Article

Use of Polynomial Regression to Investigate Biased Self-Perceptions and ADHD Symptoms in Young Adolescents

Journal of Attention Disorders
2018, Vol. 22(12) 1113–1122

DOI: 10.1177/1087054715573993
journals.sagepub.com/home/jad
SAGE

Sarah A. Fefer[1], Julia A. Ogg[2], and Robert F. Dedrick[2]

Abstract

Objective: This study investigated biased self-perceptions of academic and social competence among young adolescents with a range of ADHD symptoms. The goal was to better understand how to measure agreement and disagreement between competence ratings from multiple informants. **Method:** The commonly used discrepancy methodology was used along with polynomial regression/response surface analyses to explore the relationship between biased self-perceptions and ADHD symptoms. Participants were 164 middle school students and their homeroom teachers. Students and teachers completed measures about academic and social competence, and teachers rated ADHD symptoms. **Results:** Discrepancy score and polynomial regression/response surface analyses both supported the relationship between student overestimation of competence and ADHD symptoms. Response surface analyses also suggest that some students with ADHD symptoms accurately perceive their impairments, particularly in the academic domain. **Conclusion:** Findings demonstrate the importance of using more advanced methods to understand the relationship between both accurate and discrepant perceptions of competence and ADHD symptoms. *(J. of Att. Dis. 2018; 22(12) 1113-1122)*

Keywords

positive illusory bias, biased self-perceptions, polynomial regression, response surface analysis, ADHD, middle school

Symptoms of ADHD affect a significant number of youth in schools (Froehlich et al., 2007). Approximately 7% to 10% of school-age children meet diagnostic criteria for ADHD (Froehlich et al., 2007), with higher prevalence when teacher ratings of symptoms are considered rather than diagnosis (14.8% among middle and high school students; Nolan, Gadow, & Sprafkin, 2001). Students with ADHD are at risk of negative academic and social functioning, with symptoms and impairments commonly persisting into adolescence (Bussing, Mason, Bell, Porter, & Garvan, 2010).

Given the difficulties faced by students with ADHD symptoms, it may be expected that these students would be at risk for low self-concept. However, past studies show that youth with ADHD may not perceive or report their deficits and tend to overestimate competence in domains of significant impairment (Hoza et al., 2004). The terms biased self-perceptions and positive illusory bias have been used to refer to the phenomenon in which individuals with ADHD "unexpectedly provide extremely positive reports of their own competence in comparison to other criteria reflecting actual competence" (Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007, p. 335). The majority of studies on this topic have compared the self-perceptions of elementary-age children with ADHD diagnoses to control groups without ADHD in clinical settings (Hoza et al., 2004). This study represents the first to explore biased self-perceptions among a diverse school-based sample of young middle school students with a full continuum of ADHD symptoms. Exploring these self-perceptions among older students with a broader range of ADHD symptoms is important because adolescents who had elevated ADHD symptoms, but who did not meet diagnostic criteria, were shown to experience similar impairments compared to students diagnosed with ADHD (Bussing et al., 2010). Biased self-perceptions have been shown to be present across the academic and social domains (e.g., Hoza et al., 2004) that are often the target of school-based assessment and intervention efforts. The presence of a positive bias may suggest that students with ADHD symptoms provide inaccurate self-report ratings. In addition, students with positively biased self-perceptions may not perceive a need for intervention (Hoza & Pelham, 1995), and have been shown to demonstrate less response to intervention compared to youth with accurate perceptions of

[1]University of Massachusetts Amherst, MA, USA
[2]University of South Florida, Tampa, FL, USA

Corresponding Author:
Sarah A. Fefer, University of Massachusetts Amherst, 363 Hills South, 111 Thatcher Road, Amherst, MA 01003, USA.
Email: sfefer@educ.umass.edu

competence (Mikami, Calhoun, & Abikoff, 2010). It is clear that gaining a better understanding of biased self-perceptions among youth in schools is a needed contribution to this literature.

Measuring Biased Self-Perceptions

Despite the clear need to further understand biased self-perceptions to inform practice, researchers struggle to find valid methods to investigate this complex phenomenon. Methods previously used to measure biased self-perceptions include (a) the absolute difference method (e.g., Hoza, Pelham, Milich, Pillow, & McBride, 1993), in which mean self-concept ratings of individuals with ADHD are compared with a control group or normative sample, and (b) pre-/post-performance ratings to identify biased perceptions related to specific tasks or situations (Hoza, Waschbusch, Owens, Pelham, & Kipp, 2001). The pre-/post-performance method involves children rating their performance (either before or after completing a task) and comparing ratings with actual performance and/or with children in a control group. Each of these methods has significant limitations and has yielded inconclusive results about biased self-perceptions. Currently, use of the criterion or discrepancy analysis is suggested to be best for this area of research (Owens et al., 2007). This method involves subtracting a criterion score (i.e., an external source of competence information such as teacher ratings or standardized achievement test score) from students' self-ratings of their domain-specific competence. Discrepancy analysis (i.e., difference scores) continues to be recommended and used often in literature on self-perceptions and ADHD despite extensive critiques of discrepancy scores as methodologically problematic (e.g., Edwards, 2001). The primary concerns described in the difference score literature include decreased reliability of difference scores (particularly when the components that are used to compute the difference score [teacher and student ratings] are correlated), increased Type II error rates (Edwards, 2001), and ambiguity in interpreting results because individual ratings (e.g., self and teacher) are combined into one score, which reduces the complex three-dimensional relationship between each of these individual ratings and an outcome to two dimensions (Edwards, 2002). Each of these concerns could contribute to the inconsistencies in the past literature using difference scores.

Improved methodology for exploring agreement and disagreement between self- and other-ratings has been proposed in the fields of business and industrial-organizational psychology (Shanock, Baran, Gentry, Pattison, & Heggestad, 2010). A combination of polynomial regression and response surface methods has been recommended as a viable alternative to overcome many of the limitations of difference scores outlined above (Edwards, 2001, 2002; Shanock et al., 2010). This method allows for a three-dimensional exploration of relationships among key variables by replacing the discrepancy score with each of its component measures (e.g., teacher and student ratings), as well as the product and squares of the components (Edwards, 2002). Polynomial regression involves regressing an outcome variable on these separate variables (e.g., teacher and student ratings; Shanock et al., 2010). Coefficients from this regression equation are then used to calculate response surface values to create a graph that allows for interpretation of separate and joint effects of the predictors along a three-dimensional continuum (Edwards, 2002). These effects (e.g., teacher, student, quadratic terms for the teacher and student, and product terms for the teacher and student) are interpreted collectively rather than in isolation. This allows researchers to explore different combinations of two predictor variables (i.e., self- and teacher ratings) and how agreement and disagreement between these variables relate to an outcome variable (i.e., ADHD symptoms; Shanock et al., 2010). Edwards (2002) advocates for the use of polynomial regression to answer complex research questions that previously relied on difference scores because this approach allows for different perspectives across informants (e.g., student and teachers) to be considered within data interpretation rather than combining measures into one difference score. Extensions of this method to research on biased self-perceptions are needed as this allows for an exploration of how separate self- and teacher ratings, and different combinations of agreement and disagreement (i.e., agreement about low or high competence, overestimation, and underestimation) between these multi-informant ratings of competence, predict ADHD symptoms (Shanock et al., 2010). This novel measurement approach also allows for the investigation of the degree and direction of agreement/disagreement in relation to an outcome variable of interest. These methods have the potential to overcome the ambiguity of interpreting difference scores to measure biased self-perceptions, and may inform research and practice, which often relies on multi-informant data collection for students with ADHD symptoms.

Study Purpose

This study investigated perceptions of academic and social competence among young adolescents with a range of ADHD symptoms. The goals were to (a) extend past literature on this topic by being the first study to explore biases in the self-perceptions of a diverse school-based sample of young adolescents with a full continuum of ADHD symptoms, and (b) advance the understanding of how to measure biased self-perceptions by exploring the novel approach of polynomial regression and response surface analyses. The commonly used discrepancy score methodology and the more advanced method of polynomial regression and

Table 1. Comparison of Sample (n = 164) and School Demographics.

	School A sample (n = 76)	School B sample (n = 88)	Total sample (n = 164)	Combined school population (n = 1,983)	District population (n = 207,285)
Variable	%	%	%	%	%
Gender					
Male	28.9	39.8	34.8	50.1	51.6
Female	71.1	60.2	65.2	49.9	48.4
Grade					
6	65.8	31.8	47.6	33.5	[a]
7	17.1	34.1	26.2	34.3	[a]
8	17.1	34.1	26.2	32.3	[a]
Ethnicity					
White	25.0	44.3	35.4	31.1	40.4
Hispanic	19.7	36.4	28.7	32.4	29.4
African American/Black	46.1	9.1	26.2	27.3	21.7
Asian American	2.6	2.3	2.4	3.1	3.3
Other/Multiracial	6.6	8.0	7.3	5.8	5.0
FRL status					
Yes	72.4	44.3	57.3	65.5	56.1
No	27.6	55.7	42.7	34.5	43.9

Note. Chi-square tests for independence were used to compare the sample with the total school and district populations. Gender was the only variable to show a significant difference between the current sample and the school population, $\chi^2(1, n = 1{,}983) = 16.78$, $p < .001$, and district $\chi^2(1, n = 207{,}285) = 18.65$, $p < .001$. FRL = free/reduced price lunch.
[a]Data were not available.

response surface analysis were both used to address the question of how agreement and disagreement between self- and teacher ratings of competence relate to ADHD symptoms. Findings are presented to illustrate how the novel techniques of polynomial regression and response surface analysis can extend our understanding of the relationships between the ratings of multiple informants.

Method

Participants

The data for the current study were from a larger study investigating symptoms of ADHD among students from two middle schools (Grades 6-8). Parent consent was obtained for 198 students (12% of total eligible students across schools), and 183 students were present and assented to participate in the study. Data from 164 students with all measures completed (student and teacher) were analyzed for the current study (see Table 1 for demographic information).

Student Measures

Demographic form. Students were asked to complete a demographic form containing questions about age, grade, gender, and race/ethnicity.

Self-Perception Profile for Children (SPPC). The scholastic competence and social acceptance domains of the SPPC (Harter, 1985), which includes six items per subscale, were used within the current study to measure academic and social competence. Each item on the SPPC is scored from 1 (*low*) to 4 (*high*) using a "structure alternative format" (Harter, 1982, p. 89) designed to combat the tendency for children to provide socially desirable responses. After accounting for reverse-scored items, subscale means were calculated. The SPPC has been used in both elementary and middle school samples (Grades 3-8; Harter, 1985). High internal consistency with middle school students is supported by alpha coefficients ranging from .80 to .85 for both the academic and social domains (Harter, 1985). In the current study, αs were .81 and .73 for the academic and social domains, respectively.

Teacher Measures

Teacher's Rating Scale of the Child's Actual Behavior. The Teacher Rating Scale of the SPPC (SPPC-TRS; Harter, 1985) is directly comparable with the SPPC and is used to assess children's domain-specific competencies. The three items that comprise both the Scholastic Competence and Social Acceptance domains were utilized for this study, for a total of six items. Each item was scored from 1 (*low*) to 4 (*high*). Items within each domain were averaged, resulting

in separate subscale means for each domain. High internal consistency is evidenced by alpha coefficients of .96 and .93 for the Scholastic Competence and Social Acceptance domains, respectively (Harter, 1982). Within the current study, αs were .89 and .92 for the academic and social domains, respectively.

Vanderbilt ADHD Diagnostic Teacher Rating Scale (VADTRS). The VADTRS (Wolraich, Feurer, Hannah, Baumgaertel, & Pinnock, 1998) instructs teachers to rate ADHD symptoms that directly correspond to ADHD diagnostic criteria. There are nine items that assess inattention (IA) and nine items assessing hyperactive/impulsive (HI) symptoms with responses ranging from 0 (*low*) to 3 (*high*). The degree of symptoms was considered for each participant by averaging the 18 VADTRS items representing each symptom type to understand the overall ADHD symptoms. Within national and international samples, internal consistencies ranged from .95 to .96 for IA items, and from .87 to .93 for HI items (Wolraich et al., 2003). In the current study, αs were .96 for IA and .95 for HI.

Procedures

Approval for the study was obtained through the school district and university Institutional Review Board. Recruitment and data collection plans were determined collaboratively with school administrators. Students and teachers received small incentives for their participation.

Student participation required documented parent permission and student assent. Students completed surveys in groups during one class period during the school day. Researchers monitored the room throughout survey administration to ensure accurate survey completion and to answer questions.

Informed consent was requested from the homeroom teacher for each child participant. Fifty-one teachers participated. The number of rating scales completed by each teacher ranged from 1 to 10 and was dependent on the number of student participants in each classroom. On the day of student data collection, teachers were provided with rating scales for each student participant in their homeroom. Questionnaires took approximately 5 min to complete per student. Teachers were given 1 week to complete the measures.

Analyses

SPSS 21 statistical software was used for all analyses. Correlations and descriptive statistics were calculated first (see Table 2). Assumptions of ANOVA and regression were examined (i.e., independence, normality, linearity, homogeneity) and results were within acceptable limits.

Discrepancy analysis and polynomial regression/response surface methods were both conducted to measure agreement and disagreement about competence and how this related to ADHD symptoms. First, the base rates of discrepancies between student and teacher ratings of competence in the academic and social domains were examined to determine the presence of agreement/disagreement (Shanock et al., 2010) and to determine the distribution of discrepancies within the sample (Edwards, 2002). Shanock and colleagues (2010) suggest that this should occur before conducting polynomial regression to provide a rationale for further exploring discrepancies. Difference scores were calculated by subtracting the teacher rating from the student rating in each domain as is common in past literature on positive bias in ADHD (e.g., Hoza et al., 2004). Positive difference scores suggest overestimation of competence by the student. As suggested in past literature using polynomial regression, any participant with a competence rating half a standard deviation above or below the other competence rating was considered discrepant (Fleenor, McCauley, & Brutus, 1996; Shanock et al., 2010). Percentages of agreement and disagreement were then examined in both domains (see Table 3). The presence of discrepancies between self- and teacher ratings (i.e., more than half than sample) provides a rationale for moving forward with polynomial regression analyses (Shanock et al., 2010).

Two stages of analyses to measure biased self-perceptions were then compared. First, discrepancy analyses using ANOVA were completed to compare accuracy groups. This is aligned with methods used in past research on biased self-perceptions; however, the groups compared in previous research were ADHD and non-ADHD with discrepancy scores measured on a continuum used as the outcome variable. In the present study, the grouping variable used in the ANOVA was the accuracy condition (underestimation, accurate, and overestimation) and the outcome was the continuum of ADHD symptoms. The second analysis type, polynomial regression, and response surface analyses required additional data preparation. First, competence variables were centered around the midpoint of the 4-point scale to enhance interpretability of results (Edwards, 2002). Next, new variables were created in each domain: (a) the square of the centered self-competence rating, (b) the interaction (i.e., cross-product) between centered self- and teacher ratings, and (c) the square of the centered teacher rating of student competence. To conduct polynomial regression, ADHD symptoms were regressed on the simultaneously entered predictor variables (self- and teacher ratings), squared competence variables, and cross-product. A polynomial regression equation takes this form:

$$Z = b_0 + b_1 X + b_2 Y + b_3 X^2 + b_4 XY + b_5 Y^2 + e. \quad (1)$$

Z represents ADHD symptoms, X is self-ratings, Y is teacher ratings, b_0 is the intercept, b_1 through b_5 represent the estimated regression coefficients, and e is the error

Table 2. Intercorrelations, *M*, and *SD* for All Variables.

Variable	*M* (*SD*)	1	2	3	4	5	6
1. ADHD symptoms	0.54 (0.65)	1					
2. Academic self-perceptions	3.02 (0.66)	−.26**	1				
3. Social self-perceptions	3.01 (0.60)	−.02	.21**	1			
4. Teacher ratings of academic competence	3.16 (0.79)	−.63**	.35**	.06	1		
5. Teacher ratings of social competence	3.15 (0.79)	−.30**	.12	.33**	.34**	1	
6. Academic accuracy (SPPC-TRS)	0.00 (1.14)	.33**	.57**	.13	−.57**	−.20*	1
7. Social accuracy (SPPC-TRS)	0.01 (1.16)	.24**	.08	.58**	−.24**	−.58**	.28**

Note. SPPC-TRS = Self-Perception Profile for Children–Teacher Rating Scale.
*$p < .05$. **$p < .01$.

Table 3. Frequencies of SPPC Scores Over, Under, and In-Agreement With SPPC-TRS Scores.

Agreement groups	*n*	% of sample	*M* SPPC	*M* SPPC-TRS
Academic domain	*n* = 164			
Student overestimation	46	28.05	3.40	2.52
In agreement	66	40.24	3.16	3.33
Student underestimation	52	31.71	2.51	3.51
Social domain	*n* = 164			
Student overestimation	52	31.71	3.33	2.51
In agreement	63	38.41	3.14	3.32
Student underestimation	49	29.87	2.58	3.56

Note. Both SPPC and SPPC-TRS are measured on a 4-point scale with higher numbers representing greater competence ratings. SPPC = Self-Perception Profile for Children; SPPC-TRS = Self-Perception Profile for Children–Teacher Rating Scale.

(Kazen & Kuhl, 2011). If the regression results indicate that the R^2 is significant, then the unstandardized beta coefficients for that analysis are used to calculate response surface patterns, which allows for the creation of three-dimensional graphs. Four surface test values, a_1 through a_4, are examined. The slope of the line of perfect agreement (a_1) was calculated by adding b_1 (the unstandardized beta coefficient for the first predictor, self-ratings of competence) to b_2 (the unstandardized regression coefficient for the second predictor, teacher ratings of competence). The curvature of the line of perfect agreement was assessed by a_2, calculated by adding b_3 (the unstandardized beta coefficient for the squared self-ratings), b_4 (unstandardized beta coefficient for the interaction between self- and teacher ratings), and b_5 (unstandardized beta for the squared teacher ratings). The slope of the line of incongruence (which represents the direction of the discrepancy between self- and teacher ratings) was assessed by a_3, calculated by subtracting b_2 from b_1. The curvature of this line of incongruence (which is the indication of the degree of the discrepancy) was represented by a_4, which is equal to $b_3 - b_4 + b_5$. Graphs for each domain of competence are then created with these response surfaces using an Excel template (see Shanock et al., 2010).

Results

Discrepancy Analysis

A one-way between-subjects ANOVA was conducted to examine the relation between accuracy of self-perceptions (i.e., underestimation, accurate, and overestimation groups; see Table 3) and ADHD symptoms. Accuracy grouping had a significant relation to ADHD symptoms in the academic, $F(2, 161) = 10.62$, $p < .001$ ($\eta_p^2 = .12$) and social domains, $F(2, 161) = 8.31$, $p < .001$ ($\eta_p^2 = .09$). Across both domains, Tukey's post hoc tests indicated that mean ADHD symptoms for the overestimation group (academic: $M = 0.89$, $SD = 0.82$; social: $M = 0.84$, $SD = 0.77$) were significantly higher than the accurate group (academic: $M = 0.40$, $SD = 0.51$; social: $M = 0.40$, $SD = 0.55$) and the underestimation group (academic: $M = 0.40$, $SD = 0.52$; social: $M = 0.42$, $SD = 0.54$). ADHD symptoms were highest among students who overestimated their competence (i.e., demonstrate positively biased self-perceptions).

Polynomial Regression and Response Surface Analyses

Polynomial regression analyses were then conducted to investigate how self- and teacher ratings separately, and the agreement/disagreement between the two, predict ADHD symptoms. Separate analyses were conducted for the academic and social domains with ADHD symptoms regressed on the simultaneously entered centered predictor variables.

Academic domain. The results of the polynomial regression with student and teacher ratings of academic competence along with the X^2, Y^2, and XY terms as predictors of ADHD symptoms are presented in Table 4. The significant R^2 value of .412, $F(5, 158) = 22.12$, $p < .001$, suggests that moving forward with response surface analyses was appropriate (Shanock et al., 2010), and that approximately 41% of the variance in ADHD symptoms was accounted for by the variables in this equation.

Table 4. Correlations Between Predictors and Results of Polynomial Regression With Self- and Teacher Rating of Academic Competence Predicting ADHD Symptoms.

	1	2	3	4	*B*	*SE*
Intercept					.85**	.07
1. Self-rating (centered)	—				−.01	.10
2. Teacher ratings (centered)	.01	—			−.52**	.08
3. Self-rating^2	−.54	.21	—		.14	.09
4. Self × Teacher	−.20	−.47	−.44	—	−.10	.09
5. Teacher rating^2	−.07	−.54	.04	−.14	.08	.06
R^2					.41**	

	Coefficient	*SE*	*t* value
Surface value: a_1	−.53	.13	−4.14**
Surface value: a_2	.12	.12	1.02
Surface value: a_3	.51	.13	3.98**
Surface value: a_4	.32	.16	2.00**

Note. n = 164. *B* = unstandardized regression coefficient; a_1 = slope of line of perfect agreement; a_2 = curvature of the surface along the line of perfect agreement; a_3 = slope of line of incongruence; a_4 = curvature of the surface along the line of incongruence.
*p < .05. **p < .01.

The coefficients from the regression analyses were used to create three-dimensional response surface graphs (see Figures 1 and 2) to better understand the relationship between self- and teacher ratings and ADHD symptoms by examining the four surface values. The significant negative value for the slope of the line of perfect agreement (a_1) suggests that agreement between self and teachers is related to ADHD symptoms, with self–teacher agreement of low competence predicting high ADHD symptoms. The slope of the line of incongruence (a_3) was significant and positive, suggesting that high ADHD symptoms were predicted by positively biased self-perceptions (i.e., when students rate competence higher than their teacher). A significant positive value for the curvature of the line of incongruence (a_4) suggests a convex surface, meaning that ADHD symptoms increase more sharply as the degree of the discrepancy between self- and teacher ratings increases. Results show that only a_2, the curvature of the line of perfect agreement, was not significant.

Further investigation of these values along with the response surface graph (Figure 1) shows that ADHD symptoms are high when students and teachers both provide low ratings of academic competence, and when students rate academic competence higher than their teacher. This suggests that some middle school students with ADHD symptoms are aware of their academic impairments, whereas others demonstrate positively biased self-perceptions.

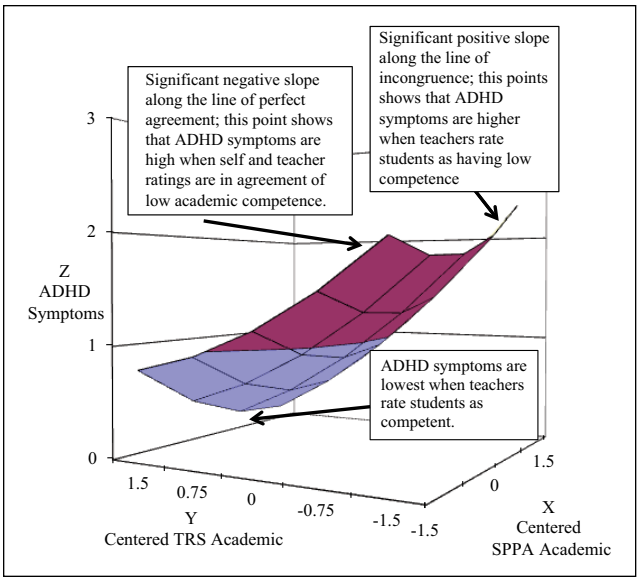

Figure 1. Response surface graph for ADHD symptoms predicted by student and teacher ratings of academic competence.
Note. SPPA = Self-Perception Profile for Children; TRS = Teacher Rating Scale.

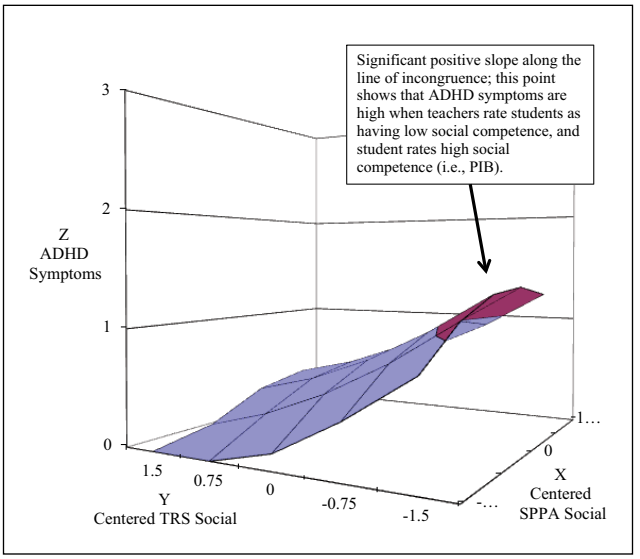

Figure 2. Response surface graph for ADHD symptoms predicted by student and teacher ratings of social competence.
Note. SPPA = Self-Perception Profile for Children; TRS = Teacher Rating Scale; PIB = Positive Illusory Bias.

Social domain. The results of the polynomial regression with student and teacher ratings of social competence along with the X^2, Y^2, and XY terms as predictors of ADHD symptoms are presented in Table 5. The significant R^2 value of .11, $F(5, 158) = 3.77$, $p < .05$, suggests response surface graphing

Table 5. Correlations Between Predictors and Results of Polynomial Regression With Self and Teacher Rating of Social Competence Predicting ADHD Symptoms.

	1	2	3	4	*B*	*SE*
Intercept					.66**	.09
1. Self-rating (centered)	—				.17**	.12
2. Teacher ratings (centered)	−.29	—			−.33**	.09
3. Self-rating^2	−.56	.32	—		−.12	.12
4. Self × Teacher	−.05	−.37	−.50	—	.02	.12
5. Teacher rating^2	.09	−.37	.15	−.40	.06	.07
R^2					.11**	

	Coefficient	*SE*	*t* value
Surface value: a_1	−.16	.13	−1.25
Surface value: a_2	−.04	.12	−0.34
Surface value: a_3	.50	.17	2.96**
Surface value: a_4	−.08	.24	−0.33

Note. n = 164. *B* = unstandardized regression coefficient; a_1 = slope of line of perfect agreement; a_2 = curvature of line of perfect agreement; a_3 = slope of line of incongruence; a_4 = curvature of line of incongruence.
**p < .01.

should be used (Shanock et al., 2010). This significant R^2 value indicates that 11% of the variance in ADHD symptoms was accounted for by the predictor variables. Response surface analyses showed that only the slope of the line of incongruence (a_3) was statistically significant. This significant positive value indicates higher ADHD symptoms when the self-rating is higher than the teacher rating. This finding supports the presence of positively biased self-perceptions in the social domain for students with ADHD symptoms. An examination of the response surface graph (see Figure 2) shows that higher ADHD symptoms were consistently predicted by low teacher ratings, but that ADHD symptoms were associated with both high *and* low self-ratings of social competence. Interestingly, it appears that students with high ADHD symptoms rate themselves moderately, while teachers provide low ratings of social competence for those students.

Discussion

The current study illustrates the use of polynomial regression and response surface analyses as an approach for evaluating the relationship between informant discrepancies (e.g., self- and teacher ratings) and student behavioral symptoms. This approach overcomes the limitations of differences scores and expands the information that is provided by the more commonly used discrepancy analysis approach.

When difference scores were used to categorize participants into three groups (underestimation, accurate, and overestimation), more than half of the study participants exhibited biased self-perceptions and either over- or underestimated their competence compared with teachers. Results demonstrated that ADHD symptoms were highest among students in the overestimation group supporting the presence of positively biased self-perceptions in this school-based sample of young adolescents with a range of ADHD symptoms. This is in line with studies suggesting that this phenomenon is present among some adolescents with ADHD (Hoza et al., 2010).

Building on these results, polynomial regression and response surface methods provided more information about agreement and disagreement. These analyses support past findings about positively biased self-perceptions among youth with high ADHD symptoms; however, results also indicate that ADHD symptoms are predicted by agreement between students and teachers when both ratings reflect low levels of academic and social competence. The relationship between ADHD symptoms and agreement reflecting low competence may be overlooked when relying on difference scores that do not consider the direction of agreement (i.e., agreement at the low or high end of the scale of competence). For example, when students are grouped based on agreement/disagreement (as was done in the ANOVA analyses in the current study), the agreement group consists of any student with a discrepancy score near zero. This includes students with both high and low competence ratings that are aligned with their teachers' ratings. Response surface graphs in the academic and social domain suggested that some students with high ADHD symptoms accurately perceive their impairments, whereas others demonstrate a positive bias. This relationship is particularly strong in the academic domain where response surfaces were significant for both agreement and disagreement. A reliance on discrepancy analyses, which only consider the direction of disagreement, seems to overlook an important group of students with ADHD symptoms who accurately rate their competence and acknowledge impairments. These findings support the use of polynomial regression/response surface methods to explore biased self-perceptions, and provide methods for future research to investigate the important question of what characteristics differ among students with ADHD symptoms with and without biased self-perceptions.

In both domains, inspection of response surface graphs shows that ADHD symptoms were high when students and teachers were in agreement that the student was not highly competent. This has not been demonstrated with discrepancy analyses, which consider accuracy as any type of agreement (i.e., high or low competence). The slope of the line of incongruence, representing disagreement between students and teachers in the current study, was significant and positive in both the academic and social domains. This suggests that self-ratings higher than teacher ratings (i.e., positive bias) predict greater levels of ADHD symptoms. This analysis method demonstrated that ADHD symptoms

relate to agreement of low competence *and* overestimation, particularly in the academic domain where multiple response surface values were shown to be significant. These findings could be used to explain some of the contradictory findings about whether students with ADHD have biased self-perceptions (Hoza et al., 2004; Whitley, Heath, & Finn, 2008) and supports variability in self-perceptions across domains of competence.

Interestingly, a significant relationship between the degree of the discrepancy between self- and teacher ratings and ADHD symptoms was demonstrated in the academic domain. Specifically, the convex surface of the graph suggested that symptoms of ADHD increased more sharply as the student perception of competence was more positively biased (i.e., greater than the teacher rating). One previous study explored self-perceptions in relation to the intensity of ADHD symptoms and showed that students with higher ADHD symptoms demonstrated greater social bias than students with lower ADHD symptoms (Diamantopoulou, Henricsson, & Rydell, 2005).

In the social domain, the significant response surface values suggested that ADHD symptoms were related to positively biased self-perceptions. An examination of the response surface graph shows higher ADHD symptoms were associated with low teacher ratings in general, but that some students with high ADHD symptoms agreed with their teachers about low social competence. Interestingly, it appears that students with the highest ADHD symptoms actually rate their social competence moderately, with teachers reporting more social impairments. This suggests that some students with ADHD symptoms may acknowledge their social impairments, while many exhibit positively biased self-perceptions. Examination of the significant response surface values suggests that positively biased self-perceptions may be more associated with ADHD symptoms in the social domain compared with the academic domain among this sample of young adolescents.

Taken together, results using both analysis methods show that positively biased self-perceptions are present among middle school students with ADHD symptoms. However, results of polynomial regression and response surface methods suggest that a group of students with ADHD symptoms accurately perceive their impairments (and therefore agree with their teachers about low competence). These students may be missed by discrepancy analyses that group students as either accurate or discrepant without explicit consideration of the degree or direction of agreement/disagreement. There is little literature to draw from to make sense of these response surface results because past research has not used methods to provide a more nuanced understanding of agreement and disagreement. It is possible that agreement at the low end of the competence scales was more common in this middle school sample compared with the younger samples used in past research suggesting that positively biased self-perceptions may decrease over time (Hoza et al., 2010). According to the cognitive immaturity hypothesis that has been used to explain this phenomenon, children with ADHD symptoms may eventually outgrow inflated self-perceptions (Owens et al., 2007). Furthermore, students are likely to have received an accumulation of both positive and negative feedback by the time they reach middle school. Students with ADHD symptoms may be more likely to receive negative feedback. It is possible that an accumulation of negative feedback over time has maintained the positively biased self-perception and the need for self-protection for some adolescents with ADHD symptoms, and decreased this in others, especially in the academic domain. Feedback received in the academic domain is likely to be more frequent and objective (e.g., grades). There are no comparable mechanisms for feedback within the social domain, with social feedback likely being more subtle and difficult to interpret.

Limitations

The relatively low response rate and high percentage of female participants in the sample may limit the generalizability of these findings. However, this diverse school-based sample of adolescents extends upon past self-perception research examining bias that has primarily been conducted with more homogeneous samples consisting of mostly elementary-age boys (e.g., Hoza et al., 2004). The use of self-report and teacher report methods is another potential limitation to this study design. The use of self-report for research related to self-perceptions is unavoidable; however, precautions were taken to ensure that measures demonstrated strong psychometric properties and had been used with similar populations. Comparing self-reports to indicators of actual competence (e.g., teacher reports) is recommended as the best-practice methodology for research on biased self-perceptions (Owens et al., 2007), and relates to best-practice assessment guidelines to gather information from multiple informants (Batsche, Castillo, Dixon, & Forde, 2008). The use of teacher report could also be considered as a limitation, particularly due to shared variance across variables as teachers reported both ADHD symptoms and student competence. However, this is often done in past research using polynomial regression/response surface (e.g., Kazen & Kuhl, 2011). In addition, the nature of middle school scheduling could limit the ability of teachers to accurately rate social and academic competence; however, reports from homeroom teachers were used because they have opportunities to observe students in both academic and social contexts and because these teachers knew the students for a minimum of 2 months. Teachers are suggested to be the most relevant reporters for students' daily behavioral concerns (Gadow et al., 2004).

Implications for Research and Practice

Exploring agreement and disagreement in competence ratings between students and teachers has the potential to inform practitioners who work with youth with ADHD symptoms. The relationship between ADHD symptoms and competence ratings is more complex than was previously thought; results showed that some students with ADHD symptoms provide inflated reports whereas others may accurately report low academic or social competence. This study provides evidence that some middle school students with elevated ADHD symptoms have positively biased self-perceptions, and that this may be more common within the social domain. Future research using the proposed methodology should explore the characteristics (such as age, gender, executive functioning skills, etc.) that may differentiate between students with ADHD symptoms who overestimate their competence compared with those who more accurately perceive their impairments.

Unfortunately, there is little guidance in the literature regarding actions that should be taken, if any, for students who overestimate their abilities, or those who accurately perceive their impairments. Emerging literature suggests that positively biased self-perceptions may be problematic. Harter (2012) suggests that discrepant perceptions of academic competence may compromise learning because students with inaccurate self-perceptions select easier tasks. Hoza and colleagues (2010) suggest that positively biased self-perceptions among students diagnosed with ADHD may be a risk factor for increased aggression, and that these overestimations of competence may not serve as a protective factor against depression (Owens et al., 2007). Another study found that overly positive self-ratings of social competence were related to negative psychosocial outcomes for girls with ADHD, but related to positive outcomes for girls without ADHD (Ohan & Johnston, 2011). In addition, biased self-perceptions negatively influence social functioning; students with ADHD who overestimated their competence exhibited less prosocial and effortful behavior than students with ADHD who more accurately perceived their competence (Linnea, Hoza, Tomb, & Kaiser, 2012). These findings suggest positively biased self-perceptions are likely maladaptive and indicate that interventions may be warranted for the subgroup of students with ADHD symptoms who provide inflated ratings of their competence.

Regarding assessment, although it is well documented that students with ADHD do not accurately report externalizing behavior (Wolraich et al., 2003), this research suggests that some students with ADHD may also provide inaccurate reports of their social and academic competence. Future research investigating how ratings of competence vary depending on the tool used (e.g., interviews, open-ended questionnaires, or more traditional rating scales) would inform the selection of appropriate self-report methods. These findings highlight the importance of multi-source data collection evaluating students with symptoms of ADHD to fully understand the students' abilities and impairments, and whether positive biases are present.

Regarding intervention, findings from previous literature suggest that positively biased self-perceptions decrease the effectiveness of behavioral interventions (Hoza & Pelham, 1995; Mikami et al., 2010). Students who do not accurately perceive their abilities may not fully engage in the complex behavioral interventions necessary to see improvement in areas of impairment. This is particularly problematic because skill building would be a likely intervention approach for students with self-ratings of competence significantly higher than their teachers. However, there is promising research suggesting that attributions in both the academic and social domains can be changed through intervention (Hudley, Graham, & Taylor, 2007). These findings suggest that biased self-perceptions may be an appropriate target for school-based intervention efforts. Additional research using polynomial regression and response surface methodology is needed to better understand what differentiates students who inflate versus accurately report their competence to inform service delivery for students with ADHD symptoms.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

Batsche, G., Castillo, J., Dixon, D., & Forde, S. (2008). Linking assessment to intervention. In J. Grimes & A. Thomas (Eds.), *Best practices in school psychology V* (Vol. 2, pp. 177-194). Bethesda, MD: NASP.

Bussing, R., Mason, D. M., Bell, L., Porter, P., & Garvan, C. (2010). Adolescent outcomes of children attention-deficit/hyperactivity disorder in a diverse community sample. *Journal of the Academy of Child & Adolescent Psychiatry*, *49*, 595-605. doi:10.1016/j.jaac.2010.03.006

Diamantopoulou, S., Henricsson, L., & Rydell, M. (2005). ADHD symptoms and peer relations of children in a community sample: Examining associated problems, self-perceptions, and gender differences. *International Journal of Behavioral Development*, *29*, 388-398. doi:10.1177/01650250500172756

Edwards, J. R. (2001). Ten difference score myths. *Organizational ResearchMethods*,*4*,265-287.doi:10.1177/109442810143005

Edwards, J. R. (2002). Alternative to difference scores: Polynomial regression analysis and response surface methodology. In F. Drasgow & N. Schmitt (Eds.), *Measuring and analyzing*

behavior in organizations: Advances in measurement and data analysis (pp. 350-400). San Francisco, CA: Jossey-Bass.

Fleenor, J. W., McCauley, C. D., & Brutus, S. (1996). Self-other agreement and leadership effectiveness. *Leadership Quality*, *7*, 487-506. doi:10.1016/S1048-9843(96)90003-X

Froehlich, T. E., Lanphear, B. P., Epstein, J. N., Barbaresi, W. J., Katusic, S. K., & Kahn, R. S. (2007). Prevalence, recognition, and treatment of attention-deficit/hyperactivity disorder in a national sample of U.S. children. *Archives of Pediatric Adolescent Medicine*, *161*, 857-864. doi:10.1001/archpedi.161.9.857

Gadow, K. D., Drabick, D. A. G., Loney, J., Sprafkin, J., Salisbury, H., Azizian, A., & Schwartz, J. (2004). Comparison of ADHD symptom subtypes as source-specific syndromes. *Journal of Child Psychology and Psychiatry*, *45*, 1135-1149. doi:10.1111/j.1469-7610.2004.00306.x

Harter, S. (1982). The Perceived Competence Scale for Children. *Child Development*, *53*, 87-97. doi:10.2307/1129640

Harter, S. (1985). *Manual for the self-perception profile for children*. Denver, CO: University of Denver.

Harter, S. (2012). *The construction of the self: Developmental and sociocultural foundations* (2nd ed.). New York, NY: Guilford Press.

Hoza, B., Gerdes, A. C., Hinshaw, S. P., Arnold, L. E., Pelham, W. E. J., Molina, B. S. G., . . .Wigal, T. (2004). Self-perceptions of competence in children with ADHD and comparison children. *Journal of Consulting and Clinical Psychology*, *72*, 382-391. doi:10.1037/0022-006X.72.3.382

Hoza, B., Murray-Close, D., Arnold, L. E., Hinshaw, S. P., Hechtman, L., & The MTA Cooperative Group. (2010). Time-dependent changes in positively biased self-perceptions of children with attention-deficit/hyperactivity disorder: A developmental psychopathology perspective. *Development and Psychopathology*, *22*, 375-390. doi:10.1017/S095457941000012X

Hoza, B., & Pelham, W. E. (1995). Social-cognitive predictors of treatment response in children with ADHD. *Journal of Social & Clinical Psychology*, *14*, 23-35. doi:10.1007/BF00917535

Hoza, B., Pelham, W. E., Milich, R., Pillow, D., & McBride, K. (1993). The self-perceptions and attributions of attention deficit hyperactivity disordered and nonreferred boys. *Journal of Abnormal Child Psychology*, *21*, 271-286. doi:10.1007/BF00917535

Hoza, B., Waschbusch, D. A., Owens, J. S., Pelham, W. E., & Kipp, H. (2001). Academic task persistence of normally achieving ADHD and control boys: Self-evaluations, and attributions. *Journal of Consulting and Clinical Psychology*, *69*, 271-283. doi:10.1037/0022-006X.69.2.271

Hudley, C., Graham, S., & Taylor, A. (2007). Reducing aggressive behavior and increasing motivation in school: The evolution of an intervention to strengthen school adjustment. *Educational Psychologist*, *42*, 251-260. doi:10.1080/00461520701621095

Kazen, A., & Kuhl, J. (2011). Directional discrepancy between implicit and explicit power motives in related to well-being among managers. *Motivation and Emotion*, *35*, 317-327. doi:10.1007/s11031-011-9219-8

Linnea, K., Hoza, B., Tomb, M., & Kaiser, N. (2012). Does a positive bias relate to social behavior in children with ADHD? *Behavior Therapy*, *43*, 862-875. doi:10.1016/j.beth.2012.05.004

Mikami, A. Y., Calhoun, C. D., & Abikoff, H. B. (2010). Positive illusory bias and response to behavioral treatment among children with attention-deficit/hyperactivity disorder. *Journal of Clinical Child & Adolescent Psychology*, *39*, 373-385. doi:10.1080/15374411003691735

Nolan, E. E., Gadow, K. D., & Sprafkin, J. (2001). Teacher reports of DSM-IV ADHD, ODD, and CD symptoms in school children. *Journal of the American Academy of Child and Adolescent Psychiatry*, *40*, 241-249. doi:10.1097/00004583-200102000-00020

Ohan, J. L., & Johnston, C. (2011). Positive illusions of social competence in girls with and without ADHD. *Journal of Abnormal Child Psychology*, *39*, 527-539. doi:10.1007/s10802-010-9484-0

Owens, J. S., Goldfine, M. E., Evangelista, N. M., Hoza, B., & Kaiser, N. M. (2007). A critical review of self-perceptions and the positive illusory bias in children with ADHD. *Clinical Child and Family Psychology Review*, *10*, 335-351. doi:10.1007/s10567-007-0027-3

Shanock, L. R., Baran, B. E., Gentry, W. A., Pattison, S. C., & Heggestad, E. D. (2010). Polynomial regression with response surface analysis: A powerful approach for examining moderation and overcoming limitations of difference scores. *Journal of Business Psychology*, *25*, 543-554. doi:10.1007/s10869-010-9183-4

Whitley, J. L., Heath, N. L., & Finn, C. A. (2008). The role of attention-deficit hyperactivity disorder in the self-perceptions of children with emotional and behavioural difficulties. *McGill Journal of Education*, *43*, 65-80. doi:10.7202/019574ar

Wolraich, M. L., Feurer, I. D., Hannah, J. H., Baumgaertel, A., & Pinnock, T. Y. (1998). Obtaining systematic teacher reports of disruptive behavior disorders utilizing DSM-IV. *Journal of Abnormal Child Psychology*, *26*, 141-152. doi:10.1023/A:1022673906401

Wolraich, M. L., Lambert, E. W., Baumgaertel, A., Garcia-Tornel, S., Feurer, I. D., Bickman, L., & Doffing, M. A. (2003). Teachers' screening for attention deficit/hyperactivity disorder: Comparing multinational samples on teacher ratings of ADHD. *Journal of Abnormal Child Psychology*, *31*, 445-455. doi:10.1023/A:1023847719796

Author Biographies

Sarah A. Fefer, PhD, is an Assistant Professor in the School Psychology Program at the University of Massachusetts in Amherst, Massachusetts. Her research interests include exploring the positive bias among youth with ADHD symptoms, and assessment and intervention for students with challenging behaviors.

Julia A. Ogg, PhD, is an Assistant Professor in the School Psychology Program at the University of South Florida in Tampa, Florida. Her research interests include early identification and intervention for youth with externalizing behaviors.

Robert F. Dedrick, PhD, is a Professor of Educational Measurement and Research at the University of South Florida, Tampa, Florida. His research interests include the development and validation of psychological and educational measures and multilevel modeling.