the other hand, principle factor and unweighted least squares methods do not assume anything about the underlying distribution, but they also provide limits with respect to statistical testing.

Another important consideration with regards to factor extraction is the prior communalities estimate that will be used. Communalities refer to the amount of variation in the manifest variables that is expected to be explained by the common factors (Truxillo & Hamer, 2003). Exploratory factor analysis uses initial estimates of communalities to build the model. There are numerous methods that can be used to estimate prior communalities, but the three most common include: the highest correlation of a variable with the remaining variables, the squared multiple correlation of a variable with the remaining variables, and iterated estimates. A strength

of using the squared multiple correlation is that it can be considered to be the lower bound of the communality estimate (Floyd & Widaman, 1995).

One of the most researched methodological decisions regarding factor analysis is the number of factors that should be retained to adequately represent the sample (Preacher, Zhang, Kim, & Mels, 2013). An incorrect selection of factors, both too few and too many, can cause erroneous results (Fabrigar et al., 1999; Ledesma & Valero-Mora, 2007). Too few factors can cause a false loading of variables on the maintained factors and therefore cause an incorrect interpretation of the model (Fabrigar et al., 1999) while too many factors may cause an over complexity of the data to occur. Many methodologies exist with respect to the number of factors that should be obtained. One such methodology, the Kaiser criterion, suggests that the number of factors to obtain should be equal to the number of eigenvalues computed that have a value greater than or equal to one. An eigenvalue essentially represents the variance in all the variables that is accounted for by that factor, or the amount of information that is captured by a factor (DeVellis, 2012). The rationale behind choosing one as the lower bound for the eigenvalue criterion stems from the idea that a component with an eigenvalue less than one will contain less information than the average item (DeVellis, 2012) and would also have a negative reliability (Cliff, 1988), therefore not being useful for the scale. However, this criterion may be viewed as being arbitrary, and leading to over factorization (Fabrigar et al., 1999; Hayton, Allen, & Scarpello, 2004; Ledesma & Valero-Mora, 2007). A second criterion that can be used to determine the number of factors to obtain in a model is the "scree test" (Cattell, 1966), which plots the eigenvalues in descending order for each potential factor. This plot often shows an "elbow" where there is a significant drop in eigenvalue (Hayton et al., 2004; Truxillo & Hamer, 2003), and thus the model should include the number factors present prior to the last drop.

However, one major criticism of this selection criterion is its great subjectivity (Fabrigar et al., 1999), due to the lack of an objective cut off point (Ledesma & Valero-Mora, 2007). An additional method to determine the number of factors to obtain involves assessing the interpretability of the factors. With respect to interpretability, variables that are within a factor should share a common meaning, and variables between factors should measure different constructs (Truxillo & Hamer, 2003). Additionally, there should be at least three items loading on each factor, and the items should have a large enough loading value to be considered significant to the factor.

There have been large discrepancies regarding what factor loading value is considered to be significant. Factor loadings greater than 0.3 or 0.4 are generally considered to be meaningful (Floyd & Widaman, 1995), however Peterson (2000) performed a meta-analysis of factor loading values and concluded that studies range from using a value of 0.2 to 0.7. He also concluded that the most common cutoff value was 0.4 (used in 33% of studies), followed by 0.3 (used in 26% of studies), followed by 0.5 (used in 19% of studies). It has also been noted that those greater than $\pm$0.3 are considered to meet the minimal level for the model, those greater than $\pm$0.4 are considered more important, and those greater than $\pm$0.5 are considered to be practically significant (Hair, Anderson, Tatham, & Black, 1998; Peterson, 2000).

Rotation methods must be used in order to increase the interpretability of the factors after they have been extracted. These rotations allow for a simpler structure to be achieved from the factor analysis where each variable loads highly on a single factor and has smaller loadings on all remaining factors (Johnson & Wichern, 1992), although this is not always the case. Factor rotation methods can be categorized into two different classifications: orthogonal rotation methods and oblique rotation methods (Floyd & Widaman, 1995; Rennie, 1997). Orthogonal

rotation methods are appropriate for factor models where the common factors are independent, while oblique rotation methods allow for correlations to occur between factors (Johnson & Wichern, 1992; Truxillo & Hamer, 2003). While there are numerous types of orthogonal rotation methods, the varimax rotation method (Kaiser, 1958) is the most commonly used throughout the social and behavioral sciences. This rotation method maximizes the variance of a column of the factor pattern matrix (Truxillo & Hamer, 2003). An advantage of using an orthogonal rotation method, such as varimax, is its conceptual clarity and simplicity with regards to the interpretation of factors (Fabrigar et al., 1999). In contrast to the varimax rotation method, the promax rotation method is an oblique method which is performed in two steps: first the varimax rotation method is performed and then the orthogonality requirement is relaxed and factors are further rotated to maximize the variance between the common factors (Truxillo & Hamer, 2003). An advantage of an oblique rotation method is that it may provide more accuracy and reliability because it does not assume that the factors are uncorrelated.

After a scale is developed from the results of an exploratory factor analysis, the reliability of the scale should be determined. The most commonly used method to determine the reliability of a scale from an exploratory factor analysis is Cronbach's alpha (Cronbach, 1951), which is a more generalized form of the KR-20 formula (Kuder & Richardson, 1937) which was used to determine the reliability of a dichotomous rating scale. Cronbach's alpha can be used for measures with multiple response categories, and represents the average correlation of items within the scale. Cronbach's alpha has the following formula:

$$\alpha = \left(\frac{n}{n-1}\right)\left(\frac{\sum_{i \neq j} cov(Y_i Y_j)}{var(Y_o)}\right)$$

Where n is the number of variables, **Y** are the variables in the scale, and Y_o is the sum of all the variables in **Y.** A Cronbach's alpha score of 0.7 or greater indicates a reliable scale (Truxillo & Hamer, 2003).

2.6 Confirmatory Factor Analysis

Though a confirmatory factor analysis will not be completed in this report, this technique has been performed to determine the appropriate model to evaluate the occurrence of ADHD. A confirmatory factor analysis is used to evaluate whether a predetermined factor model provides a good fit to the data (Floyd & Widaman, 1995), and therefore can be used to confirm results found in an exploratory factor analysis. Pillow (1998) performed a confirmatory factor analysis to determine which model would adequately capture ADHD occurrence. The results of this study illustrated that support existed for different models of ADHD. There was support for a 3-factor model, representative of the DSM-III ADHD criteria, where inattention, impulsivity, and hyperactivity were considered to be three separate constructs. There was also support for a 2-factor model, representative of the DSM-IV criteria, where impulsivity and hyperactivity were combined, while inattentiveness was its own construct. However, this only occurred when ADHD and CD/ODD symptoms were examined together rather than just ADHD symptoms alone (Pillow, Pelham Jr, Hoza, Molina, & Stultz, 1998). Additionally, Burns (2001) performed a confirmatory factor analysis to evaluate the use of five different models considering both ADHD and ODD. This study did not include CD, as it was argued that CD symptoms do not occur enough to be used in the analysis. The results of the study illustrated that a 3-factor model including an inattentive, hyperactivity/impulsivity, and ODD factor produced a well-fitting model for the organization of these symptoms (Burns, Boe, Walsh, Sommers-Flanagan, & Teegarden, 2001).

3. METHODOLOGY

3.1 Study Design

Project to Learn about ADHD in Youth (PLAY), a prospective cohort study, was conducted in two research sites, the University of Oklahoma Health Sciences Center and the University of South Carolina. The baseline assessments of the study were conducted between 2002 and 2006 and were designed to assess the community-based prevalence rates of ADHD, the rates of comorbidity, and the rates of health risk behaviors among children with ADHD. The study was conducted using a two phase design; the first phase of the study comprised a school-wide screening (including teacher report and ADHD diagnosis) and those who either screened high risk for ADHD by teacher report, were identified as having ADHD or were taking medication for ADHD by parent or teacher report were invited for the second phase of the study. Phase I of the study was conducted in six different school districts, one in South Carolina and five in Oklahoma. The school districts that were selected comprised different communities including rural, suburban, and urban, and thus the student population was diverse. The target population for this study was children in elementary school, specifically from kindergarten to fifth grade. Both the South Carolina and Oklahoma sites used a representative sampling procedure. All children identified as high ADHD risk, as well as a gender proportional sample of remaining children who were identified as low ADHD risk, were invited to participate in an interview on diagnosis, symptoms and associated health risk behaviors.

Additionally, a follow up study was conducted to investigate the trajectory of symptoms, functioning, services and other developmental outcomes for non-clinical samples of youth, identified with and treated for ADHD. The final sample size for the South Carolina study was

481, and 379 had at least one follow-up interview. Data from the South Carolina contributed to this analysis. Data from the Oklahoma site was not used in this analysis, but could be used for future research involving the results from this report, such as for a confirmatory factor analysis.

3.2 Measurements

3.2.1 Phase I: ADHD Screening

For phase I of the South Carolina PLAY study site, each student was assessed for ADHD risk using a teacher-reported screener and a two-question screener completed by both the parents and teachers. The teacher-reported screening instruments included the Vanderbilt ADHD Diagnostic Rating scale (Wolraich, Bard, Neas, Doffing, & Beck, 2013) which measured the core symptoms of ADHD, and the impairment section of the Strengths and Difficulties Questionnaire (Goodman, 2001) which measured general behavior and associated functioning. The two-question screener asked parents and teachers if the child had ever been diagnosed with ADHD and if the child was currently taking medication for ADHD.

The screening data were used to stratify the students into either the high ADHD risk or low ADHD risk groups. Students were classified as high ADHD risk if they had six or more ADHD core symptoms in either or both of the ADHD dimensions on the Vanderbilt ADHD Diagnostic Rating scale, and had intermediate impairment ratings on the Strength and Difficulties Questionnaire, or if their parent or teacher report indicated that they had received an ADHD diagnosis or were taking medication for ADHD. All remaining children were categorized as low ADHD risk. Children from four sex-by-screening status strata were recruited into the baseline interview. Out of the 481 children whose parents completed the baseline

interview in the South Carolina study site, 133 were high-screen for ADHD and the remaining 348 were low-screen for ADHD.

3.2.2 Phase II: Diagnostic Interview for Mental Disorders

In Phase II of the study, the child-reported instruments included the Diagnostic Interview for Children (DISC-IV) (Shaffer et al., 2000), the Marsh Self-Description Questionnaire (Marsh, 1990), and the Pediatric Quality of Life Inventory (Varni, Seid, & Rode, 1999). The parent-reported assessments included a demographic survey, a developmental assets survey, the Health Risk Behavior Survey (Centers for Disease Control and Prevention, 2013), the Parent-Child Relationship Inventory (Gerard, 1994), a parent's Mental Health Questionnaire, a parent Pediatric Quality of Life Inventory, a parent version of the Vanderbilt ADHD Diagnostic Rating scale, and a parent version of the Strengths and Difficulties Questionnaire, as well as the Diagnostic Interview for Children (DISC-IV), which will be the primary focus of this analysis.

The PLAY study followed the DSM-IV guidelines for the case definition of ADHD. The DSM-IV criteria includes a symptom count of six or more, a positive DISC-IV impairment rating, which occurred if at least one of the DISC-IV ADHD impairment questions were rated severe or two were rated moderate, and also an age of onset before 7 years. In order to be considered an ADHD case for the PLAY study children had meet the following criteria (Wolraich et al., 2012): The high ADHD risk children who had six of more symptoms and some impairment, as reported by teachers, also needed to have six or more symptoms and a positive DISC impairment rating, as well as an onset age before 7 years. The high ADHD risk children who had a report of ADHD diagnosis or current ADHD medication also had to have six or more symptoms and positive DISC impairment rating, an onset age before 7 years, and also at least

four teacher-reported screening symptoms. The low ADHD risk children were classified as an ADHD case if they had six or more symptoms and positive impairment rating, an onset age before 7 years, and also at least four teacher-reported symptoms and "some" Strength and Difficulties Questionnaire impairment.

3.3 DISC-IV

The DISC-IV assesses about 34 diagnoses in 26 diagnostic sections that are arranged into six modules of related diagnoses. The PLAY study looked at four out of the six modules to assess various conditions; the anxiety disorders module, which assesses social phobia, separation anxiety disorder, specific phobia, panic disorder, agoraphobia, generalized anxiety disorder, selective mutism, obsessive-compulsive disorder, and post-traumatic stress disorder; the mood disorders module, which includes major depressive episode/ dysthymic disorder, and manic/hypomanic episode; the disruptive behavior disorders modules, which assesses ADHD, ODD, and CD, and the schizophrenia module. For the purpose of this analysis, only questions pertaining to impairment for ADHD (ADHD-Inattentive and ADHD-Hyperactive) and the four most commonly co-occurring mental disorders (generalized anxiety disorder (GA), major depression/dysthymic disorder (MD), conduct disorder (CD), and oppositional defiant disorder (ODD)) will be considered.

Each parent was asked whether or not the child had a specific problem associated with each condition; for ADHD-Inattentive the problem was trouble paying attention or concentrating, for ADHD-Hyperactivity the problem was being overactive; for ODD the problem was being angry or uncooperative; for CD the problem was threatening, being in a fight, or hurting someone or something; for major depression the problem was feeling sad, depressed/grouchy, or

irritable; and for generalized anxiety disorder the problem was worrying about different things. The parent was then asked the following questions related to the impairment involving the aforementioned symptoms: how often did the child's caretakers get annoyed or upset with him/her because he/she was this way; how often did being this way keep the child from doing things or going places with his/her family; how often did being this way keep the child from doing things or going places with other people his/her age; how bad were the problems the child had with his/her schoolwork because he/she was this way; how often were the child's teachers annoyed or upset with him/her because he/she was this way; and how bad did this seem to make the child feel. Each question was graded on a 3-point scale, with one being the least severe and three being the most severe.

3.4 Statistical Analysis

The PLAY ADHD case definition used the ADHD-specific DISC-IV impairment ratings when assessing ADHD criteria. SAS statistical software version 9.3 was used to perform an exploratory factor analysis to determine whether it would be psychometrically more sound to use a composite scale that includes the assessment of ADHD-I, ADHD-H, generalized anxiety, major depression, conduct disorder and oppositional defiant disorder, when assessing the impairment criteria for a diagnosis of ADHD. The factor analysis therefore included each of the six questions for the six conditions previously mentioned (Table 1), resulting in a total of 36 variables. An initial factor analysis was run using the principle factor analysis method to extract the factors, with all prior communality estimates set to equal the squared multiple correlations. The varimax rotation method was used in order to make the factors more interpretable, which assumes that uncorrelated factors are on perpendicular axes.

To determine the number of factors to retain, both the scree test and the interpretability of the factors were considered. The scree test was used to plot the eigenvalues that were found in the non-rotated factor patterns, and the number of factors to retain was determined by finding where the elbow in the plot was located. Furthermore, interpretability of the factors was also considered in addition to the scree test results. Interpretability criteria suggests that at least three items loaded on each factor, the factor loading values are greater than 0.5, the variables within the factor share a conceptual meaning and the variables between factors measure different constructs.

After a factor analysis the original PLAY data was run, and the number of factors to retain was determined, a sensitivity analysis was completed to determine the validity of the results. In order to complete the analysis, ten new datasets were created by jittering the original PLAY data. A random uniform deviate from negative 0.4 to positive 0.4 was added to each of the variables to create the new datasets, each using a different seed. This was done in order to introduce some variability into the data to determine if the scale would still be reliable. An exploratory factor analysis was then run on each of the datasets, with the same options as in the original factor analysis; however this time the number of factors was pre-specified by the results from the first factor analysis. Correlations were computed between the variables found in each of the factors of the jittered datasets, and Cronbach's alpha was determined in order to estimate the internal consistency of the scale. An empirical 95% confidence interval of the Cronbach's alpha values for all of the datasets was then computed to determine the reliability of the initial results from the PLAY study data.

4: RESULTS

4.1 Original PLAY Data Results

The initial factor analysis included the analysis of 480 out of 481 observations of the PLAY South Carolina data, due to missing values for one participant. Using the principle factor analysis method to extract the factors, a scree plot was produced with an apparent elbow around factor 5 or 6 (Figure 1). By applying the interpretability criteria to the variables with respect to the factors sharing a conceptual meaning and the variables between factors measuring different constructs, 6 factors were pre-selected for the sensitivity analysis. This represents the fact that it is reasonable to expect that the questions about the six different conditions included in the DISC-IV impairment measurement would load together by condition.

The factor loading for the original PLAY data was as follows: ADHD Factor 1 included questions regarding how bad the child's schoolwork was because of their inattentive symptom (ADHD-I-Q4), how often the teacher was annoyed with the child because of their inattentive symptom (ADHD-I-Q5), how bad the child felt because their teacher was annoyed with them because of their inattentive symptom (ADHD-I-Q6), how often the caretaker was annoyed with the child because of their hyperactive symptom (ADHD-H-Q1), how bad the child's schoolwork was because of their hyperactive symptom (ADHD-H-Q4), and how often the teacher was annoyed with the child because of their hyperactive symptom (ADHD-H-Q5); ADHD Factor 2 included how often the child's hyperactivity or inattentiveness kept them from doing things or going places with their family (ADHD-I-Q2 and ADHD-H-Q2), and how often the child's hyperactivity or inattentiveness kept the child from doing things or going places with other children (ADHD-I-Q3 and ADHD-H-Q3); CD Factor included all CD questions; GA factor

included all GA questions; MD Factor included all MD questions; and OD Factor included all OD questions except how bad the child's problems were with their schoolwork because they were angry or uncooperative (OD-Q4) and how bad the child felt because their teacher was annoyed with them because they were angry or uncooperative (OD-Q6) (Table 1). The Cronbach's coefficient alpha for scale reliability of the original PLAY data yielded an alpha value of 0.844 for ADHD Factor 1; 0.779 for ADHD Factor 2, 0.884 for the CD Factor, 0.831 for the ODD Factor, 0.857 for the GA Factor, and 0.861 for the MD factor.

4.2 Sensitivity Analysis Results

The results from the sensitivity analysis produced six different factors for each dataset, each of which was comprised of variables from the same condition (Table 2). While the factors were comprised of variables from the same condition, there was some variation for which questions had high enough loading values (greater than 0.5) for each factor, and thus for some datasets certain questions would load on a factor, while in other datasets it would not. Therefore, there was variation in those variables which were unused for each of the six factors (Table 3).

With respect to CD, ODD, GA and MD, there was variation between which questions loaded on which factors for 100% of the jittered datasets. For all of the datasets, Q1 significantly loaded in the CD and ODD factors; Q2 and Q3 significantly loaded on the CD factor; Q4 significantly loaded on the GA and MD factor; Q5 significantly loaded on the MD factor; and Q6 significantly loaded on the GA and MD factor (Table 4).

While there were two factors for ADHD, the factors did not group by the subtype (Inattentive or Hyperactive), but rather appeared to group by question (Table 5). In 90% or greater of the jittered datasets ADHD Factor 1 included Q4 and Q5 from both the inattentive and

hyperactive subtypes, and ADHD Factor 2 included Q2 from the inattentive subtype. ADHD-H-Q2 also significantly loaded on ADHD Factor 2 in 70% of the jittered datasets. ADHD-I-Q3 significantly loaded on ADHD Factor 2 in 20% of all datasets, while ADHD-H-Q3 significantly loaded on ADHD Factor 2 in 30% of the datasets. ADHD-I-Q1 loaded on ADHD Factor 2 in 10% of the datasets and ADHD-H-Q1 loaded on ADHD Factor 1 in 40% of the datasets and on ADHD Factor 2 in 20% of the datasets. ADHD-I-Q6 significantly loaded on Factor 1 in 40% of the datasets, while ADHD-H-Q6 did not significantly load on any of the factors in any datasets.

The mean alpha value for the jittered datasets were as follows: ADHD Factor 1: 0.813 (95% CI: 0.810-0.816), ADHD Factor 2: 0.700 (95% CI: 0.693-0.707), CD Factor: 0.791 (95% CI: 0.783-0.799), ODD Factor: 0.784 (95% CI: 0.778-0.789), GA Factor: 0.705 (95% CI: 0.699-0.712), and MD Factor: 0.740 (95% CI: 0.731-0.749) (Table 6).

5: DISCUSSION

The purpose of this report was to determine whether or not a composite impairment scale, spanning across multiple conditions, or a disorder-specific impairment scale would be beneficial when assessing the impairment criteria for an ADHD diagnosis. As comorbid conditions such as oppositional defiant disorder and conduct disorder are prevalent in children with ADHD, it may beneficial to assess a more global impairment scale with respect to diagnostic criteria. While a more global assessment of impairment was recommended as part of the diagnostic process for earlier versions of the Diagnostic and Statistical Manual of Mental Disorders (DSM), it was dropped in DSM-5, further supporting disorder-specific assessments of the mental health disorders. If impairment is attributed to conditions other than ADHD, a condition specific impairment rating may misclassify some individuals as not having the required impairment level, and thus an underestimation of ADHD prevalence may occur. An exploratory factor analysis was performed to determine what the grouping of different questions would be. It would be reasonable to believe that the factors may have grouped by type of question, such as all of the questions regarding getting along with parents/caretakers (all Q1s) would group together, all questions regarding participating in family activities (all Q2s) would group together, all questions regarding participating in peer activities (all Q3s) would group together, all questions regarding academic/occupational function (all Q4s) would group together, all questions regarding relationships with teacher (all Q5s) would group together, and all questions regarding distress attributable to symptoms (all Q6s) would group together, regardless of the symptom/condition referenced in the question. The factors may have also grouped together by specific condition (ADHD-I or ADHD-H, CD, ODD, GA, MD), or by type of condition, i.e. externalizing (ADHD, CD, ODD) vs. internalizing (GA, MD). If the factors had grouped by

characteristics other than by specific condition, then this may have supported the need for a global assessment of impairment for diagnosis.

The exploratory factor analysis of the original PLAY data yielded six different factors, grouped by condition, with the exception of the two ADHD factors, which were not grouped by specific subtype. However, the questions that loaded significantly on each factor also varied by condition. For example, the conduct disorder, generalized anxiety disorder and major depression disorder factors included all questions relating to those conditions, while the oppositional defiant disorder factor did not include Q4 or Q6, which referred to how bad the child's problems were with their schoolwork due to their condition and how bad the child felt because the teacher was annoyed with them due to their condition. These results illustrate that different questions may be more beneficial in assessing impairment for different conditions and therefore it is important to include a variety of questions. Each of the six factors produced a Cronbach's alpha value greater than 0.7, indicating a reliable scale.

Interestingly, the two ADHD factors did not group by subtype (inattentive and hyperactive), but rather seemed to group by question. ADHD Factor 1 included questions for both the inattentive and hyperactive subtype involving issues at school, specifically how bad the problems the child had with their schoolwork because of the condition (Q4) and how often their teacher was annoyed or upset because of the condition (Q5). This factor also included ADHD-I-Q6, which referred to how often the child's caretaker got annoyed or upset with the child, and ADHD-H-Q1 which referred to how bad the child felt because their teacher was annoyed with them. On the other hand, ADHD Factor 2 included questions for both the inattentive and hyperactive subtypes involving issues with going other places, either with the child's family (Q2) or with other children (Q3). The fact that the ADHD factors did not group by subtype, but rather

by question illustrates the idea that it is important to look at multiple questions when assessing impairment. Furthermore, this stresses the importance of looking at impairment with respect to both hyperactivity and inattentiveness, especially because in addition to the inattentive and hyperactive ADHD subtypes, there is also a combined subtype encompassing the other two.

The results of the sensitivity analysis via the ten jittered datasets further illustrates that the variables group together by condition, though there was variation for which variables had high enough loading scores to be included in the factor. Additionally, although the mean Cronbach's alpha that was determined for the 10 datasets were lower than the Cronbach's alpha for the original PLAY dataset, they were all still above 0.7, which represents a reliable scale. Thus the sensitivity analysis provided additional evidence to support the conclusion that impairment factors group by condition, rather than by type of condition or by question.

An interested finding of this study was that a few variables, GA-Q2, GA-Q5, MD-Q2, MD-Q3, and CD-Q4 significantly loaded on the original dataset, but not on any of the jittered datasets. This may be because in the original dataset, 96% or more of the answers to these questions were a "1" and thus the variability was not high enough for the jittered data to produce a representative effect. Another possible explanation is reflective on the measurement instrument; it may be that the questions do not allow for sufficient variability in responses to be useful in diagnosis and thus most of the answers were the same.

5.1 Implications

The results of this analysis illustrate that it is not necessary to include a more composite indicator of impairment when assessing criteria for the diagnosis of ADHD. The factors that resulted from the factor analysis grouped by condition, and thus a condition-specific assessment

of impairment should be able to adequately identify impairment. These results also support the revision of the DSM criteria from the multi-axial system, suggesting that the multi-axial system may not be necessary in the diagnosis of certain conditions. These findings also have important implications for continued public health research. Often it is beneficial to use smaller assessments for financial and time reasons, although it could be thought that a smaller assessment may be less valuable and may actually miss important information. However, these results illustrate the validity in relying on a condition-specific impairment scale in order to make an informed decision regarding impairment for the diagnosis of ADHD.

5.2 Strengths and limitations

This analysis included data from a school-based community study, which can be generalized to the entire school district. Additionally, the fact that a sensitivity analysis involving ten jittered datasets yielded the same results as the original PLAY study data illustrates the reliability of the results. Despite these strengths, there are also some limitations to the analysis. For example, the DISC-IV impairment questions were only on a 3 point scale. A scale with only three options may not allow for enough variability in answers to be useful. Therefore a larger scale may allow for further interpretability of the results. Additionally, another limitation may have been that an orthogonal rotation method was used rather than an oblique rotation method. It is reasonable to believe that the common factors (the different conditions) may be correlated with each other and thus the orthogonal rotation method may have led to misleading results. However, the results of this analysis can still be considered valid using an orthogonal rotation method because the factors still grouped by condition, even despite the possibility of comorbidity in children in the study.

5.3 Recommendations

These results can be useful for future studies regarding ADHD diagnosis and prevalence. With respect to the PLAY data, these results could further be confirmed by performing a confirmatory factor analysis using the Oklahoma data, or using some of the longitudinal follow-up data that was collected. Furthermore, the results could be used to determine whether or not a global assessment of impairment may be used to capture multiple conditions at one time, since the results of this study illustrated that the factors grouped by condition. A possible study would be to use a measurement which offers a broad assessment of impairment, such as the Strength and Difficulties Questionnaire (Goodman, 2001), and compare the results to the condition specific impairment questions, such as the DISC-IV, to determine if the global assessment is sensitive and specific enough to not have to ask every question for each condition, or if it is possible to ask an impairment question without references the specific symptom that is associated with the condition. Additionally, an oblique factor rotation method could be explored to determine if some of the factors appear to be correlated, and if so, could be used as the basis for the interpretability of the factors. Furthermore, these results illustrate that future studies may use condition-specific impairment ratings (such as the ADHD questions for the DISC-IV), when assessing impairment, and not necessarily need to consider impairment across other conditions.

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Appendix: TABLES AND FIGURES

Figure 1: Scree Plot of Eigenvalues for Original PLAY Data

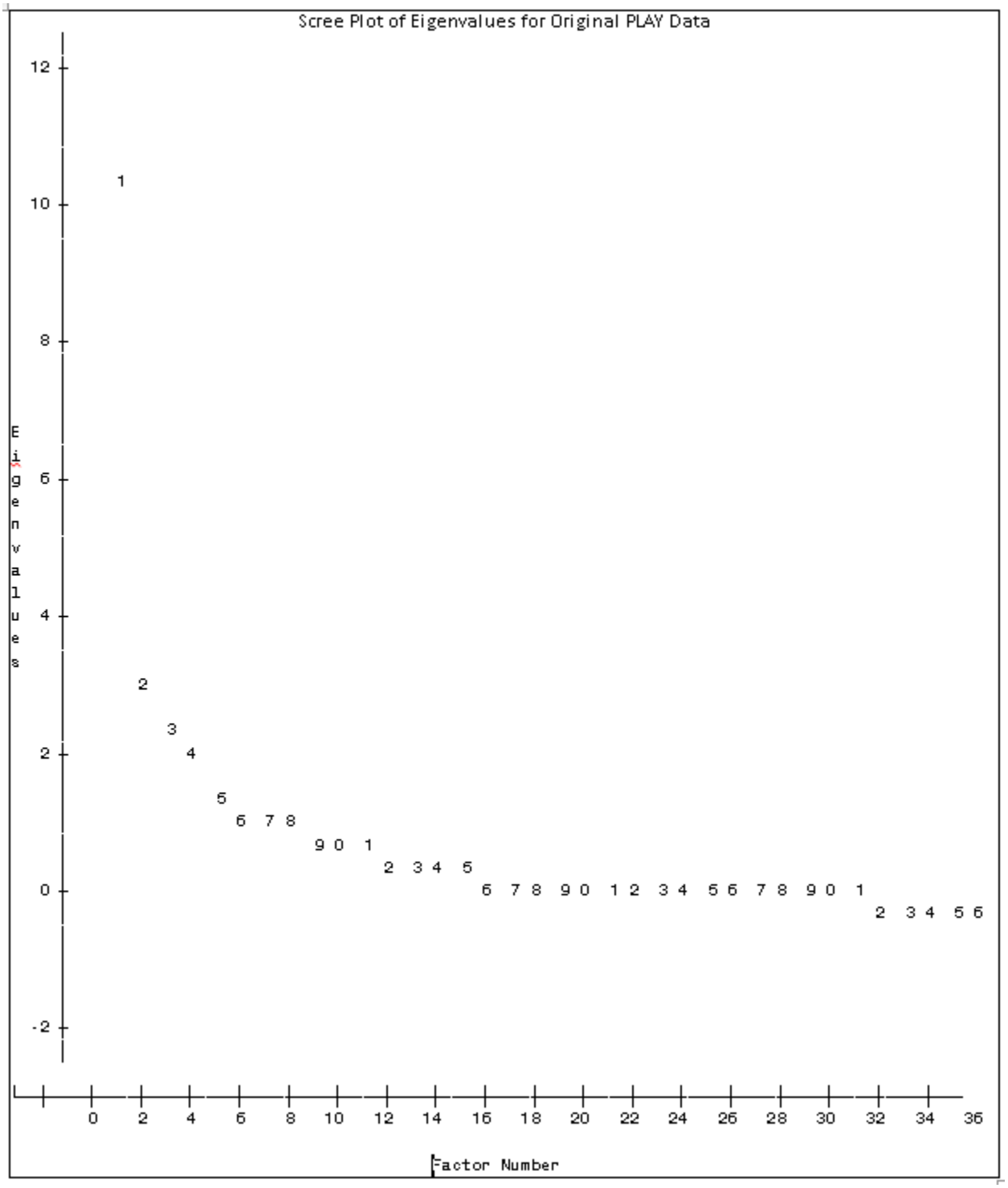

Table 1: List of Questions For Each Condition	
Question Number	**Question**
Q1	How often did [his/her] (CARETAKERS) get annoyed or upset with [him/her] because [he/she] was this way?
Q2	How often did being this way keep [him/her] from doing things or going places with [you (or his/her family)]?
Q3	How often did being this way keep [him/her] from doing things or going places with other [children/people [his/her]] age?
Q4	How bad were the problems [he/she] had with [his/her] schoolwork because [he/she] was this way?
Q5	How often were [his/her] teachers annoyed or upset with [him/her] because [he/she] was this way?
Q6	How bad did this seem to make [him/her] feel?

Table 2: Results of Factor Analysis for 10 Jittered Datasets and Original PLAY Data							
Dataset	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Unused**
1	ADHD-I-Q4 ADHD-I-Q5 ADHD-H-Q1 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	ODD-Q1 ODD-Q2 ODD-Q3 ODD-Q5	GA-Q1 GA-Q3 GA-Q4 GA-Q6	MD-Q4 MD-Q5 MD-Q6	ADHD-I-Q2 ADHD-H-Q2	ADHD-H-Q6 CD-Q4 GA-Q2 GA-Q5 MD-Q2 MD-Q3 ODD-Q4 ODD-Q6 ADHD-I-Q1 ADHD-I-Q3 ADHD-I-Q6 CD-Q5 CD-Q6 MD-Q1 ADHD-H-Q3
2	ADHD-I-Q4 ADHD-I-Q5 ADHD-I-Q6 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	ADHD-I-Q2 ADHD-H-Q1 ADHD-H-Q2 ADHD-H-Q3 ADHD-H-Q5	MD-Q1 MD-Q4 MD-Q5 MD-Q6	ODD-Q1 ODD-Q2 ODD-Q3	GA-Q1 GA-Q4 GA-Q6	ADHD-I-Q1 ADHD-H-Q6 CD-Q4 GA-Q5 ODD-Q4 ODD-Q6 CD-Q5 CD-Q6 ADHD-I-Q3 GA-Q2 GA-Q3 MD-Q2 MD-Q3 ODD-Q5
3	ADHD-I-Q4 ADHD-I-Q5 ADHD-I-Q6 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	MD-Q1 MD-Q4 MD-Q5 MD-Q6	ADHD-I-Q2 ADHD-H-Q2 ADHD-H-Q3	GA-Q1 GA-Q4 GA-Q6	ODD-Q1 ODD-Q2 ODD-Q3	ADHD-I-Q1 ADHD-H-Q6 CD-Q4 CD-Q6 GA-Q5 MD-Q3 ODD-Q4 ODD-Q5 ADHD-H-Q1 CD-Q5 ADHD-I-Q3 MD-Q2 GA-Q2 GA-Q3 ODD-Q6

Table 2: Results of Factor Analysis for 10 Jittered Datasets and Original PLAY Data (continued)							
Dataset	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Unused**
4	ADHD-I-Q4 ADHD-I-Q5 ADHD-I-Q6 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	MD-Q4 MD-Q5 MD-Q6	ODD-Q1 ODD-Q2 ODD-Q3	ADHD-I-Q2 ADHD-H-Q2 ADHD-H-Q3	GA-Q1 GA-Q3 GA-Q4 GA-Q6	ADHD-I-Q1 ADHD-H-Q1 ADHD-H-Q6 CD-Q4 CD-Q6 GA-Q2 ODD-Q4 CD-Q5 MD-Q1 MD-Q2 MD-Q3 ODD-Q5 ODD-Q6 ADHD-I-Q3 GA-Q5
5	ADHD-I-Q4 ADHD-I-Q5 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	ODD-Q1 ODD-Q2 ODD-Q3 ODD-Q5	ADHD-I-Q2 ADHD-H-Q1 ADHD-H-Q2	MD-Q4 MD-Q5 MD-Q6	GA-Q4 GA-Q6	ADHD-I-Q1 ADHD-H-Q3 ADHD-H-Q6 CD-Q4 MD-Q2 MD-Q3 ODD-Q4 ADHD-I-Q6 ADHD-I-Q3 CD-Q5 CD-Q6 ODD-Q6 GA-Q5 GA-Q1 GA-Q2 GA-Q3 MD-Q1
6	ADHD-I-Q4 ADHD-I-Q5 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3 CD-Q5	ADHD-I-Q2 ADHD-H-Q2	ODD-Q1 ODD-Q2 ODD-Q3 ODD-Q5	MD-Q1 MD-Q4 MD-Q5 MD-Q6	GA-Q1 GA-Q3 GA-Q4 GA-Q6	ADHD-I-Q1 ADHD-H-Q1 ADHD-H-Q6 CD-Q4 CD-Q6 MD-Q2 MD-Q3 ODD-Q4 ADHD-I-Q6 ADHD-I-Q3 ADHD-H-Q3 ODD-Q6 GA-Q5 GA-Q2

Table 2: Results of Factor Analysis for 10 Jittered Datasets and Original PLAY Data (continued)							
Dataset	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Unused**
7	ADHD-I-Q4 ADHD-I-Q5 ADHD-H-Q1 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	ODD-Q1 ODD-Q2 ODD-Q3 ODD-Q5	MD-Q1 MD-Q4 MD-Q5 MD-Q6	GA-Q1 GA-Q3 GA-Q4 GA-Q6	ADHD-I-Q2	ADHD-I-Q3 ADHD-H-Q3 ADHD-H-Q6 CD-Q4 CD-Q6 GA-Q2 MD-Q3 ODD-Q4 ODD-Q6 ADHD-I-Q1 ADHD-I-Q6 CD-Q5 MD-Q2 GA-Q5 ADHD-H-Q2
8	ADHD-I-Q4 ADHD-I-Q5 ADHD-H-Q1 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3 CD-Q5 CD-Q6	GA-Q1 GA-Q4 GA-Q6	ODD-Q1 ODD-Q2 ODD-Q3 ODD-Q5	MD-Q4 MD-Q5 MD-Q6	ADHD-I-Q2 ADHD-I-Q3	ADHD-H-Q6 CD-Q4 GA-Q2 GA-Q5 MD-Q2 ODD-Q4 ADHD-I-Q1 ADHD-I-Q6 GA-Q3 MD-Q1 MD-Q3 ODD-Q6 ADHD-H-Q2 ADHD-H-Q3
9	ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	ODD-Q1 ODD-Q2 ODD-Q3 ODD-Q5	MD-Q1 MD-Q4 MD-Q5 MD-Q6	GA-Q1 GA-Q3 GA-Q4 GA-Q6	ADHD-I-Q1 ADHD-I-Q2 ADHD-I-Q3 ADHD-I-Q5	ADHD-I-Q6 ADHD-H-Q3 CD-Q4 CD-Q6 GA-Q5 MD-Q2 MD-Q3 ODD-Q4 ADHD-H-Q6 ADHD-I-Q4 ADHD-I-Q5 ADHD-H-Q2 CD-Q5 ODD-Q6 GA-Q2

Table 2: Results of Factor Analysis for 10 Jittered Datasets and Original PLAY Data (continued)							
Dataset	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Unused**
10	ADHD-I-Q4 ADHD-I-Q5 ADHD-I-Q6 ADHD-H-Q1 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3	ADHD-I-Q2 ADHD-H-Q2	ODD-Q1	MD-Q4 MD-Q5 MD-Q6	GA-Q1 GA-Q4 GA-Q6	ADHD-I-Q1 ADHD-H-Q3 ADHD-H-Q6 CD-Q4 GA-Q2 ADHD-I-Q6 CD-Q5 CD-Q6 MD-Q1 MD-Q2 MD-Q3 ODD-Q3 ODD-Q4 ODD-Q5 ODD-Q6 ADHD-I-Q3 GA-Q3 GA-Q5
Original	ADHD-I-Q4 ADHD-I-Q5 ADHD-I-Q6 ADHD-H-Q1 ADHD-H-Q4 ADHD-H-Q5	CD-Q1 CD-Q2 CD-Q3 CD-Q4 CD-Q5 CD-Q6	GA-Q1 GA-Q2 GA-Q3 GA-Q4 GA-Q5 GA-Q6	MD-Q1 MD-Q2 MD-Q3 MD-Q4 MD-Q5 MD-Q6	ADHD-I-Q2 ADHD-I-Q3 ADHD-H-Q2 ADHD-H-Q3	ODD-Q1 ODD-Q2 ODD-Q3 ODD-Q5	ADHD-I-Q1 ADHD-H-Q6 ODD-Q4 ODD-Q6
Alpha	**0.844**	**0.884**	**0.857**	**0.861**	**0.779**	**0.831**	

Table 3: Frequency of Non-Loading Questions in the 10 Jittered Datasets	
Question	**Percent**
ADHD-I-Q1	90
ADHD-I-Q3	80
ADHD-I-Q4	10
ADHD-I-Q6	70
ADHD-H-Q1	40
ADHD-H-Q2	30
ADHD-H-Q3	70
ADHD-H-Q6	100
CD-Q4	100
CD-Q5	80
CD-Q6	90
GA-Q1	10
GA-Q2	100
GA-Q3	50
GA-Q5	100
MD-Q1	50
MD-Q2	100
MD-Q3	100
ODD-Q2	10
ODD-Q3	10
ODD-Q4	100
ODD-Q5	40
ODD-Q6	100

Table 4: Frequency of Each Question for the Condition Factors in the 10 Jittered Datasets

Question	CD Factor	ODD Factor	GA Factor	MD Factor
Q1	10	10	9	5
Q2	10	9	0	0
Q3	10	9	5	0
Q4	0	0	10	10
Q5	2	6	0	10
Q6	1	0	10	10

Table 5: Frequency of Each Question for ADHD Factors in the 10 Jittered Datasets

Question	ADHD Factor 1	ADHD Factor 2
ADHD-I-Q1	0	1
ADHD-I-Q2	0	10
ADHD-I-Q3	0	2
ADHD-I-Q4	9	0
ADHD-I-Q5	9	1
ADHD-I-Q6	4	0
ADHD-H-Q1	4	2
ADHD-H-Q2	0	7
ADHD-H-Q3	0	3
ADHD-H-Q4	10	0
ADHD-H-Q5	10	1
ADHD-H-Q6	0	0

Table 6: Alpha Values for the 10 Jittered Datasets and Original Data

Factor	Original PLAY Data	Jittered Data (mean)	95% CI Jittered Data
AD/HD-1	0.844	0.813	(0.810, 0.816)
AD/HD-2	0.779	0.700	(0.693, 0.707)
CD	0.884	0.791	(0.783, 0.799)
ODD	0.831	0.784	(0.778, 0.789)
GA	0.857	0.705	(0.699, 0.712)
MD	0.861	0.740	(0.731, 0.749)