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Reduced delay of gratification and effortful control among young children with autism spectrum disorders

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Abstract

We explored internal control of behavior using direct observation and parent report. Previous research has found that both the delay gratification task and parent-reported effortful control predict later social ability and more positive outcomes in typically developing children. Children with autism spectrum disorder (ASD) have previously been reported to have reduced effortful control, whereas delay of gratification ability has not been tested in a group with ASD. The current study compared 21 children with ASD and 21 typically developing children between 6 and 7 years of age – all of whom had cognitive ability at or above the average range. Children with ASD were less able to delay gratification and their parents reported significantly reduced effortful control; however, scores on these measures were unrelated within the group with ASD. Among the children with ASD, lower effortful control was associated with more severe clinician-observed social symptoms.

Keywords

autism; effortful control; inhibition; reward; delay of gratification; temperament; social ability; symptom expression; executive control

In order to effectively respond to the environment and adjust their behavior with respect to immediate needs and long-term consequences, children must learn to control their behavior. In the neurocognitive literature, development of this ability is linked to executive control, and in the temperament literature, it is associated with effortful control (Rueda, Posner and Rothbart, 2005). Both constructs involve inhibiting conflicting thoughts or behaviors in order to achieve long term goals and are thought to rely on internal, or self-controlled, processes that allow a child to overcome the tendency to respond to stimulus-driven impulses (Nigg et al., 2000; Rothbart, Ahadi, Hershey et al., 2001; Rueda et al., 2005; Rueda, Posner, & Rothbart, 2004). Executive control and effortful control are likely overlapping constructs that measure similar underlying abilities but emphasize different methodological approaches. As a group, children with autism spectrum disorders (ASD) exhibit impaired executive control on experimental measures (see Hill, 2004; Kenworthy,

Yerys, Anthony et al., 2008 for reviews) and reduced effortful control on temperament questionnaires (e.g. De Pauw, Mervielde, Van Veeuwen et al., 2011; Konstantareas and Stewart, 2006). As Nigg (2000) highlights, integrating both literatures would provide a more systematic approach to understanding the difficulties associated with clinical conditions such as ASD. He further argues that thoughtful task selection is critical to integrating these methodological traditions. In the present study, we examined the temperamental factor of effortful control among young children with ASD along with their performance on one potentially related experimental task of executive control, delay of gratification. Importantly, effortful control has been both theoretically and empirically linked to successful delay of gratification among typically developing children (Derryberry & Rothbart, 1997; Duckworth, Tsukayama & Kirby, 2013; Mischel & Ayduk, 2004; Posner & Rothbart, 2000, but see Duckworth and Kern, 2011).

The delay of gratification task is sensitive to maturation of executive control between preschool and middle childhood (Ayduk, Mendoza-Denton, Mischel et al., 2000; Eigsti, Zayas, Mischel et al., 2006). During the task, children are faced with a dilemma: they may eat a tempting treat immediately or they may earn a larger serving of the desired food by waiting for an unspecified amount of time. Thus, a conflict arises between stimulus-driven motivation and self-controlled, future-oriented cognitive strategies. Mischel and colleagues suggest that developing the ability to inhibit attention to the treat and suppress the desire to eat it immediately (i.e., executive control) underlies the improved performance observed with older children (Casey et al., 2011; Metcalfe and Mischel, 1999). At the same time, manipulation of reward salience continues to influence performance (Casey et al., 2011), such that executive control over thoughts and behaviors may be undermined by more compelling stimuli. As a consequence, delay of gratification differs from many other measures of inhibition because it requires the ability to delay a response in the face of an explicit reward by shifting attention from appetitive to cognitive aspects of the task (Peake et al., 2002).

Temperament more broadly measures constitutionally based individual differences in self-regulation and motor and emotional reactivity. Rothbart's model of temperament includes an effortful control factor, which incorporates internally driven, willful inhibition and attention and differs from other aspects of temperament that are stimulus-driven and reactive. Effortful control is comprised of four subscales: Inhibitory Control, Low Intensity Pleasure, Perceptual Sensitivity, and Attention Focusing. Effortful control parallels the ability to delay gratification in its developmental course and reliance on inhibition and attention control, but measures these abilities more globally across a variety of settings.

Measuring delay gratification and effortful control may be important in understanding the development of children with ASD for several reasons. First, difficulties with inhibition, a domain once thought to be relatively spared within the executive profile of ASD (e.g., Kleinmans et al., 2005; Ozonoff & Jenson, 1999; Ozonoff & Strayer, 1997), have been detected in more recent samples of individuals with ASD including children and older individuals without cognitive impairment (Geurts, Verté, Oosterlaan et al., 2004; Joseph, McGrath, and Tager-Flusberg, 2005; Luna, Doll, Hegedus et al., 2007; Pellicano, Maybery, Durkin et al., 2006; Pellicano, 2007). Within this domain, inhibitory difficulties were

detected for children with ASD via tasks that required ignoring distracting information rather than inhibiting dominant responses, which highlights the need for more careful assessment within the inhibitory domain in ASD (Christ, Holt, White et al., 2007; Christ, Kester, Bodner et al., 2011). Examining delay of gratification and effortful control in young children extends this work because both measures emphasize deliberate focusing of attention and inhibiting thoughts and behaviors that are incompatible with future goals.

Second, delay of gratification and effortful control may provide information about the development of neurocognitive systems that support social development. Both delay of gratification and effortful control are predictive of a number of meaningful individual differences in social outcomes among typically developing children. Individual differences in the ability to delay gratification predict later social and cognitive abilities, coping skills and self-regulation, and more positive outcomes in adulthood (e.g. Ayduk et al., 2000; Mischel et al., 2011; Mischel, Shoda and Peake, 1988; Casey, Somerville Gotlib et al., 2011). Likewise, individual differences in effortful control are related to social functioning, empathy, and being perceived as prosocial and agreeable by peers (see Eisenberg, Smith, Sadovsky et al., 2004 for review). The delay of gratification task may be particularly interesting for examining individual differences in ASD because it is thought to represent a balance between interconnected appetitive and executive control systems in the brain (see Ochsner and Gross, 2005; Somerville and Casey, 2010 for reviews). Both systems have been implicated in ASD (Bachevalier and Loveland, 2006; Dawson et al., 1998). Bachevalier and Loveland (2006) proposed that individual differences in the timing and location of disruptions to these systems in children with ASD may correspond with individual differences in both the course of symptom onset and severity of social and cognitive impairments. Consistent with this prediction, symptom severity among children with ASD has been linked to individual differences in effortful control (Konstantareas and Stewart, 2006; Samyn et al., 2011). Thus, examining individual differences among children with ASD may help clarify the heterogeneity of symptom presentation and underlying etiology. Nevertheless, delay of gratification has not been tested in ASD and only a few studies have measured effortful control among young children with ASD.

Reduced effortful control is consistently reported in the temperament profile of children and adolescents with ASD. For example, school-aged children with ASD and cognitive delays had lower effortful control than comparison children (Konstantareas and Stewart, 2006). Parents reported their children with ASD focused and shifted attention less effectively and had lower inhibitory control. Reduced effortful control was also reported for a larger group with ASD relative to comparison children (De Pauw et al., 2011). However, higher-IQ children and teens with ASD did not self-report lower effortful control compared to a typically developing comparison group (Schwartz et al., 2009). In short, parent report of effortful control consistently distinguishes children with ASD from typically developing children and children with developmental delays; yet, it has not been measured in young children with ASD who do not have cognitive delays.

Individual differences in effortful control among children and adolescents with ASD are linked to lower expression of ASD symptoms and externalizing behaviors such as hyperactivity (Konstantareas and Stewart, 2006; Samyn, Roeyers and Bijttebier, 2011;

Schwartz, Henderson, Inge et al., 2009). Similarly, individual differences in temperament in typical children have been linked to the development of psychopathology (e.g. Eisenberg et al., 2004; Lemery, Essex, and Smider, 2002; Pitzer, Esser, Schmidt et al., 2009) and social skills (Dollar and Stifter, 2012; Rothbart, Ahadi and Hershey, 1994). However, using temperament measures to detect individual differences in children with ASD is complicated by the potential overlap of behaviors measured in temperament questionnaires and those associated with existing psychopathology. For example, Rothbart's temperament questionnaire includes items such as, "Enjoys just being talked to" and "Does not seem to notice parents' facial expressions." Thus, it may be difficult to disentangle the possibility that parent report measures are influenced by behaviors associated with ASD. Two possibilities arise: temperament may capture individual differences that are related to *expression* of psychopathology (i.e., represent a more sensitive way to capture existing heterogeneity of symptoms in the population with clinical groups falling on the extreme of the continuum) or it may represent individual differences that are related to the *development* of subsequent behavioral symptoms (see Nigg, 2006 for review). Using multiple methodologies is one strategy for isolating the contributions common to both measures from those that may overlap with behaviors related to psychopathology. A final, related challenge in understanding effortful control is that comorbid conditions such as attention deficit hyperactivity disorder (ADHD) are common among children with ASD (Leyfer, Folstein, Bacalman et al., 2006). And, symptoms of ADHD also potentially overlap with the construct of effortful control for scales such as Attention Focusing and Inhibitory Control. Thus, it is also important to account for the possibility that differences in effortful control are influenced by the presence of symptoms of ADHD among a subgroup of children with ASD.

The current study had three goals. The first was to test whether children with ASD differ from age and IQ-matched typically developing children in their ability to delay gratification. To our knowledge, this is the first use of delay of gratification with ASD. We selected the classic task developed by Mischel, Shoda, and Rodriguez (1989) given its sensitivity to individual differences in preschoolers and older school-aged children. Carlson (2005) demonstrated continued developmental sensitivity of this task with a 15-minute delay among typically developing 6-year-olds and provided guidelines for pass-fail criteria. Following Carlson's (2005) recommendation for task selection when examining children with neurocognitive disorders such as ASD, we recruited six and seven year olds for our study with the expectation that many typically developing children would be successful and group differences, if detected, would be due to a clear delay among children with ASD. With no prior data for delay of gratification in ASD, we based our prediction that children with ASD would have greater difficulty inhibiting their desire for an immediate reward on previous findings of reduced inhibition during cognitive tasks by young children with ASD without cognitive impairment (Pellicano, 2007; Pellicano et al., 2006).

Second, we were eager to extend the measurement of effortful control in young children with ASD to a sample without cognitive delays in order to evaluate potential group differences relative to typically developing children. On the basis of previous work with higher functioning, older children (De Pauw et al., 2011; Samyn et al., 2011; Schwartz et al., 2009), we anticipated that children with ASD would have reduced effortful control. We also

expected that lower levels of effortful control would correspond to inability to delay gratification as has been found with typical children (Duckworth et al., 2013). Although not the primary focus of the current study, we also tested two additional temperament scales that may be related to appetitive demands of the delay of gratification task, Approach/Positive Anticipation and Impulsivity, because recent work suggests children with ASD have aberrant motivation and hedonic responses to rewards (see Kohls, Chevallier, Troiani et al., 2011 for review) that may contribute to individual differences in performance.

The third goal was to explore whether individual differences in delaying gratification and effortful control within the ASD group related to social abilities and symptoms. We predicted that reduced ability to delay gratification and less effortful control would correspond with increased autism symptoms and worse social functioning given previous work with typically developing children (Kim et al., 2013), children with ASD (Konstantareas and Stewart, 2006; Samyn et al., 2011), and the proposed etiological relation between executive control and ASD symptom severity (Bachevalier and Loveland, 2006). We also examined whether delay of gratification and effortful control related to the behavioral challenges of ADHD, inattention and hyperactivity, extending work by Samyn et al. (2011).

Method

Participants

Fifty-nine children were initially recruited in order to obtain the final sample (31 children with autism; 28 typically developing children). Seven children with ASD were not included in the final sample because had they either obtained IQ scores below 85 ($n=6$) or did not meet instrument criteria for the ADOS ($n=1$; see below). Six of the typically developing children were also excluded either because their IQ scores were too high for matching with the ASD group ($n=5$) or because their Vineland-2/BASC-2 scores were outside the average range ($n=1$). Four children did not complete the study. The final set of participants for the experimental battery were 21 young children with idiopathic autism spectrum disorders and 21 typically developing children (per criteria described below). All were 6–7 years old (see Table 1 for descriptive characteristics of the sample). Groups were matched on chronological age; all but two pairs fell within 4 months. Importantly, only children with cognitive ability in the average or above average range were included. The school age core of the Differential Ability Scales-2 (DAS-2; Elliott, 1990) was used to assess cognitive ability yielding General Conceptual Ability (GCA) standard scores (comparable to Full Scale IQ) greater than 85 for all children. Groups did not differ on either GCA or the Verbal Ability composite score (see Table 1). Nonetheless, the range of cognitive ability within both groups was wide (i.e. over 30 points), so analyses were conducted to examine the effect of individual IQ differences. The sample reflected the sex distribution of ASD yielding 15 boys and 6 girls in each group. Groups did not differ in racial composition, parental education level or household income. The sample was 88% white, parents were highly educated and mean household income level was high.

All children with ASD had a previous clinical diagnosis of autism or a related spectrum disorder, which was confirmed using the Autism Diagnostic Interview-Revised (ADI-R;

Rutter, Le Couteur and Lord, 2003) according to Collaborative Programs of Excellence in Autism (CPEA) criteria (see Sung et al., 2005 for details) and the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore et al., 2002) according to revised criteria (Gotham, Risi, Pickles et al., 2007) by the first author who was research reliable for both measures. Diagnostic classification was then made per DSM-IV-TR diagnostic criteria (American Psychiatric Association, 2000).

Both groups were recruited for a larger study of neurocognitive function, reward response, and neural connectivity. Recruitment sources included flyers, newsletters, electronic bulletins, local service providers, parent groups, and research registries at the university Autism Center and Communication Studies Subject Pool. Exclusionary criteria for both groups included medical disorders or injuries with implications for the central nervous system, major physical abnormalities, seizures, and significant sensory or motor impairments. In addition, exclusionary criteria for typically developing children included family history of ASD, birth or developmental abnormalities, learning or language disability, current or past history of psychiatric or neurological disorders, or regular use of psychoactive medication. Exclusionary criteria were assessed during study enrollment using a screening interview. Two parental measures, the Vineland-2 (Sparrow, Cicchetti and Balla, 2005) and the Behavior Assessment System for Children (BASC-2; Reynolds and Kamphaus, 2004), were used to obtain additional information about the presence of delays in adaptive function and behavioral challenges and used to confirm that children in the typically developing group did not have delays or behavioral challenges. In addition, two scales of the BASC-2, Hyperactivity and Attention Problems, provided information about the presence of behaviors related to ADHD. The group with ASD had significantly elevated scores on both (Table 1). The study was conducted in accordance with the university human subjects division.

Testing procedure and instruments

During their initial lab visit, all children first completed intelligence testing and children with ASD then completed the ADOS. In a second visit, children completed a two-hour neuropsychological battery with fixed order that included the Delay of Gratification task. All children were able to complete the full battery.

The Delay of Gratification Task (Mischel et al., 1989) presents the opportunity to earn a larger treat by choosing to wait rather than receiving a smaller, immediate treat. Children were first asked whether they would prefer the smaller (e.g. one cookie) or larger (e.g. two cookies) reward of their choosing (e.g. Chips Ahoy cookies, Reese's peanut butter cups, Oreos). Children were told the examiner would leave the room to prepare for the next activity and they would receive the larger treat by waiting without eating the reward or standing up. In addition, children were told that if they preferred not to wait they could ring a bell to summon the examiner immediately, but would receive only the smaller reward. To ensure all children understood these instructions, a rule check followed. Children were not told how long they would need to wait. Children were seated at a table with the larger and smaller treats and a bell. Apart from recording equipment, the room was otherwise empty. The task continued until children reached the 15 min time limit, violated a rule, or rang the

bell. The primary dependent variable was the duration of the delay and children passed if they reached the full 15 min. As a behavioral measure of the ability to shift attention away from the temptation, the proportion of time looking at the bell or rewards was also coded (Rodriguez, Mischel and Shoda, 1989).

The Children's Behavior Questionnaire (CBQ; Rothbart et al., 2001) is a parent report measure of child temperament consisting of 195 items. Parents are asked to rate each item from 1 (extremely untrue of your child) to 7 (extremely true of your child). The measure is appropriate for use with 3 to 7 year olds, with good internal consistency (reported alphas from .64–.92). The CBQ yields 16 scales that load onto three factors. The Effortful Control factor is computed from the Inhibitory Control, Low Intensity Pleasure, Perceptual Sensitivity, and Attention Focusing scales. Two additional scales were examined in order to assess their potential relation to delay of gratification: Approach/Positive Anticipation and Impulsivity. One parent in the ASD group did not complete the CBQ.

To obtain information about symptom expression and social functioning for examination of individual differences in children with ASD, several measures were used. Current symptoms of autism were measured using the ADOS. Of note, ADOS scores afforded measurement by an independent observer, rather than relying on parent report for both temperament and symptom expression. The current ADOS algorithm (Gotham et al., 2007) provides scores in two scales: social-affective symptoms and repetitive behaviors and interests. The ADOS Social-Affect calibrated severity score (Hus, Gotham and Lord, 2012) was included in analyses as a measure of social symptom severity. Functioning in the social domain was measured with the Social Skills Rating System (SSRS; Gresham and Elliott, 1990), a parent questionnaire that provides a standardized total score from Cooperation, Assertion, Responsibility and Self-Control sub-domains, and with the Vineland-2 Socialization score which is a composite of Interpersonal Relations, Play and Leisure, and Coping subscales. The possibility that delay of gratification and effortful control related to ADHD-associated behavioral challenges was assessed via the BASC-2 Attention Problems and Hyperactivity scales. Data were available for all children in the ASD group for all measures. As expected, groups differed on parent report of social function (Vineland-2 Socialization and Social Skills Rating Scale). Means, standard deviations, and significance tests are presented in Table 2.

Analysis plan

Groups were first compared for delay of gratification behavior and parent report of temperament. Delay duration had significantly different group variance, so Mann-Whitney U scores were also computed with identical results to reported parametric analyses. Passing rate for the delay of gratification was compared via nonparametric analysis. Many children waited for the maximum delay during the Delay of Gratification, resulting in a skewed distribution of scores. Where group differences were detected, the possibility of a delay in development was examined by comparing the age of children who waited the entire delay to those who did not and by computing the correlation between age and effortful control. The same approach was used with intelligence and the BASC-2 Attention Problems and Hyperactivity scales to determine their influence on performance. ANCOVA was computed

to examine group differences above and beyond factors that were significantly correlated. Next, individual differences in social symptoms and functioning were examined within the group with ASD using t-tests to compare children who passed and failed the delay of gratification and by computing Pearson correlations with effortful control.

Results

Delay of Gratification performance by group

Groups significantly differed in the duration that they waited, $t(40) = -2.93, p = .006, d = -0.91$. The mean wait time for the group with ASD was 11 min, 9 s ($SD = 5$ min 34 s), while typically developing children waited for 14 min, 45 s ($SD = 49$ s). Passing rates (i.e. the percentage of children who waited 15 min) also significantly differed by group (Fisher's exact test, one-sided, $p = .02$): 57.1% in the ASD group versus 90.5% in the typically developing group passed. These differences were not due to reward preference or task comprehension. All children in both groups expressed a preference for the larger reward prior to the task and the proportion of children who answered all four questions correctly during the rule check did not differ (Fisher's exact test, one-sided, $p = .21$), nor did groups differ by the number of items passed during the rule check, $t(40) = -1.37, p = .18, d = -0.42$. Of the 11 children who failed to reach the end of the delay, 7 (6 ASD) rang the bell, 2 (1 ASD) became upset and the task was discontinued, and 2 (both ASD) violated a rule by leaving the table. Despite group differences in waiting, the groups did not differ in the proportion of time spent looking at the temptation (i.e. bell and treat), $t(40) = 1.20, p = .24, d = 0.37$. On average, both groups of children attended to the temptation a little over half the time ($M_{ASD} = .61, SD = .21, M_{TD} = .55, SD = .12$).

The possibility that delay of gratification performance was linked with age, IQ and ADHD-related behavioral challenges was examined among children with ASD but not among typically developing children for whom performance approached ceiling. First, t-tests were computed to compare the age of children who passed versus failed the task to assess potential developmental changes in task performance. Within the group with ASD, age did not differ between these groups, $t(19) = 1.29, p = .21, d = 0.57$. Intelligence was also examined and DAS-2 General Conceptual Ability did not differ for those who failed to reach the end of the delay within the ASD group, $t(19) = 1.03, p = .32, d = 0.47$. Likewise, the group who failed did not differ in BASC-2 Attention Problems, $t(19) = -0.12, p = .91, d = -0.05$, or BASC-2 Hyperactivity, $t(19) = -0.11, p = .92, d = -0.05$.

Effortful Control, Approach/Positive Anticipation and Impulsivity by group

Parent responses to the CBQ indicated children with ASD had lower scores than typically developing children in Effortful Control, $t(39) = -3.81, p < .001, d = -1.2$. In addition, scores for the four subscales that comprised Effortful Control as well the Impulsivity and Approach/Anticipation subscales were compared with a Bonferroni correction ($\alpha < .008$). As shown in Table 2, children with ASD had significantly lower scores for Attentional Focusing, $t(39) = -3.47, p = .001, d = -1.1$ and Inhibitory Control, $t(39) = -4.76, p < .001, d = -1.5$. Low Intensity Pleasure did not survive Bonferroni correction and the Perceptual

Sensitivity, Approach/Anticipation, and Impulsivity scales were not significantly different between groups.

Again, the possible influences of age, intelligence, and behavior related to ADHD were examined. Within the group with ASD, individual differences in age, intelligence and BASC-2 scores were unrelated to Effortful Control ($r_s < .38$, $p_s > .10$) or the two scales within this factor that differed between groups—Attention Focusing ($r_s < .40$, $p_s > .08$) and Inhibitory Control ($r_s < .42$, $p_s > .06$). This was also true for the typically developing group for Effortful Control ($r_s < .36$, $p_s > .11$), Attention Focusing ($r_s < .32$, $p_s > .16$), and Inhibitory Control ($r_s < .41$, $p_s > .06$) with one exception. Higher BASC-2 Hyperactivity related to lower CBQ Inhibitory Control, $r(21) = -.59$, $p = .005$ among typically developing children. Group differences remained for Inhibitory Control when BASC-2 Hyperactivity scores were covaried, $F(1, 38) = 9.1$, $p = .005$.

Individual differences within children with ASD

T-tests were computed to compare the social function and symptoms of children with ASD who passed the delay of gratification task to those who did not, whereas Pearson correlations were examined to determine whether performance on parent report of effortful control corresponded to individual differences in social function and symptoms of autism. Greater Effortful Control related to lower levels of observed Social Affect symptoms on the ADOS, but not social function (see Table 3). Compared with children who passed, children who failed to wait for the full delay during the Delay of Gratification task did not have significantly different social symptoms, $t(18) = -0.81$, $p = .43$, $d = -0.36$, or function on the Social Skills Rating System, $t(19) = 0.68$, $p = .50$, $d = 0.31$, or Vineland-2 Socialization domain, $t(19) = 0.82$, $p = .42$, $d = 0.35$. Three additional analyses indicated that children who failed to wait during the delay of gratification did not differ from children who waited on Effortful Control, $t(18) = 0.84$, $p = .41$, $d = 0.21$, or the Approach/Anticipation, $t(18) = 1.18$, $p = .26$, $d = 0.52$, and Impulsivity, $t(18) = 1.09$, $p = .29$, $d = 0.49$, scales of the CBQ.

Discussion

The present study investigated the ability to delay gratification, parent report of effortful control, and their relation to social abilities and symptoms in young children with ASD. We first addressed whether a sample of young 6–7 year olds with ASD without cognitive delay differed from typically developing children in their ability to delay gratification. On average, children with ASD were not able to wait as long to receive a larger, desired reward. Likewise, the rate of children with ASD who passed by delaying gratification for the entire 15 minutes was lower. Group differences were not accounted for by the ability to look away from the treat or to understand the rules, and children with ASD who passed did not differ from those who failed in age, cognitive ability, or behaviors associated with ADHD. In our sample, about 40% of children with ASD did not wait for the full 15 minute delay. These results are consistent with the theoretical prediction that executive control may be disrupted for a subset of children with ASD (Bachevalier and Loveland, 2006; Dawson et al., 1998). The use of the delay of gratification task extends previous investigations of executive control by demonstrating difficulties on a task that requires effortful inhibition in the face of

explicit rewards and, as a result, is sensitive to the balance between neural systems that underlie reward seeking and those that control such impulses to support more strategic behavior.

Second, parents of children with ASD reported that their children had lower levels of effortful control as compared to typically developing children. In other words, characteristics such as the ability to show strong concentration, persist with tasks, wait before engaging with a task, easily stop an activity when told “no,” and enjoy just sitting quietly were rated as less representative of the children with ASD. Within the Effortful Control composite, children with ASD were rated as having lower scores on two scales: Attentional Focusing, which measures the tendency to maintain attention on a task, and Inhibitory Control, a measure of the ability to plan and suppress inappropriate approach responses when directed or in situations of uncertainty. Reduced effortful control, particularly attentional focusing and inhibitory control, in the current sample is consistent with previous reports of reduced effortful control in young children with ASD and cognitive impairment (Konstanteas and Stewart, 2006) and older children with and without cognitive impairment (De Pauw et al., 2011; Samyn et al., 2011). The current study extends these findings to younger children with ASD without cognitive impairment. Among children with ASD, effortful control did not significantly relate to age or intelligence, suggesting it reflects individual differences independent of general cognitive ability or development in this sample. Together with findings from other studies, it appears that reduced effortful control may represent an aspect of the ASD profile that is stable throughout childhood and independent of intelligence. In addition, effortful control was unrelated to parent report of hyperactivity and attention problems in this sample. This result suggests that temperament may measure individual differences that are distinct from comorbid conditions such as ADHD. However, this result should be interpreted with caution. Larger ASD samples provide evidence of a relation between effortful control and both internalizing and externalizing behavior above and beyond age and diagnostic group status (De Pauw et al., 2011) and of specific relations between effortful control and inattention and impulsivity (Samyn et al., 2011). Our relatively small sample of children with ASD had higher levels of inattention and impulsivity on average, but sample size may have limited the ability to detect a relation between temperament and behaviors related to ADHD. Future work with younger children will be useful in exploring the relations between effortful control, development of comorbid conditions such as ADHD, and age.

The third goal was related to understanding individual differences in performance on delay of gratification and in effortful control among children with ASD. Higher levels of effortful control related to fewer clinician-observed symptoms in the social affect domain of the ADOS. That is, children with higher levels of effortful control had better non-verbal social behavior, social initiation, and rapport with an examiner as well as more reciprocal conversation, social engagement and shared enjoyment. This is consistent with prior demonstrations of this relation among children with ASD and lower IQ (Konstantareas and Stewart, 2006) and older children with ASD without cognitive impairment (Samyn et al., 2011). The current study extended this question by examining whether effortful control also related to social function beyond social symptoms; no relation was detected. The relation between effortful control and social symptoms but not function may be due to the similarity

of some items on the Effortful Control scale with autism symptoms. Another possibility is that better effortful control allows children to suppress unusual social behaviors associated with ASD, thereby reducing symptoms more than increasing prosocial behaviors.

An unexpected result was that children with the ability to delay gratification did not perform better than children who failed to wait on measures of social functioning or symptoms or with effortful control. Further, children who passed the delay of gratification task did not differ from those who failed on the Approach/Anticipation and Impulsivity scales of the CBQ, which were included to explore the possible relation between performance and reactivity to tempting stimuli. The pattern of results highlights the benefit of examining related constructs with multiple methodologies in the same sample. To the extent that both delay of gratification and parent report of effortful control measure common abilities, they should both be spared or impaired in the same sample. Yet, a closer examination of the measures highlights subtle but potentially important differences that may distinguish them and account for the observed pattern of findings. For example, the Inhibitory Control scale contains items that involve inhibition in the context of a social interaction including, "Is good at following instructions," and "Can easily stop an activity when s/he is told 'no.'" In contrast, although a person presents instructions for the delay of gratification, the instructions are neutral and non-directive with respect to the adult's desire for the child to wait. Instead, the child is told that the decision to wait or not is his or hers. Another distinction is that measuring effortful control relies on parent observation whereas delay of gratification presents a rare opportunity to observe the child's willpower when left alone in a room with a temptation. Thus, it is possible that both measures are sensitive to the development of self-control, but differ in the context that it is demonstrated. Effortful control may be more sensitive to the ability to exert control over behavior in social situations, and, consequently more closely linked with social symptoms of ASD. Thus, consistent with the recommendation of Nigg (2000), assessing similar constructs with multiple measurement approaches may be particularly informative in clinical populations.

An alternative explanation for the lack differences between children with ASD who passed and failed the delay of gratification is methodological. It is possible that the ability to detect differences was limited by relatively small number of children with ASD who did not complete the entire delay – only about 40% of the children with ASD failed to wait the full 15 minutes – constraining power to detect subgroups for this measure. Another possibility is that delay of gratification provides an objective measurement and parent-reported effortful control may be related to parental expectations that influence their responses. While observing the Delay of Gratification task, several parents expressed surprise that their children with ASD were able to remain seated in a room alone for 15 minutes. Thus, as has been suggested elsewhere (Samyn et al., 2013), parent expectations may have influenced effortful control ratings. The current study, which, as a first step, focused on examining group differences for these measures, cannot resolve these possibilities.

These findings raise additional questions for future research. The novel finding of reduced ability to delay gratification among young children with ASD should be replicated and correlates of this ability must be clarified. The current study found executive control related to delaying rewards as well as effortful control, including attention focusing and inhibition,

were reduced in some individuals with ASD and suggests that these individual differences have a potentially meaningful, but complex relation to behavioral symptoms. Use of related behavioral and parent-report measures with young children represents a first step in better understanding how these abilities relate to ASD symptomatology. Longitudinal work is needed to resolve whether temperament domains such as effortful control are more sensitive measures of existing symptoms or predictive of the course of symptom development in ASD. Second, given poor performance of 6–7 year olds during delay of gratification, it will be of interest to test delay of gratification in 3–5 year olds with ASD because it may capture greater variability and more meaningful individual differences at younger ages. It also will be of interest to examine whether individual differences in delaying gratification among children with ASD are predictive of the same types of outcomes found in longitudinal work with typically developing individuals such as executive control, coping and self-regulation (Ayduk et al., 2000; Mischel et al., 2011; Mischel et al., 1988; Casey et al., 2011). Given difficulties in these domains for older individuals with ASD, the finding of an impaired ability to delay gratification for some children with ASD will be important to pursue in future research as it may help predict which children would benefit from additional support and monitoring.

While the current study uniquely adds to the existing literature, it is not without limitations. First, our sample was limited by its size, which may have limited the ability to detect some relations, and by its representativeness. Specifically, we excluded children with below average IQ and our sample was mostly white with well-educated, affluent parents. Second, some caveats should be noted regarding our measures. Using the BASC-2 to confirm that comparison children were in the non-clinical range may have exaggerated group differences on ADHD-related behaviors, and using the ADOS as both an eligibility and experimental measure may have influenced our correlations. The ADOS has traditionally been limited as a measure of severity by lack of standardization across child characteristics and lack of scores for subscales, but the Social Affect calibrated severity scores (Hus et al., 2012) used in our study address these limitations. Finally, children were aware that their parents were watching the session, which may have led the groups to behave differently during the delay of gratification. For instance, children in the typically developing group may have been more influenced by anticipation of parental praise for their compliance with task demands.

Clinically, this study is important because teachers and parents may assume that children on the autism spectrum with strong cognitive ability should not have difficulties related to executive or effortful control. One widespread belief among educators and clinicians is that rule-based teaching strategies are effective for verbal children with ASD. While this study did not specifically test adherence to rules, delay of gratification was significantly more challenging for children with ASD even though they demonstrated knowledge of the rules. Recognizing that ASD, even without intellectual disability, is associated with reduced self-control may allow parents and teachers to better understand children's challenging behaviors. In particular, this study highlights potential difficulties with inhibition in the face of rewards and effortful control – abilities that allow a child to modulate reactivity in order to learn from the environment and respond in a socially appropriate and regulated way (Cole et al., 2009). Additionally, rewards are a central component of many early interventions for ASD, and individual differences in the ability to exert executive control in the face of

reward may be an important factor to explore in predicting differences in treatment response. As a consequence, understanding the developmental processes that contribute to development or maldevelopment of executive control as it interacts with reward and social-emotional processing may be especially useful in understanding meaningful subgroups of children with ASD (Bachevalier et al., 2006; Dawson et al., 1998).

In conclusion, the current investigation provides preliminary evidence for impaired ability to delay gratification and reduced effortful control in young children with ASD without intellectual disability. The examination of individual differences in social symptoms of ASD, social function and behavioral challenges suggest that effortful control and inhibition of an immediate desired response may contribute unique and complementary information about the severity of current symptoms and functioning. Future work is needed to understand how this profile relates to the etiology of ASD and prediction of outcomes, though developmental work with typical children suggests these measurements will likely be informative to both.

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Table 1

Participant descriptive characteristics with Means (Standard Deviations), and Ranges

	ASD	TD	Signif.(<i>t, p</i>)
Age (in months)	82.0 (7.1); 72–94	80.3 (7.6); 72–95	0.75, <i>ns</i>
Family gross annual income	102.6 (34.7); 45–190	126.3 (63.5); 35–300	–1.5, <i>ns</i>
Paternal highest education	6.3 (0.9); 4–7	6.2 (0.8); 4–7	0.5, <i>ns</i>
Maternal highest education	6.2 (0.9); 4–7	6.3 (0.6); 5–7	–0.6, <i>ns</i>
DAS-2 General Conceptual Ability	104.0 (11.6); 87–133	109.1 (7.2); 100–131	–1.7, <i>ns</i>
DAS-2 Verbal Composite	107.1 (10.8); 89–125	109.0 (9.5); 94–123	–0.6, <i>ns</i>
DAS-2 Nonverbal Composite	99.0 (13.0); 76–125	103.4 (8.0); 89–124	–1.3, <i>ns</i>
DAS-2 Spatial Composite	104.5 (13.4); 87–148	111.1 (8.0); 93–127	–1.9, <i>ns</i>
Vineland-2 Adaptive Beh. Comp.	85.7 (7.6); 71–96	99.9 (3.7); 92–106	–7.7, <.001
BASC-2 Behav. Symptoms Index	65.8 (10.0); 50–86	48.7 (6.8); 35–64	6.5, .001
BASC-2 Hyperactivity	60.6 (9.7); 50–87	51.6 (6.3); 35–62	3.6, .001
BASC-2 Attention Problems	63.3 (7.2); 49–75	48.8 (7.2); 35–64	6.6, <.001
ADI-R Social	19.6 (4.8); 8–26 (cutoff = 10)		
ADI-R Communication	17.4 (4.7); 7–24 (cutoff = 8)		
ADI-R Repetitive Behavior	7.3 (3.0); 1–12 (cutoff = 3)		
ADOS Total	13.3 (3.9); 8–25 (cutoff = 7)		

Note: Household income is reported in thousands of US dollars. Parental education is coded as 4= high school, 5=some college, 6=college, 7=graduate school. DAS-2 (Differential Ability Scales-2nd Edition) standard scores have an average range from 85–115. BASC-2 (Behavior Assessment System for Children-2nd Edition) T scores have a clinical cut off 70 and At Risk range from 60–69. Raw scores are reported for the ADI-R (Autism Diagnostic Interview-Revised) and ADOS (Autism Diagnostic Observation Schedule). Children who were -2 points on a single ADI-R domain were included.

Table 2

Means (Standard Deviations), and Ranges for Measures of Social Ability and Temperament

	ASD	TD	Signif.(<i>t, p</i>)
Scores for measures of individual differences in social ability			
Social Skills Rating System	79.2 (13.9); 56–104	107.3 (10.5); 84–127	–7.3, <.001
Vineland-2 Socialization	81.4 (8.4); 66–96	100.2 (5.3); 91–110	–.6, <.001
ADOS Social Affect CSS	7.5 (1.8); 4–10		
Temperament scales contributing to Effortful Control			
Effortful Control	4.3 (0.6); 3.3–5.2	4.9 (0.4); 3.9–5.7	–3.8, <.001
CBQ Attention Focusing	4.0 (0.7); 2.6–5.6	4.7 (0.6); 3.6–5.8	–3.5, .001
CBQ Inhibitory Control	3.9 (0.9); 2.5–5.6	5.0 (0.6); 4.1–6.2	–4.8, <.001
CBQ Low Intensity Pleasure	4.8 (0.8); 3.6–6.1	5.5 (0.7); 3.4–6.4	–2.8, <.01
CBQ Perceptual Sensitivity	4.3 (1.2); 2.0–6.1	4.3 (0.7); 3.3–5.9	.02, <i>ns</i>
Other temperament scales theoretically related to Delay of Gratification			
CBQ Approach	5.3 (0.8); 3.9–6.3	5.2 (0.6); 4.2–6.2	.38, <i>ns</i>
CBQ Impulsivity	4.6 (0.8); 3.4–5.9	4.6 (0.6); 2.9–5.5	.00, <i>ns</i>

Note: Means are reported with standard deviations in parentheses followed by ranges. Group differences were examined using *t*-tests. Standard scores, which have an average range from 85–115 and a mean of 100, are reported for the Social Skills Rating System and Vineland-2. The calibrated severity score is reported for the ADOS (Autism Diagnostic Observation Schedule) Social Affect scale and average raw score for CBQ (Child Behavior Questionnaire) scales.

Table 3

Correlations among children with ASD for effortful control and social ability

Variable	1	2	3
1. CBQ Effortful Control	—		
2. ADOS Social Affect CSS	-.52*	—	
3. Social Skills Rating System	.20	-.29	—
4. Vineland-2 Socialization	-.02	-.14	.68**

Note:

*
 $p < .05$,**
 $p < .01$.

For each measure, Pearson correlations are presented. CBQ: Children's Behavior Questionnaire; ADOS: Autism Diagnostic Observation Schedule; CSS: calibrated severity score