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Social functioning difficulties in ADHD: Association with PDD risk

Erika Carpenter Rich [Licensed clinical psychologist], Sandra K. Loo [Assistant Professor In Residence], May Yang [Statistician], Jeff Dang [Statistician], and Susan L. Smalley [Professor In Residence]

Center for Neurobehavioral Genetics, Semel Institute for Neuroscience & Human Behavior, University of California, Los Angeles, CA

Abstract

Although social difficulties are a common feature of Attention-Deficit/Hyperactivity Disorder (ADHD), little is known about the diversity of social problems, their etiology, or their relationship to disorders of social behavior, such as autism or pervasive developmental disorder (PDD). In 379 children and adolescents with ADHD, social functioning was assessed using the Child Behavior Checklist (Achenbach, 1991). Factor analysis and structural equation modeling revealed two factors that we labeled Peer Rejection and Social Immaturity. A factor reflecting 'PDD risk' was defined from eight items of a separate screening instrument for PDD and examined for its association with these two social factors. There was a significant association with both factors, but the association was much stronger for the Social Immaturity (Standardized Beta [β] = .51) than Peer Rejection (β = .29) factors. Social Immaturity was also associated with a greater number of hyperactive symptoms while high Peer Rejection was associated with increased aggression and lower IQ in the ADHD children.

Keywords

aggression; autism; Child Behavior Checklist; hyperactivity; peer rejection

Introduction

Although social problems are a common associated feature among children with Attention-Deficit Hyperactivity Disorder (ADHD; Cantwell, 1996; Friedman et al., 2003), there is still a paucity of knowledge regarding social problems, their etiology, and particularly their relationship with disorders of social behavior, such as Pervasive Developmental Disorder (PDD). Cantwell (1996) described a type of social difficulty in ADHD by a 'lack of savoir faire' and estimated that this social naivety may affect some 20% of ADHD children and adolescents. Despite this awareness of a sort of poor social understanding, much research on social problems in ADHD has focused on aggressive and oppositional behaviors and their negative effects on social development (e.g., Landau, Milich, & Diener, 1998).

PDD is one umbrella term for the diagnoses of autism, Asperger's Disorder and PDD, Not Otherwise Specified in the DSM classification scheme. PDD is characterized by poor social functioning, typically including a level of poor understanding of social cues (see Krasny, Williams, Provencal, & Ozonoff, 2003 for a review) similar to what Cantwell may have referred to as a 'lack of savoir faire'. Yet, the exploration of the true overlap of PDD and ADHD is

limited in part by the exclusionary criteria of the two disorders under the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; APA, 1994) where a dual diagnosis is precluded (APA, 1994). This overlap will be discussed in greater detail below. An emerging body of literature from both phenotype (Clark, Feehan, Tinline, & Vostanis, 1999; Luteijn et al., 2000) and molecular genetic investigations (Smalley, Loo, Yang, & Cantor, 2005) are beginning to address the common characteristics of some domains of ADHD with those of PDD, and this appears to be an area of needed research. The focus of the present investigation is on the social difficulties of the ADHD child and how risk status for PDD is associated with these social deficits.

Social Functioning in ADHD and PDD

Children with ADHD experience significant social difficulties. It is estimated that approximately 50–60% of ADHD children experience rejection by their peers (Barkley, 1990), whereas only 13–16% of children in elementary school classrooms are rejected (Terry & Coie, 1991). In fact, many ADHD children are disliked within minutes of the initial social interaction (Pelham & Bender, 1982) and then denied further opportunities to practice social skills which, in part, leads to further rejection (Landau et al., 1998). Specific play behaviors have been linked with resulting rejection in ADHD children and include being: bossy, intrusive, inflexible, controlling, annoying, explosive, argumentative, easily frustrated, inattentive during organized sports/games, and violating the rules of the game (Guevremont & Dumas, 1994; Pelham et al., 1990; Taylor, 1994; Whalen & Henker, 1985). Classroom behaviors of children with ADHD associated with being disliked by peers include being off-task, disruptive, help-seeking, defiant, and unable to exhibit self-control (e.g., Flicek, 1992). Multiple studies of social functioning difficulties in ADHD have focused on co-morbid behaviors and ADHD symptomatology as sources of poor social functioning, specifically aggression, disruptive behavior disorders, and hyperactive-impulsive symptoms. Social functioning by ADHD subtype varies somewhat according to rater (e.g., teachers, parents, and peers), however, the general consensus is that all ADHD subtypes are at risk for peer rejection (Carlson & Mann, 2000; Hodgins, Cole, & Boldizar, 2000).

The presence of co-morbid psychiatric disorders tends to exacerbate social impairments in children with ADHD (e.g., Antshel & Remer, 2003; Greene et al., 1996). This is significant when considering that over 2/3 of individuals with ADHD have a co-morbid psychiatric disorder (Cantwell, 1996) with co-morbidity rates reported to be 15–75% with mood disorder, 15–75%, 25% with anxiety, and 30–50% with conduct disorder (CD; Biederman, Newcorn, & Sprich, 1991). Karustis, Power, Rescorla, Eiraldi, & Gallagher (2000) found that anxiety and depression together accounted for 30% of the variance in social impairments in ADHD. Children with both ADHD and a learning disability have also been found to have greater peer relations difficulties than children with only a learning disability (Flicek & Landau, 1985).

Children with PDD are also at risk for peer rejection, perhaps not surprising given that social relatedness difficulties are part of the diagnostic criteria of PDD. One study found that 60% of children with developmental disabilities, including autism, were rejected by their peers (Wolfberg, Zercher, Lieber, Capell, Matias, Hanson, & Odom, 1999). In PDD, the social skills deficits include a preference to play alone, impaired ability to play appropriately with toys, a lack of social reciprocity, difficulty reading nonverbal social cues, a one-sided conversational style, and an impaired ability to understand the emotions, motivations and intentions of peers (e.g., Charlop-Christy & Kelso, 1999; Klin & Volkmar, 1999; Smith, Magyar, & Arnold-Saritepe, 2002; Travis & Sigman, 2000; Twatchman-Cullen, 1998). By the time children with autism reach middle childhood, one study found that they prefer to play alone, engage in much lower level play, and are less cooperative than developmentally delayed peers. These children were also less responsive to the social bids of their peers and less likely to make social bids of

their own (Sigman & Ruskin, 1999). Even high functioning children with PDD suffer from difficulties with social interaction and have trouble integrating the information necessary to achieve a successful social exchange (Klin & Volkmar, 1999).

Diagnostic and symptom similarities between ADHD and PDD

One half to three-quarters of children referred to clinics for PDD also present with significant ADHD symptoms, e.g., inattention, hyperactivity, impulsivity (Goldstein & Schwebach, 2004; Sturm, Fernell, & Gillberg, 2004; Yoshida & Uchiyama, 2004). Moreover, in a study specifically examining the overlap of ADHD and PDD, Frazier et al. (2001) found that 5% of children with ADHD also met criteria for PDD and 83% of children with PDD also met criteria for ADHD. Clark et al. (1999) investigated the presence of autism symptoms in a sample of ADHD children and found the highest mean score on difficulties in social interaction compared with other domains of PDD such as restricted repertoire of activities and interests or problems in verbal and nonverbal communication. Similarly, Luteijn et al. (2000) found that those diagnosed with ADHD were indistinguishable from those diagnosed with PDD-NOS on the Social Insight subscale of one of the measures administered in their investigation. In a study examining twins, those with ADHD-Combined Subtype were the most impaired on a Social Responsiveness Scale when compared to non-ADHD twins (Reiersen, Constantino, Volk, & Todd, 2007). Utilizing the CBCL, Luteijn and colleagues found that the greatest impairments on the Social Problems subscale were in children with PDD-NOS (i.e., the PDD-NOS and comorbid PDD-NOS/ADHD groups). Children diagnosed with only ADHD fared the best on the Social Problems subscale in this study, although these scores were still substantially higher than both clinical and normal control groups (Luteijn et al., 2000). Downs and Smith (2004) investigated the social-emotional abilities of children with autism in comparison to children with ADHD and Oppositional Defiant Disorder (ADHD/ODD) and, contrary to their expectations, discovered that the ADHD/ODD group was more impaired than children with autism or those with no psychiatric diagnoses regarding social-emotional understanding. Collectively, studies demonstrate that the social difficulties present in ADHD and PDD may share similar features as well as severity for certain subgroups of ADHD populations. It remains to be seen, however, if a measure of risk status for PDD might be associated with the particular types of social impairment seen in the ADHD child.

What are the similarities and differences in social problems across ADHD and PDD and what subgroups within ADHD show elevated problems in social functioning? Santosh and Mijovic (2004) hypothesized that two types of social difficulties exist in the ADHD child: one consisting largely of socially inappropriate behavior and one that can be described as more “autistic-like” including an inability to read social cues and a general paucity of responses. Two social subtypes emerged from principal components analysis: Relationship Difficulty (REL; child difficulties interacting with family members and other adults) and Social Communication Difficulty (SCD; child possessing an autistic-like disturbance plus being socially disinhibited and having difficulty getting along with peers). The REL factor was related to conduct and emotional difficulties in a sample of children and adolescents with Hyperkinetic Disorder (similar to ADHD). In this sample, SCD was also related to conduct and emotional difficulties, although less strongly than the relationship between REL and these two constructs. SCD was related to developmental delays, particularly speech and language, and repetitive behaviors. Of the PDD domains surveyed, “difficulties with social reciprocity” was the most common difficulty reported in this sample. These authors contend that children with ADHD exhibit a “PDD-like social impairment profile” (p. 149) in some cases commensurate with the deficits seen in children with PDD (Santosh & Mijovic, 2004). Actual risk status for PDD was not directly assessed in this study, but a screening tool (Autism Screening Questionnaire) was used to evaluate PDD and autism in the sample.

The Present Study—The present study seeks to add to the literature by evaluating both the social problems and the risk status for PDD in a large sample of ADHD children and adolescents drawn from ongoing genetic studies of ADHD. We first estimate the types of social problems evident in the sample, examine the sibling sharing and specific risk factors that may contribute to such social problems, and lastly, examine the relationship of such social problems with measures of risk for PDD.

Methods

Sample

A subset of families with at least one child with ADHD who participated previously in an ADHD Genetics study was included in the current study. From these research studies, a sample of affected sibling pairs diagnosed with ADHD who completed a screening assessment for PDD during the direct interview ($n = 379$) were selected. These children were found within 27 singleton and 165 multiplex families. Comparisons with the total sample of participants from which the current sample was drawn indicated that there were no differences in families that were administered the detailed PDD screen and those without the PDD screen based on measures of social functioning, ADHD symptoms, co-morbid diagnoses, age, sex, or socioeconomic status (data not shown). Families were recruited from the community with advertisements distributed and posted local agencies, support networks, pediatricians and schools.

Procedure

All families were evaluated in a two-step process. First, families were screened for the presence of an ADHD child between the ages of 5 and 18, using the SNAP-IV (Swanson, 1995) behavior rating scale as a screening tool. In addition, subjects were screened for other inclusion (i.e., must be English speaking and have both biological parents available to participate) and exclusion criteria (i.e., full scale IQ less than 70, diagnoses of schizophrenia or autism, or presence of a known genetic conditions associated with ADHD, such as Tuberous Sclerosis, Fragile X, generalized resistance to thyroid hormone). Once the child was deemed eligible to participate, the family was scheduled for a full evaluation.

After providing written informed consent (including assent for participants under age 18) approved by the UCLA Institutional Review Board, parents and children were interviewed directly using the semi-structured interviews, K-SADS-PL (Schedule for Affective Disorder and Schizophrenia for School-Age Children-Present and Lifetime Version; Kaufman et al., 1997) for ages 5–17, and SADS-LAR-IV (Schedule for Affective Disorders and Schizophrenia-Lifetime Version, Modified for the Study of Anxiety Disorders and Updated for DSM-IV; Fyer, Endicott, Mannuzza, & Klein, 1995) for ages 18 and older. The K-SADS-PL was administered to the mother followed by a direct interview with the child if age 8 years or older. Because the KSADS-PL does not systematically assess for autism and other PDDs, the 8-item PDD screener described below was added. The items and a scoring algorithm (Bolton et al., 1998) were used to flag cases for possible PDD/autism. If individuals exceeded the cutoff, the Social Communication Questionnaire (SCQ; formerly known as the Autism Screening Questionnaire; Berument, Rutter, Lord, Pickles, & Bailey, 1999) was administered to distinguish whether the child met symptom thresholds for autism (SCQ of 22 or above) and other PDDs (SCQ of 15 or above; Berument et al., 1999). All interviews were conducted by clinical psychologists or highly trained interviewers with extensive experience in psychiatric diagnoses. Diagnoses were confirmed after a comprehensive review of symptoms, course, and impairment level by board-certified child psychiatrists. Diagnoses were based on all available information, including WISC scores, CBCL scores, etc. All diagnostic categories were dichotomized as either absent or present. Inter-rater reliabilities were computed with a mean

weighted kappa of 0.84 across all diagnoses with a greater than 5% occurrence in the sample. To be included in the study, at least one sibling needed to meet full DSM-IV diagnostic criteria for ADHD (see Smalley et al., 2000 for details).

Measures

PDD-risk was identified using a screening family history interview for PDD symptoms following the Family History Research approach used in genetic studies of Autism/PDD (Bolton, Pickles, Murphy, & Rutter, 1998). The eight PDD screening items probe for evidence of a history of speech delay, past or current difficulty initiating or sustaining conversation, past or current disinterest in playing with others, past or current difficulty in developing friendships, past or current displays of behaving in socially inappropriate ways, past or current poor eye contact, past or current preoccupation with certain interests or objects, and past or current inflexible routines. Responses are either yes or no with a 'yes' requiring significant impairment in functioning.

Family socioeconomic status (SES) was determined using the primary income generator's education and occupation following the Hollingshead scale (1957). Social functioning was assessed using the mother's report on the Social Problem scale of the child behavior checklist (CBCL; Achenbach, 1991; Achenbach & Edelbrock, 1983). The Aggressive subscale was used to assess aggressive behaviors as well. T-scores on these subscales falling between 65 and 70 are considered to be in the borderline clinical range, while T-scores at or above 70 are in the clinically significant range.

Exploratory Analysis

A double-entry verification procedure in SAS, version 9.1 (SAS, 1999), was used for data entry. In addition, all relevant variables were examined using a standardized process detailed in Tabachnick and Fidell (2001) prior to analysis for accuracy and all identification of potential outliers that could impact the proceeding statistical analyses. Two separate analyses were conducted on the CBCL Social Problems and PDD risk items to determine the measurement models and underlying factor structure. Exploratory factor analysis was conducted using maximum likelihood extraction and direct oblimin rotation (a type of oblique rotation). A principal components analysis (PCA) was employed to identify the number of factors to retain for the principal factor analysis. In selecting factor retention, examination of the scree plot along with the Kaiser-Guttman criterion (eigenvalues above 1.0) played a determinative role in the process. The statistical criteria implemented to evaluate factor loadings from the ultimate factor analysis were those established by Comrey and Lee (1992). Items with high loadings on two or more factors were considered for removal in order to generate unidimensional constructs. In addition, factors with only one or two high loading items were considered for removal given the lack of reliability of such scales (Comrey & Lee, 1992; Tabachnick & Fidell, 1996). To provide further assessment of the psychometric quality of the scales internal consistency estimates were calculated to determine the overall cohesiveness of the items. The Cronbach's alpha statistic of .80 or more is typically deemed to suggest a measure is reliable (Anastasi & Urbina, 1998). In this study, internal consistency was determined to be adequate at .70, good at .80, and excellent at .90.

Structural Equation Modeling

A model building approach was employed to examine the measurement models of the social factors defined from the CBCL items and the PDD-risk factor from the items collected in the family history interview. Each measurement model was run separately using the latent variable modeling program Mplus version 4.0 (Muthén & Muthén, 1998–2004). To evaluate the overall fit of models, three goodness of fit indices were computed: the chi square statistic, root mean square error of approximation (RMSEA) and comparative fit index (CFI). The chi square

statistic is used to compare the predicted covariance matrix of the observed values with the actual covariance matrix. Small values suggest minor differences between the two matrices indicating good fit to the data. However, based on recommendations by Bentler (2004), we also used RMSEA and CFI to evaluate model fit since the chi square test has been shown to be sensitive to sample size (Hu & Bentler, 1998). RMSEA is commonly referred to as an absolute fit index and is estimated by taking the square root of the estimated discrepancy divided by the degrees of freedom. RMSEA is bounded below by the value of 0 which indicates perfect fit while larger positive values reflect poorer fit. We interpreted values $\leq .05$ as close fit, $.05-.10$ as adequate fit, and $>.10$ as poor fit (Browne & Cudeck, 1993; Kaplan, 2000). CFI reflects a comparison between the estimated covariance matrix to a baseline model (that assumes no association between the observed variables). Higher CFI values indicated better fit with $.97$ or higher reflecting good fit, $.91-.96$ adequate fit, and $\leq .91$ as poor fit (Kline, 2005). After establishing the structural validity of the measurement model, all of the factors were included in a structural equation model along with hypothesized paths. Modification indexes were then used to guide changes to the final structural model (MacCallum, 1986). Theoretically plausible paths that significantly improved model fit were considered for modification.

The structural equation or latent variable models were estimated using the mean and variance adjusted weighted least squares (WLSMV) procedure to handle dichotomous and categorical variables (Muthén, 1993; Muthén, du Toit, & Spisic, 1997). In addition, robust standard errors were calculated to account for the complex design features (Muthén & Muthén, 1998–2004). This procedure incorporates sampling weights to adjust for the clustering effects and can reduce the bias resulting from the correlation of children nested within families (Lehtonen & Pahkinen, 2004). For the multivariate analyses, missing data made up a small fraction of the total sample (ranged from 1–5%). Missing data were handled using two different procedures: full information maximum likelihood (FIML) and listwise deletion (Allison, 2002). Results are provided for analyses utilizing the listwise deletion procedure since each of the missing data techniques produced similar estimates.

Results

Demographic characteristics

Approximately 29.0% of the sample was female ($n = 110$) and 71.0% male ($n = 269$) with a mean age of 10.41 ($SD = 3.22$). The ethnic breakdown of the sample was as follows: 73.5% Caucasian, 5.6% Hispanic, 1.6% African-American, 2.1% Asian/Pacific Islander and 17.1% Other or Mixed Ethnicity. The average socioeconomic status (SES; Hollingshead, 1957) for the families included in the study was 2.46 ($SD = 0.96$) with approximately 70% of the sample with a SES rank of 2 or 3 (1 is the highest and 5 is the lowest). A majority of the sample was classified with the Inattentive (49.6%, $n = 188$) or Combined subtype (42.0%, $n = 159$) while only 8.4% of the sample was classified with the Hyperactive-Impulsive subtype ($n = 32$). In addition, 42.5% were diagnosed with a co-morbid disruptive disorder (e.g., ODD or CD), 19% with a Mood Disorder, and 6.9% with at least two Anxiety Disorders. Finally, the average IQ of the sample was 107.82 ($SD = 15.80$).

Scores on CBCL behavior scales, PDD risk status items

The CBCL scale behavior scores for the total sample are provided below. The average t-score for the behavior scales was 59.30 ($SD = 9.06$) for withdrawn, 59.65 ($SD = 9.33$) for somatic complaints, 59.52 ($SD = 9.39$) for anxious/depressed, 60.42 ($SD = 10.29$) for social problems, 60.04 ($SD = 9.06$) for thought problems, 67.80 ($SD = 9.24$) for attention problems, 58.62 ($SD = 8.12$) for delinquent behavior, and 61.67 ($SD = 10.52$) for aggressive behavior.

Approximately 15.3% of the sample ($n = 58$) met criteria on the PDD screener items and were subsequently administered the SCQ to provide a more comprehensive evaluation of PDD/Autism. Two individuals had scores on the SCQ above the cutoff for PDD, none exceeded the cutoff recommended for autism; this is consistent with our screening approach considering that a history of autism was exclusionary for study participation. The two PDD cases were included in subsequent analysis although results did not vary when they were excluded (data not shown).

Latent factors derived from exploratory analysis

Using the items from the CBCL Social Problem scale, a two-factor solution was the best-fitting model ($\chi^2 = 30.27$, $df = 10$, $p < .001$; RMSEA of 0.06). The first factor included items 1 (acts young), 11 (clings), 62 (clumsy), and 64 (prefer young) and we labeled this ‘Social Immaturity’. The second factor included items 25 (not get along) and 48 (not liked) and 39 (teased) and we labeled this ‘Peer Rejection’. Item 38 (teased) was theoretically related to peer rejection but loaded on both factors. To improve the reliability of the measures, item 38 was allowed to load on both factors in subsequent analyses. Item 55 (overweight) on the other hand did not have a loading above .32 on either factor and was removed during model refinement. The measurement model of the PDD risk status items revealed that a one factor solution ($\chi^2 = 42.12$, $df = 16$, $p < 0.001$; RMSEA=.067) adequately accounted for the item covariation. Parameter estimates from the exploratory factor analysis are available upon request.

Confirmatory factor analysis of measurement models

The measurement model for each of the two social factors was tested using confirmatory factor analyses based on the results from the exploratory analysis. The path diagram for the two factor model is presented in Figure 1. Many of the model fit indexes suggested that this model fit the data well ($\chi^2 = 33.56$, $df = 10$, $p = 0.002$; CFI = 0.98; TLI = .98, RMSEA = 0.08, and WRMR = 0.83). In addition, reflective indicators on peer rejection and social immaturity had “good” to “excellent” loadings on the latent factors. The correlation between the two factors was also strong suggesting that peer rejection and social immaturity were highly associated with each other.

The measurement model for the PDD risk factor was evaluated within the confirmatory factor analytic framework. All items were included and allowed to load on the PDD risk factor. The single factor solution is marginally adequate when all criteria are examined ($\chi^2 = 30.36$, $df = 11$, $p = 0.001$; CFI = 0.91; TLI = .92, RMSEA = 0.07, and WRMR = 0.92) and as shown in the figure, all of the items loaded strongly on the PDD risk factor.

Each factor was found to have adequate internal consistency (Social Immaturity -Cronbach’s $\alpha = 0.60$, Peer Rejection - Cronbach’s $\alpha = 0.78$, and PDD-risk - Cronbach’s $\alpha = 0.70$). These results provide further support that the revised scales have adequate psychometric properties.

Structural equation models

It was hypothesized that a child’s Peer Rejection and/or Social Immaturity would be associated with PDD-risk if the constructs are reflecting similar domains. Several other variables were also hypothesized to be associated with Peer Rejection and Social Immaturity based on the literature and include: age, sex, socioeconomic status, full scale IQ, co-morbid psychiatric disorders (mood, anxiety, externalizing disorders), number of hyperactive symptoms, and aggression (as assessed by the CBCL Aggression scale).

The structural model including all variables fit the data well ($\chi^2 = 113.15$, $df = 65$, $p = 0.0002$; CFI = 0.94; TLI = .94, RMSEA = 0.05, and WRMR = 1.02). In order to generate that best fitting model, the structural model was rerun allowing variables that were significantly associated with the latent factors to be retained and other variables (non-significant) were

removed. The reduced model (eliminating non-significant paths) fit the data well ($\chi^2 = 95.64$, $df = 48$, $p = 0.001$; CFI = 0.95; TLI = .95, RMSEA = 0.05, and WRMR = 1.04) and is shown in Figure 3. PDD-risk was associated with Social Immaturity with a medium effect size (26% variance) and Peer Rejection with a small effect size (8.4% variance). Both had a positive relationship, indicating the higher the PDD risk, the more socially immature and the greater the peer rejection. Aggression was also associated with both social factors. Each unit increase in IQ was negatively associated with Peer Rejection indicating that children with higher IQ were less likely to have peer rejection, but IQ was not associated with Social Immaturity. Conversely, ADHD symptom count for hyperactive symptoms was associated with Social Immaturity (more hyperactive symptoms, more immature) and not with Peer Rejection.

Discussion

Social skills deficits are a major area of impairment for children and adolescents with ADHD. The results of the present study aid in the understanding of these deficits, both in line with traditional conceptualizations and through a more unique view of the symptoms by comparing them with PDD risk status. In order to examine these social skills difficulties, we used the Social Problems scale of the CBCL, a broad-based behavioral measure that is commonly administered by both researchers and clinicians. Based on the factor analysis, two latent factors were created from seven of the eight Social Problems items of the CBCL, which we labeled Peer Rejection and Social Immaturity. The Peer Rejection factor captured the behaviors typically descriptive of ADHD children, i.e., being teased, not able to get along with others, and not being liked. The Social Immaturity factor was composed of items that are not what one might typically expect to be prototypical of the ADHD child: clingy, preferring younger children, clumsy, and acting young, which may overlap with the social deficits of PDD.

We found that the 'PDD-risk' factor was associated with both the Social Immaturity and the Peer Rejection factors, but to a much larger extent for the former. This suggests that risk for PDD in children with ADHD may lie in a particular subset of behaviors that reflect 'immature' behavior. It should be noted that none of the ADHD cases included in this analysis had scores above the autism cutoff on the SCQ and only 2 exceeded the PDD cutoff. Those numbers needed to be viewed in light of the exclusionary criteria applied at the time of screening for ADHD in subject recruitment (i.e., autism was an exclusionary criteria) and should not be interpreted to reflect an estimate of the frequency of autism in ADHD. Exclusion of the 2 PDD cases did not affect the results at all so the current findings should be interpreted as reflective of social problems in ADHD children *without* PDD/autism. The Social Immaturity factor was associated with increased hyperactivity while Peer Rejection was associated with increased aggression. IQ was only associated with Peer Rejection (higher IQ, less rejected).

Consistent with the literature on social skills deficits, the current findings support the relationship of aggressive behavior to social problems in ADHD children. Aggression was a small but significant predictor of Peer Rejection ($\beta = .34$) and Social Immaturity ($\beta = .38$), indicating that aggression is a valuable area to consider for intervention.

The discovery of a strong relationship between PDD-risk and measures of social difficulties assessed by the CBCL in children with a diagnosis of ADHD opens a new avenue of research. These data support a strong relationship of Social Immaturity as assessed by four CBCL items (clingy, preferring younger children, being clumsy, and acting young) with PDD-risk as assessed by family history interview. A significant (but less strong) association was observed for Peer Rejection. What is the significance of this finding? We think the distinction of two types of social problems in ADHD children – without autism or PDD – reflect important subclinical constructs that may be shared across the two disorders, ADHD and PDD. Building on the findings of Santosh and Mijovic (2004), we found not only that children with ADHD

exhibit aspects of social deficits that are similar to those experienced by children with PDD, but that children with ADHD who also have a higher risk status for PDD are more likely to display these deficits (i.e., Social Immaturity). As we think of social functioning along a continuum, use of the CBCL items, particularly those reflecting Social Immaturity, may identify a subgroup of ADHD children that share etiological underpinnings with PDD/autism.

It may be useful here to conceptualize certain aspects of PDD as being found along a continuum, as well. It could be that rather than PDD being a specific yes/no category, PDD contains characteristics in the social realm (e.g., social immaturity and peer rejection) that are diagnostic by their quantity versus their quality. By utilizing this framework, it can be seen that these characteristics can also contribute to the deficits displayed in other diagnoses, such as ADHD, as examined here. With respect to treatment, the ability to define specific deficits is much more informative than a diagnostic label alone.

The concept of DAMP (deficits in attention, motor control, and perception) may also be relevant to our findings. DAMP consists of children with a diagnosis of both ADHD and Developmental Control Disorder (DCD) who do not have a learning disability or cerebral palsy and has a 4–8% prevalence rate in the general population (Gillberg, 2003). Half of all cases of ADHD meet the criteria for DAMP. Moreover, autism is strongly related to severe DAMP, with two-thirds of these individuals meeting criteria for PDD. Studies have indicated that DAMP, versus ADHD or DCD alone, accounts for autistic features in these populations (Gillberg, 2003). Due to our finding that Social Immaturity, which includes clumsiness, is related to PPD risk, a question emerges as to whether DAMP might better account for the overlap between ADHD and PDD. Unfortunately, our research battery does not assess for developmental coordination difficulties, therefore, future research is needed to answer this question.

Additional research is needed in this area utilizing alternative tools of assessment including genetic, brain imaging methods, and neuropsychological testing to investigate etiological factors that may be shared across diagnostic classifications. We speculate that further research using the Social Immaturity items from the CBCL may help define neurobiological processes of a putative ‘endophenotype’ that may be shared with PDD/autism and useful for genetic investigations. From a clinical standpoint, these four items may identify a subgroup of children within ADHD that are most likely to benefit from social skills programs that prove effective in treatment within the PDD/autism populations, to the extent that the curriculums of these programs match the deficits described here.

Limitations and Future Directions

There are several limitations to the present study. First, the current analyses are based on parent report for the creation of the social factors through the use of the parent-rated CBCL and/or through a family history interview for PDD-risk. Although several of our predictors used alternate methods, it would be important to confirm the findings of the present study through the use of teacher ratings or peer ratings of acceptance, for example, and/or observational ratings of social behavior in naturalistic settings. Second, the current analyses are descriptive and correlational in nature. We do not yet have the biological marker research available to investigate how these social factors may reflect hypothesized shared etiological underpinnings but future research along these lines is planned. Third, these findings are also in need of replication in order to determine the validity of the Peer Rejection, Social Immaturity, and PDD-risk factors. While the internal consistency was adequate in consideration of the small number of items comprising each factor, we would also like to see future research improve upon these psychometrics. Lastly, future research is necessary which includes larger samples of singleton ADHD children as well as children with a diagnosis of PDD. The majority of families in the current study are multiplex so findings may not generalize to the more common

singleton type of family. Research that includes these clinical samples as well as longitudinal data will inform us on generalizability of the findings as well as whether this association will continue across time and represents a qualitative or quantitative delay in social development among children with ADHD.

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Figure 1. Confirmatory Factor Analysis of Social Problems Scale

Rectangles represent information directly measured (observed) and each rectangle in the model stands for an individual item. Circles represent latent variables or unobserved variables that are not directly measured. The relationships or paths between variables are specified through a series of directional lines. Factor loadings are shown for observed variables on the latent factors. Correlations are represented by double-headed arrows.

Figure 2. Confirmatory Factor Analysis of PDD Risk Symptoms Scale

Rectangles represent information directly measured (observed) and each rectangle in the model stands for an individual item. Circles represent latent variables or unobserved variables that are not directly measured. The relationships or paths between variables are specified through a series of directional lines. Factor loadings are shown for observed variables on the latent factors.

Figure 3. Structural equation model of PDD symptoms and Social Problems

Rectangles represent information directly measured (observed) and each rectangle in the model stands for an individual item. Circles represent latent variables or unobserved variables that are not directly measured. The relationships or paths between variables are specified through a series of directional lines. Path coefficients are typically assigned to each line corresponding to the strength of effect. Correlations are represented by double-headed arrows. Model fit indices: $\chi^2 = 95.64$, $df = 48$, $p = 0.001$; CFI = 0.95; TLI = .95, RMSEA = 0.05, and WRMR = 1.04.