

# Supporting the Spectrum Hypothesis: Self-Reported Temperament in Children and Adolescents with High Functioning Autism

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Published online: 20 November 2015  
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**Abstract** This study tested the *spectrum hypothesis*, which posits that children and adolescents with high functioning autism (HFA) differ *quantitatively* but not *qualitatively* from typically developing peers on self-reported temperament. Temperament refers to early-appearing, relatively stable behavioral and emotional tendencies, which relate to maladaptive behaviors across clinical populations. Quantitatively, participants with HFA (N = 104, aged 10–16) self-reported less surgency and more negative affect but did not differ from comparison participants (N = 94, aged 10–16) on effortful control or affiliation. Qualitatively, groups demonstrated comparable reliability of self-reported temperament and associations between temperament and parent-reported behavior problems. These findings support the *spectrum hypothesis*, highlighting the utility of self-report temperament measures for understanding individual differences in comorbid behavior problems among children and adolescents with HFA.

**Keywords** High-functioning autism · Temperament · Spectrum hypothesis · Self-report

## Introduction

Individuals with high-functioning autism (HFA) display a great deal of heterogeneity in presentation of maladaptive behavior problems, prognosis, and patterns of comorbidity, particularly as they enter adolescence (Kerns et al. 2014; van Steensel et al. 2011). Identifying trait-level characteristics, such as temperament, which help explain the heterogeneity of presentation in individuals with HFA may help identify children at greatest risk for developing comorbid psychiatric disorders (Garon et al. 2009; Hepburn and Stone 2006). Temperament has shown concurrent and predictive associations with psychopathology in the typically-developing (TD) literature (Chronis-Tuscano et al. 2009; Rothbart 2007). However, a question remains of whether temperament traits function in similar ways in individuals with HFA as in typically developing (TD) individuals. Shiner and Caspi (2003) proposed the *spectrum hypothesis*, which provides a method for testing whether behavior problems and its predictors function similarly across typical and clinical groups. They hypothesize that group differences in are *quantitative*, but not *qualitative* in nature, suggesting that temperament profiles would predict behavior problems similarly in individuals with HFA. Individuals at the extremes of this continuum may be at higher risk for psychopathology, but are not qualitatively different than individuals who fall within the normal range. In testing the spectrum hypothesis, it is important to examine both mean-level group differences (quantitative) and within-group associations and reliability patterns (qualitative) to determine whether traits function similarly across groups (Van Leeuwen et al. 2007). This is the first study to test the spectrum hypothesis on self-reported measures of temperament in a sample of children and adolescents with HFA and a TD comparison sample.

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Temperament refers to early appearing, biologically based individual differences in behavior tendencies that remain relatively stable across development (Goldsmith et al. 1987; Rothbart and Derryberry 1981). The current study uses Rothbart and Derryberry (1981) conceptualization, in which temperament is characterized as the interaction of reactive tendencies (i.e., Surgency, Negative Affect) and regulatory abilities (i.e. Effortful Control). Surgency describes approach-oriented behaviors, positive affect, and activity level, and is strongly related to the personality construct of Extraversion (Rothbart et al. 2000). Another reactive aspect of temperament involves negative affectivity in daily life, including frustration, depressed mood, and aggression. These two reactive aspects of temperament are not orthogonal, as individuals can exhibit both under different circumstances. To regulate one's reactive tendencies, Effortful Control of attention, and inhibition are necessary. Different temperament profiles predict increased or reduced risk for psychopathology, including internalizing problems such as anxiety, depression, or withdrawal, or externalizing problems, such as inattention, hyperactivity, and conduct problems.

The spectrum hypothesis proposes that clinical groups differ in temperament profiles, but great variability exists within these groups. Temperament may function in several ways to influence the presence and presentation of impairing behaviors that characterize the disorder. Specific temperament traits may put individuals at risk for developing psychopathology, in addition to influencing the course of the disorder. These associations may be reciprocal, as psychopathology can also influence an individual's later temperament and personality (Shiner and Caspi 2003). For example, a temperament profile of reduced Surgency and Effortful Control may put an adolescent at risk for depression, and also influence symptom presentation and progression of the disorder because they struggle to increase their approach motivation (Carver et al. 2008; Eisenberg et al. 2010). Episodes of depression may also influence an individual's later surgency. Although the associations between temperament and maladaptive behavior problems have been established in the TD literature, the similarity of associations has not been directly tested for self-reported temperament in children and adolescents with HFA. This is of high importance, as temperament profiles may relate to psychopathology in individuals with ASD, and may explain higher rates of anxiety, depression and attention problems in this population.

Understanding the utility of self-report is particularly important as children enter adolescence and have the best insight into their behavior (Achenbach et al. 1987). Insight into one's behavior relative to others increases and becomes more objective as children enter middle childhood

and are able to report on their own behavior (Marsh et al. 1998). Some aspects of temperament constitute privileged information, on which the child or adolescent themselves has the best insight. Specifically, for approach-oriented behaviors related to Surgency that describe an individual's motivational state, the individual themselves may possess unique insight on their temperament. Thus, it is pivotal to understand the reliability and validity of self-reported measures at this age to determine whether they provide unique insight into the child's development.

Van Leeuwen et al. (2007) identified a quantitative method for examining whether clinical and non-clinical samples differ *quantitatively* and/or *qualitatively* in behavior problems and their predictors. This method involves testing three progressive levels of differences between samples. Level 1 examines group differences in means and variances, indicative of *quantitative* group differences—whether the groups fall at different mean levels along the continuum of each temperament dimension. Level 2 compares the reliability estimates of measures, with group differences indexing *qualitative* differences in the patterns of responses between groups. Level 3 probes differences in covariance patterns between traits, or the associations between temperament and maladaptive behaviors, between groups. Differences in Level 3 indicate *qualitative* differences in the processes linking temperament and behavior problems.

## Temperament and Autism: A Review of Previous Research

### Level 1: Differences in Means and Variances

Individuals with HFA consistently demonstrate different patterns both self- and parent-reported temperament traits, as well as elevated rates of internalizing and externalizing problems relative to their TD peers (De Pauw et al. 2011; Schwartz et al. 2009). Schwartz and colleagues (2009) found that children and adolescents with HFA reported lower levels of Surgency and higher levels of Negative Affectivity, with no differences in Effortful Control or Affiliation. Similarly, parents of children with HFA report lower Surgency and higher Negative Affect compared to TD children (De Pauw et al. 2011). However, parents of children with HFA rated them as exhibiting lower Effortful Control in several studies (De Pauw et al. 2011; Myles et al. 2007). There may be meaningful differences between parent- and self-reports of Effortful Control for individuals with HFA, as parents report greater differences than children, even when tested in the same sample (Samyn et al. 2015). No study to our knowledge has tested whether differences in the variances of self-reports exist in children

with autism. Overall, the reactive tendencies (Surgency and Negative Affect) of individuals with HFA differ from their TD peers, while there is mixed support for differences in regulatory abilities.

### Level 2: Differences in Psychometric Properties

Though the reliability of the measure of temperament for children and adolescents has been extensively tested in TD children (Capaldi and Rothbart 1992; Ellis and Rothbart 2001; Putnam et al. 2001), similarities in psychometric properties should not be assumed to translate from non-clinical to clinical populations (Hepburn and Stone 2006). No study to date has directly compared reliability of self-reported temperament traits between children and adolescents with HFA and a TD sample. However, several studies have examined the reliabilities of self-reports in children and adolescents with autism on other behavioral characteristics. White et al. (2012) found similar, high levels of internal consistency in both parent- and self-reports of measures of anxiety and depression in a sample of children with HFA. Similarly, Mazefsky et al. (2011) examined reliability, sensitivity and specificity of measures of anxiety, depression, obsessions, and attention problems in a sample of adolescents with HFA. Compared to normative data, individuals with HFA demonstrated similar reliability on all measures, but lower sensitivity and specificity to the normative data on measures of depression, obsessions and attention problems. This indicates that the constructs assessed in this study may function similarly in individuals with autism, but the current measures may not effectively discriminate depression, obsessions and attention problems for this population. The current study extends prior studies by applying the Level 2 test proposed by Van Leeuwen et al. (2007) to the reliability of a measure of temperament in a large sample of typically developing children and adolescents and those with HFA.

### Level 3: Differences in Covariance Patterns

Emotional and behavioral problems and their predictors may be important factors that explain the great heterogeneity of presentation of individuals with HFA (Ozonoff et al. 2005; Sukhodolsky et al. 2008). Though the relation between temperament and maladaptive behavior problems has been extensively studied in the TD literature, there is a relative dearth of research on these associations in individuals with HFA. Schwartz et al. (2009) is the only study to date to examine the associations between self-reported temperament and independent reports of maladaptive behavior problems in a sample of children and adolescents with HFA and a comparison sample. Across both groups, high levels of Surgency related to lower internalizing

problems. Conversely, both elevated Negative Affect and low Effortful Control were linked to both higher internalizing and externalizing problems. Affiliation was not associated with either broad domain of maladaptive behavior. Importantly, groups did not differ significantly on the relations between variables, indicating that similar processes link temperament and maladaptive behavior in children with and without HFA.

The current study examines similar constructs as those assessed in by Schwartz et al. (2009), but utilizes different analytic techniques to probe for Level 3 differences on the *spectrum hypothesis*. Schwartz and colleagues examined correlations between temperament and socio-emotional difficulties in their examinations, noting where they identified correlations of differing magnitudes. The current study seeks to probe the unique associations between each temperament trait (Surgency, Negative Affect, Effortful Control, and Affiliation) and maladaptive behaviors (Internalizing and Externalizing problems), and to examine whether group status moderates the association between these constructs.

Given the early-appearing and relatively stable nature of temperament traits, they may prove especially useful in explaining the great heterogeneity of presentation of comorbid behavior problems in individuals with HFA (Ozonoff et al. 2005; Sukhodolsky et al. 2008), including anxiety (Chronis-Tuscano et al. 2009), depression (Clark and Watson 1991), and Attention-Deficit Hyperactivity Disorder (White 1999). However, no study to date has examined whether these traits function in similar ways in individuals with HFA. Quantitative differences in temperament profiles have consistently been found in children and adolescents with HFA compared to their typically developing peers. However, there is little evidence of qualitative differences, as reliability estimates and associations with behavior problems have generally been comparable to levels in TD samples. This previous research supports the *spectrum hypothesis* that temperament traits fall at different points along the continuum, but function in similar ways in individuals with HFA.

### Present Study

This is the first study to systematically test the *spectrum hypothesis* for temperament in a large sample of children and adolescents with HFA, and a typically developing comparison sample. We hypothesized that children and adolescents with HFA will differ *quantitatively* but not *qualitatively* from a comparison sample (COM) on their self-reports of temperament and maladaptive behaviors. We used a multi-informant approach, where children/adolescents reported on their temperament, while adults

characterized the participants' maladaptive behavior problems, in order to avoid the confound of examining associations across the same informant. This project will inform the utility of self-reports in individuals with autism, and reaffirm the importance of examining temperament as a factor that may explain the wide variability observed in individuals with HFA.

## Method

### Participants

Participants in the current study are 198 children and adolescents (aged 10–16 years, 104 HFA, 94 COM) and their parents who participated in two separate studies of social-emotional adjustment (Study 1 and Study 2, described below) in high-functioning children and adolescents with autism at the University of Miami (UM). Several participants from Study 1 ( $N = 82$ ) were included in the paper on temperament in children with HFA by Schwartz et al. (2009). However, the current study incorporates a larger sample size (116 additional participants—54 additional in Study 1, 62 in Study 2), and analyzes different hypotheses. Recruitment and questionnaire-related methods were comparable across studies. To confirm high-functioning status, all participants were required to have verbal IQ  $> 70$  to be eligible for the study. The Vocabulary and Similarities subtests from the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler 2003) were administered to all participants to obtain an index of verbal intelligence. As part of these studies, all participants and their parents completed the Early Adolescent Temperament Questionnaire—Revised (EATQ-R) and the Behavior Assessment System for Children—Parent Rating Scales (BASC-PRS) in the same manner.

Participants in the HFA group were recruited through a letter or e-mail to parents of children with autism spectrum disorder, Asperger's Syndrome and/or high-functioning autism from the Center for Autism and Related Disabilities at UM. All participants with HFA had diagnoses from community mental health professionals using DSM-IV or DSM-5 criteria. The Autism Diagnostic Observation Schedule (ADOS), Social Communication Questionnaire (SCQ) and Autism Spectrum Screening Questionnaire (ASSQ) were administered to all participants with HFA to confirm an autism spectrum disorder (ASD) diagnosis; participants were required to meet clinical levels of ASD symptomatology on 2 of 3 to be included. Of the HFA sample, 72 % met criteria on all three measures, and 90 % met criteria on the ADOS. This is consistent with current estimates of sensitivity on the ADOS (Gotham et al. 2007). Comparisons between Study 1 and 2 indicated that HFA

participants did not significantly differ on age, gender, or verbal IQ (all  $p$ 's  $> .05$ ).

Participants for the comparison sample were recruited through letters sent home from school with students in the Miami-Dade County school system (Study 1 and Study 2) and through publicly-available mailing lists (Study 2). The letters included an explanation of the study and contact information for families who were interested in participating. Typically developing participants who had previously participated in research at UM and consented to be contacted were also contacted directly for Study 2. The parents of all COM participants completed the SCQ and ASSQ. In Study 1, COM participants also completed the ADOS. COM participants in Study 1 were excluded if they exceeded cutoff criteria for more than one of the diagnostic measures. COM participants in Study 2 were excluded if parents reported elevated levels of ASD symptoms on either the SCQ or the ASSQ. Clinical judgment of graduate-level psychology students was also used to confirm that COM participants did not exhibit clinically-significant ASD symptoms. Comparisons between Study 1 and 2 indicated that there were no differences between Study 1 and Study 2 participants' age, gender, or verbal IQ (all  $p$ 's  $> .05$ ). Participants in the current study included 80 males and 17 females in the HFA group and 63 males and 27 females in the COM group.

The sample was primarily Hispanic (46.2 %) and non-Hispanic Caucasian (37.2 %). The remaining participants were African-American (6.3 %), Asian (1.8 %), or Mixed-race (4.9 %), or chose not to report their ethnicities (3.6 %). The sample was highly educated, with parents reporting having an advanced or professional degree (25.1 % of mothers and 30.5 % fathers), some graduate school (21.5 % of mothers and 12.6 % of fathers), a four-year college education (26.0 % of mothers and 20.2 % of fathers), some college education (19.7 % of mothers and 13.9 % of fathers), a high school education (13.5 % of fathers), and less than a high-school education (2.7 % of fathers). The remaining parents chose not to report their education levels (2.2 % of mothers and 6.7 % of fathers). Participants' annual household income fell within the ranges of \$100,000 (35.0 %), \$75,000–99,000 (16.6 %), \$50,000–74,999 (21.1 %), \$25,000–49,000 (9.9 %), \$10,000–24,999 (8.5 %), and less than \$10,000 (2.2 %). The remaining participants (6.7 %) chose not to report their family household income.

No participants overlapped between Study 1 and Study 2. Recruitment for Study 1 occurred between November 2005 and February 2010 ( $N = 136$ ), while Study 2 participants were recruited between July 2013 and October 2014 ( $N = 62$ ). Interested families were invited to take part in two laboratory visits that included diagnostic confirmation testing, a cognitive assessment, and several additional psychophysiological and behavioral assessments, which varied between Study 1 and 2.

## Procedure

All procedures for both studies were approved by the Institutional Review Board at University of Miami. Families in both studies participated in two visits to the Coral Gables campus of the University of Miami. Participants and their caregivers provided assent and consent, respectively. All questionnaire measures were completed in a room free from distractions, and participants and parents were encouraged to take their time completing all questionnaires.

## Measures

*Social Communication Questionnaire: Lifetime Version (SCQ; Berument et al. 1999)*

Parents of participants completed the SCQ, which is a brief 40-question instrument for the valid screening or verification of autism spectrum disorder symptoms in children. The SCQ has demonstrated valid discrimination of ASD from non-ASD individuals, with a clinical cut-off score of 12.

*Autism Spectrum Screening Questionnaire (ASSQ; Ehlers et al. 1999)*

The ASSQ is a 27-item parent-report checklist that was designed as a brief screening device to identify symptoms associated with either Asperger Syndrome (AS), or other high-functioning autism spectrum disorders, in children and adolescents of normal intelligence or mild mental retardation. The clinical cut-off score for the ASSQ is 13.

*Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000)*

The ADOS is a semi-structured standardized observational assessment of ASDs. It measures communication, social interaction, play and the imaginative use of materials. The ADOS consists of a series of standard activities designed to allow the examiner to observe aspects of social, communicative, cognitive, and self-regulatory behavior that have been identified as important in the diagnosis of autism. The ADOS was administered and scored by trained, reliable coders.

*Early Adolescent Temperament Questionnaire: Revised (EATQ-R; Ellis and Rothbart 2001)*

The EATQ-R is a self-report form that assesses 12 dimensions of temperament. These 12 dimensions are combined and averaged into four global temperament

factors. The four global factors include Surgency (high-intensity pleasure, shyness—reverse scored, fear—reverse scored), Negative Affect (frustration, depressive mood, aggression), Effortful Control (attention, inhibitory control, activation control), and Affiliation (affiliation, perceptual sensitivity, pleasure sensitivity). Surgency indexes deriving pleasure from high intensity activities and novelty. Negative Affect assesses elevated levels of negative affect, loss of enjoyment or interest in activities, and hostile reactivity including aggression. Effortful Control assesses the ability to maintain attention and suppress a dominant response in favor of a subdominant response. Finally, Affiliation indexes a desire for warmth and closeness with others, and deriving pleasure from familiar and low intensity stimuli and environments. The EATQ-R includes 65 questions rated on a Likert scale from 1 (almost always untrue) to 5 (almost always true).

*Behavior Assessment System for Children, Second Edition (BASC-2; Reynolds and Kamphaus 2004)*

The BASC-2 is a parent-report questionnaire assessing a child's social and emotional functioning. Two versions are available depending on the child's age: child (ages 6–11) and adolescent (ages 12–21). The BASC contains 160 and 150 questions for the child and adolescent versions, respectively. Questions are answered regarding the child or adolescent's behavior over the last several months on a scale from 'never' to 'almost always.' Items are aggregated into clinical and adaptive behavior T-scores, with age- and reporter-appropriate dimensions and higher-order factors. The mean of BASC-2 T-scores is 50, with a standard deviation of 10. The scales of interest for the present study are: Internalizing Problems (Anxiety, Depression, Somatization), Externalizing Problems (Hyperactivity, Aggression, Conduct Problems).

## Results

### Preliminary Analyses

Group differences on gender, age and verbal IQ were examined to identify whether any of these variables should be included as covariates for between-group analyses (see Table 1). There were no significant group differences between HFA and COM participants on age. However, the HFA and COM groups differed significantly on verbal IQ, such that the COM group had higher verbal IQ than the HFA group. In addition, groups differed on gender composition, with the HFA group comprised of a larger proportion of males. Thus, gender and verbal IQ were as included as covariates in all between group analyses.

**Table 1** Sample demographic and diagnostic information

	Diagnostic group				Test values	
	HFA, N = 104		COM, N = 94		F	$\eta^2$
	M (SD)	Range	M (SD)	Range		
Age	13.31 (2.06)	10.00–16.83	13.41 (1.85)	10.00–16.75	0.11	.001
Verbal IQ (WISC-IV)	102.31 (14.80)	71–140	109.21 (13.43)	71–155	11.74**	.06
ADOS Score	11.54 (4.29)	0–21	2.03 (3.24)	0–19	233.79***	.59
SCQ Total Score	20.47 (6.69)	3–33	4.36 (3.49)	0–20	436.11***	.69
ASSQ Total Score	27.13 (8.93)	5–50	4.22 (3.79)	0–23	531.89***	.73
Gender	90 M, 14 F		65 M, 29 F		$\chi^2(1) = 8.78**$	

HFA high functioning autism, COM comparison without autism, ADOS autism diagnostic observation schedule, SCQ Social Communication Questionnaire, ASSQ Autism Spectrum Screening Questionnaire

†  $p < .10$ ; \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

**Level 1: Group Differences in Means and Variances**

Multivariate analyses of covariance (MANCOVA) were conducted to examine group differences in self-reported temperament profiles between the HFA and COM groups. Our dependent variables of interest were the broad temperament factors of Surgency, Negative Affect, Effortful Control and Affiliation. As expected, the groups differed overall in temperament profiles, when controlling for gender and verbal IQ, Wilks’s  $\Lambda = .88$ ,  $F(4, 182) = 6.26$ ,  $p < .001$ ,  $\eta^2_{\text{partial}} = .12$ . Specifically, the HFA group reported lower levels of Surgency, and higher Negative Affect. However, HFA and COM groups did not differ on Effortful Control or Affiliation (see Table 2). Levene’s test of homogeneity of variances revealed that the HFA and COM samples did not differ in the variance of responses on any temperament domain.

Unexpectedly, gender differences were detected on overall temperament profiles, Wilks’s  $\Lambda = .92$ ,  $F(4, 182) = 4.08$ ,  $p = .003$ ,  $\eta^2_{\text{partial}} = .08$ . Follow-up tests indicated that girls ( $M_{\text{adj}} = 3.63$ ,  $SE = .08$ ) reported higher levels of Affiliation than boys ( $M_{\text{adj}} = 3.28$ ,  $SE = .04$ ),  $F(1, 185) = 3.77$ ,  $p < .001$ ,  $\eta^2_{\text{partial}} = .07$ . Girls and boys did not differ on any other broad temperament factor. Verbal abilities were not related to temperament profiles, Wilks’s  $\Lambda = .97$ ,  $F(4, 182) = 1.50$ ,  $p > .05$ ,  $\eta^2_{\text{partial}} = .03$ .

Additional MANCOVAs were conducted to examine fine-grained group differences in individual subscales of temperament profiles by domain to determine if any subscale differences were driving the differences in factor. For this additional analysis, we were interested in the contrast of individual subscales within each broad factor. Within the Surgency factor, group differences were found on all three subscales (Fear, Shyness, and High-Intensity Pleasure). Participants with HFA reported higher Fear and Shyness,

and lower High-Intensity Pleasure. Groups also differed on all three subscales of Negative Affect (Aggression, Depressive Mood, and Frustration), with elevated levels of each in the HFA group. Though groups did not differ overall on Effortful Control, group differences emerged in the subscale of Attention, but not for Activation Control or Inhibitory Control. No group differences were detected on any Affiliation subscales (Affiliation, Pleasure Sensitivity, Perceptual Sensitivity). Adjusted means, and variance contrasts are presented in Table 2 for all subscale analyses. There were significantly different variances between groups on the Fear and Shyness, but not High Intensity Pleasure subscales of the Surgency factor. Participants with HFA showed greater variability in both Fear and Shyness than COM participants. No variance differences were detected on any of the Negative Affect, Effortful Control, or Affiliation subscales.

**Level 2: Group Differences in Psychometric Properties**

Reliability estimates and 95 % confidence intervals are presented in Table 3. In both groups Cronbach’s coefficient alphas were acceptable to high for all broad temperament factors, ranging from .64 (HFA Affiliation) to .83 (COM Negative Affect). Reliability was typically slightly lower for individual subscales in both groups, particularly the subscales within the Effortful Control and Affiliation factors. For each temperament trait, reliability estimates were similar between groups, as evidenced by overlapping confidence boundaries between the groups (Van Leeuwen et al. 2007).

**Level 3: Group Differences in Covariance Patterns**

Regression analyses were used to examine the relations between self-reported temperament and parent-reported

**Table 2** Level 1 analyses examining differences in means and variances of temperament

$\eta^2$	HFA		COM		Test means		Levene's test (F)
	$M_{adj}$	SE			$M_{adj}$	SE	F
Surgency	3.17	.06	3.51	.06	15.39***	.08	3.54 <sup>†</sup>
Fear (loads negatively)	2.89	.09	2.54	.09	7.76**	.04	5.04*
Shyness (loads negatively)	2.69	.10	2.40	.10	3.90*	.02	12.42***
High-intensity pleasure	3.05	.08	3.45	.08	13.17***	.07	.97
Negative affect	2.77	.06	2.42	.05	17.98***	.09	.77
Aggression	2.29	.08	1.96	.08	8.61**	.05	2.98 <sup>†</sup>
Depressive mood	2.71	.07	2.22	.07	23.63***	.12	1.02
Frustration	3.35	.08	3.09	.08	5.51	.03	.59
Effortful control	3.31	.05	3.42	.05	1.82	.01	.70
Activation control	3.13	.08	3.14	.08	.01	.00	.30
Attention	3.23	.06	3.42	.06	4.61*	.02	.52
Inhibitory control	3.57	.07	3.69	.07	.63	.01	1.10
Affiliation	3.36	.06	3.35	.06	.03	.00	.10
Affiliation	3.54	.07	3.57	.07	.11	.00	.97
Pleasure sensitivity	3.12	.08	2.99	.08	1.14	.01	.33
Perceptual sensitivity	3.43	.08	3.48	.08	.24	.00	2.45

Adjusted means and standard errors are presented for broad temperament factors and subscales, controlling for verbal IQ and gender

HFA high functioning autism, COM comparison without autism

<sup>†</sup>  $p < .10$ ; \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

**Table 3** Level 2 analyses examining differences in internal consistencies of temperament

	# Items	HFA		COM	
		$\alpha$	95 % CI	$\alpha$	95 % CI
Surgency	16	0.72	[0.62–0.80]	0.66	[0.55–0.75]
High-intensity pleasure	6	0.53	[0.36–0.67]	0.47	[0.28–0.62]
Fear	6	0.69	[0.59–0.78]	0.62	[0.48–0.73]
Shyness	4	0.82	[0.75–0.87]	0.74	[0.65–0.82]
Negative affect	19	0.76	[0.68–0.83]	0.83	[0.78–0.88]
Frustration	7	0.67	[0.55–0.76]	0.75	[0.66–0.82]
Depressive mood	6	0.59	[0.44–0.71]	0.73	[0.63–0.80]
Aggression	6	0.76	[0.67–0.83]	0.75	[0.66–0.82]
Effortful control	16	0.74	[0.65–0.81]	0.75	[0.67–0.82]
Attention	6	0.54	[0.37–0.67]	0.50	[0.32–0.64]
Inhibitory control	5	0.48	[0.29–0.63]	0.51	[0.33–0.65]
Activation control	5	0.51	[0.34–0.65]	0.62	[0.49–0.73]
Affiliation	14	0.64	[0.51–0.74]	0.79	[0.72–0.85]
Affiliation (subscale)	5	0.54	[0.36–0.67]	0.67	[0.55–0.77]
Perceptual sensitivity	4	0.54	[0.36–0.67]	0.55	[0.38–0.69]
Pleasure sensitivity	5	0.58	[0.42–0.70]	0.72	[0.62–0.80]

HFA high functioning autism, COM comparison without autism

maladaptive behavior (Table 4), as well as whether group status moderated these associations. Eight models were run with different temperament factors as predictors and maladaptive behaviors as dependent variables. Due to the large number of EATQ-R subscales (12), only the broad

temperament factors were analyzed at Level 3. Internalizing and Externalizing problems were the dependent variables of interest. Covariates of gender and verbal abilities were entered in step one. Temperament factors (Surgency, Effortful Control, Negative Affect, or Affiliation) were

**Table 4** Level 3 analyses examining differences in covariation between temperament and maladjustment by group

	Internalizing problems			Externalizing problems		
	ΔF	B	ΔR <sup>2</sup>	ΔF	B	ΔR <sup>2</sup>
Gender, verbal IQ	0.61	−0.08, −0.89	0.01	2.82	−2.61, −0.11*	0.03
Surgency	29.24***	−8.94***	0.15	2.57	−0.44	0.02
Group	41.66***	12.13***	0.17	19.81***	6.84***	0.10
Group × surgency	1.08		0.00	0.20		0.00
Gender, verbal IQ	0.61	−0.08, −0.89	0.01	2.82	−2.61, −0.11*	0.03
Negative affect	30.91***	9.19***	0.15	24.92***	6.02***	0.12
Group	40.94***	12.02***	0.16	12.96***	5.31***	0.06
Group × negative affect	1.96		0.01	0.01		0.00
Gender, verbal IQ	0.61	−0.89, 0.08	0.01	2.82	−2.61, −0.11*	0.03
Effortful control	17.85***	−8.18***	0.10	25.91***	−6.94***	0.13
Group	56.71***	13.54***	0.23	21.17***	6.35***	0.09
Group × effortful control	0.00		0.00	0.01		0.00
Gender, verbal IQ	0.61	−0.89, 0.08	0.01	2.82	−2.61, −0.11*	0.03
Affiliation	3.62	−3.98	0.02	0.62	−1.14	0.00
Group	59.61***	14.29***	0.26	22.76***	7.00***	0.12
Group × affiliation	0.61		0.00	0.03		0.00

Gender and verbal IQ were entered in step 1 of all analyses as covariates

†  $p < .10$ ; \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

entered in step two, and group status (dummy coded as COM = 0, HFA = 1) was entered in step three. Finally, the interaction of temperament factor and group status was entered in step four to determine whether the associations between temperament and maladjustment varied by group.

It was hypothesized that the associations between temperament and maladaptive behavior problems would not differ by group, but would be consistent with previous studies linking these constructs, which have indicated that high levels of Surgency relate to elevated externalizing and reduced internalizing problems, while high Negative Affect is linked to high internalizing and externalizing. Low levels of Effortful Control is a risk factor for externalizing problems, while Affiliation has been linked to both elevated internalizing but reduced externalizing problems. Overall, self-reported temperament dimensions related to parent-reported internalizing and externalizing behaviors in ways that are consistent with previous reports in the literature (e.g. De Pauw et al. 2011; Rothbart 2007). For all participants, lower Surgency, elevated Negative Affect, and lower Effortful Control were associated with higher Internalizing problems. Elevated Negative Affect and lower Effortful Control were associated with increased Externalizing problems. However, Affiliation was not associated with either class of behavior problems. Participants with HFA were rated as exhibiting significantly higher Internalizing and Externalizing problems, as indicated by significant Step 3 additions of Group status to all regression models. As expected, none of the associations between self-reported temperament and parent-reported

behavior problems differed by group, indicating that the relationship between these constructs is comparable across groups.

### Discussion

This is the first study to date to test whether self-reported temperament traits are *quantitatively* or *qualitatively* different in children and adolescents with high-functioning autism compared to their TD peers. Previous research has tested the *spectrum hypothesis* of parent-reported temperament traits, concluding that differences between parent-reports of TD and HFA children’s temperament are *quantitative*, but not *qualitative* in nature (De Pauw et al. 2011). Consistent with and extending these findings, we detected *quantitative* differences in the mean and standard deviation of several factors of self-reported temperament (Level 1). However, no *qualitative* differences were identified in the reliability of self-reported temperament (Level 2) or the associations between temperament and maladaptive behavior problems across reporters (Level 3). These findings support Shiner and Caspi’s (2003) *spectrum hypothesis* that individuals from clinical and non-clinical groups fall along the same continuum of traits, differing only in group mean and variances. Differences in mean levels of temperament may help explain the elevated levels of both internalizing and externalizing behavior problems exhibited by individuals on the autism spectrum.



## Level 1: Differences

Consistent with the previous literature, different profiles of temperament emerged for individuals with and without HFA. Relative to their TD peers, individuals with HFA reported lower Surgency and higher Negative Affect but did not differ in Effortful Control or Affiliation. Surgency and Negative Affect may be important temperament traits that differentiate individuals with HFA from their typically-developing children, and could help explain increased rates of Internalizing and Externalizing problems in individuals with HFA. Interestingly, girls demonstrated higher levels of Affiliation in both the HFA and COM groups. This highlights a potential strength for girls with HFA. Using the motivation to interact with others could provide more opportunities to practice social skills, particularly within the context of a social skills intervention.

Previous studies revealed mixed results in Effortful Control, with some studies showing reduced parent-reported levels (De Pauw et al. 2011; Konstantareas and Stewart 2006; Samyn et al. 2015), and others reporting no differences, or differences only on specific subscales, on self-reports of Effortful Control (Samyn et al. 2015; Schwartz et al. 2009). Interestingly, a previous study found discrepancies between self- and parent-reports of attention problems in children with HFA (Mazefsky et al. 2011). Children were less likely to report attention problems than their parents, which was interpreted as children and adolescents with HFA being unaware of their attention problems, or its impact on their daily functioning. Samyn et al. (2015) also proposed that the inconsistency between parent- and self-report may stem from reduced psychometric reliability. However, in the current study children with HFA exhibited comparable, high levels of reliability in their reports of Effortful Control. Differences between self- and parent-reported levels of Effortful Control, relative to typically-developing children, may arise from an interaction of Effortful Control with the rigid and repetitive behaviors that are central to the diagnosis of ASD. The outcome of this interaction may be interpreted differently by each informant. Specifically, individuals with HFA may interpret rigid behaviors as intentional self-control, while parents perceive a lack of effortful self-control (separate from the restricted behaviors). In cases of consistent informant discrepancies, De Los Reyes and Kazdin (2005) propose that both parents and children provide different but useful information on the child's functioning. Different raters may interpret similar behaviors differently, or observe the individual in different situations. Future studies would benefit from examining the concordance of parent and child reports in predicting outcomes, as well as situational factors that may impact an individual's ability to sustain Effortful Control.

Individuals with HFA exhibited greater variability in both Fear and Shyness subscales of the Surgency factor. This may be indicative of the great heterogeneity of anxiety levels in children and adolescents with HFA: some may be characterized as extremely withdrawn and fearful, while others are described as approach-oriented and unafraid (Burnette et al. 2011; Wing and Gould 1979). A recent study found that levels of social anxiety related to social skills in an interaction with a novel peer in a sample of children and adolescents with HFA, indicating the ecological importance of understanding the relationships between these constructs (Usher et al. 2015). The wide heterogeneity in levels of Fear and Shyness may relate to adaptive functioning in real-world contexts with unfamiliar peers. Future studies should examine the longitudinal associations between the Fear and Shyness subdomains, levels of social anxiety, and assessments of adaptive functioning in individuals with HFA to identify early markers for developing comorbid anxiety.

Temperament may help identify different subtypes within the same diagnostic categories of individuals with clinical disorders. For example, Karalunas et al. (2014) identified three novel types of individuals with ADHD, differentiated by temperament profiles. Those in the "Mild" group exhibited typical levels of emotion regulation, while those in the "Surgent" and "Irritable" group demonstrated extreme temperament profiles, displaying elevated positive approach and negative emotionality, respectively. These groups also displayed significant differences in resting state functional brain connectivity, indicating a neural substrate underlying these temperament dimensions. Future studies should examine whether similar groups emerge in an HFA sample, and assess other emotional and behavioral outcomes and neural correlates.

Understanding how temperament traits differ between various childhood disorders, such as ASD, ADHD, conduct problems, anxiety and depression may add utility of differentiating diagnostic categories by temperament profiles. For example, Sizoo et al. (2014) examined temperament as an endophenotype that differentiated adults with HFA from those with ADHD. Using the Temperament and Character Inventory, they found that novelty seeking differentiated ADHD from HFA, with higher levels in the ADHD group. In addition, individuals with HFA displayed elevated levels of harm avoidance. However, levels of other temperament traits did not differ by group. Temperament traits show promise for clinical utility in differentiating various disorders. However, for scores to be meaningful, better norms and more extensive psychometric investigations are needed for both TD individuals and various clinical groups.

## Level 2: Differences

Reliability estimates for both groups were acceptable to high for all broad temperament factors, with alphas ranging from .64 to .76 for the HFA group, and .66 to .83 for the COM group. The HFA and COM groups did not differ in the reliability of their self-reported temperament factors. The Rothbart scales may facilitate reliable responding because they assess concrete, time-limited behaviors that are relatively easy to determine how true a statement is for an individual (for example, “It frustrates me if people interrupt me when I’m talking.”). This measure does not automatically bring about thoughts of temperament or maladjustment, which could influence the reporter’s willingness to endorse certain items. These qualities make the EATQ-R self-report ideal for individuals with HFA, who may be more likely to accurately answer direct and concrete questions.

The similar, moderate to high levels of reliability in both groups are promising for the use of the EATQ-R and similar measures in individuals with HFA. However, caution is warranted in assuming that all future samples of individuals with autism are able to reliably report other measures. First, lower-functioning individuals with autism may not be able to reliably complete questionnaires, particularly at a young age. In addition, children with HFA may be less able to report on their internalizing and externalizing problems, which were not directly examined within the scope of the current study. Additionally, certain children may possess more insight than others. There may be a subset of children with and without autism who are inconsistent reporters, particularly on measures of autism symptom severity, social skills, and friendship quality, which require more knowledge of others’ reactions to the individual’s behaviors. Future studies should examine whether individuals with HFA are able to report on other measures of emotional functioning, and whether there are predictors of accuracy of reporting abilities in children with and without autism.

## Level 3: Differences

Temperament is an important set of individual-level traits that meaningfully relate to internalizing and externalizing problems, which are common in children with HFA. Overall, there were no group differences in the relations between self-reported temperament and parent-reported behavior problems, indicating that temperament shows similar predictive utility for children with HFA as for TD samples. For all participants, higher Negative Affect and lower Effortful Control were both associated with more parent-reported internalizing and externalizing problems. In addition, lower Surgency and Affiliation (trend-level)

were associated specifically with internalizing, but not externalizing, problems. This is largely consistent with previous research, highlighting the risk and protective factors of different aspects of temperament (Rothbart 2007; Schwartz et al. 2009). These strong associations between temperament and internalizing and externalizing problems may provide early markers for comorbidity in both TD children and those with HFA.

## Limitations and Future Directions

The scope of this article is narrow in our choice to focus exclusively on self-reported temperament and behavior problems in a high-functioning sample of children and adolescents with autism. These instruments were chosen because of the large body of research linking them, and availability of self-report measures for temperament. Parent-reported maladaptive behavior was the outcome of interest to examine these associations across reporters and reducing the impact of reporter biases on the association. Future research may benefit from examining whether temperament modifies or interacts with the core difficulties faced by those with ASD, such as socio-communicative abilities and social skills. For example, temperament may influence individual differences in motivation to interact with others, the experience and regulation of negative emotion, and self-regulatory abilities. It will be important to examine how temperament modifies the quantity and quality of social interactions to affect core difficulties of ASD (Mundy et al. 2007). Future studies should also extend this research to examine associations across multiple raters and assessment methods, as well as multiple time points to examine causal links between constructs. A critical next step would be to take a similar analytic approach to determine whether children and adolescents with HFA can report on their internalizing and externalizing problems.

Future research should also examine at what point children and adolescents, both with and without HFA, are able to reliably report on their temperament. The current study examined children within the age range suggested for the EATQ-R (10–16 years of age), but future studies should examine the same questions in younger children. This would provide great utility to research studies of younger children, where self-report measures are able to garner valuable information about individuals in a short period. Understanding the appropriateness and limits of self-reports may also inform clinical practice, where self-reports provide meaningful information about the client, in addition to the assessment and parent-reported battery. Fully understanding the scope of reliability of self-reported temperament may inform a wide range of practices with the population of children with autism.

## Conclusions

This study recruited a large sample of children and adolescents with HFA and a comparison sample of typically developing children to assess whether levels of self-reported temperament differ quantitatively or qualitatively across groups. Previous studies have compared groups drawn from different studies and different sites, and have not directly compared the abilities of children and adolescents to report on their temperament (e.g., De Pauw et al. 2011). This project was the first to examine the utility of self-report in children and adolescents with HFA at a developmental period characterized by many transitions. Results from this study and previous investigations have consistently demonstrated that temperamental differences between children with HFA and their TD peers are quantitative, not qualitative in nature.

Late childhood and early adolescence is a time when internalizing problems, and some externalizing problems become much more prevalent and impairing, particularly for individuals with HFA (Gotham et al. 2015). Validating questionnaires that assess correlates of maladaptive behavior problems is critical to understanding factors that may place some children at risk for developing disorders. The EATQ-R shows promise for identifying factors that may place individuals at risk for increased levels of internalizing and externalizing behavior problems. In addition, children typically become more independent in adolescence, with more control over their activities and peer groups. Using psychometrically-validated self-report measures becomes pivotal for conducting research on children and adolescents of this age.

In conclusion, the current study provides support for the reliability and utility of self-reported temperament in children with and without autism spectrum disorders. Consistent with previous research using parent-reports, self-reported temperament trait profiles differed *quantitatively*, but not *qualitatively* by group, suggesting that that traits are distributed along the same continuum in children with and without HFA. This supports the *spectrum hypothesis*, which contends that behaviors and traits operate in similar ways in individuals in clinical (i.e., HFA) as in non-clinical samples. This study also highlights the utility of using measures of temperament to understand variability in comorbid behavior problems in children with autism spectrum disorder, suggesting that temperament traits relate meaningfully to both internalizing and externalizing problems in this population.

**Acknowledgments** This research was supported by the National Institutes of Health, Grant R01 MH71273 (Motivation, Self-Monitoring, & Family Process in Autism; PIs Henderson & Mundy); the University of Miami: General Research Support Award (PI

Henderson) & Provost Research Award (PI Henderson); and the Marino Autism Research Institute.

**Author Contributions** CB conceived of and executed Study 2, performed the statistical analyses, and drafted the manuscript; LU conceived of and executed Study 2, and helped to draft the manuscript; CS conceived of and executed Study 1, and helped to draft the manuscript; PM conceived of Study 1, and helped to draft the manuscript; and HH conceived of Study 1 and 2, and helped to draft the manuscript.

## Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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