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Factors Related to Agreement between Parent and Teacher Ratings of Children's ADHD Symptoms: an Exploratory Study Using Polynomial Regression Analyses

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Abstract

Inter-rater agreement about children's symptoms of attention-deficit/hyperactivity disorder (ADHD) is crucial for accurately identifying and treating children with this condition. Decades of empirical research demonstrate that parents and teachers rarely agree about children's ADHD symptoms, yet few studies have tested the factors that relate to parent-teacher agreement. This exploratory study examined potential associations between parent-teacher agreement about child ADHD symptoms, and child factors (academic functioning, demographic characteristics, externalizing psychopathology, and social functioning), in a community (n = 752; mean age = 7.28; 51.3% male; 46.5% White) and in a clinical (n = 213; mean age = 8.58; 69.0% male; 70.4% White) sample. Agreement was examined using polynomial regression analyses, which overcome mathematical limitations and constraints imposed by using difference scores. Parent-teacher agreement about ADHD symptoms related to several academic and social functioning variables in the community sample. Most relationships were non-linear (e.g., quadratic, cubic). The 3-dimensional distribution of the results revealed that parent-teacher agreement was strongest for children functioning approximately 1 standard deviation below the mean (but not lower) on grades, academic enablers, academic performance, and social functioning. In the clinical sample, only teacher-rated social functioning related to parent-teacher agreement about ADHD symptoms. These findings provide a more nuanced understanding of parent-teacher agreement, thereby advancing theoretical knowledge. An implication for assessment and treatment is that children with very poor, or conversely, very good, social and academic functioning are at risk for parent-teacher disagreement on ADHD symptom ratings.

Keywords Attention-deficit/hyperactivity disorder · ADHD · Informant discrepancies · Parent-teacher agreement · Polynomial regression

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder affecting approximately 5% percent of school-aged children worldwide (Sayal et al., 2018). A childhood diagnosis of ADHD confers elevated risk for adverse outcomes in adolescence and adulthood (e.g., comorbid psychiatric disorders, educational and occupational difficulties, accidents, and criminality; Faraone et al., 2015), suggesting the importance of early intervention. However, concerns also exist about overdiagnosis and overmedication of ADHD, resulting in unnecessary treatment, cost, and adverse medication side effects (Merten et al., 2017). Taken together, these factors underscore the importance of accurate assessment of ADHD.

Current diagnostic criteria for ADHD (American Psychiatric Association, 2013) require that a child shows at least six of nine symptoms of inattention and/or six of nine symptoms of hyperactivity/impulsivity, for 6 months or longer, which appear before age 12 and cause impairment. Because symptoms must be present in two or more settings (e.g., home and school), best practice for diagnosis usually recommends soliciting ADHD symptom ratings from parents and classroom teachers (Owens et al., 2020b). For example, the Canadian ADHD Practice Guidelines (Canadian ADHD Resource Alliance, 2020) state: "Communicating with the

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child or adolescent's school is crucial to collect information... If parent(s) object to having the school involved, the physician should let the parent(s) know that an understanding of any ADHD-related difficulties in the classroom is needed to make a full assessment (p. 8)".

However, informants often provide discrepant ratings of children's behavioral problems. A meta-analysis of 119 studies published over 30 years ago suggested that agreement between different informants (e.g., parents and teachers) was generally low on ratings of child/adolescent problem behaviors ($r = .27$; Achenbach et al., 1987). Recent work has replicated these results, finding average correlations of $r = .21$ and .28 between parents and teachers for ratings of children's internalizing and externalizing problems, respectively (De Los Reyes et al., 2015). Specific to ADHD, many studies report the extent to which parents and teachers agree on children's ADHD symptoms, including in nationally representative samples (e.g., Murray et al., 2018; Narad et al., 2015), and among children referred for ADHD assessment (e.g., Mitsis et al., 2000) or diagnosed with ADHD (e.g., Antrop, et al., 2002). Similar to what is found for other types of behavior problems, most studies obtain small to medium correlations ($.10 < r < .50$) between parent and teacher ratings of ADHD (e.g., Mitsis et al., 2000; Murray et al., 2018; Narad et al., 2015; although see Antrop et al., 2002 [$r < .10$] and Hartman et al., 2007 [$r > .50$]).

Crucially, rather than just reflecting error, informant discrepancies have been posited to provide useful information about variations in the child's functioning across environments, with greater discrepancies predicting maladjustment and negative behavioral outcomes (De Los Reyes, 2011). Yet, informant discrepancies can also result in misdiagnosis because it is unclear to clinicians how to reconcile disparate reports, thereby preventing children who need treatment from accessing it, or contributing to overdiagnosis. Although it is beyond the scope of the current study to suggest how clinicians should proceed when parents and teachers disagree, we aim to explore the circumstances under which informant discrepancies are likely to occur. Such results could inform the meaning of discrepancies, or suggest when clinicians should most expect them.

A handful of studies have examined factors related to parent-teacher agreement on child ADHD symptoms (Harvey et al., 2013; Lawson et al., 2017, Phillips and Lonigan, 2010; Sherman et al., 2010; Takeda et al., 2016, van der Ooord et al., 2006; Yeguez & Sibley, 2016), and have yielded mixed results. Whereas some studies found poorer parent-teacher agreement to relate to more parental depression (Harvey et al., 2013) and comorbid child externalizing problems (Takeda et al., 2016), other studies found no such relationship (Harvey et al., 2013, van der Oord et al., 2006; Yeguez & Sibley, 2016). Similarly, racial background (Black and Latinx) and lower socioeconomic status (SES) predicted poorer parent-teacher agreement in some studies (Harvey et al., 2013; Phillips & Lonigan, 2010), but not in others (Harvey et al., 2013; Lawson et al., 2017; Takeda et al., 2016). To our knowledge, parental stress is the only variable that related to poorer parent-teacher agreement on child ADHD symptoms in two separate investigations (van der Oord et al., 2006; Yeguez & Sibley, 2016), with other variables (e.g., lower child adaptive behaviors [Sherman et al., 2016], more homework difficulties [Takeda et al., 2016], higher parental ADHD and lower education [Yeguez & Sibley, 2016]) requiring replication. Consistent with De Los Reyes (2011), overall these findings support the notion that discrepancies in-and-of-themselves are associated with poorer child and parent functioning.

One potential difficulty in reconciling findings in the existing literature pertains to the methodology used to quantify agreement. The majority of the aforementioned studies have done so by calculating difference scores (i.e., subtracted one informant's score [parent] from another informant's score [teacher] on the same measure) which were regressed onto the variables of interest. Although difference scores are commonly used to quantify informant discrepancies, research increasingly outlines their limitations (see Laird & De Los Reyes, 2013, Laird & LaFleur, 2016, and Laird & Weems, 2011). One limitation is that a difference score is created from two component scores (e.g., parent and teacher ratings), so its relationship to a second variable is fully determined by the variances of these two component scores and their independent relationship to the same second variable (Laird & De Los Reyes, 2013). Any non-zero correlation between the difference score and a second variable must therefore be the result of differences in either (a) how strongly the two component scores correlate with the second variable, or (b) the variances of the two component scores (Edwards, 1994; Laird & Weems, 2011). Importantly, component scores with equal variances and equal relationships with a second variable *will not* result in a difference score that is associated with the second variable.

A second limitation is that difference scores impose mathematical constraints on their relationship with other variables. As outlined by Laird and Weems (2011) and Laird and De Los Reyes (2013), one can represent difference scores in a regression equation as follows:

$$Y = b_0 + b_1(Parent\ ratings - Teacher\ ratings) + e \quad (1)$$

Which, in turn, be expanded to:

$$Y = b_0 + b_1\left(Parent\ ratings\right) - b_2\left(Teacher\ ratings\right) + e \quad (2)$$

Equation 2 illustrates that parent and teacher ratings are constrained to have coefficients of equal magnitude, but opposite in sign (e.g., parent ratings have a positive relationship with the outcome variable while teacher ratings have a negative relationship with the outcome variable). Thus, an

underlying assumption of using difference scores is that the ratings between two informants (in this case, between parents and teachers) are orthogonal with one another.

A similar constraint is imposed when examining difference scores as the outcome variable. As outlined by Laird and LaFleur (2016), Eq. 1 can be re-written so that the difference score is the outcome variable being predicted by a second variable (X), as follows:

$$Parent\ ratings - Teacher\ ratings = b_0 + b_1(X) + e \quad (3)$$

Which in turn can be expanded to:

$$Parent\ ratings = (1)(Teacher\ ratings) + b_0 + b_1(X) + e \quad (4)$$

Equation 4 shows that the coefficient of teacher ratings is constrained to 1, forcing a perfect linear relationship between parent and teacher ratings: For every 1 unit increase in parent scores, teacher scores also increase by 1 unit. In summary, the limitations imposed by using difference scores prevent nuanced examinations of informant discrepancies by artificially masking factors that could be related to agreement, or constraining associations between two informants as being either orthogonal to one another, of equal magnitude, or in perfect agreement.

The use of polynomial regression overcomes the aforementioned limitations of difference scores (Edwards, 1994; Laird & LaFleur, 2016) by instead using interaction terms to test whether agreement between two informants is moderated by a variable of interest. That is, it tests whether a correlation (i.e., agreement) between parent and teacher ratings differs depending on levels of a third variable (e.g., child demographics and functioning). Polynomial regression models also test the potential for both linear and more complex, non-linear patterns of agreement, via inclusion of a set of interaction terms (linear by linear, linear by quadratic, and quadratic by linear; Edwards, 1994). For these reasons, polynomial regression is considered to be a more valid and accurate approach than using difference scores (Laird & De Los Reyes, 2013; Laird & LaFleur, 2016).

To our knowledge, only two studies have used polynomial regression to examine informant agreement (Laird & LaFleur, 2016; Lawson et al., 2017). First, Laird and LaFleur (2016) documented how polynomial regression can be used to test agreement between two raters (mothers' and adolescents' reports of the adolescent's rule-breaking behavior) as predicted by a variable of interest (parenting practices), finding that agreement was higher when mothers reported engaging in more solicitation or control through rules. Second, in supplementary analyses, Lawson et al. (2017) used polynomial regression to explore main and interactive effects of parent and teacher ratings of children's ADHD symptoms as predictors of outcomes (child ethnicity and SES). Although Lawson et al. (2017) reported several main effects (e.g., teacher, but not parent, reports predicting SES), none of the interaction terms were statistically significant. Furthermore, the approach used by Lawson et al. (2017) differed from that of Laird and LaFleur (2016), in which the agreement between two raters was the outcome variable.

The present study adopted the same methodology as Laird and LaFleur (2016) to examine potential factors associated with parent-teacher agreement about ADHD symptoms, thereby providing another application of the more precise polynomial regression framework for testing informant agreement. Our study was exploratory and sought to identify which factors related to parent-teacher agreement, and in what ways this might occur (e.g., linear, quadric relationships). The end goal was to help identify which subgroups of children are likely to have poorer parent-teacher agreement about their ADHD symptoms, which could stimulate future research about how to integrate discrepant ratings when making ADHD diagnoses.

General Method

We examined factors associated with parent-teacher agreement on children's ADHD symptoms in a community sample of elementary school students (Study 1), and a treatment-seeking sample of children with ADHD diagnoses (Study 2). Factors were sorted into categories of child academic functioning, demographics, externalizing psychopathology (Study 2 only), and social functioning. Following Laird and LaFleur (2016), Eq. 5 shows a polynomial regression model testing a variable of interest (Z) as a predictor of agreement between parent (P) and teacher (T) ratings of ADHD. As a form of grand mean centering, predictors (P and Z) were z-scored. The interaction term (b_5PZ) tests whether the association between teacher and parent ratings of ADHD (i.e., informant agreement) differs depending on the level of Z:

$$T = b_0 + b_1P + b_2P^2 + b_3Z + b_4Z^2 + b_5PZ + e \quad (5)$$

Crucially, because agreement between two informants may be non-linear at different levels of the variable of interest, Edwards (1994) recommended a more complex model composed of Eq. 5 plus a set of coefficients one order of magnitude greater. In Eq. 6, teacher ratings of ADHD (T) are regressed onto mean-centered, quadratic, and cubed parent ratings of ADHD (P), mean-centered, quadratic, and cubed values of the variable of interest (Z), and the linear, linear by quadratic, and quadratic by linear interactions of P and Z:

$$T = b_0 + b_1P + b_2P^2 + b_3P^3 + b_4Z + b_5Z^2 + b_6Z^3 + b_7PZ + b_8P^2Z + b_9PZ^2 + e \quad (6)$$

In the current study, variables of interest were entered individually into the models outlined in Eqs. 5 and 6. Given the exploratory nature of the study, findings that were significant at $p < .05$ are discussed. However, we acknowledge the potential inflation of Type 1 error associated with this strategy. Therefore, we highlight the findings that remained statistically significant after applying the Benjamini-Hochberg Procedure (B-HP; Benjamini & Hochberg, 1995; false discovery rate set to .05) to correct for multiple comparisons within each sample.

Statistically significant interaction terms were graphed in 3-dimensions using a template modified from Shanock et al. (2010) that incorporated the higher-order coefficients and graphed points along each mean-centered predictor variable ranging from −3.5 to 3.5 standard deviations (SDs). Supplemental Fig. 1 depicts what perfect parent-teacher agreement (across all levels of the variable of interest) looks like on this template, so our results can be compared to this visual.

Study 1

Participants

The community sample contained 752 children in Kindergarten through 5th grade. Children were students in 46 general education classrooms in public schools in Ohio, United States (366 children) and in Vancouver, BC, Canada (386 children). Additional demographic information is presented in Table 1. Full details about the sample are in (Mikami et al., 2020a, 2021). The participants reflect two different cohorts of children whose teachers were taking part in a social-emotional learning intervention (Mikami et al., 2020a, 2021). However, all data in the present study came from the baseline (pre-intervention) time point at the start of the school year.

Procedure

Procedures were approved by the institutional review boards at the participating universities and school boards. Teachers provided informed consent, and distributed study information to the parents of their students. Parents who agreed to have their children participate returned a consent form and reported on their family demographics and their child's ADHD symptoms. We solicited child assent from the children whose parents had consented. The average participation rate was 71% across the 46 classrooms (range = 48% to 95%).

One month into the school year, teachers rated all consented children's inattention and hyperactivity/impulsivity on the ADHD Rating Scale-5 (ADHD-RS-5; DuPaul et al., 2016), and social impairment on the Dishion Social Acceptance Scale (DSAS; Dishion & Kavanagh, 2003). Parents completed the Hyperactivity/Inattention subscale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 2001). Within each class, three to five children with the highest teacher ratings of ADHD symptoms and social problems were chosen as an at-risk sample; teachers completed more measures about this subset (and these children received additional intervention). Parent ratings of ADHD symptoms were considered if there was a tie. The at-risk children differed from their classmates in ADHD symptoms and social impairment (see Supplemental Table 1). We also interviewed all consented children individually to collect sociometric data, and children's grades on the first report card of the school year were recorded.

Measures

Child ADHD Symptoms

Teacher-Reported ADHD Symptoms Teachers completed the ADHD-5 Rating Scale (DuPaul et al., 2016), which is an update of the ADHD-4 (DuPaul et al., 1998), keyed to DSM-5 ADHD diagnostic criteria. Teachers rated all children on the nine inattentive and the nine hyperactive/impulsive symptoms of ADHD in the DSM-5, each on a 4-point scale (0 = *never*, 3 = *very often*). The scale was normed in a sample of 1070 teachers, each of whom rated two randomly-selected students. The previous version of the scale (DuPaul et al., 1998) showed good 4-week test–retest reliability, correlations with observations and other ADHD rating scales, and ability to discriminate between children with and without a diagnosis of ADHD. Internal consistency for inattention ($\alpha = .96$) and hyperactivity/impulsivity ($\alpha = .95$) was excellent in the current sample. We used the total ADHD symptom score, representing the sum of all 18 items.

Parent-Reported ADHD Symptoms Parents completed the Hyperactivity/Inattention subscale of the SDQ (Goodman, 1997) about their children, which has five items assessing inattention and hyperactivity/impulsivity (sample items: "easily distracted, concentration wanders", "constantly fidgeting or squirming") on a 3-point metric (0 = *not true*, 2 = *certainly true*). The SDQ is often used in research and clinical settings to assess child adjustment (Goodman, 2001). The Hyperactivity/Inattention subscale has high specificity (92%) and negative predictive value (99%) for clinical diagnoses of ADHD (Goodman, 2001), and relates well to ratings of the 18 ADHD symptoms (Ullebø et al., 2011). In our sample, internal consistency of the five items was $\alpha = .78$, which is similar to the value of $\alpha = .77$ in Goodman (2001). We used the sum of the items to represent parents' ratings of total ADHD symptoms.

Table 1 Demographic Characteristics of Participants

	Study 1 *N*= 752	Study 2 *N*= 213
	Mean (SD)	*Mean (SD)*
Age	7.28 (1.39)	8.58 (1.55)
	n (% sample)	*n (% sample)*
Gender		
Male	386 (51.3%)	147 (69.0%)
Female	365 (48.5%)	66 (31.0%)
Other	1 (0.1%)	
Grade		
Kindergarten	61 (8.1%)	
1st grade	166 (22.1%)	37 (17.4%)
2nd grade	183 (24.3%)	31 (14.6%)
3rd grade	214 (28.5%)	48 (22.5%)
4th grade	99 (13.2%)	45 (21.1%)
5th grade	29 (3.9%)	35 (16.4%)
6th grade		17 (8.0%)
Primary Caregiver Education		
Less than high school	48 (6.4%)	3 (1.4%)
High school graduate	136 (18.1%)	7 (3.3%)
Some college or university	250 (33.2%)	28 (13.1%)
Associates degree	40 (5.3%)	49 (23.0%)
Bachelor's degree	191 (25.4%)	83 (39.0%)
Master's or Doctoral degree	66 (8.8%)	31 (14.6%)
Missing	21 (2.8%)	12 (5.6%)
Race		
White	309 (41.1%)	150 (70.4%)
Black/Afro-Canadian/African American	90 (12.0%)	2 (0.9%)
Asian/Asian Canadian/Asian American	143 (19.0%)	11 (5.2%)
Hispanic/Latino	66 (8.8%)	2 (0.9%)
Aboriginal/American Indian/Alaskan Native	4 (0.5%)	
Biracial/Multiracial	128 (17.0%)	35 (16.4%)
Other	11 (1.5%)	
Missing	1 (0.1%)	13 (6.1%)

Academic Functioning

Academic Enablers Teachers completed three subscales from the Academic Competence Evaluation Scale-Short Form (ASF; Anthony & DiPerna, 2018) about all children to assess academic enablers (behaviors, attitudes, and skills that contribute to academic success). The subscales were: Engagement (3 items; e.g., asks questions when confused), Interpersonal Skills (5 items; e.g., interacts appropriately with other students), and Motivation (5 items; e.g., makes the most of learning experiences), with each item rated on a 5-point scale (0 = *Never*, 4 = *Almost Always*). Subscale scores reflect the average of items. These subscales had high internal consistency in the current sample (α *range* = .87 to .95), and have previously been found to correlate with academic achievement (*r range* = .18 to .40; Anthony & DiPerna, 2018).

Academic Performance Teachers completed two subscales from the Academic Performance Rating Scale (APRS; DuPaul et al., 1991) on the at-risk sample only. Academic Success (7 items) measures children's performance outcomes, such as work quality (0 = *consistently poor*, 4 = *consistently successful*), work accuracy (0 = *0–49%*, 4 = *90–100%*), and learning skills (0 = *poor,* 4 = *excellent*). Productivity (12 items) assesses performance related to the learning process, such as work completion (0 = *0–49%*, 4 = *90–100%*) and ability to work independently and to follow instructions (0 = *never*, 4 = *very often*). We summed the items on each subscale. In our sample, internal consistency was high for Academic Success (α = .91) and Productivity (α = .89). Previous studies report both subscales to correlate with achievement and academic enablers (*r range* = .39 to .62; DuPaul et al., 1991; Owens et al., 2020a).

Grades Children's language arts and math grades were used as ecologically valid indicators of their academic functioning. Because schools use different grading systems, grades were transformed into numeric values using a 4-point scale. A score of 4 indicates advanced achievement (e.g., A range), a score of 3 indicates proficient achievement (B range), and scores of 2 and 1 correspond to basic (C range) and limited (D or below) achievement, respectively.

Demographic Variables

Parents reported the primary caregiver's education level and the child's age, gender, and race (dichotomized as White versus non-White, in line with Takeda et al., 2016).

Externalizing Psychopathology

No measures of externalizing psychopathology were collected in Study 1.

Social Functioning

Peer Sociometrics Children nominated an unlimited number of consented classmates whom they "liked the most" (positive nominations), "really did not like" (negative nominations), and "considered a friend" (Coie et al., 1982). Children also indicated their feelings about each consented classmate on a scale from 1 (*really do not like*) to 5 (*really like*). For each child, positive and negative nomination proportion scores were calculated by dividing the number of each type of nomination received by the number of peers who participated in the procedure. The proportion of reciprocated friendships (where two children nominate each other as a friend) was computed by dividing the number of such friendships by the number of peers who participated. Each child's average sociometric rating received from peers was calculated.

Teacher-Reported Peer Regard Teachers estimated the percentage of classmates who like/accept, dislike/reject, and ignore/are neutral to each consented child on the Dishion Social Acceptance Scale (DSAS; Dishion & Kavanagh, 2003). These three percentage scores were used as indicators of peer regard (Like, Dislike, and Ignore). Correlations between DSAS scores and sociometric variables have been reported as moderate in Dishion and Kavanagh (2003).

Student-Teacher Relationship Teachers completed two subscales of the Student-Teacher Relationship Scale-Short Form (STRS-SF; Pianta, 2001) about their relationship with each child in the at-risk sample only. Items were answered on a 5-point scale (0 = *definitely does not apply*, 4 = *definitely applies*); the subscale score reflected the sum of the individual items. Closeness (7 items) refers to warmth, open communication, and affection. Conflict (8 items) measures disharmony, negativity, and antagonism. Internal consistency in the current sample was acceptable (Closeness: $\alpha = .88$; Conflict: $\alpha = .83$). These subscales have previously been found to correlate with children's behavioral problems (Pianta, 2001; Pianta & Stuhlman, 2004).

Results

Descriptive statistics for all measures are in Table 2. Teacher and parent ratings of total ADHD symptoms were moderately correlated ($r = .44$, $p < .001$). Bivariate correlations between other Study 1 measures are in Supplemental Tables 2 and 3. Post-hoc power analyses showed that for the second-order polynomial regression model (5 predictors, 1 tested predictor), this study had 0.97, 1.00, and 1.00 power to detect small ($f = .02$), medium ($f = .15$), and large ($f = .35$) effect sizes with $\alpha \leq .05$. For the third-order polynomial regression model (9 predictors, 2 tested predictors), power was 0.94, 1.00, and 1.00 for small, medium, and large effect sizes, respectively. The results of our primary analyses are in Table 3 and presented below.

Academic Functioning

Statistically significant third-order (but not second-order) interactions were observed for five of the seven academic functioning variables tested. Of these, one third-order interaction (math grades) remained statistically significant after applying the B-HP. Supplemental Figs. 2–6 graph the surface area in 3-dimensions for each moderator variable, and reveal some similar patterns in parent-teacher agreement across moderator variables.

As seen in Supplemental Figs. 2 and 3 (representing academic enablers as measured by ASF Engagement and ASF Motivation, respectively), the best parent-teacher agreement occurred for children who scored at the mean, or slightly below (0 to −1 SD). For children in this range of ASF scores, the graphs show a linear positive slope between parent and teacher ratings of ADHD, indicating that that as parents tended to rate children as having higher ADHD symptoms, so did teachers. However, parents and teachers showed poor agreement for children with very high ASF Engagement scores (≥ 2.5 SD above the mean), with teachers reporting low ADHD symptoms across the board for these children which parent ratings varied. Among children with very low scores on ASF Engagement (≤ −2.5 SD) there was a u-shaped distribution, reflecting a group for whom teachers reported high ADHD symptoms but parents did not. For ASF Motivation, there was also poor agreement for children with very high scores, with teachers and parents having nearly opposite perceptions about children's ADHD symptoms. For children far below the mean on ASF Motivation, parent-teacher agreement

Table 2 Descriptive Statistics of Study Variables

	Study 1 *N*= 752	Study 2 *N*= 213
	Mean (SD)	*Mean (SD)*
Academic Functioning		
ASF – Engagement	3.5 (0.99)	
ASF – Interpersonal	4.1 (0.83)	
ASF – Motivation	3.4 (1.02)	
APRS – Academic Productivity	34.1 (9.15)	
APRS – Academic Success	19.7 (6.26)	
Grades – Language Arts	2.6 (0.84)	
Grades – Math	2.8 (0.88)	
SSIS – Academic Competence		81.7 (11.07)
WIAT-III[1] – Numerical Operations		92.6 (18.14)
WIAT-III[1] – Word Reading		97.6 (16.64)
ADHD		
ADHD-5 - Total score	12.9 (13.36)	
CSI-4 – ADHD Module (Parent Rated)		37.8 (7.84)
CSI-4 – ADHD Module (Teacher Rated)		30.2 (11.85)
SDQ – Hyperactivity/Inattention subscale	3.7 (2.48)	
Externalizing Psychopathology		
CBCL – CP		63.9 (8.77)
CBCL – ODP		64.8 (8.56)
TRF – CP		61.4 (9.44)
TRF – ODP		61.8 (8.52)
Social Functioning		
DSAS – Like	77.3 (21.62)	0.31 (0.23)
DSAS – Dislike	5.3 (11.46)	0.19 (0.20)
DSAS – Ignore	17.4 (16.60)	0.50 (0.26)
Proportion Positive Nominations	0.32 (0.17)	
Proportion Negative Nominations	0.14 (0.16)	
Proportion Reciprocated Friendship Nominations	0.14 (0.11)	0.14 (0.12)
Sociometric Rating	3.9 (0.55)	
STRS Closeness	29.2 (5.87)	30.6 (6.45)
STRS Conflict	20.5 (7.75)	18.0 (7.22)

Note. ASF = Academic Competence Evaluation Scales – Short Form; ADHD-5 = ADHD Rating Scale 5; APRS = Academic Performance Rating Scale; CBCL = Child Behavior Checklist; CP = Conduct Disorder Problems; CSI-4 = Child Symptom Inventory 4; DSAS = Dishion Social Acceptance Scale; ODP = Oppositional Defiant Problems; SDQ = Strengths and Difficulties Questionnaire; SSIS = Social Skills Improvement System; STRS = Student-Teacher Relationship Scale; TRF = Teacher's Report Form; WIAT = Wechsler Individual Achievement Test

[1] At the Ottawa/Gatineau site in Study 2, children were administered the WIAT-II because it is available in French

on ADHD symptoms was poor because teachers reported uniformly high symptoms while parent ratings varied.

The graphs for academic performance (Supplemental Fig. 4, representing APRS Academic Success in the at-risk subset; Supplemental Figs. 5 and 6, representing language arts and math grades) all also suggest that parent-teacher agreement was strongest for children near the mean of functioning, or slightly below (0 to −1 SD). In each of these measures, for children with the best academic performance there was a u-shaped distribution in agreement where there was a group of children for whom teachers, but not parents, reported high ADHD symptoms.

Demographic Variables

No interactions were statistically significant for the four demographic variables tested.

Table 3 Study 1 Second- and Third-Order Polynomial Regression Values

	Second-Order Model			Third-Order Model			
	Predictor *n*	*R* (R^2)	Parent Rating by Predictor β (.95CI)	*R* (R^2)	Sig. *F* Change	Parent Rating^2 by Predictor β (.95CI)	Parent Rating by Predictor^2 β (.95CI)
Academic Functioning							
ASF – Engagement	743	.50 (.25)	−0.05 (−1.43 to 0.25)	.50 (.25)	.18	0.00 (−0.78 to 0.71)	−0.11 (−1.62 to −0.09)*
ASF – Interpersonal	743	.83 (.69)	−0.01 (−0.83 to 0.48)	.84 (.70)	<.05	−0.04 (−0.83 to 0.31)	−0.03 (−0.84 to 0.47)
ASF – Motivation	743	.77 (.60)	−0.04 (−1.24 to 0.21)	.78 (.61)	<.01	0.04 (−0.28 to 0.94)	−0.10 (−1.57 to −0.11)*
APRS – Academic Productivity	185	.38 (.14)	−0.04 (−2.04 to 1.25)	.40 (.16)	.50	0.29 (−0.19 to 3.01)	0.00 (−1.57 to 1.56)
APRS – Academic Success	185	.28 (.08)	0.11 (−0.62 to 2.66)	.33 (.11)	.25	0.41 (0.15 to 3.52)*	−0.12 (−2.20 to 0.71)
Grades – Language Arts	692	.52 (.27)	0.04 (−.34 to 1.45)	.54 (.29)	<.005	0.14 (.25 to 1.94)*	−0.10 (−1.46 to −.44)*
Grades – Math	695	.49 (.24)	0.05 (−0.28 to 1.45)	.52 (.27)	<.001	0.21 (0.86 to 2.43)** [a]	−0.07 (−1.16 to 0.23)
Demographics							
Age	748	.45 (.20)	−0.02 (−1.15 to 0.71)	.46 (.21)	.18	0.08 (−0.13 to 1.52)	−0.05 (−1.28 to 0.32)
Gender	752	.52 (.27)	−0.05 (−2.73 to 0.78)	.52 (.27)	.80	−0.06 (−3.04 to 0.77)	0.02 (−1.15 to 1.88)
Race	752	.44 (.20)	−0.05 (−2.60 to 0.90)	.46 (.20)	.60	−0.04 (0.46 to −2.66)	−0.02 (−1.72 to 1.34)
Socioeconomic Status	751	.46 (.21)	−0.03 (−1.24 to 0.59)	.46 (.21)	.88	0.03 (−0.53 to 1.00)	0.00 (−0.78 to 0.85)
Social Functioning							
DSAS – Like	743	.59 (.35)	−0.12 (−2.32 to −0.66)** [a]	.59 (.35)	.43	−0.04 (−1.01 to 0.49)	0.02 (−0.59 to 0.82)
DSAS – Dislike	743	.63 (.40)	−0.03 (−1.10 to 0.50)	.63 (.40)	.16	−0.02 (−0.89 to 0.62)	0.09 (−0.19 to 0.67)
DSAS – Ignore	743	.51 (.26)	0.07 (0.04 to 1.83)*	.51 (.26)	.16	0.03 (−0.57 to 1.07)	0.01 (−0.58 to 0.66)
Proportion Positive Nominations	731	.48 (.23)	−0.02 (−1.04 to 0.59)	.49 (.24)	.09	0.10 (−0.03 to 1.35)	−0.01 (−0.52 to 0.46)
Proportion Negative Nominations	731	.60 (.36)	−0.01 (−0.99 to 0.66)	.61 (.37)	.09	−0.14 (−1.60 to −0.01)*	0.00 (−0.65 to 0.65)
Proportion Reciprocated Friendship Nominations	728	.47 (.22)	−0.02 (−1.21 to 0.69)	.47 (.22)	.48	0.05 (−0.38 to 1.25)	0.02 (−0.56 to 0.84)
Sociometric Rating	731	.54 (.29)	−0.02 (−1.09 to 0.60)	.56 (.31)	<.01	0.15 (0.19 to 1.64)*	0.03 (−0.58 to 0.88)
STRS Closeness	178	.20 (.04)	−0.02 (−2.12 to 1.61)	.28 (.08)	.15	−0.20 (−3.31 to 0.84)	−0.12 (−2.37 to 0.80)
STRS Conflict	178	.31 (.10)	0.09 (−0.78 to 2.65)	.36 (.13)	.24	0.11 (−0.91 to 2.18)	−0.18 (−3.16 to 0.40)

Note. ASF = Academic Competence Evaluation Scales – Short Form; ADHD-5 = ADHD Rating Scale 5; APRS = Academic Performance Rating Scale; DSAS = Dishion Social Acceptance Scale; STRS = Student-Teacher Relationship Scale

Gender coded as 0 = male, 1 = female; Race coded as 0 = White, 1 = Non-White; For Socioeconomic Status (parent education), we used the average of the parents' highest educational attainment. For children with only one parent, we used the single parent's educational attainment. The APRS and STRS measures were administered only to at-risk children ($n = 185$).

* $p < .05$, ** $p < .01$, [a] $p < .05$ after correction for multiple comparisons using the Benjamini-Hochberg Procedure

Social Functioning

Of the nine social functioning variables, two second-order and two third-order statistically significant interactions were observed. Only the interaction involving DSAS Like remained statistically significant after applying the B-HP.

Supplemental Figs. 7 and 8 outline the 3-dimensional response surface area for the DSAS Like and DSAS Ignore variables, representing teachers' reports of peer preference. These distributions reveal that parent-teacher agreement was strong for children who were below the mean on DSAS Like, or above the mean on DSAS Ignore, with the strongest agreement occurring for children scoring approximately −1 SD on DSAS Like or 1 SD on DSAS Ignore (e.g., children who were functioning slightly poorer than their peers). By contrast, there was little parent-teacher agreement for children who were high on DSAS Like or low on DSAS Ignore, with teachers rating these children as having few ADHD symptoms uniformly.

Supplemental Figs. 9 and 10 outline the 3-dimensional response surface area for Negative Nominations and Sociometric Ratings, representing peer sociometric measures. Parent-teacher agreement about ADHD symptoms was stronger for children above the mean on negative nominations or below the mean on sociometric ratings, with the best agreement again occurring for children scoring approximately 1 SD on negative nominations or − 1 SD on ratings (e.g., children who were functioning

slightly poorer than their peers). For children low in negative nominations or high in sociometric ratings, there was a u-shaped distribution where for some children, teachers rated them high in ADHD symptoms but parents did not.

Discussion

In a community sample, polynomial regression analyses identified five academic and four social functioning variables that moderated the association between parent and teacher ratings of children's ADHD symptoms. Of these, one academic and one social variable continued to moderate parent-teacher agreement after applying the B-HP. For academic variables, parent-teacher agreement was strongest for children with academic enablers (positive academic behaviors and cognitions rated by teachers) and academic performance (grades and teacher ratings of academic skills) that were at the mean to 1 SD below the mean. For social variables, parent-teacher agreement was strongest for children 1 SD below the mean on peer regard (e.g., below the mean on peer acceptance and liking ratings, and above the mean on peer ignoring and negative nominations), both as reported by teachers and as obtained in peer sociometrics.

Study 2

Participants

This clinical sample contained 213 children with ADHD (ages 6–11) enrolled in a treatment study of ADHD and social problems. Families were recruited from schools, hospitals, and clinics in Vancouver, BC ($n = 95$) and Ottawa/Gatineau, ON/QC ($n = 118$), Canada. Demographic information about this sample (alongside the Study 1 sample) is also in Table 1. Full details about the study are in Mikami et al. (2020b). All measures for the present study were collected before participants were randomized or began intervention.

Procedure

The study received ethics approval by the institutional review boards at the participating universities and hospitals. Parents and teachers provided written consent and children assented to take part. In a screening conducted via phone or e-mail, parents and teachers rated the child's ADHD symptoms using the Child Symptom Inventory-4 (CSI-4; Gadow & Sprafkin, 2002), and peer problems using the SDQ Peer Problems subscale (Goodman, 1997). Initial study eligibility required both parents and teachers reporting a minimum of any four symptoms of inattention and/or any four symptoms of hyperactivity/impulsivity as "often" or "very often" on the CSI-4, and at least a score of 3 on the SDQ Peer Problems (corresponding to 1 SD above the mean). Families of children who met these criteria were invited to the lab during which we administered the Kiddie-Schedule for Affective Disorders and Schizophrenia (K-SADS; Axelson, et al., 2009) to parents. All children received a diagnosis of ADHD based on DSM-5 criteria where they had at least six symptoms of inattention and/or hyperactivity/impulsivity endorsed by parents on the K-SADS or teachers on the CSI, following the "or" algorithm (established in the DSM-IV field trials) where a symptom is considered present if endorsed by parents or teachers (Lahey et al., 1994). The K-SADS was used to document impairment associated with ADHD symptoms. Parents also reported on children's demographics and externalizing psychopathology.

Standardized intelligence tests were administered to children to assess IQ, and subscales of the Wechsler Individual Achievement Test (WIAT–III; Wechsler, 2009) were administered to assess achievement in reading and mathematics. Children were excluded from the study if they had Full Scale IQ < 75, autism spectrum disorder, a severe mental health condition (e.g., psychosis), or distress requiring immediate intervention (e.g., suicidal intent). Children taking medication for ADHD and/or those diagnosed with common comorbidities (e.g., anxiety, conduct disorder) were not excluded. Teachers reported on children's academic functioning, externalizing psychopathology, and social functioning by mail.

Measures

Child ADHD Symptoms

Teacher- and Parent-Reported ADHD Symptoms Both parents and teachers independently rated children on the nine inattentive and nine hyperactive/impulsive symptoms on the Child Symptom Inventory-4 (CSI-4; Gadow & Sprafkin, 2002), which correspond to the DSM-IV criteria (American Psychiatric Association, 2000). Each item is rated on a 4-point scale (0 = *never*, 3 = *very often*). The CSI-4 is a widely-used screening tool for child disorders. The inattention and hyperactivity/impulsivity subscales were found in community samples to have high internal consistency ($\alpha = .93$), and to correlate with other rating scales of ADHD (Gadow et al., 2004). In our clinical sample, internal consistency for inattention was $\alpha = .79$ (parents) and .89 (teachers), and for hyperactivity/impulsivity it was $\alpha = .85$ (parents) and .92 (teachers). A total ADHD symptom score was calculated by summing the scores on the 18 items.

Academic Functioning

Academic Competence Teachers completed the Social Skills Improvement System (SSIS) Academic Competence Scale (Gresham & Elliott, 2008), with seven items assessing children's academic motivation, performance in reading and math, and cognitive functioning. Each item was rated relative

to other students on a 5-point scale from 0 (*lowest 10%*) to 4 (*highest 10%*). Raw scores were calculated and converted to standardized scores based on the manual norms. This well-normed, widely-used scale has strong psychometric properties and correlates with achievement (r = .67 for reading and r = .60 for math; Gresham & Elliott, 2008).

Academic Achievement This was assessed through standardized scores on two subtests of the WIAT-III (Wechsler, 2009). Word Reading measures the accuracy of reading decontextualized words. Numerical Operations measures written mathematical calculation skills.

Demographic Variables

Child gender, race (dichotomized as White versus non-White), age, household income, and the primary caregiver's education level were reported by parents.

Externalizing Psychopathology

Parents and teachers completed the Child Behavioral Checklist (CBCL; Achenbach & Rescorla, 2001) and Teacher Report Form (TRF; Achenbach & Rescorla, 2001), respectively. Both are widely-used, well-normed measures that contain parallel questions. Each item is rated on a 3-point scale (0 = *not true,* 2 = *very true or often true*). The Oppositional Defiant Problems (ODP) and Conduct Problems (CP) subscales were used, which reflect behaviors characteristic of Oppositional Defiant Disorder and Conduct Disorder. The CBCL and TRF DSM-oriented scales have robust psychometric properties, including high internal consistency (α average = .80) and test-retest reliability (r average = .83; Achenbach et al., 2003) in the norming sample.

Social Functioning

Reciprocated Friendship Nominations Teachers administered a modified sociometric procedure where students received a list of their classmates and were asked to circle as many peers as they considered to be their friends. Teachers tabulated the information for the child in the study and presented it to the study team without revealing the identities of any peers. A proportion score was computed for the child in the study by dividing the number of reciprocated nominations received (i.e., the number of peers who the child nominated as a friend, who reciprocated the nomination), by the number of peers who participated in the procedure.

Teacher-Reported Peer Regard As in Study 1, teachers estimated the percentage of classmates who like/accept, dislike/reject, and ignore/are neutral to the child on the DSAS (Dishion & Kavanagh, 2003).

Student-Teacher Relationship As in Study 1, teachers completed the Closeness and Conflict subscales from the STRS-SF (Pianta, 2001) about the child in the study. The internal consistency was acceptable in our sample (Closeness: α = .84; Conflict: α = .80).

Results

Descriptive statistics about Study 2 variables are in Table 2 (alongside those from Study 1). Parent and teacher ratings of total ADHD symptoms were weakly correlated (r = .20, p < .05) in this clinical sample. Supplemental Tables 4 to 6 contain bivariate correlations between Study 2 measures. For the second-order polynomial regression model (5 predictors, 1 tested predictor), the present study has power of 0.54, 0.99, and 1.00 for detecting small, medium, and large effect sizes, respectively. The third-order polynomial regression model (9 predictors, 2 tested predictors) has power of 0.43, 0.99, and 1.00 for detecting small, medium, and large effect sizes, respectively. The results of our primary analyses are outlined in Table 4 and presented below.

Academic, Demographic, and Externalizing Psychopathology Variables

No second- or third-order statistically significant interactions were observed for any of the twelve academic, demographic, and externalizing psychopathology variables tested.

Social Functioning

No second-order interactions were statistically significant for any social functioning variables. Of the seven variables examined using third-order models, only one interaction (DSAS Ignore) was statistically significant. This interaction did not remain after applying the B-HP.

Supplemental Fig. 11 outlines the 3-dimensional response surface area for the DSAS Ignore variable, representing teachers' reports of peer preference. Parent-teacher agreement was strongest for children who were 1 SD above the mean on DSAS Ignore. There was less parent-teacher agreement for children who fell between 0 to −1 SDs on DSAS Ignore, while agreement improved for children who were far below the mean on DSAS Ignore (≥ −2.5 SDs).

Discussion

In a clinical sample of children diagnosed with ADHD, the vast majority of variables did not moderate the association between parent and teacher ratings of children's ADHD symptoms. One social functioning variable was statistically significant, but this finding did not remain after applying a correction to control for type-I error. Parent-teacher agreement appeared strongest for

Table 4 Study 2 Second- and Third-Order Polynomial Regression Values

	Second-Order Model			Third-Order Model			
	Predictor *n*	*R* (R^2)	Parent Rating by Predictor β (.95CI)	*R* (R^2)	Sig. *F* Change	Parent Rating^2 by Predictor β (.95CI)	Parent Rating by Predictor^2 β (.95CI)
Academic Functioning							
SSIS – Academic Competence	190	.30 (.09)	0.12 (−0.31 to 3.02)	.36 (.13)	.07	−0.16 (−2.60 to 0.44)	−0.01 (−1.60 to 1.49)
WIAT-III[a] – Numerical Operations	212	.25 (.06)	−0.04 (−2.03 to 1.09)	.29 (.08)	.30	−0.20 (−2.76 to 0.03)	0.10 (−0.57 to 1.56)
WIAT-III[a] – Word Reading	210	.23 (.06)	0.03 (−1.25 to 2.00)	.24 (.06)	.92	−0.09 (−2.10 to 0.74)	0.03 (−1.04 to 1.42)
Demographics							
Age	210	.28 (.08)	−0.03 (−2.06 to 1.43)	.31 (.09)	.56	−0.21 (−3.32 to 0.29)	−0.07 (−2.29 to 1.21)
Gender	210	.24 (.06)	−0.12 (−1.63 to 0.54)	.25 (.06)	.91	−0.14 (1.79 to 0.56)	0.08 (−2.34 to 3.27)
Race	210	.23 (.05)	−0.03 (−5.01 to 3.31)	.26 (.07)	.20	0.04 (−3.70 to 5.61)	0.25 (−0.33 to 7.43)
Socioeconomic Status (education)	210	.26 (.07)	0.07 (−0.70 to 2.29)	.31 (.10)	.18	0.01 (−1.39 to 1.59)	0.06 (−1.80 to 2.57)
Socioeconomic Status (income)	180	.25 (.06)	0.01 (−1.55 to 1.81)	.31 (.09)	.20	−0.13 (−2.69 to 0.84)	−0.25 (−2.15 to 0.01)
Externalizing Psychopathology							
CBCL – CP	198	.27 (.07)	−0.03 (−2.13 to 1.42)	.28 (.08)	.89	0.00 (−1.82 to 1.82)	0.09 (−1.29 to 2.60)
CBCL – ODP	198	.31 (.10)	−0.08 (−2.78 to 0.98)	.34 (.11)	.58	0.06 (−1.57 to 2.34)	0.12 (−1.16 to 3.10)
TRF – CP	196	.49 (.24)	−0.03 (−1.87 to 1.16)	.50 (.25)	.81	−0.07 (−2.06 to 0.93)	−0.04 (−1.59 to 1.10)
TRF – ODP	196	.47 (.22)	−0.02 (−1.71 to 1.24)	.49 (.24)	.34	0.01 (−1.31 to 1.43)	−0.08 (−2.20 to 1.06)
Social Functioning							
DSAS – Like	195	.27 (.07)	0.12 (−0.29 to 3.05)	.30 (.09)	.51	−0.05 (−1.98 to 1.14)	0.15 (−0.52 to 2.40)
DSAS – Dislike	195	.27 (.08)	−0.05 (−2.30 to 1.13)	.30 (.09)	.53	−0.13 (−2.72 to 0.58)	0.20 (−0.28 to 2.64)
DSAS – Ignore	195	.25 (.06)	−0.06 (−2.45 to 0.91)	.32 (.10)	.09	0.15 (−0.30 to 2.77)	0.24 (0.35 to 3.63)*
Proportion Reciprocated Friendship Nominations	147	.33 (.11)	0.03 (−1.42 to 2.10)	.34 (.12)	.95	−0.10 (−3.01 to 1.60)	0.01 (−1.66 to 1.74)
STRS – Closeness	196	.25 (.06)	0.06 (−0.96 to 2.49)	.27 (.07)	.73	−0.13 (−2.78 to 0.61)	0.07 (−1.08 to 2.09)
STRS – Conflict	196	.55 (.30)	0.03 (−1.08 to 1.76)	.56 (.31)	.76	0.01 (−1.20 to 1.40)	−0.03 (−1.74 to 1.29)

Note. CBCL = Child Behavior Checklist; CP = Conduct Disorder Problems; CSI-4 = Child Symptom Inventory 4; DSAS = Dishion Social Acceptance Scale; ODP = Oppositional Defiant Problems; SDQ = Strengths and Difficulties Questionnaire; SSIS = Social Skills Improvement System; STRS = Student-Teacher Relationship Scale; TRF = Teacher's Report Form; WIAT = Wechsler Individual Achievement Test

Gender coded as 0 = male, 1 = female; Race coded as 0 = White, 1 = Non-White; For Socioeconomic Status (parent education), we used the average of the parents' highest educational attainment. For children with only one parent, we used the single parent's educational attainment. For Socioeconomic Status (household income), we first log-transformed the data to reduce skew and kurtosis and then used the log-transformed version of the variable for analyses.

[a] At the Ottawa/Gatineau site in Study 2, children were administered the WIAT-II instead because this is the version that is available in French

* $p < .05$, ** $p < .01$, [a] $p < .05$ after correction for multiple comparisons using the Benjamini-Hochberg Procedure

children approximately 1 SD below the mean in teacher-reported peer preference (e.g., above the mean on peer ignoring), which mirrors the findings observed on the same variable in Study 1. However, in Study 2, parent-teacher agreement was also high for children who were far above the mean in peer functioning (e.g., the lowest levels of peer ignoring).

General Discussion

The present study explored whether child factors (i.e., academic functioning, demographic characteristics, externalizing psychopathology, and social functioning) related to parent-teacher agreement on ratings of children's ADHD symptoms. To answer this question, we conducted a series of polynomial regression analyses, a statistical method that overcomes constraints imposed by using difference scores. The results were modeled in 3-dimensions to understand how parent-teacher agreement changes at higher and lower levels of these child factors. Analyses were conducted in a community sample of children in general education classrooms (Study 1) and in a clinical sample of children diagnosed with ADHD (Study 2). In the community sample, several child academic (e.g., academic enablers, grades, academic performance) and social functioning variables (e.g., teacher-rated peer regard and peer sociometrics) moderated parent-teacher agreement about child ADHD symptoms. The graphs revealed mostly non-linear patterns, including u and inverted-u distributions. Demographic variables did not relate to agreement. In the clinical sample, the vast majority of the child academic functioning, demographic, externalizing psychopathology, and social functioning variables (with the one exception of teacher-rated peer regard) did not moderate parent-teacher agreement about child ADHD symptoms. When we applied the B-HP to correct for multiple comparisons, only one academic and one social variable in the community sample, and no variables in the clinical sample, continued to moderate parent-teacher agreement.

Previous research suggests that informant discrepancies may, in and of themselves, be associated with poorer child functioning (for a review see De Los Reyes, 2011). Our findings in some ways support this idea, but also offer a more nuanced conclusion. Specifically, children in the community sample with very poor academic or social functioning (e.g., ≥ −2.5 SDs) did have low parent-teacher agreement on their ADHD symptoms. An example of this was the highly discrepant ADHD ratings provided by teachers and parents for children with far below average teacher-rated ASF Motivation scores, which seemed to occur mostly as a result of teachers rating these children as uniformly high on ADHD symptoms (while parent ratings varied). However, the majority of our polynomial regression analyses found that parent-teacher agreement was strongest for children who were at or slightly below the mean (e.g., 0 to −1 SD), as opposed to for children with the best functioning. In fact, and contrary to previous research on informant agreement, children with much above average functioning (e.g., ≥ 2.5 SDs) were more likely to show u-shaped distributions for parent-teacher agreement about ADHD. For example, on language arts and math grades, and sociometric ratings received, among children with the best functioning on these variables there was a group for whom teachers perceived ADHD symptoms but parents did not. On ASF Engagement, children with the best functioning tended to have low or no ADHD symptoms as reported by teachers, while parent ratings varied. Thus, for children with very high levels of functioning, raters also often disagreed about these children's symptoms.

One possible reason our results differ from the existing literature (see review in De Los Reyes, 2011) is that previous studies have relied almost exclusively upon difference scores to quantify parent-teacher agreement. As discussed, the use of difference scores has several limitations, including imposing mathematical constraints on the magnitude and directionality of agreement as well as obscuring non-linear relationships. Applying polynomial regression analyses in the current study may have allowed us to identify more nuanced relationships, including quadratic and cubic patterns. Our findings therefore underscore the potential utility of polynomial regression methods to answer questions about informant discrepancies.

In our data, for all academic and social variables on which interaction effects were found, parent-teacher agreement was strongest for children who were approximately 0 to 1 SD below the mean in functioning. This finding is remarkable, in part because this pattern occurred across different measures (e.g., ASF, APRS, grades, DSAS, sociometrics), domains of functioning (e.g., academic, social), and raters (e.g., teachers, parents, and peers). We speculate that children with below average functioning may attract the attention of parents and teachers in a way that facilitates parent and teacher communication, such as through meetings. That is, children who struggle academically and/or socially are likely to elicit concern which, in turn, promotes discussions between parents and teachers about the child. Such discussions have the potential to reconcile different perspectives and opinions, thereby increasing parent-teacher agreement in general as well as on ADHD symptoms. However, for children with much below average functioning (≥ −2.5 SDs), defensiveness from parents and/or teachers may result in more polarized opinions despite parent-teacher discussions, thereby increasing rater disagreement. In addition, children with very poor functioning likely represent more complex cases wherein challenging behavior may be attributed to a variety of problems across raters (accurately or inaccurately), resulting lower agreement on any one measure (like ADHD symptoms).

No demographic or externalizing psychopathology variables moderated parent-teacher agreement about children's ADHD symptoms. The existing literature is mixed, with some studies finding that being non-White and lower SES (Harvey et al., 2017; Phillips & Lonigan, 2010), and having a comorbid externalizing disorder (Takeda et al., 2016), are associated with poorer parent-teacher agreement, but other studies not finding this (Harvey et al., 2013; Lawson et al., 2017; Takeda et al., 2016). Additionally, almost all factors related to agreement in our study were found in the community sample (Study 1) and not in the clinical sample (Study 2).

One potential explanation for our lack of findings in Study 2 is that all children met criteria for ADHD diagnosis and were seeking treatment for ADHD, suggesting a certain severity of

symptoms and impairment. Using a more clinical sample is likely to restrict the range of scores obtained on measures of interest, thereby attenuating relationships between study measures (Salkind, 2012). Other clinical samples in the literature may not be as severe as our Study 2 sample; for instance, Takeda et al. (2016) enrolled referrals for ADHD assessment, among whom 25.2% did not meet criteria for ADHD. Different child factors (or fewer factors) may also relate to parent-teacher agreement about the intensity of ADHD symptoms once a threshold of symptoms is passed. For example, in a clinical sample, receipt of school-based services for ADHD may result from, and facilitate, more parent-teacher communication about the child's symptoms, thereby correlating with better parent-teacher agreement about symptoms.

Another consideration is that none of the existing studies examining predictors of parent-teacher agreement about child ADHD symptoms (as the outcome measure of interest) have used polynomial regression. Instead, most studies have used difference scores to quantify parent-teacher agreement (with a smattering of other methodology), which may obscure comparisons to our findings. Nonetheless, the benefits of polynomial regression for testing informant discrepancies have been well-laid out (Laird & De Los Reyes, 2013; Laird & LaFleur, 2016).

We also acknowledge that parent-teacher informant discrepancies could reflect genuinely divergent levels of ADHD behaviors displayed at home versus school. This might occur in response to legitimately different executive functioning demands at home versus school, or different supports in each setting. Relatedly, ADHD behaviors (and the resultant ratings) could vary depending on whether the child is taking medication for ADHD in that setting. In Study 2, stimulant medication for ADHD was taken by 58.2% of the children. Parents and teachers were asked to rate children's symptoms off medication (such as when medication was wearing off), but teachers were likely unable to do so if children were medicated during all school hours.

There are several limitations to our study. First, varied measures were used to rate child ADHD symptoms. Whereas teachers completed the ADHD-5 or the CSI-4 in both samples, parents completed the CSI-4 in the clinical sample but a different measure (the SDQ Hyperactivity/Inattention subscale) in the community sample. The ADHD-5 and the CSI-4 are nearly identical, containing ratings of each of the 18 ADHD symptoms on a 4-point scale. However, the SDQ measure contains only five items reflecting inattention, hyperactivity, and impulsivity, rated on a 3-point scale. Although the SDQ has been previously validated as a screener for ADHD symptoms and diagnoses, using different measures of ADHD symptoms increases the difficulty in comparing parent and teacher ADHD symptom ratings in the community sample, and in comparing results across the two samples. As well, we looked at parent-teacher agreement about the total ADHD symptom score to reduce the number of analyses and because the SDQ does not break into symptom domains, but future research should examine agreement about the inattentive and hyperactive/impulsive symptoms separately.

In addition, different measures were sometimes used to assess the same construct across samples, and we did not have measures of externalizing psychopathology in the community sample. Another limitation is that we only tested child factors because these were the measures we had in both our samples, but factors in parents or teachers (e.g., parental psychopathology, teacher stress) are likely also relevant for parent-teacher agreement. We also dichotomized race into White versus non-White, which, while providing consistency in analyses across samples, obfuscates important differences between racial groups. Finally, we conducted a large number of analyses because this was an exploratory study. However, our results need to be considered in light of the many tests run, and those that survived after the B-HP.

A clinical implication of our findings is that clinicians should not anticipate high, or even moderate, agreement between parents and teachers on child ADHD symptoms. In contrast to other findings on informant discrepancies (De Los Reyes, 2011), however, clinicians should not assume that greater rater discrepancy indicates greater dysfunction. Our data suggest a more nuanced pattern, and that parent-teacher agreement appeared to be strongest for children with slightly below-average functioning. By contrast, clinicians might need to be aware that children with extremely high or conversely, extremely low, social and academic functioning may be at more risk for parents and teachers disagreeing about their ADHD symptoms, and therefore might be underdiagnosed given the DSM-5 criteria that symptoms be present in at least two settings. Especially in those situations, clinicians might provide instructions about how to rate – a technique suggested to improve parent-teacher agreement (Johnston et al., 2014). Ultimately, the complexity of parent-teacher agreement suggests that it may be useful for clinicians to familiarize themselves with factors associated with low informant agreement, including child, rater, and contextual factors. Furthermore, clinicians should consider structuring the assessment to identify factors that may explain any informant discrepancies, and using multiple methods to determine whether the child meets diagnostic criteria (see Owens et al., 2020b).

In summary, parent-teacher agreement on child ADHD symptoms may be associated with the child's academic and social functioning. Greater agreement may occur more frequently in children with somewhat below average functioning, and clinicians might be aware of this when assessing or treating children with ADHD. However, factors may relate to parent-teacher agreement in complex and non-linear ways. Future studies are encouraged to use polynomial regression analyses to further understanding of non-linear relationships (e.g., quadratic, cubic) between factors and parent-teacher agreement, and to explore methods for combining multi-

informant ratings that minimize the impact of informant discrepancies on ADHD diagnosis.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10862-021-09892-1) contains supplementary material, which is available to authorized users.

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Declarations

Informed Consent Informed consent was obtained for all adult participants in the study. For children, written informed consent was obtained from the children's legal guardians and assent was obtained from the individual children.

Research Involving Human Participants All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The studies were also approved by the research ethics boards at the participating universities and the school districts where participants were recruited. The article does not contain any studies with animals as subjects.

Disclosure of Potential Conflicts of Interest Boaz Saffer, Amori Mikami, Hongyuan Qi, Julie Owens, and Sébastien Normand declare that they have no conflicts of interest.

Experiment Participants This study included human subject participants. The current study was performed in accordance with the ethical standards for human subjects research.

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