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Resistance to Temptation in Toddlers at Genetic Risk for Autism Spectrum Disorder

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Abstract

Children with autism spectrum disorder (ASD) often demonstrate difficulties with self-regulation, although studies of this construct in young children with ASD are limited. In this study developmental changes were examined using a measure of self-regulation appropriate for young children, resistance to temptation. At 22, 28, and 34 months, toddlers with an older sibling with ASD (high risk; HR) and toddlers with typically-developing older siblings (low risk; LR) were presented with an appealing toy and instructed not to touch it. Observers coded whether or not children touched the toy and the strategies they used to resist touching it. At 36 months children were assessed for ASD, yielding 3 groups: HR children with ASD, HR children without ASD (HR-noASD), and LR children. At 22 months most children, regardless of group, touched the forbidden toy; at 28 and 34 months many HR-noASD and LR children resisted the temptation to touch the toy, whereas most of the children with ASD did not. Differences in delay strategies were also evident. Some, but not all group differences, were accounted for by differences in language ability. Results highlight one early index of impulse control that differentiates children with emerging ASD from age-mates prior to the third birthday.

Keywords

High risk siblings; resistance to temptation; autism spectrum disorder

Introduction

Autism Spectrum Disorder (ASD) is defined by deficits in social interaction and communication, and the presence of repetitive and stereotyped behaviors, but many children with ASD also demonstrate difficulties with self-regulation, including the control of behavior, attention, and affect (Konstantareas and Stewart, 2006; Mazefsky et al., 2012). Self-regulation in young children is reflected primarily in the ability to control negative emotions, delay gratification, control impulses, and comply with adult requests (Kochanska et al., 1998; Kopp, 1989; Mischel et al., 1989). Typically developing toddlers show advances in the ability to regulate impulses and emotions across the second and third years of life (Kopp, 1982; Vaughn et al., 1984), although wide individual differences are apparent in toddlerhood (Calkins, 2007; Kopp, 1989) and the preschool period (Mischel et al., 1989).

Individual differences in self-regulation in toddlerhood and early preschool are also associated with variations in language development, with more advanced language supporting the development of self-regulation by providing young children with alternative ways of controlling their behavior (Petersen et al., 2015; Vallotton and Ayoub, 2011). Brownell and Kopp (2007) note that developmental advances in inhibitory and attentional control in toddlerhood also co-occur with advances in social skills, social cognition, and emotion regulation. Further, children who show optimal levels of self-regulation in early childhood also demonstrate higher levels of social competence in adolescence and beyond (Mischel et al., 2011).

In contrast, early difficulties with self-regulation predict a range of negative outcomes including poorer social, academic, and adaptive functioning. Most research on the sequelae of poor self-regulation in early childhood has focused on emerging attention deficit hyperactivity disorder (ADHD) and related externalizing problems (Campbell et al., 1994; Kochanska et al., 1998; Olson et al., 2005). For example, poor performance on resistance to temptation and delay of gratification tasks administered at preschool age predicts later symptoms of inattention and impulsivity in typically developing preschoolers (Campbell and von Stauffenberg, 2009) and preschoolers at risk for ADHD (Campbell et al., 1994; Olson et al., 2005). Problems inhibiting impulses and regulating negative emotions are likewise evident in young children with ASD, with implications for social and communicative difficulties (Arbelle et al., 1994; Christ et al., 2007; Nuske et al., 2017).

In an effort to trace the early emergence and developmental course of specific behaviors that characterize ASD, recent research has focused on young children at genetic risk (HR) for ASD because they have an older sibling with the disorder. By studying HR children prospectively, research has begun to shed light on early signs of ASD and to delineate when HR toddlers who receive an ASD diagnosis diverge from HR toddlers without a diagnosis (HR-noASD) and from low risk (LR) toddlers with typically-developing older siblings on selected behavioral markers that have implications for social and communicative development. For example, Garon et al. (2009) reported that HR toddlers who received a diagnosis of ASD at 36 months were rated by parents as less able to control attention and impulses at 24 months than HR-noASD and LR toddlers. In the current report, we examine the performance of HR and LR toddlers at 22, 28, and 34 months on a resistance to temptation task, a measure of impulse control appropriate for young children, as the instructions are easily understood and are similar to everyday experiences of having to wait for a desired outcome.

Self-Regulation in Children with ASD

Several studies have used laboratory measures to assess aspects of self-regulation in young children with ASD. Konstantareas and Stewart (2006) compared children with ASD (ages 3 to 10) and typically-developing age-matched control children on a frustration task during which they were briefly handed an attractive toy which was then rapidly withdrawn. Children with ASD were less likely to comply with the examiner's request to return the toy and were rated by parents as lower in focused attention and inhibitory control than comparison children. Jahromi et al. (2012) assessed responses to frustration in high

functioning preschool-age children with ASD and mental-age matched typically-developing children who were asked to complete unsolvable puzzles and given an appealing toy in a locked box with incorrect keys. Children with ASD showed more resignation, avoidance, and irritability, and fewer positive problem-focused coping strategies than comparison children, even with controls for verbal ability, suggesting more passivity in the face of frustration. More recently, Nuske et al. (2017) examined emotion regulation in toddlers and preschoolers with ASD and age-matched typically-developing children. Both groups used a variety of strategies to regulate negative emotions when frustrated or challenged including approach, avoidance, self-distraction, and comfort-seeking, but children with ASD sought comfort from their parents more often, suggesting a delay in the emergence of more autonomous coping strategies.

Two studies used a delay of gratification paradigm to examine compliance with parental prohibitions. Arbelle et al. (1994) observed preschool children with ASD, developmental delay, and typical development matched for mental age. The examiner presented the child with candy and instructed the parent to prohibit the child from eating it for 30-seconds. Fewer children with ASD were able to resist eating the candy during the delay interval than children in the other two groups. Within the group with ASD, older chronological age, but not mental age, was associated with the ability to delay. Ostfeld-Eztion et al. (2015) also assessed the ability of preschoolers with ASD and mental-age matched comparison children to comply with parental prohibitions. Children were shown a plate of sweets and told that the examiner needed to leave and they were not to eat the sweets until she returned. Most children had difficulty waiting the full five minutes, but a higher proportion of control children than children with ASD were able to resist eating the candy during the delay interval. The children with ASD were also rated by parents as showing less inhibitory control than comparison children.

In the current study, we used a resistance to temptation paradigm to assess the ability of HR and LR toddlers to refrain from touching a tempting toy. Children were assessed at 22, 28, and 34 months to examine developmental and group differences across this key period in the emergence of self-regulation. It was expected that children who received a diagnosis of ASD would have more difficulty resisting the tempting toy than LR children at each assessment and that the proportion of LR children who were able to resist touching the toy would increase with age. In addition to coding whether or not the child touched the toy, we coded delay strategies. We expected LR children to use more advanced strategies (i.e., self-distraction, self-instruction; Campbell et al., 1994; Mischel et al., 1989; Raver, 1996) than children with an ASD diagnosis, especially at later ages. Because so little work has been done with this HR population, we did not make specific predictions about the responses of the HR children who did not receive a later diagnosis (HR-noASD). It was possible that they would show uneven development, look more similar to the children with a diagnosis of ASD, or perform more like the LR children. Finally, given the links between self-regulation and language development in TD children and the language deficits that characterize ASD, we asked whether differences in language ability accounted for any differences obtained between the children with ASD and the LR and HR-noASD groups.

Method

Participants

Participants in this prospective study (N=168) include children with an older sibling with ASD and comparison children with a typically developing older sibling. Most children were recruited in infancy and followed up at 22, 28, and 34 months for a play-based assessment of social behavior that included the resistance to temptation paradigm described below. Children were also seen at 36 months for a diagnostic assessment. Parents signed informed consents at each visit prior to participation; the research protocol was approved by the University Institutional Review Board.

HR toddlers (78, 46 males) were recruited between 6 and 16 months for a study of cognitive and social development, through the Autism Center, with the exception of four HR children who joined the study between 18 and 22 months. To be eligible for inclusion in the HR group, children had to be born full-term after an uncomplicated pregnancy and delivery, and have an older sibling diagnosed with ASD according to research criteria. The older sibling's diagnosis was confirmed by research reliable staff who administered the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000) under the supervision of a licensed psychologist, prior to the younger sibling's enrollment. Infants whose older siblings had known genetic or other anomalies, such as Fragile X, were excluded. Four HR toddlers were half-siblings of the child with ASD.

LR toddlers (90, 51 males) were recruited from the local obstetrics hospital and the community. Full-term healthy children with a typically developing older sibling and negative family history of ASD in first and second degree relatives comprised the LR group. Parents of LR children completed the Social Communication Questionnaire (Rutter et al., 2003) on the older sibling prior to study enrollment; all scored well below the ASD cut-off of 15.

Participating children are predominantly Caucasian and non-Hispanic (87%) and all but six children (3 LR, 2 HR-noASD, 1 ASD) live in two-parent families. The sample included in this report overlaps with participants in several prior publications (Campbell et al. 2015; 2016; 2017; 2018).

The resistance to temptation task was administered as part of a longer assessment to 141 children at 22 months, 154 children at 28 months, and 157 children at 34 months. Data at 22 and 28 months were missing for some children because most HR and many LR toddlers were recruited in infancy for another study and the toddler study began after some children were already two years old. Scheduling difficulties, child noncompliance, and equipment problems also accounted for missing data. A few children did not show interest in the toy (see below), so their behavior could not be coded (22 months: $n = 2$, both ASD; 28 months: $n = 6$, 1 LR, 2 HR-noASD, 3 ASD; 34 months: $n = 3$, 2 LR, 1 ASD). Thus, N 's for this task were as follows: 22 months ($n=15$ with ASD; $n=46$ HR-noASD; $n=78$ LR); 28 months ($n=17$ with ASD; $n=49$ HR-noASD; $n=82$ LR); 34 months ($n=15$ with ASD; $n=58$ HR-noASD; $n=81$ LR).

Procedure

Resistance to temptation was assessed during a visit that included free play with a parent and toy clean-up. Once the toys from free play were out of sight, the experimenter introduced an attractive and appealing toy (Fisher-Price Laugh and Learn Basketball Set at 22 and 28 months; Playskool Explore and Grow Busy Ball Popper at 34 months). Both toys were battery-operated, with lights and music activated each time the child threw the ball into the hoop or shoot. After demonstrating the toy, the experimenter engaged the child's attention; she then said that she had forgotten something important and instructed the child not to touch the toy until she returned. Before leaving she repeated the instructions, again looking directly at the child and saying in a firm tone "remember, don't touch the toy until I come back." She then left the room for 90-seconds, during which the child's behavior was coded. Parents were told about this procedure at the start of the visit and asked not to intervene. When the experimenter returned she permitted the child to play with the toy for two minutes.

Coding and Reliability

Toddlers' responses to the tempting toy were coded from videotape for 90-seconds, beginning as soon as the experimenter left the room; coders were blind to group and diagnostic status. Coders first determined whether the child was interested in the toy, as this was a prerequisite for demonstrating self-control. During the initial introduction of the toy and immediately after the experimenter left the room, almost all children looked at, pointed to, and/or approached the toy. However, children who displayed none of these behaviors and either walked away or totally ignored the toy and examiner were considered uninterested and their data were not included.

Once it was established that the child was interested in the toy, the following behaviors were coded: *Latency to touch toy* was coded in seconds from the time the examiner left the room. Since some children touched the toy briefly and others played with the toy continually during the delay interval, *total time in contact with the toy* in seconds was also calculated. *Delay strategies* were coded *only* when children were *not* in physical contact with the toy. Delay strategies were coded as present or absent in 10-second intervals across the 90-seconds, including *visual attention to toy* (child looks at the toy intently, but does not touch it); *look at and talk about toy* (child looks at toy and either talks to self or parent about it); *self-distract* (child is engaged in another activity such as looking at self in mirror, looking at pictures on wall, singing to self). *Disengagement* or *look away* and *self-instruct* (child reminds self not to touch the toy) were also coded, but occurred infrequently and are not considered further.

Coders were trained to reliability before being permitted to code independently. Inter-observer reliability was determined throughout data collection on at least 20% of the tapes at each age. Intraclass correlation coefficients (ICC) were above .80 for all variables included in the analysis.

Developmental and Autism Assessments

Mullen Scales of Early Learning—The Mullen Scales of Early Learning (Mullen, 1995) were administered at 24 months. Scores on the Receptive and Expressive Language

scales formed the Verbal Composite; the Visual Reception and Fine Motor scales were combined into the Non-verbal Composite (both $M = 50$, $SD = 10$). Six children were missing Mullen scores at 24 months, so their 36 month Mullen Verbal and Non-verbal scores were substituted. Another four children (2 HR-noASD, 2 ASD) are missing Mullen scores at both ages because of missed appointments ($n=3$) or lack of cooperation ($n=1$). One child with ASD has a verbal, but not a non-verbal score. Groups differed significantly in Mullen Verbal, $F_{(2, 163)} = 29.83$, $p < .001$, and Non-verbal scores, $F_{(2, 162)} = 12.13$, $p < .001$. Follow-up tests on the Verbal Composite indicated that the children with ASD ($M = 35.78$, $SD = 12.95$) scored significantly lower than either the HR-no ASD ($M = 51.09$, $SD = 8.32$) or the LR children ($M = 53.89$, $SD = 8.93$), who did not differ from each other. Follow-up tests on the Non-verbal Composite indicated that the children with ASD ($M = 43.68$, $SD = 9.08$) also obtained lower scores than the HR-noASD ($M = 49.68$, $SD = 7.45$) and LR ($M = 53.57$, $SD = 8.87$) groups. The LR group also received significantly higher scores than the HR-noASD group on the Non-verbal Composite.

Evaluations for Autism—Both HR and LR toddlers were evaluated for an ASD diagnosis at follow-up, using the Autism Diagnostic Observation Schedule (ADOS, Lord et al., 2000). The ADOS, a semi-structured observational assessment, includes play-based activities meant to elicit reciprocal social interaction, communication, and stereotyped behaviors, with scoring rules for a diagnosis of ASD. All children received either Module 1 or 2. Evaluations were conducted by a research-reliable tester under the supervision of a licensed clinical psychologist from the Autism Center with extensive experience assessing children with ASD; no one involved in the diagnostic assessments conducted the laboratory visits. Diagnostic decisions were based on the 36-month assessment or later for all HR-noASD children. Two children with a diagnosis were seen at 24, but not 36 months, so their 24-month ADOS was used. Finally, one HR child was given a diagnosis of ASD at a local developmental clinic specializing in autism. Most LR children were assessed at 36 months, but three missed the 36-month visit and their 24-month ADOS was substituted.

Children were classified as ASD if they met cut-off scores on the ADOS (Lord et al., 2000) and also met DSM-IV criteria for an autism spectrum disorder (American Psychiatric Association, 2000), as determined by interview and observation. Parents of children with elevated ADOS scores and/or serious clinical concerns were interviewed using the Autism Diagnostic Interview-Revised (ADI-R, Lord et al. 1994) to provide further information. Final diagnoses, made by a licensed clinical psychologist, were based on a combination of structured diagnostic measures, DSM-IV criteria, and clinical judgment; 19 HR toddlers (13 boys) received a diagnosis of ASD. One LR boy with an earlier language delay and some social concerns received an ASD diagnosis and is included in the ASD group in the analyses.

Data Analysis Plan

Although we planned to analyze the data as continuous variables and to examine both between group differences and developmental change, the highly skewed distributions led us to create binary and categorical variables instead. For binary dependent variables, we analyzed the data using logistic regression with outcome group dummy coded and the LR

group serving as the reference group. To examine potential differences between the HR-noASD and ASD groups, regressions were also re-run with the HR-noASD group as the reference group. All analyses were run with and without Mullen Verbal Composite scores included in the model to assess the role of verbal ability in accounting for group differences. These analyses excluded the four children with missing Mullen verbal scores.

Results

Latency to Touch Toy

The distributions of *latency to touch* were highly skewed. At 22 months, most toddlers, regardless of group, were not able to resist touching the forbidden toy within the first few seconds (severe positive skew); by 28 months, most children either touched the toy immediately or were able to resist completely (a bimodal distribution), and by 34 months, most children were able to resist touching the toy (severe negative skew). Therefore, we recoded the *latency* measure into a categorical variable indicating whether or not (*yes/no*), the child touched the forbidden toy during the delay interval (see Figure 1).

At 22 months, 91% of toddlers touched the toy during the delay interval and outcome group was not a significant predictor. However, by 28 months about 40% of the LR and HR-noASD toddlers were able to resist touching the tempting toy, while *none* of the children with an ASD diagnosis were able to refrain from touching it. Because there was no variability in the dependent variable for the ASD group, we could not run a logistic regression for *touch* at this age. A linear probability model was used instead. Children in the ASD group were significantly more likely to touch the toy than children in the LR ($B = 0.40$, $SE = 0.12$, $t(145) = 3.25$, $p = .001$) and HR-noASD groups ($B = .39$, $SE = 0.13$, $t(145) = 2.96$, $p = .004$). A similar pattern was evident at 34 months, with a majority of LR (73%) and HR-noASD (64%) children able to resist touching the toy in contrast to only 20% of the children with a diagnosis. Logistic regression revealed that children with ASD were significantly more likely to touch the toy than children in the other outcome groups (LR reference: $OR = 10.73$, $95\% CI = 2.76-41.65$, $p = .001$; HR-noASD reference: $OR = 7.05$, $95\% CI = 1.78-27.84$, $p = .005$).

To determine whether verbal ability played a role in these group differences, analyses were rerun with Mullen Verbal Composite scores included in the models. Mullen verbal scores were a significant predictor of whether or not a child touched the toy at 28 months ($B = -0.11$, $SE = 0.004$, $t(142) = -2.66$, $p = .009$) and 34 months ($OR = 0.95$, $95\% CI = 0.91-0.99$, $p = .01$). With verbal scores controlled, group differences in touch toy were no longer significant at 28 months (LR reference: $B = 0.21$, $SE = 0.15$, $t(142) = 1.44$, $p = .15$; HR-noASD reference: $B = 0.23$, $SE = 0.15$, $t(142) = 1.56$, $p = .12$). At 34 months, however, even with Mullen verbal scores controlled the ASD group remained significantly more likely than the LR group ($OR = 4.68$, $95\% CI = 1.06-20.75$, $p = .042$) and marginally more likely than the HR-noASD group ($OR = 3.81$, $95\% CI = 0.85-17.03$, $p = .08$) to touch the toy during the delay interval.

Time in Contact with Toy

Not surprisingly, *time in contact* was also skewed; thus, this variable was categorized as *no contact*, *1–30"*, *31–60"*, and *61–90"* *in contact with toy*. Linear regression was used to determine whether outcome group predicted time in contact with the toy (categorized as described above). At 22 months, most children were in contact with the forbidden toy for most of the delay interval, so time in contact did not vary by group ($F_{(2, 136)} = 1.08$, $p = .34$; See Figure 2). At 28 and 34 months, however, group status was a significant predictor, with ASD children spending more time in contact with the toy than children in the LR ($B = 1.51$, $SE = 0.34$, $t(145) = 4.48$, $p < .001$) and HR- noASD groups ($B = 1.31$, $SE = 0.36$, $t(145) = 3.70$, $p < .001$). At 28 months, among children who touched the toy, only about 55% of the LR children and 63% of HR-noASD children spent more than 60 seconds in contact, while 88% of children with ASD spent from 61–90 seconds in contact. Group differences were also significant at 34 months (LR reference: $B = 1.23$, $SE = 0.29$, $t(151) = 4.12$, $p < .001$; HR-noASD reference: $B = 1.03$, $SE = 0.30$, $t(151) = 3.41$, $p = .001$). LR and HR-noASD did not differ from one another at either age.

Mullen verbal scores were a significant predictor of time in contact with the toy at 28 ($B = -0.03$, $SE = 0.012$, $t(142) = -2.44$, $p = .016$) and 34 months ($B = -0.36$, $SE = 0.009$, $t(147) = -4.12$, $p < .001$). Even with Mullen verbal scores controlled, however, the ASD group remained significantly different from both other groups in time in contact with the toy at 28 months (LR reference: $B = 1.02$, $SE = 0.39$, $t(142) = 2.59$, $p = .011$; HR-noASD reference: $B = 0.92$, $SE = 0.40$, $t(142) = 2.31$, $p = .02$), but group differences were no longer significant at 34 months (LR reference: $B = 0.52$, $SE = 0.32$, $t(147) = 1.62$, $p = .11$; HR-noASD reference: $B = 0.45$, $SE = 0.32$, $t(147) = 1.42$, $p = .16$).

Delay Strategies

Delay strategies were coded only when children were not in contact with the toy. At 22 months delay strategies could not be analyzed because most children played with the toy for most of the delay interval. However, by 28 months three delay strategies occurred with sufficient frequency to be analyzed: *visual attention to toy*, *look at and talk about toy*; *self-distract*. Because the data were highly zero-laden and positively skewed, these variables were also recoded to yes/no, indicating whether the child *ever* used that delay strategy during the 90-second waiting period. Table 1 displays the percentage of children in each group using each of these strategies at least once at 28 and 34 months, and Table 2 displays the results of logistic regression analyses use of predicting delay strategies at each age, with and without verbal scores included, with the LR group as the reference group. Odds ratios (OR) are included in Table 2 when the LR group is the reference group and in the text for comparisons between the ASD and HR-noASD groups. As can be seen in Table 1, overall more children used these delay strategies at 34 months than at 28 months.

At 28 months, children with ASD were less likely than the LR children to *visually attend* to the toy, *look at the toy and talk about it*, or try to *distract* themselves (see Table 2); the children with ASD were also less likely than HR-noASD children to *visually attend* ($OR = 0.12$, $95\% CI = 0.01–0.97$, $p = 0.046$) or use *self-distraction* ($OR = 0.21$, $95\% CI = 0.06–0.74$, $p = .016$.) as a delay strategy at this age. At 34 months, the children with an ASD

diagnosis were significantly less likely than the LR children to *talk about* the toy or use *self-distraction*, and marginally less likely to *visually attend* to the toy. They were also less likely than HR-noASD children to use any of the three delay strategies: *attend to toy* ($OR = 0.18$, $95\% CI = 0.05–0.69$, $p = .013$); *look at toy and talk about it* ($OR = 0.10$, $95\% CI = 0.01–0.82$, $p = .032$); and *self-distraction* ($OR = 0.17$, $95\% CI = 0.05–0.59$, $p = .005$) at 34 months. The HR-noASD children were also marginally less likely to *look at the toy and talk about it* than LR children at 34 months, but LR and HR-noASD toddlers did not differ from each other in use of any other strategy at either age.

Next, delay strategies were reanalyzed controlling for Mullen verbal scores. The verbal score did not predict *visual attention to toy* at either age; toddlers with ASD remained significantly less likely than LR, but not HR-noASD children ($OR = 0.19$, $95\% CI = 0.02–1.61$, $p = .14$) to use this strategy at 28 months. At 34 months, the ASD group was no longer significantly different from the LR group, but remained marginally less likely than the HR-noASD group ($OR = 0.24$, $95\% CI = 0.55–1.03$, $p = .054$) to *visually attend to toy*. The verbal score did predict whether or not children *looked at and talked about* the toy at both 28 and 34 months. Group differences in the use of this strategy were no longer significant at 28 months (HR-noASD reference: $OR = 0.33$, $95\% CI = 0.04–2.95$, $p = .32$) with verbal scores controlled. However, at 34 months, the children with ASD remained significantly less likely to use this strategy than the LR children, even with verbal scores controlled, but the differences between the ASD and HR-noASD groups ($OR = 0.18$, $95\% CI = 0.02–1.56$, $p = .12$), and between the LR and HR-noASD groups were no longer significant. Mullen scores were not a significant predictor of *self-distraction* at 28 months; group differences remained with these scores in the model (HR-noASD reference: $OR = 0.25$, $95\% CI = 0.06–0.99$, $p = .048$). However, at 34 months verbal scores did predict the use of self-distraction, and accounted for the differences between the children with ASD and the other two groups (HR-noASD reference: $OR = 0.50$, $95\% CI = 0.11–2.22$, $p = .36$).

Discussion

We examined self-regulation in toddlers at high and low genetic risk for ASD at three ages: 22, 28, and 34 months. Using a simple resistance to temptation task with age-appropriate toys, we explored group and developmental differences in children's ability to inhibit a prepotent response, touching an attractive toy that was temporarily off-limits. We also studied the strategies that children used to help themselves refrain from touching the toy. Group and developmental differences shed light on the emergence of self-regulation in typically-developing children and in HR children who do and do not go on to receive a diagnosis of ASD.

Several findings stand out. First, there were similarly marked developmental changes between 22 and 34 months in the ability of LR toddlers and HR-noASD toddlers to resist the tempting toy. The proportion of children in both the LR and HR-noASD groups who refrained from touching the toy increased with age and they also spent less time engaging with the toy over time. In contrast, children with ASD showed comparatively little change between 22 and 34 months on these two measures, as they were generally unable to resist playing with the toy. Second, at both 28 and 34 months, higher proportions of LR and HR-

noASD children employed strategies to help them cope with the delay interval than did the children with ASD. Increasing ability to resist temptation and use delay strategies have been reported in other studies of emerging self-regulation in typically-developing children (Calkins, 2007; Vaughn et al., 1984). Third, the LR children and the HR-noASD children generally did not differ from one another, although both differed from the children with ASD on most measures at both 28 and 34 months, but not at 22 months. These data highlight developmental differences in emerging self-regulation between toddlers with a diagnosis of ASD and high and low risk children without ASD.

At 22 months, almost all children regardless of group were unable to refrain from touching the toy and they played with it for most of the 90-second delay interval, indicating that the desire to play with the toy overwhelmed the ability of these young children to inhibit their impulses. However, by 28 months about 40% of both the LR and HR-noASD children were able to resist touching the toy, but none of the children with ASD refrained from touching it. Overall, between 22 and 34 months, the toddlers without a diagnosis, regardless of genetic risk, showed developmental change in the ability to resist temptation, mostly ignoring the instructions of the examiner at 22 months, but generally following her prohibition by 34 months. This is consistent with expectations about developmental change in self-regulation in typically-developing toddlers (Calkins, 2007; Kochanska et al., 1998; Kopp, 1989; Vaughn et al., 1984), most of whom are becoming more compliant with adult requests and playing more cooperatively with peers by 34 months of age.

Furthermore, at 28 months and especially at 34 months, when children in the HR-noASD and LR groups did touch the toy, they did so for shorter periods of time than the children with ASD. This suggests that even when the children without ASD touched the forbidden toy, they showed some degree of self-regulation and some realization that they were not following the examiner's instructions. Most of the children with a diagnosis ignored the examiner's prohibition across age showing only minimal developmental change, consistent with results of other studies indicating that young children with a diagnosis of ASD are less likely than comparison children to follow parental prohibitions during delay of gratification tasks (Arbelle et al., 1994; Ostfield-Etzion et al., 2015) and have more difficulty coping with frustration when desired toys cannot be accessed (Jahromi et al., 2012; Nuske et al., 2017). However, this is the first study of which we are aware to examine delay capacity longitudinally, albeit in a slightly different context, and to highlight the divergent pathways in the ability to resist temptation between children with and without ASD between 22 and 34 months.

Because it was not possible to code delay strategies if children were touching the toy, it is hardly surprising that group differences in strategy use emerged between the children with ASD and the other two groups at 28 and 34 months. Thus, both the LR and HR-noASD children were more likely than the children with ASD to look passively at the toy, to look at the toy and talk about it, and to try to distract themselves as ways of bridging the delay interval. In typically-developing children, self-distraction and looking at the toy while talking about it reflect more active attempts to resist the tempting toy than passive looking (Campbell et al., 1994; Raver, 1996). Despite group differences, at both ages, children in all three groups used self-distraction as the most common delay strategy and the proportions of

children using this strategy increased between 28 and 34 months. The proportions of LR and HR-noASD toddlers looking at the toy while talking about it also increased from 28 to 34 months, whereas not surprisingly, the ASD group rarely used this strategy at either age.

In their study of emotion regulation in preschool children with ASD and typically-developing age-mates, Nuske et al. (2017) also coded delay strategies including focusing on the tempting toy and self-distraction, but they did not find group differences, possibly because the children in their study were older and scores were composited across a wider range of tasks. However, Nuske et al. also reported that the children with ASD were somewhat delayed in their ability to use unfamiliar adults to help them cope with frustration. Jahromi and colleagues (2012) found that their sample of high functioning children with ASD used more passive avoidance and fewer constructive strategies like self-distraction than comparison children. These results are consistent with our findings that the children with ASD were delayed relative to non-ASD peers in their ability to harness more adaptive delay strategies.

Although neither of the above-mentioned studies found associations between self-regulation and cognitive functioning, we found that verbal ability was confounded to some degree with the ability to resist the tempting toy, not at 22 months, when almost no child resisted playing with the toy, but at 28 and 34 months, when language ability appeared to support delay capacity and the use of delay strategies. This suggests that LR and HR-noASD children's emerging language skills provided them with alternative ways of coping with the task, as suggested by Vallotton and Ayoub (2011), whereas the children with ASD were less likely to have the language skills to help them regulate their own behavior. While differences in delay capacity and strategy use between the ASD children and both HR-noASD and LR children were partly accounted for by differences in language development, several differences remained with language controlled. Thus, the ability to refrain from touching the tempting toy and instead use strategies to bridge the delay interval appears to reflect something fundamental about individual differences in self-control that is not entirely a function of language skills. By 34 months, the LR and HR-noASD toddlers appeared to have internalized something about adult expectations (Kopp, 1982), possibly including the desire to please the experimenter. Even with Mullen verbal scores controlled, children with ASD were roughly four times more likely to touch the forbidden toy than either HR-noASD or LR children. Further, although children with ASD had lower verbal scores, and about half showed developmental delays, at 28 months they all touched the toy and at 34 months a number of children with average scores touched it as well, indicating that language delay alone cannot explain group differences. Clearly, the role that language and other cognitive and social delays play in impeding the development of self-control in young children with ASD or at risk for ASD are areas ripe for more systematic research.

The strengths of this study include the longitudinal data and the use of a novel measure of self-regulation with HR siblings. However, the lack of complete data on all participants at each age and the inability to utilize statistical techniques that correct for missing data are weaknesses that could not be overcome. Because the data were so skewed, we had to rely on cross-sectional statistical techniques, thereby missing the opportunity to test directly for developmental change. Despite these weaknesses, this is the first study, to our knowledge, to

examine resistance to temptation in HR children under the age of 3, during the time when this skill is first developing. Findings indicate a significant deficit in this ability among children with ASD as compared to their same-aged peers without the disorder.

Thus, these results have implications for early intervention and suggest the importance of incorporating a focus on self-regulation into treatment programs (Mazefsky et al., 2010). Children who have difficulty resisting temptation are less likely to comply with adult requests, follow classroom rules and routines, or play successfully with peers. Interventions for young children with ASD that help parents and other caregivers encourage joint engagement, social reciprocity, and language development during every day social interactions (Dawson et al., 2010) are also likely to scaffold children's regulation of behavior and emotion (Gulsrud et al., 2010; Ostfeld-Etzion et al., 2015; Vallotton and Ayoub, 2011) by providing emotional support, positive role models, and building simple vocabulary that may facilitate self-regulation.

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Figure 1.

Percent of toddlers in each outcome group who touched the toy during the delay interval at 22, 28, and 34 months

Note: At 28 and 34 months, the children with ASD were more likely to touch the toy than children in the HR-noASD and LR groups, $p < .01$.

Figure 2.
Percent of toddlers in each outcome group in contact with the toy for 0–61+ seconds

Table 1

Percent of toddlers ever (yes/no) using each delay strategy at 28 and 34 months by outcome group

	28 months			34 months		
	LR (n=82)	HR-noASD (n=49)	ASD (n=17)	LR (n=81)	HR (n=58)	ASD (n=15)
Visual Attention to Toy	48.78	34.69	5.88	45.68	58.62	20.00
Attend to Toy Using Language	36.59	24.49	5.88	58.02	41.38	6.67
Self-Distract	69.51	59.18	23.53	87.65	79.31	40.00

Note: Strategies were coded only when children were not in contact with the forbidden toy.

Table 2

Logistic regression results (Odds Ratios) predicting delay strategies at 28 and 34 months with the Low Risk Group as the Reference Group.

		Model 1			Model 2: With Mullen Verbal				
		95% CI for OR			95% CI for OR				
	OR	Lower	Upper	p-value	OR	Lower	Upper	p-value	
Visual Attention: 28 mos									
HR-noASD	0.56	0.27	1.16	0.12	0.61	0.29	1.29	0.20	
ASD	0.07	0.01	0.52	0.01	0.11	0.01	0.97	0.05	
Verbal Score					1.03	0.99	1.08	0.13	
Visual Attention: 34 mos									
HR-noASD	1.69	0.85	3.33	0.13	1.78	0.89	3.58	0.11	
ASD	0.3	0.08	1.13	0.08	0.42	0.10	1.83	0.25	
Verbal Score					1.02	0.98	1.05	0.40	
Look and Talk: 28 mos									
HR-noASD	0.56	0.26	1.24	0.15	0.63	0.28	1.4	0.26	
ASD	0.11	0.01	0.86	0.04	0.21	0.02	1.79	0.15	
Verbal Score					1.04	1.00	1.09	0.08	
Look and Talk: 34 mos									
HR-noASD	0.51	0.26	1.01	0.05	0.6	0.3	1.21	0.15	
ASD	0.05	0.01	0.41	0.01	0.11	0.01	0.92	0.04	
Verbal Score					1.05	1.01	1.10	0.02	
Self-Distract: 28 mos									
HR-noASD	0.64	0.30	1.33	0.23	0.68	0.32	1.44	0.32	
ASD	0.14	0.04	0.46	0.001	0.17	0.04	0.67	0.01	
Verbal Score					1.01	0.97	1.05	0.69	
Self-Distract: 34 mos									
HR-noASD	0.54	0.22	1.35	0.19	0.67	0.26	1.77	0.42	
ASD	0.09	0.03	0.32	<.001	0.33	0.07	1.52	0.16	
Verbal Score					1.08	1.03	1.14	0.002	