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Temperament as a Predictor of Symptomotology and Adaptive Functioning in Adolescents with High-Functioning Autism

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Abstract

Variation in temperament is characteristic of all people but is rarely studied as a predictor of individual differences among individuals with autism. Relative to a matched comparison sample, adolescents with High-Functioning Autism (HFA) reported lower levels of Surgency and higher levels of Negative Affect. Variability in temperament predicted symptomotology, social skills, and social-emotional outcomes differently for individuals with HFA than for the comparison sample. This study is unique in that temperament was measured by self-report, while all outcome measures were reported by parents. The broader implications of this study suggest that by identifying individual variability in constructs, such as temperament, that may influence adaptive functioning, interventions may be developed to target these constructs and increase the likelihood that individuals with HFA will achieve more adaptive life outcomes.

Keywords

high-functioning autism; temperament; symptomology; social emotional functioning; social skills

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Temperament is thought to reflect constitutionally based individual differences in reactivity and self-regulation, which influences the ways in which individuals adjust and respond to environmental changes (Rothbart, Posner, & Hershey, 1995). More specifically, reactivity refers to variability in the biological changes, such as the excitability and arousal of behavioral and physiological systems, which occur in response to environmental stimuli (Rothbart et al., 1995; Rothbart & Derryberry, 1981). Reactivity includes both emotional reactions and behavioral action tendencies (Rothbart & Bates, 2006). Self-regulation refers to aspects of temperament, such as effortful control and attention regulation, which serve to modulate reactivity (Rothbart & Bates, 2006; Rothbart et al., 1995). Early research on childhood temperament identified nine dimensions measuring reactivity and self-regulation: activity level, rhythmicity, approach/withdrawal, adaptability, intensity, mood, attention span/persistence, distractibility, and threshold (Thomas, Chess, Birch, Hertzig, & Korn, 1963; Rothbart & Bates, 2006). However, current classifications of temperament have collapsed the nine dimensions into four broad factors: Surgency/Extroversion, Negative Emotionality, Effortful Control, and Agreeableness/Adaptability (Rothbart & Bates, 2006).

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Temperament is a species general characteristic, meaning that variations in temperament exist among all humans and many other animals (Gosling, Kwan, & John, 2003). Variations in temperament begin influencing an individual's social development from infancy. Aspects of an infant's temperament such as activity level, soothability, and attention, influence and are influenced by the responsiveness of their caregiver, creating the infant's very first social experiences (Rothbart & Derryberry, 1981; Fox & Henderson, 1999). Throughout an individual's lifetime, temperament continues to impact physical and emotional development and the ways in which individuals interact with and interpret their social world (Rothbart & Deryberry, 1981).

When an individual is classified or receives a diagnosis, the perception of the commonalities that define the diagnosis often overwhelms the appreciation of the role of constitutional differences in symptom expression within a diagnostic category. Hence, it is not surprising that there has been limited research examining variation in temperament among individuals with developmental disorders, such as autism. However, this is a much needed area of research, as temperament has been said to influence not only the course of many psychopathologies, but also an individual's response to psychotropic or therapeutic interventions (Rothbart, Posner, & Hershey, 1995). It is not yet clear if this is the case for individuals with developmental disorders and hence, research must begin to determine the importance of examining variability in temperament among individuals in this population.

In addition, temperament has been shown to influence the development of psychopathologies such as Anxiety, Depression, and Attention Deficit Hyperactivity Disorder, three disorders for which individuals with autism are at increased risk (Rothbart, Posner, & Hershey, 1995; Kim, Szatmari, Bryson, Streiner, & Wilson, 2000; Goldstein & Schwebach, 2004). In typical development, approach tendencies serve a protective function in decreasing the likelihood of an individual developing psychopathology. However, individuals with extreme approach tendencies or deficits in attention are at increased risk for the development of externalizing disorders such as conduct problems and hyperactivity (Rothbart, Posner, & Hershey, 1995; Rothbart & Bates, 2006). On the other hand, extreme withdrawal tendencies have been shown to be related to anxiety disorders and social withdrawal (Rothbart, Posner, & Hershey, 1995). In addition, a tendency towards negative affectivity is thought to have detrimental effects on a variety of adaptive outcomes such as social competence, and predispose individuals to both internalizing and externalizing disorders (Rothbart & Bates, 2006).

In the current study, temperament was assessed in children with high-functioning autism (HFA) and in a matched comparison sample of typically developing children using a self-report measure examining four broad temperament factors: Surgency (approach motivation), Self-Regulation/Effortful Control, Affiliativeness, and Negative Affectivity. The first goal of this study was to examine group differences along these four temperament dimensions. The second goal was to extend beyond examining group differences, to begin to determine the role temperament may play in predicting individual differences in symptom presentation, social skills, and psychopathology among individuals with HFA.

The current diagnostic classification system fails to capture individual differences among individuals within many diagnostic categories (Cicchetti & Rogosch, 1996; Beauchaine, 2003), including autism. Although all individuals with autism have qualitative impairments in communication and social interaction, and exhibit restricted repetitive and stereotyped behaviors or interests (American Psychiatric Association, 2000), the exact constellation of symptoms and deficits in cognitive and adaptive skills vary greatly. For example, the intellectual abilities of individuals with autism range from severe mental retardation to above average (Barnard, Harvey, Potter, & Prior, 2001) and the outcomes achieved by individuals with autism in adolescence and adulthood range from the need for constant care and supervision

to the ability to live independently (Barnard et al., 2001). Even among well-defined subgroups of individuals with autism, such as those with IQs above the range of mental retardation (IQ>70), the range of social and life outcomes remains wide (Barnard et al., 2001).

While research has focused on differences between individuals with autism and typically developing individuals or individuals with other developmental disabilities, such as Down syndrome or Fragile X (Hatton, Bailey, Hargett-Beck, Skinner, & Clark, 1999; Nygaard, Smith, & Torgersen, 2002), relatively little research has explored factors that may account for variations *within* groups of individuals with autism. While it has been suggested that this variation could be accounted for by comorbid psychopathologies (Frith, 2003), there is a limited amount of information on individual variability, which has a significant impact on autism research. If the sources of variability in autism remain poorly understood, individual differences will continue to confound basic behavioral, neuroscience and genetic studies. An imprecise understanding of the nature of individual differences also makes it difficult to develop interventions specifically targeted to meet the diverse needs of subgroups of individuals with autism spectrum disorders.

In response to the need for greater clarity on this topic, a recent paper has described a new model for conceptualizing individual differences in symptom expression and social development, at least among children with HFA. (Mundy, Henderson, Inge, & Coman, 2007). This “modifier model” of HFA suggests that etiological processes specific to autism interact with modifiers to influence variability in the behavioral phenotype of individuals with HFA at different points in development. These modifiers are not syndrome specific; they are constructs such as socialization processes and temperament, which vary across all individuals, and influence outcomes, such as social skills, comorbidity, and treatment response in individuals with HFA (Mundy et al., 2007). The current study took a closer look at the possible modifying role of temperament in the development of children with HFA. Temperament was chosen as the focus of this study, in part, because measures of temperamental variability have been shown to be predictive of language development and social skills in typically developing children (Rothbart & Bates, 2006; Sanson, Hemphill, & Smart, 2004; Seifer, 2000), two of the main areas of deficit in individuals with autism.

A Review of the Literature on Temperament and Autism Spectrum Disorders

Studies Examining Between Group Differences—A wide array of group differences in temperament profile have been found between individuals with autism spectrum disorders and comparison groups of typically developing individuals and individuals with other developmental disorders. Several studies have reported differences in temperament profile between children with autism and comparison groups as early as one year of age. Retrospective parent reports of children diagnosed with autism, have suggested that at one year of age these children exhibited significantly more self-regulatory deficits than typically developing children, which was manifested in difficulty engaging with the world and regulating reactions to stimulation (Gomez & Baird, 2005; Greenspan, 1981). In a study of infant siblings of children with autism, those infants who were later diagnosed with autism showed atypical reactivity, higher levels of passivity, decreased activity, and an inability to disengage their visual attention within the first year of life, as reported by their parents (Zwaigenbaum et al., 2005). An ability to disengage visual attention in infancy plays an important role in the development of self-regulation (Rothbart, Ziaie, & O’Boyle, 1992), as an infant’s primary means of controlling the stimulation they receive is their ability to engage and disengage their attention.

A number of studies have also compared individuals with autism to individuals with other developmental disorders, such as Fragile X, Attention Deficit Hyperactivity Disorder (ADHD), and Down syndrome. One study compared a group of children with autism and a group of

children with Fragile X to the typically developing reference sample of the Behavioral Style Questionnaire (McDevitt & Carey, 1978), which assesses temperament along the original nine temperament dimensions. Parents rated their children in both the autism and Fragile X groups as being less adaptable and persistent, and exhibiting more withdrawal tendencies than the reference group. Additionally, the individuals with autism were rated as more distractible and less rhythmic than the reference group (Bailey, Hatton, Mesibov, Ament, & Skinner, 2000). Self-report of temperament on the Temperament and Character Inventory (Cloninger, Przybeck, & Svrakic, 1993) has been used to compare adults with autism and ADHD. Results indicated that individuals with autism rated themselves as lower on novelty seeking and reward dependence, and higher on harm avoidance than the ADHD group (Anckarsater et al., 2006). Additional research utilizing more well-defined subgroups of individuals with autism spectrum disorders may help to bring clarity to the wide range of group differences found in the current literature.

Studies Examining Variability in Temperament among Individuals with Autism—A few studies have gone beyond examining group differences to examine individual variation in temperament among individuals with autism. One study found that within a group of children with autism, those who were rated by their parents as more difficult displayed less engagement and responsiveness during a social interaction with either their parent or the experimenter (Kasari & Sigman, 1997). In this study, difficulty was defined as a composite of rhythmicity, approach/withdrawal, adaptability, intensity, and mood. Hence, while the results may appear to be suggesting that a child with a difficult temperament is simply more socially withdrawn, approach/withdrawal tendencies are only one aspect of a difficult temperament, other dimensions of temperament are also at play. This was one of the first studies to indicate a relation between variation in temperament and social skills in individuals with autism, the main area of deficit in autism spectrum disorders. In addition, a study by Konstantareas and Stewart (2006) examined individual differences in a sample of children with autism between three and 10 years of age with academic age estimates ranging from age appropriate to three years delayed. Results from this study indicated that variability in symptomatology, as rated by the Childhood Autism Rating Scale, was related to variability in effortful control among children with autism, with 48% shared variance.

A wide range of temperament profiles have also been shown among the highest functioning individuals with Asperger disorder (Soderstrom, Rastam, & Gillberg, 2002). For example, within a group of individuals with Asperger disorder a subgroup of individuals self-reported high levels of reward dependence, indicating that they were strongly motivated by rewards (Soderstrom et al., 2002). The authors interpreted this finding as suggesting a desire for close social interactions. These results may also be interpreted to suggest that this subgroup of individuals with Asperger disorder reported approach oriented tendencies and high levels of affiliativeness. Similarly, data from psychophysiological indices of approach/withdrawal, as indexed by frontal EEG asymmetry (Sutton & Davidson, 1997) suggest that children with HFA may differ in their constitutional tendencies of reward (Behavioral Approach) or punishment (Behavioral Inhibition) based on motivational tendencies that relate to differences in their social-emotional development (Sutton et al., 2005). In typically developing individuals, those with right frontal EEG asymmetry tend to be more withdrawn and express more negative affect while individuals with left frontal EEG asymmetry tend to be more approach oriented and express more positive affect (Baving, Laucht, & Schmidt, 2002; Davidson, 1998; Fox, 1991). Similarly, children with HFA with left frontal EEG asymmetry are more approach oriented than children with HFA and right frontal EEG asymmetry. As a result, the children with left frontal EEG asymmetry have the appearance of fewer social symptoms, but experience higher levels of social anxiety and social stress and less satisfaction with their interpersonal relationships than the right frontal children (Sutton et al., 2005). These authors suggested that

differences in motivation influenced the left frontal group to be more active and interactive, but consequently more aware of or sensitive to their interpersonal difficulties.

The current study was designed to extend the foregoing research in several ways. A relatively large and older sample of children with HFA was recruited to examine temperament at a point in development when it may be well consolidated. Well developed temperament measures of self-regulation (Effortful Control), approach motivation (Surgency), sensitivity to social reward/desire for close social relationships (Affiliativeness), and Negative Affectivity were chosen a-priori for this study. These were chosen to extend previous work indicating that individuals with autism may display significant differences in self-regulation and approach motivation processes that influence their social-emotional outcomes (e.g., Anckarsater et al., 2006; Gomez & Baird, 2005; Soderstrom et al., 2002; Sutton et al., 2005). Following previous research, this study was also designed to directly test the relations between temperament and variability in symptom expression and social development in children with HFA (Kasari & Sigman, 1997; Konstantareas & Stewart, 2006; Sutton et al., 2005). In this regard, self-report measures of temperament were employed not only because they have been found to be valid among individuals with HFA (Meyer, Mundy, Vaughan, & Durocher, 2006), but also because they decrease shared method variance relative to the parent-report measures used to assess symptomotology, and social and emotional outcomes.

Hypotheses

It was hypothesized that individuals with HFA would report lower levels of Surgency, Effortful Control, and Affiliativeness, and higher levels of Negative Affectivity than the comparison sample. In addition, due to increased risk for internalizing and externalizing disorders among individuals with autism, it was hypothesized that parents would report higher levels of withdrawal tendencies, and internalizing and externalizing symptoms in the HFA group compared with the comparison sample.

It was also hypothesized that within each group, relatively higher self appraisals of Surgency, Affiliativeness, and Effortful Control would be associated with more adaptive parent-reported outcomes, such as fewer autistic symptoms, lower levels of atypical behavior, and withdrawal tendencies, and higher levels of adaptive social skills. Lastly, it was hypothesized that among participants within each group, relatively higher levels of Negative Affectivity would be associated with internalizing symptoms, and lower levels of Negative Affectivity and higher levels of Surgency would be associated with externalizing symptoms.

Methods

Participants—A total of 82 participants (44 HFA (7 females); 38 Comparison Children (7 females)) ages 8 to 16 years, participating in a larger study examining motivation, self-monitoring, and family processes in higher functioning children with autism, were included in analyses. The HFA sample was recruited via a mailing sent to parents of children with Asperger disorder and High Functioning Autism from the Center for Autism and Related Disabilities at the University of Miami. The sample of typically developing children was recruited through the Miami-Dade County public schools. Diagnoses were confirmed by administering the Social Communication Questionnaire (SCQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999) and the Autism Spectrum Screening Questionnaire (ASSQ; Ehlers, Gillberg & Wing, 1999). All participants had verbal IQ estimates above the upper limit for mental retardation (IQ > 70). To ensure that the HFA and comparison samples were equally matched on age and Verbal IQ, two independent t-tests were performed. There were no differences between the diagnostic groups on age, $t(80) = -1.28$, *ns*, or Verbal IQ, $t(80) = -1.19$, *ns* (See Table 1).

Measures—Parents completed the Social Communication Questionnaire (SCQ; Berument et al., 1999). The SCQ is a brief instrument designed for the valid screening or verification of autism spectrum disorder symptoms in children. It was developed from the 40 critical items of the Autism Diagnostic Interview, compiled into a parent report questionnaire (Berument et al., 1999), and has a criterion score of 15 or higher (Rutter, Bailey, Berument, Lord, & Pickles, 2003). Scores are divided into the main areas of difficulty for individuals with autism: social interaction, communication, and restricted repetitive behaviors.

Parents also completed the Autism Spectrum Screening Questionnaire (ASSQ; Ehlers et al., 1999). The ASSQ is a 27-item checklist designed to be completed as a brief screening device to identify current symptoms associated with Asperger disorder or other high-functioning autism spectrum disorders in children and adolescents with normal intelligence or mild mental retardation. It has a criterion score of 13 (Ehlers et al., 1999).

The Behavior Assessment System for Children, Second Edition, Parent Rating Scales (BASC-2 PRS; Reynolds & Kamphaus, 2004) is an instrument used to elicit parent report of their child's social and emotional functioning by circling either never, sometimes, often, or almost always in response to an extensive list of simple, straight-forward statements. Two forms are available depending on age level: child (6–11) and adolescent (12–21). Items are combined to create T-scores for 10 clinical dimensions: hyperactivity, aggression, conduct problems, anxiety, depression, somatization, attention problems, learning problems, atypicality, and withdrawal. There are also four higher-order factors: externalizing problems, internalizing problems, school problems, and the behavioral symptoms index. Higher scores on the clinical dimensions and factors reflect elevated symptom presentation. The scales of particular interest in this study were atypicality and withdrawal, and the factor based scores of interest were the internalizing problems (composed of the anxiety, depression, and somatization scales) and externalizing problems (composed of the hyperactivity, aggression, and conduct problems scales) factors. Atypicality was chosen due to the frequent elevations on this scale seen in individuals with HFA (Reynolds & Kamphaus, 2004). The remaining scales and factors were chosen because of the high rates of comorbidity with disorders such as Attention Deficit Hyperactivity Disorder, Anxiety, and Depression seen in individuals with HFA (Gillott, Furniss, & Walter, 2001; Ghaziuddin, Ghaziuddin, & Greden, 2002; Strum, Fernell, & Gillberg, 2004). In addition to the clinical scales, the BASC-2 also has adaptive behavior scales, such as adaptability, social skills, leadership, and functional communication, where higher scores reflect more adaptive behavior. Of interest in this study was the social skills dimension. This scale was chosen because social skills are one of the main areas of deficit among individuals with autism, but there is also a great deal of variability in social skills even among the most high-functioning individuals (McGovern & Sigman, 2005). Reliability and validity for each scale ranged from .67 to .95 (Reynolds & Kamphaus, 2004). Internal consistency estimates (alpha coefficients) for children and adolescents ranged from .70 to .95 for the general normative sample and from .74–.96 for the clinical normative sample, which included individuals with Pervasive Developmental Disorders (Reynolds & Kamphaus, 2004).

All participants were administered the vocabulary and similarities subtests of The Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2003), which was used to ensure equivalent samples based on the estimated verbal comprehension index. An abbreviated version, the vocabulary and similarities subtests only, of the WISC-IV verbal scale was used to obtain an estimate of each child's verbal comprehension index. The reliability and validity for these subtests is very high, ranging from .86 to .89 and the intercorrelation between the subtests and the verbal comprehension index ranges from .89 to .91.

All participants were administered the short form of the Early Adolescent Temperament Questionnaire- Revised (EATQ-R; Ellis & Rothbart, 2001) self-report form, which assesses

temperament along 12 dimensions. The 12 dimensions are then combined to form four overarching factors by taking the mean of the dimensions composing each factor: Surgency (i.e., surgency/high intensity pleasure, shyness-reverse scored, fear-reverse scored), Effortful Control (i.e., attention, inhibitory control, activation control), Affiliativeness (i.e., affiliation, perceptual sensitivity, pleasure sensitivity), Negative Affectivity (i.e., frustration, depressive mood, aggression). Surgency reflects high levels of pleasure derived from high intensity activities or novelty, low levels of behavioral inhibition, and low levels of unpleasant affect from the anticipation of distress. Effortful Control reflects the ability to perform an action or engage in an activity despite a tendency to avoid it, focus or shift attention, and suppress inappropriate responses. Affiliativeness reflects a desire for warmth and closeness with others, deriving pleasure from familiar and low intensity activities, and the ability to perceive low intensity stimulation in the environment. Lastly, Negative Affectivity reflects high levels of negative affect related to the interruption of a task or goal, loss of enjoyment or interest in activities, and hostile reactivity and actions, including physical or verbal aggression. There are a total of 65 items on the questionnaire, each of which is rated on a Likert scale from 1 (almost always untrue) to 5 (almost always true). Each dimension consists of four to seven questions. Reliability estimates for the 10 dimensions range from .64 to .81 (Ellis & Rothbart, 2001).

Procedure—For all participants, parents who called the lab in response to recruitment letters were given additional information about the study. If they agreed to participate, three lab sessions were scheduled for participation in the larger study of social-emotional development. Data for the current study was collected in one session. At the start of the first session, parents signed an informed consent, and children signed an informed assent approved by the University of Miami Institutional Review Board (IRB). Parents and children then filled out a set of questionnaires, including a child self-report of temperament and parent-report of symptoms and adaptive functioning. In cases in which a child requested help reading items on the temperament questionnaire, assistance was provided by a trained researcher. However, this was a very rare occurrence. In addition, the children completed two verbal subtests of the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV). Children whose families participated in the study were presented with $40.00 compensation for each session they attended.

Results

Between Group Analyses—A multivariate ANOVA was conducted to examine group differences on the four temperament factors, which revealed a main effect of group, F (4, 75) = 4.69, p =.002, η^2 = .20. Follow-up univariate ANOVAs revealed group differences on self-reports of Negative Affectivity, F(1, 78) = 10.45, p = .002, η^2 = .12, and Surgency, F(1, 78) = 15.40, p < .001, η^2 = .17, such that the HFA group reported higher levels of Negative Affectivity and lower levels of Surgency than the comparison sample. The groups did not differ on self-reported Effortful Control, F(1, 78) = .08, *ns*, η^2 = .001, or Affiliativeness, F(1, 78) = 1.29, *ns*, η^2 = .02 (See Table 2).

Follow-up multivariate ANOVAs were conducted to determine which dimensions within the Negative Affectivity and Surgency factors drove the overall group differences. Regarding the Negative Affectivity factor, the HFA group reported significantly higher levels of depressive mood, F(1, 78) = 7.55, p = .007, η^2 = .09, frustration, F(1, 78) = 6.77, p = .011, η^2 = .08, and aggression, F(1, 78) = 4.54, p = .036, η^2 = .06. On the Surgency factor, group differences existed for surgency, F(1, 78) = 16.52, p < .001, η^2 = .18, and fear, F(1, 78) = 7.08, p = .009, η^2 = .08, but not shyness, F(1, 78) = 1.82, *ns*, η^2 = .02, such that the HFA group reported lower levels of surgency and higher levels of fear.

A multivariate ANOVA was conducted to examine group differences on all outcome measures, including autistic symptoms, atypical behavior, social skills, withdrawal, externalizing problems, and internalizing problems, which revealed a main effect of group, $F(9, 72) = 33.39$, $p < .001$, $\eta^2 = .81$. Follow-up univariate ANOVAs revealed group differences on parent reports of all outcome variables (See Table 1), such that parents reported the HFA group to have higher levels of autistic symptoms, externalizing symptoms, internalizing symptoms, atypical behaviors, and withdrawal, and lower levels of social skills.

Predicting Outcomes within Groups—Zero order correlations were computed to explore the associations between child-report of temperament and parent-report of symptomotology and social-emotional behaviors across all participants and separately by group. These analyses revealed significant patterns of correlations (See Table 3). When there were significant correlations between temperament factors and outcome measures, follow-up multiple regression analyses were conducted by entering the dummy coded grouping variable on the first step, the centered temperament factor or factors on the second step, and the interaction between group and the centered temperament factors on the third step (See Table 4). These analyses were used to determine the unique and interactive effects of diagnostic group status and temperament in predicting the outcome.

Autistic Symptomotology: Correlation analyses indicated significant associations between self-report of Surgency and Negative Affectivity and the social interaction domain of the SCQ (See Table 3). When Surgency and Negative Affectivity were entered into the regression analyses, the overall model accounted for a significant portion of the variance in social symptoms, $F(5, 74) = 17.74$, $p<.001$. In addition, Surgency, Negative Affectivity, and Effortful Control were correlated with the repetitive behavior domain of the SCQ (See Table 3). When these three temperament factors were entered into the regression analyses, the overall model accounted for a significant portion of the variance in repetitive behaviors on the SCQ, $F(7, 72) = 23.19$, $p<.001$. Lastly, Surgency, Negative Affectivity, Affiliativeness, and Effortful Control were correlated with scores on the ASSQ (See Table 3). When all four temperament factors were entered into the regression analysis, the overall model accounted for a significant portion of the variance in current symptoms, $F(9, 70) = 23.50$, $p<.001$. However, examining the individual regression coefficients for all regression analyses, only diagnostic group accounted for a significant portion of the variance in symptoms, such that the HFA group was rated as exhibiting more symptoms than the comparison sample (See Table 4). The four temperament factors, alone or in combination with diagnostic group, did not account for unique variance in symptoms after controlling for diagnostic group.

Social-Emotional Outcomes: Correlation analyses indicated significant associations between self-report of temperament and parent-report of social-emotional outcomes (See Table 3). Correlation analyses indicated that Surgency and Effortful Control were related to atypicality (See Table 3). When both of these temperament factors were entered into the regression analysis, the overall model accounted for a significant portion of the variance in symptoms, $F(5, 74) = 20.19$, $p<.001$. However, examining the individual regression coefficients, only diagnostic group accounted for a significant portion of the variance in atypicality, such that the HFA group was rated as exhibiting higher levels of atypical behavior than the comparison sample (See Table 4). Surgency and Effortful Control, alone or in combination with diagnostic group, did not account for unique variance in atypicality after controlling for diagnostic group.

Similarly, correlation analyses indicated Surgency, Effortful Control, and Affiliativeness were related to withdrawal (See Table 3). When these three temperament factors were entered into the regression analysis, the overall model accounted for a significant portion of the variance in symptoms, $F(7, 72) = 10.23$, $p<.001$. However, examining the individual regression coefficients, only diagnostic group accounted for a significant portion of the variance in

withdrawal, such that the HFA group was rated as exhibiting higher levels of withdrawal than the comparison sample (See Table 4). Surgency, Effortful Control, and Affiliativeness, alone or in combination with diagnostic group, did not account for unique variance in withdrawal after controlling for diagnostic group.

Correlation analyses also indicated that Surgency, Effortful Control, and Negative Affectivity were related to internalizing symptoms (See Table 3). When these three temperament factors were entered into the regression analysis, the overall model accounted for a significant portion of the variance in symptoms, $F(7, 72) = 8.34$, $p<.001$. Examining the individual regression coefficients, there were significant main effects of diagnostic group and Surgency and there was a trend towards an interaction between Effortful Control and diagnostic group (See Figure 1). After controlling for diagnostic group, the three temperament factors accounted for an additional 10 percent of unique variance in internalizing symptoms (See Table 4). While the HFA group exhibited higher levels of internalizing symptoms than the comparison sample, across all participants higher levels of Surgency were predictive of lower levels of internalizing symptoms. In addition, although the addition of the interactions between group and temperament factors on the third step of the regression did not account for a significant amount of additional variance in internalizing symptoms (See Table 4), examining the individual regression coefficients, there was a trend towards an interaction between group and Effortful Control, $t(79) = 1.89$, $p = .062$. Follow-up zero-order correlations indicated that there was a significant relation between Effortful Control and internalizing symptoms in the comparison sample, such that higher levels of Effortful Control were related to lower levels of internalizing symptoms, $r(37) = -.46$, $p=.004$. In the HFA group, the correlation was not significant, $r(43) = -.21$, *ns* (See Figure 1).

Lastly, correlation analyses indicated that Effortful Control and Negative Affectivity were related to externalizing symptoms (See Table 3). When both of these temperament factors were entered into the regression analysis, the overall model accounted for a significant portion of the variance in externalizing symptoms, $F(5, 76) = 5.01$, $p=.001$. Examining the individual regression coefficients, there were significant main effects of diagnostic group and Effortful Control. After controlling for diagnostic group, the Effortful Control and Negative Affectivity accounted for an additional eight percent of unique variance in externalizing symptoms (See Table 4). While the HFA group exhibited higher levels of externalizing symptoms than the comparison sample, across all participants higher levels of Effortful Control were predictive of lower levels of externalizing symptoms.

Discussion

Recent research has shown that there is great variability in social and emotional outcomes among individuals with autism, even the highest functioning individuals (Barnard et al., 2001). In typical development, temperament has been used to predict individual differences in social skills, and internalizing and externalizing symptoms (Blair, Denham, Kochanoff, & Whipple, 2004; Fabes, Eisenberg, Jones, Smith et al., 1999). This study set out to investigate whether or not aspects of temperament could be used to distinguish individuals with HFA from typically developing individuals in two ways. First, mean differences in temperament, symptom presentation, and social-emotional outcomes were examined. Second, predictive relations between temperament and social-emotional outcomes among adolescents with HFA and typically developing adolescents were investigated.

As hypothesized, the HFA group was reported to exhibit significantly more autistic symptoms, atypical behaviors, and withdrawal tendencies than the comparison sample. These results, in combination with the finding that temperament did not aid in predicting variation in these outcomes after accounting for group differences, suggests that higher levels of

symptomotology, atypicality and withdrawal are core features of autism that serve to differentiate individuals with autism from typically developing individuals.

Regarding group differences in temperament, as hypothesized, the HFA group reported lower levels of Surgency than the comparison sample. Examining the dimensions that compose the Surgency factor, the HFA and comparison samples differed on the surgency and fear dimensions, but not the shyness dimension. Previous research has suggested that high levels of surgency do not simply reflect low levels of shyness, but the two dimensions constitute separate constructs with different underlying neural systems (Polak-Toste & Gunnar, 2006). The way in which surgency is assessed reflects the extent to which an individual gains pleasure from a high intensity activity, such as being in a large crowd or big city. Individuals with autism, even those with HFA, tend to exhibit sensory sensitivities that prohibit this type of activity from being enjoyable and hence, group differences are not surprising.

The HFA group also reported significantly higher levels of fear than the comparison sample. In examining the response pattern of each diagnostic group on the individual items of this scale, one item in particular stood out as differentiating the groups: 'I am nervous of some of the kids at school who push people into lockers and throw your books around.' This item stands out as being particularly salient for children with HFA, as children with developmental disabilities are commonly targets for bullying (Marini, Fairbairn, & Zuber, 2001). Hence, it is not surprising that this sample of individuals with HFA who are in their adolescence or approaching adolescence would not only be the target of peer victimization, but would be aware of this victimization due to their increasing self-awareness of their social difficulties (Volkmar, 2004). Future research is needed to determine if this group difference is truly reflective of temperamental differences or if this result is due to contextual effects of adolescence. Examining group differences on the fear dimension at different time points in development is clearly necessary.

The HFA group also self-reported higher levels of Negative Affectivity than the comparison sample, which is consistent with research indicating that high levels of comorbid anxiety and depression are common among individuals with HFA (Ghaziuddin, Weidmer, & Ghaziuddin, 1998). It is possible that temperamental differences, such as the group differences in Negative Affectivity found in the current study, begin in infancy or early childhood and set the stage for the development of symptoms of anxiety and depression later in life. One study found that at 12 months of age, infant siblings of children with autism who were themselves later diagnosed with autism, exhibited more frequent and intense distress reactions to stimuli, and at 24 months exhibited less expression of pleasure compared with typically developing infants and infant siblings of children with autism who were not later diagnosed with autism (Zwaigenbaum et al., 2005). A similar study found that in an at-risk sample of infants, as symptoms of autism became evident between 6 and 36 months of age, a distinct temperament profile emerged, including increased irritability and negative affect (Bryson et al., 2007). In another study, a group of two- to four-year-old children with autism were rated as having a more difficult temperament compared with children with Down syndrome and typically developing children (Kasari & Sigman, 1997). Hence, it appears as if these early temperamental differences continue into adolescence and make the development of comorbid anxiety and depression more likely for individuals with autism than for other groups of individuals.

Given these findings, it is not surprising that the HFA group reported higher levels of internalizing symptoms than the comparison sample. However, after accounting for group differences, the Surgency temperament factor was associated with more adaptive outcomes across all participants, such that higher levels of Surgency were predictive of lower levels of internalizing symptoms regardless of diagnostic group. These results are consistent with previous literature stating that internalizing symptoms are less common among children who

exhibit less social reticence (Oldehinkel, Hartman, De Winter, Veenstra, & Ormel, 2004; Ormel et al., 2005). To ensure that these results were not due to conceptual overlap between constructs, the individual items of the scales were examined. Very little overlap was found between the temperament dimensions that compose the Surgency factor and the BASC-2 scales that compose the Internalizing composite. The internalizing composite of the BASC-2 is composed of the anxiety, depression, and somatization scales. Two items from the anxiety scale of the BASC-2 regarding worrying about what others think and worrying about things that cannot be changed, and one item on the depression scale of the BASC-2 dealing with complaints of teasing, overlap only slightly with items on the fear scale of the EATQ-R, such as worrying about their parent dying or feeling nervous around bullies. Hence, it was determined that there were no common items among scales and only minimal conceptual overlap. Therefore, it can be concluded that children who are temperamentally more approach oriented and gain more pleasure from high intensity activities and/or social rewards exhibit less internalizing symptoms. One possible explanation of these results may be that these children who are more approach oriented have the tendency to seek out peer relationships beginning at an early age, which would afford them protection from peer victimization and provide them with social support. This may be particularly important during developmental transitions, such as the transition into adolescence, where increased importance is placed on the development of peer relationships. As a result, individuals who are more approach oriented would be protected against developing internalizing symptoms.

Additionally, it is particularly interesting that these findings are not specific to one diagnostic group, but rather are applicable to children across diagnostic groups. This indicates that while individuals with autism, as a group, are at increased risk for internalizing symptoms, the mechanisms linking temperament to emotional functioning are the same for individuals with HFA as they are for typically developing individuals. In other words, although individuals with autism may be at increased risk for internalizing symptoms and behaviors, those children who exhibit more approach oriented behaviors may be able to protect themselves from experiencing severe emotional distress by forming peer relationships. Future research is clearly needed to determine if this is the case. If future research confirms that those individuals with autism who are more outgoing and able to forge friendships are protected from internalizing disorders, interventions may be able to target social approach behaviors to promote more adaptive outcomes for individuals with HFA.

Lastly, Effortful Control was also found to be predictive of lower levels of internalizing symptoms in the comparison sample and lower levels of externalizing behavior across all participants. Effortful Control is composed of the ability to focus and shift attention, inhibit inappropriate behavior, and follow through on tasks and actions when there is a tendency to avoid it. All of these components enable individuals to perform adaptively and behave appropriately. The results in the comparison sample are consistent with previous research which has stated that difficulties with regulation leave children at risk for the development of anxiety (Masten & Coatsworth, 1998; Rothbart & Bates, 2006). For individuals with HFA, a better ability to regulate their behavior may allow them to suppress syndrome typical inappropriate behaviors for more appropriate learned responses. In addition, for individuals with HFA where externalizing behaviors such as hyperactivity are a commonly comorbid condition (Gillott et al., 2001; Ghaziuddin et al., 2002; Strum et al., 2004), a high level of Effortful Control may enable these individuals to inhibit these tendencies and exhibit fewer externalizing behaviors. Future research should extend these findings to determine if higher levels of Effortful Control are also protective against comorbid ADHD or other externalizing disorders among individuals with HFA.

The findings that Surgency and Effortful Control are predictive of more adaptive outcomes for individuals with HFA, fit well with the ‘modifier model’ of autism (Mundy et al., 2007). This

model suggests that etiological processes specific to autism interact with modifiers to influence variability in the behavioral phenotype of individuals with HFA at different points in development. These modifiers are not syndrome specific; they are constructs such as socialization processes and temperament, which vary across all individuals, and influence outcomes, such as social skills, comorbidity, and treatment response among individuals with HFA (Mundy et al., 2007). Importantly, neither Surgency nor Effortful Control was predictive of variability in symptom presentation, but both factors played an important role in predicting adaptive outcomes. Similar results were reported by Ozonoff et al. (2004), finding that while executive functioning was not related to symptom presentation among individuals with HFA, it was positively correlated with adaptive skills. These results are consistent with a large literature on typically developing individuals stating that a better ability to regulate behaviors and emotions is related to more adaptive social behaviors (Spinrad et al., 2004) and is important for the development of social competence (Masten & Coatsworth, 1998; Eisenberg, Liew, & Pidada, 2004; Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006).

Limitations and Future Directions—There were several limitations of this study. First of all, a concurrent assessment of self-report of temperament and parent-report of symptoms, and social-emotional outcomes was performed. Hence, it is difficult to make conclusions regarding the predictive direction between temperament and social-emotional functioning. Future research should separate the assessment of temperament and outcome in time, in order to theoretically support predictive analyses. Second, while this study extended previous research by using self- and parent-report measures to decrease shared method variance, future research should continue to expand the use of assessment methods to employ multi-method assessments of temperament and outcome. For example, it is known that self- and parent-report measures can be biased and hence, future research should consider observational measures to examine temperament and social skills during a social interaction in order to more objectively quantify observed variability in social-emotional outcomes. Third, employing multiple comparison samples, including those with elevations in anxiety, depression, and ADHD, would allow for testing whether or not the current findings were the result of commonly comorbid conditions in the HFA group, or if the findings are related to the core symptoms of autism. Lastly, future research should attempt to replicate these findings with individuals with autism of different age ranges and developmental levels to determine if the results are specific to individuals with HFA who are in their adolescence or if the results are applicable to all individuals with an autism spectrum disorder.

Conclusions—All individuals who are diagnosed with autism exhibit deficits in social and communication skills, and exhibit restricted repetitive behaviors. Very few of these individuals ever lose the diagnosis of an autism spectrum disorder over their lifetime. However, the adaptive life outcomes achieved by individuals with autism are extremely varied, even beyond what would be expected based on intellectual functioning (Sigman & Ruskin, 1999). Hence, it is clear that symptomotology alone does not provide enough information to predict day-to-day functioning. The modifier model of HFA (Mundy et al., 2007) suggests that studying non-syndrome specific constructs from the developmental and social neuroscience literatures, which vary among all individuals regardless of diagnosis, provides insight into the processes by which some individuals with HFA succeed in leading independent lives while others require constant care and supervision. The results presented in this study identified temperamental factors that are predictive of more positive outcomes for individuals with HFA.

One of the major complications for researchers and clinicians working with individuals with autism spectrum disorders is the wide range of variability that is present in this population. Therefore, it is important to begin to understand the factors within individuals, such as, temperament, desire for social interactions or adaptive social skills, and environmental factors, such as the family environment and peer relationships, that are predictive of this variability. If

factors that lead to more positive outcomes, such as fewer symptoms and more adaptive skills, can be determined, interventions can be developed that are designed to target those factors. It may also be possible in the future to assess a child's temperament profile as a way to determine the type of intervention techniques and settings that would be most effective in improving treatment outcomes.

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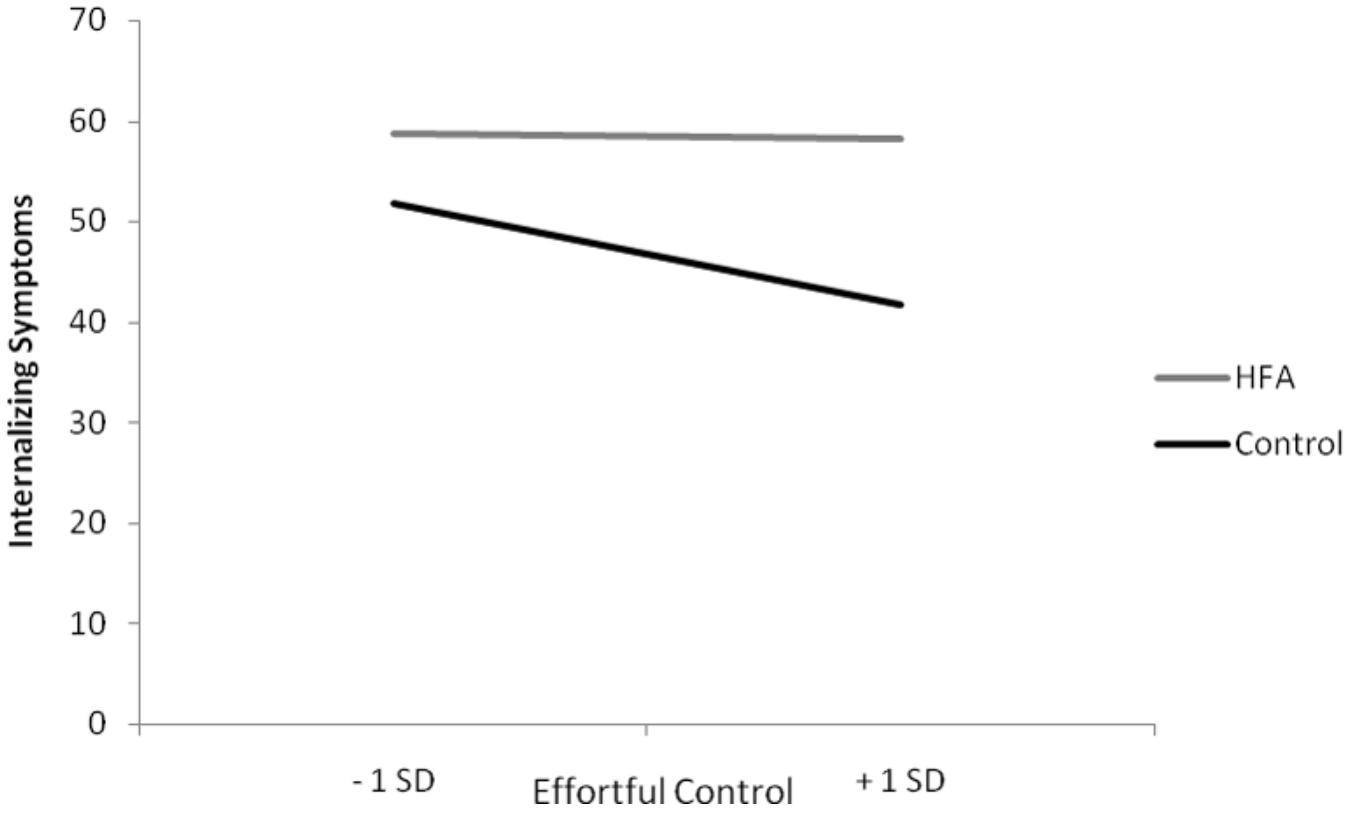

Figure 1.
Plot of regression interaction between diagnostic group and Effortful Control predicting internalizing symptoms.

Table 1

Group Means and Standard Deviations for Age, Verbal Comprehension Index, and Outcome Measures, as well as Multivariate Analysis of Variance for Outcome Measures

	HFA		Comparison		*F*	η^2
	M	**SD**	**M**	**SD**		
Age in Months	155.34	28.08	162.79	24.04		
Verbal Comprehension Index	100.59	14.26	104.32	13.95		
SCQ Social Interaction	7.70	3.53	1.61	1.53	97.52**	.55
SCQ Communication	6.48	2.27	3.00	2.12	50.97**	.39
SCQ Repetitive Behaviors	5.09	1.97	.55	.86	172.26**	.68
ASSQ	27.07	7.99	5.50	4.99	206.97**	.72
BASC-2 Externalizing	56.11	9.44	48.74	7.66	14.80**	.16
BASC-2 Internalizing	60.05	11.81	45.76	10.06	34.17**	.30
BASC-2 Atypicality	71.00	13.70	47.47	7.05	91.11**	.53
BASC-2 Withdrawal	71.20	12.43	49.79	12.89	58.51**	.42
BASC-2 Social Skills	40.75	8.22	51.74	10.28	28.90**	.27

** $p<.01$

Table 2

Means and Standard Deviations of Temperament Factors for Diagnostic Groups

	HFA		Comparison	
	M	**SD**	**M**	**SD**
Surgency	−.89	.58	−.43	.46
Effortful Control	3.26	.46	3.28	.42
Negative Affectivity	2.83	.54	2.43	.56
Affiliativeness	3.30	.48	3.16	.56

Table 3

Correlation Table of Temperament Factors and Dependent Variables Across All Participants and Separately by Group

	Surgency	Effortful Control	Negative Affectivity	Affiliativeness
All Participants				
BASC-2 Internalizing	−.44**	−.26*	.29**	.09
BASC-2 Externalizing	−.12	−.27*	.28*	.05
BASC-2 Social Skills	.15	.16	−.01	−.13
BASC-2 Atypicality	−.34**	−.16	.18	.14
BASC-2 Withdrawal	−.40**	−.16	.17	.16
ASSQ	−.32**	−.13	.30**	.18
SCQ Social	−.32**	−.11	.11	−.05
SCQ Communication	−.16	−.09	.09	.02
SCQ Repetitive Behaviors	−.33**	−.01	.22+	.12
HFA Group				
BASC-2 Internalizing	−.42**	−.21	.36*	.01
BASC-2 Externalizing	−.07	−.21	.19	.08
BASC-2 Social Skills	−.12	.21	.06	−.21
BASC-2 Atypicality	−.16	−.18	.00	.13
BASC-2 Withdrawal	−.09	−.27+	.18	.27+
ASSQ	.03	−.16	.19	.26+
SCQ Social	−.05	−.18	−.07	−.22
SCQ Communication	.20	−.11	−.14	−.03
SCQ Repetitive Behaviors	.02	.08	−.13	.06
Comparison Sample				
BASC-2 Internalizing	−.06	−.46**	−.03	.07
BASC-2 Externalizing	.24	−.43**	.22	−.09
BASC-2 Social Skills	−.04	.15	.23	.01
BASC-2 Atypicality	.23	−.34*	−.04	.03
BASC-2 Withdrawal	−.33*	−.11	−.19	−.04
ASSQ	.10	−.38*	.14	.03
SCQ Social	.03	−.07	−.29+	−.16
SCQ Communication	.03	−.09	−.04	−.09
SCQ Repetitive Behaviors	−.03	−.27+	.34*	.09

+ trend

* $p<.05$

** $p<.01$

Table 4

Hierarchical Regression Analyses

Step and Variables	B	SE B	β	R^2 Change	F Change
		SCQ Social Interaction			
Step 1				.54	91.61**
Group	6.01	.72	.74		
Step 2				.00	.27
Surgency	−.15	1.08	−.02		
Negative Affectivity	−.69	.89	−.10		
Step 3				.00	.15
Group X Surgency	−.25	1.38	−.03		
Group X Negative Affectivity	.52	1.28	.05		
		SCQ Repetitive Behaviors			
Step 1				.68	165.02**
Group	4.53	.41	.82		
Step 2				.00	.00
Surgency	.06	.63	.01		
Effortful Control	−.44	.66	−.07		
Negative Affectivity	.47	.53	.10		
Step 3				.01	1.07
Group X Surgency	−.25	.80	−.04		
Group X Effortful Control	.58	.90	.07		
Group X Negative Affectivity	−1.04	.78	−.15		
		ASSQ			
Step 1				.73	209.44**
Group	21.27	1.74	.84		
Step 2				.02	1.29
Surgency	1.28	2.65	.06		

Step and Variables	B	SE B	β	R^2 Change	F Change
Effortful Control	−3.91	3.09	−.14		
Negative Affectivity	1.64	2.52	.07		
Affiliativeness	.43	2.44	.02		
Step 3				.01	.35
Group X Surgency	−.88	3.44	−.03		
Group X Effortful Control	1.93	4.10	.05		
Group X Negative Affectivity	−.85	3.61	−.03		
Group X Affiliativeness	2.73	3.46	.08		
BASC-2 Atypicality					
Step 1				.55	97.03**
Group	23.89	2.70	.74		
Step 2				.01	1.02
Surgency	2.81	3.98	.10		
Effortful Control	−5.10	4.31	−.14		
Step 3				.01	.97
Group X Surgency	−6.19	4.96	−.17		
Group X Effortful Control	3.32	5.67	.07		
BASC-2 Withdrawal					
Step 1				.44	60.39**
Group	18.02	3.08	.55		
Step 2				.03	1.53
Surgency	−10.19	4.52	−.36		
Effortful Control	−3.10	5.06	−.08		
Affiliativeness	−2.91	3.84	−.09		
Step 3				.03	1.42
Group X Surgency	7.96	5.65	.21		
Group X Effortful Control	−2.56	6.57	−.05		

Step and Variables	B	SE B	β	R^2 Change	F Change
Group X Affiliativeness	8.44	5.65	.18		
BASC-2 Internalizing					
Step 1				.31	35.09**
Group	11.80	2.55	.46		
Step 2				.10	4.17**
Surgency	−3.08	3.94	−.14		
Effortful Control	−11.26	4.14	−.39		
Negative Affectivity	−.93	3.28	−.04		
Step 3				.04	1.69
Group X Surgency	−4.15	4.98	−.14		
Group X Effortful Control	10.62	5.61	.28		
Group X Negative Affectivity	3.27	4.88	.10		
BASC-2 Externalizing					
Step 1				.16	14.80**
Group	6.74	1.93	.36		
Step 2				.08	4.10*
Effortful Control	−7.44	3.32	−.36		
Negative Affectivity	2.00	2.27	.13		
Step 3				.01	.58
Group X Effortful Control	4.47	4.55	.17		
Group X Negative Affectivity	−.30	3.44	−.01		

+ trend

* $p<.05$

** $p<.01$