

Parental Recognition of Developmental Problems in Toddlers with Autism Spectrum Disorders

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Abstract Symptoms of Autism Spectrum Disorders (ASD) begin to manifest during the first 2 years; there is limited evidence regarding type and timing of symptom onset. We examined factors related to parental age of recognition (AOR) of early abnormalities and the association between AOR and diagnosis and levels of functioning at 2 and 4 years in 75 toddlers with ASD. Results suggest significant differences between autism and PDD-NOS in the AOR and type of first concerns. Early social and motor delays as well as maternal age was associated with AOR. Later AOR was associated with poorer social-communicative and nonverbal cognitive functioning at 2 and 4. The findings are discussed in a context of identifying distinct developmental trajectories within the autism spectrum.

Keywords Autism · PDD-NOS · Infants · Age of recognition · Regression

Introduction

Despite the wide acceptance that symptoms of Autism Spectrum Disorders (ASD) manifest during the first

2 years of life, there is still very limited evidence regarding the timing of onset and the nature and severity of the primary symptoms. Studies on parental perception of symptom onset as well as analysis of video diaries (e.g., De Giacomo & Fombonne, 1998; Werner & Dawson, 2005) suggest that some children may be exhibiting abnormal behaviors and delays within the first postnatal months, while in others the concerns arise after a period of more or less typical development and begin sometime in the second or even third year of life (see Chawarska & Volkmar, 2005 for a review).

Age of Recognition

Consistent with previous reports (e.g. Rogers & DiLalla, 1990; Volkmar, Stier, & Cohen, 1985), more recent studies suggest that the vast majority of parents of children with ASD notice abnormalities during the course of the first 2 years of life (Baghdadli, Picot, Pascal, Pry, & Aussilloux, 2003; De Giacomo & Fombonne, 1998; Tolbert, Brown, Fowler, & Parsons, 2001). De Giacomo and Fombonne administered the Autism Diagnostic Interview-Revised (ADI-R) (Lord, Rutter, & Le Couteur, 1994) to 82 parents of children with ASD (mean age 6 years). On average, parents began to recognize that their children were experiencing problems at around 19 months, with approximately 30% of parents noticing first abnormalities prior to the first birthday, and 80% by the age of 2 years. Similar results have been reported with a French sample of ASD children of a comparable age, in which the average AOR was 17 months, with 38% of parents concerned by 12 months, and 78% noticing abnormalities by 24 months (Baghdadli et al., 2003).

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Leading Reasons for Parental Concerns

Amongst the most common and often first noted concerns are delays in speech and language development, followed by abnormal social responsivity level, medical problems, and nonspecific difficulties related to sleeping, eating and attention (De Giacomo & Fombonne, 1998). In young children, concerns regarding unusual interests and stereotyped behaviors rarely trigger parental concerns, most likely due to their relatively mild manifestations in infancy or a later onset. Parental concerns sometimes emerge in response to unusual rate of progress (e.g., delays in reaching developmental milestones), apparent slowing of development (e.g., if babbling is not followed by emergence of the first words), or loss of previously acquired skills (Siperstein & Volkmar, 2004). Regression is usually reported in 20–33% of cases (Goldberg et al., 2003; Rapin & Katzman, 1998; Werner & Dawson, 2005) and can involve loss of words, vocalizations, nonverbal communication skills (e.g., eye contact, gestures), social dyadic interaction skills, imitation, or pretend play (Davidovitch, Glick, Holtzman, Tirosh, & Safir, 2000; Goldberg et al., 2003; Luyster et al., 2005). Parental reports of regression do not necessarily indicate normal development prior to the perceived loss of skills nor would early abnormalities preclude regression (Lord, Shulman, & DiLavore, 2004; Siperstein & Volkmar, 2004; Werner & Dawson, 2005; Wilson, Djukie, Shinnar, Dharmani, & Rapin, 2003). The perception of regression, however, appears to be specific, though clearly not universal, to ASD (Luyster et al., 2005; Siperstein & Volkmar, 2004).

Factors Affecting Age of Recognition

The concurrent presence of mental retardation, delays in motor milestones, significant speech delays, and medical problems tends to trigger the onset of parental concerns earlier compared to cases in which ASD is not accompanied by these challenges (De Giacomo & Fombonne, 1998). Presence of perinatal complications and sensory deficits has also been associated with earlier recognition (Baghdadli et al., 2003). Factors that have not been found to influence the AOR include birth-order, social class, and gender (De Giacomo & Fombonne, 1998). More recently, growing appreciation of the genetic factors in autism and increased risk for ASD in younger siblings of the affected children might sensitize parents to early signs of vulnerability and contribute to earlier recognition of developmental problems (Klin et al., 2004; Zwaigenbaum et al., 2005).

Age of Recognition and Developmental Outcome

To date, a handful of studies have attempted to examine the predictive relationship between age of recognition and the child's outcome; however, the studies produced rather mixed results. When outcome is defined in terms of IQ level, some researchers suggest no relationship (Rogers & DiLalla, 1990; Volkmar et al., 1985), while others report that earlier onset is related to greater severity of cognitive impairment (Short & Schopler, 1988). If the issue of outcome, still defined as IQ level, is cast around regression as a form of later onset or recognition, the evidence is also mixed. Some studies suggest poorer long-term outcome in children with reported loss of skills (Christopher, Sears, Williams, Oliver, & Hersh, 2004; Kurita, 1985; Rogers & DiLalla, 1990; Tuchman, & Rapin, 1997). This is particularly true in the rare syndrome of Childhood Disintegrative Disorder (Volkmar, Koenig, & State, 2005). Others however, report that in the short term (at 24 months), there appear to be few differences in terms of verbal and nonverbal developmental skills between children with and without loss of skills (Werner, Dawson, Munson, & Osterling, 2005). Similarly, the relationship between language levels and AOR is unclear. Rogers and DiLalla examined the relationship between age at parental recognition of social difficulties and levels of social, cognitive, and communicative outcome in young children with autism and PDD-NOS (average age 45 months), and found that children with the poorest language outcome began manifesting social problems in the second, but not in the first or third, year of life.

Reports regarding the relationship between AOR and severity of autistic symptoms are mixed as well. Some researchers find no relationship between severity of symptoms as measured by the ADI-R or clinical diagnosis (i.e., autism versus PDD-NOS) (De Giacomo & Fombonne, 1998) and the parentally reported age of onset, or between CARS scores and the AOR (Rogers & DiLalla, 1990). Others however, report a modest relationship between an earlier AOR (<18 months) and more severe autistic symptoms as measured by the CARS (Baghdadli et al., 2003; Short & Schopler, 1988). Still others argue that those with later onset, as defined by parental report of regression or loss of skills, have poorer social-communicative skills at the age of 3 years, as compared to those with an earlier recognized symptom onset (Luyster et al., 2005).

Limitations of Previous Studies

The empirical evidence regarding parental recognition of developmental abnormalities and its relationship to

outcome is inconsistent. This is not surprising given the heterogeneity of sampling procedures as well as differences in analytic and methodological approaches adopted in the aforementioned studies. Information regarding the timing and type of first symptoms has often been collected years after the onset of recognition, ranging from fewer than 2 to more than 30 years. The long interval separating AOR and the time of parental report might lead to the ‘telescoping effect’ (Cooper et al., 2001), that is, a tendency of parents, as children grow older, to report a later age of symptom recognition. Furthermore, some researchers relied on a review of medical records or questionnaires, while others collected data through standard parent interview procedures. In some studies, parental report and estimates based on expert opinion were combined. While the sample in some studies included clients living in a residential facility, others focused on clients receiving care in specialized clinics, which most likely resulted in highly variable rates of genetic and neurological problems across samples. There is also great variability of methods used to ascertain IQ information, both within and between samples (e.g., due to a wide age range in the same sample, level of cognitive functioning might be measured by developmental or IQ tests, depending on the age of the subjects). Information regarding social and communicative functioning was often obtained through parent interview, with fewer studies relying on observational scales such as CARS or the ADOS. Drawing inferences regarding the relationship between AOR and outcome, however broadly defined, might have also been complicated by the fact that in the majority of cases, information regarding AOR and outcome was collected simultaneously, leading to possible confounds.

Present Study

The age of parental recognition (AOR) of developmental problems is typically distinguished in the literature from the age of symptom onset, and the former is regarded as representing the upper-bound limit to the actual age of symptom onset (Volkmar, Stier, & Cohen, 1985). Thus, determining factors that delay or precipitate the onset of parental concerns is important, as they are likely to affect the age at which the child accesses appropriate early assessment and intervention services. Furthermore, examining the timing and type of parental concern might offer insight, albeit indirectly, into the question of the endophenotypes present within the autism spectrum. The present study revisits the question of parental recognition of developmental problems in ASD. The study provides

an improvement over earlier investigations by (1) shortening the time elapsing between the onset of concerns and the direct assessment by including only children diagnosed prior to the 3rd birthday; (2) providing prospective assessment of the outcome at the age of 4 years; (3) employing of direct and standardized assessment measures of the child’s functioning; and (4) increasing homogeneity of the sample. Presence of major perinatal complications or postnatal health problems is likely to trigger concerns regardless of the presence of social-communicative impairments, and thus, confound information regarding the early course of ASD. In the present study, we constrained the impact of some of these factors by including only children without a history of significant medical problems or serious complications associated with pregnancy or delivery, including prematurity. This resulted in a less medically compromised and more homogeneous sample.

Furthermore, in our study the AOR ranged from birth to 26 months, spanning across several important developmental epochs including the onset of dyadic and triadic social interactions, as well as nonverbal and verbal communication. Guided by the developmental milestones that are highly relevant to studies of ASD, we examined the AOR not only as a continuous variable, but also compared groups with the onset of parental concerns during the pre-verbal phase of development (birth—10 months, AOR1), early verbal (11—17 months, AOR2), and verbal phase (18 months and older, AOR3). These intervals also roughly map onto the periods of social development that involve primarily dyadic interactions (AOR1), emergence of joint attention (AOR2), and beginnings of more complex and integrated social, symbolic, and communicative development (AOR3).

Two main questions guided our analytic approach. First, we examined factors that influence the timing of parental recognition of developmental problems, including severity of autistic symptoms, concomitant cognitive delays, and parental knowledge of development. The pathogenic factors responsible for social dysfunction might be present from birth, though symptom severity and temporal pattern of expression may vary depending on the genetic and neurodevelopmental load as well as environmental factors. Such differences could result in triggering parental concerns at different times and perhaps for different reasons. Conversely, if the AOR is confounded by parental denial, lack of experience with typical developmental trajectories, or issues related to retrospective reporting, we would find no relationship between the AOR and the child’s developmental history and presentation at

the time of diagnosis. We hypothesized that parental age of recognition reflects, at least to some extent, their child's unique developmental trajectory and thus, we expected to identify a set of factors that will differentiate the earlier AOR groups from those whose parents noted abnormalities later. Second, we examined whether there is a relationship between AOR and developmental outcome several years later. We hypothesized that the different AOR groups are related to different phenotypic variants of the autism spectrum, and thus, differences in AOR will be predictive of outcome defined in terms of clinical diagnosis as well as cognitive, communication, adaptive, and social functioning.

Method

Participants

Seventy-five toddlers underwent a comprehensive evaluation prior to their 3rd birthday as part of a longitudinal study on early social-cognitive development. The inclusion criteria were: gestational age at least 34 weeks and the absence of visual or auditory impairments or seizures at the time of enrollment into the study. At Time 1, all children underwent a comprehensive assessment, which included the Mullen Scales of Early Learning (Mullen, 1995) and the Autism Diagnostic Observation Scales–G, Module 1 (ADOS-G; Lord et al., 2000). Parents were interviewed with the Vineland Adaptive Behaviors Scales-Expanded (Vineland, Sparrow, Balla, & Cicchetti, 1984) and Autism Diagnostic Interview-Revised (Lord et al., 1994). At Time 1, all children were diagnosed by the study clinicians (FV, AK, RP, and KC) as having an autism spectrum disorder. Following the assessment, all children were referred to early intervention services and were re-evaluated around their 4th birthday using the same set of assessment procedures. Based on the consensus clinical diagnosis of two clinicians, at the age of 4 years, 51 children were given the diagnosis of autism, and 24 the diagnosis of PDD-NOS (see Table 1 for sample characterization).

The vast majority of the participants were Caucasian (94%) with African Americans and Asians representing 4% and 1%, respectively. There were no differences between the diagnostic groups in terms of parental educational level or maternal age at the time of the child's birth. The diagnostic groups were also similar in terms of gestational age and the onset of the major developmental milestones, but children with PDD-NOS tended to have a marginally lower birth

weight. In both groups, approximately 40% of children were firstborn and of the 75 children, 45 (60%) had older siblings. In 44% (20 of the 45) of these cases, parents reported that the older sibling(s) had some developmental problems including ASD, speech and language delays, sensory problem, and motor delays. Within this group of siblings with developmental problems, 24% (11 of the 45) carried a diagnosis of ASD.

Procedure

Information regarding the age of parental recognition was ascertained at the time of the first assessment and prior to the 3rd birthday using the toddler version of the (ADI-R) (Lord et al., 1994). The interview was conducted by an experienced interviewer blind to the child's developmental level and diagnostic status. On average, the time elapsed between the AOR and the ADI-R interview was 13.5 months ($SD = 7.04$, range: .84–34) and did not differ between the diagnostic groups. The ADI-R was conducted independently of the child's direct assessment the day before feedback regarding the diagnosis and other findings were discussed with the parent. Through the ADI-R we also collected information about the type of concerns and their priority. The list of concerns includes (1) speech and language delays and abnormalities (S&L), (2) medical problems (e.g., seizures) and motor delays (Medical/Developmental), (3) social abnormalities manifesting as lack of interest in people (Social), (4) nonspecific problems related to sleep, eating, aggression, or activity level (Nonspec), and (5) stereotyped behaviors (SB), as well as the (6) 'Other' category including family issues, etc. In addition, information regarding parental perception of loss of skills was derived directly from the ADI-Toddler form in all but 19 cases. For these 19 participants, parents were administered a short version of the ADI-R Research Short Form (Lord, Rutter, & LeCouteur, 1994) that did not contain the regression questions. Consequently, information regarding parental perception of loss of skills was obtained from the medical and developmental history collected by a psychiatrist during the first visit. For the purpose of this study, regression was defined broadly as a loss of any skills including speech, social engagement, play or motor skills. Information regarding maternal age, history of infertility, course of pregnancy and the child characteristics (birth order, birth weight, gestational age, risk status) was obtained through a parent questionnaire. The pregnancy complication variable was created by summing up all the complications in the following categories: diabetes, hypertension,

Table 1 Sample characterization at Time 1

Characteristic	Autism (<i>N</i> = 51)	PDD-NOS (<i>N</i> = 24)	<i>P</i> -value
Age at T1 (months)	28.5 (4.7)	27.8 (5.7)	.05
Time between AOR and ADI-R (months)	13.8 (7.4)	12.9 (6.4)	ns
Pregnancy complications	.62 (.78)	.52 (.73)	ns
Birth weight (g)	3445 (571)	3179 (550)	.062
Gestational age (weeks)	39.3 (2.3)	39.1 (1.7)	ns
Social smile (months)	2.6 (1.5)	2.2 (1.3)	ns
Walked (months)	13.5 (2.5)	13.8 (2.4)	ns
% Firstborn	39	42	ns
% Children having one or more siblings with developmental problems of any kind (<i>N</i> = 45) ^a	14 (45%)	6 (43%)	ns
% Children with one or more siblings with ASD (<i>N</i> = 45) ^a	7 (23%)	4 (29%)	ns
Maternal education (years)	16 (2)	16 (2)	ns
Paternal education (years)	16 (2)	16 (2)	ns
Maternal age (years)	34 (5)	34 (5)	ns
Mullen receptive language DQ ^b	40 (23)	63 (25)	.001
Mullen expressive language DQ ^b	49 (21)	66 (18)	.001
Mullen visual reception DQ ^b	72 (18)	84 (16)	.01
ADOS Soc/Com Score	18.6 (2.8)	14.2 (4.6)	.001

^a Percentage based on a sub-sample of children who had siblings at the time of the second assessment (*N* = 60)

^b Age Equivalent/Chronological age*100

problems with thyroid, liver, heart, and other organs, infections including sexually transmitted diseases, measles, and viral infections, swelling, and X-ray exposure.

Results

Age of Recognition

The mean age of onset of parental concerns in the group with Autism was 14.7 months (*SD* = 6.5) and was comparable to that reported in the PDD-NOS group (mean = 14.9 months, *SD* = 5.6). The ADI specifies the domain of primary concern, but also allows for coding multiple concerns (up to three have been used in this study). For the purpose of this analysis we focus on the overall frequency of various concerns rather than their priority (see Table 2).

Concerns regarding language development and social relatedness were the most frequent and were equally prevalent in both diagnostic groups. However, parents of children with autism were significantly more likely to report their children as having medical problems and motor delays ($\phi = .28$), as well as unusual autistic-like stereotyped behaviors ($\phi = .36$), than parents of children with PDD-NOS. In comparison, children with PDD-NOS had more nonspecific problems related to sleeping, eating, and activity level ($\phi = .25$). The effect sizes for these effects ranged from medium to large.

Table 2 Frequency of parental concerns in autism and PDD-NOS groups

Concerns (%)	Autism	PDD-NOS	χ^2	<i>P</i> -value
Speech and language delays	70.6	79.2	.61	ns
Social difficulties	60.8	41.7	2.4	ns
Medical problems, developmental delays	29.4	4.2	6.19	.013
Stereotyped behaviors	17.6	0	4.81	.028
Nonspecific problems	5.9	33.3	9.82	.002

Determinants of AOR: Maternal and Child Characteristics

To examine whether age of recognition was related to familial risk status, parental experiences, and child characteristics either prior to, or at the time of the assessment, we compared the AOR groups on a number of variables (see Table 3).

Prior to the main series of analyses we examined whether AOR and the age of the assessment were associated. Children with an earlier AOR might have been assessed at a younger age, which in turn might have impacted their scores on the standard assessment instruments, introducing additional variance into the model. A between-group ANOVA on the age at Time 1 assessment indicated a marginally significant difference in age at Time 1, $F(2, 72) = 2.71, P < .073$. A planned contrast comparing the age in AOR1 with AOR2 and AOR1 with AOR3 revealed that AOR

Table 3 Characteristics of the three AOR groups: maternal and child factors

Characteristics	AOR1 <11 months <i>N</i> = 15	AOR2 11–18 months <i>N</i> = 27	AOR3 >18 months <i>N</i> = 33	<i>P</i> -value	Contrast
Child age (months)	5.3(3.2)	13.6 (1.8)	20.1(2.9)		
Maternal age (years)	32(3)	32(5)	36(4)	.01	1 = 2 < 3
Infertility hx. (%), (<i>N</i> = 26)	7.1%	26.9%	48.5%	.05	
Pregnancy complications	46 (.74)	.62 (.88)	.61 (.67)		
Firstborn (%), (<i>N</i> = 30)	40%	56%	27%	.084	
Sibling Risk Status (<i>N</i> = 45) ^a	44%	57%	36%		
GA (weeks)	39.8 (2.1)	38.8 (3.0)	39.3 (1.5)		
BW (g)	3422 (449)	3278 (3.0)	3399 (508)		
Social smile (mo)	3.50 (2.1)	2.04 (1.2)	2.60 (1.1)	.02	1 > 2 = 3
Walked (months)	15.0 (3.5)	13.1 (2.2)	13.3 (1.7)	.05	1 > 2 = 3
Mullen VR DQ	85 (22)	78 (18)	70 (13)		
Mullen FM DQ	78 (13)	78 (16)	70 (12)		
Mullen RL DQ	59 (36)	52 (26)	37 (18)	.02	1 = 2 > 3
Mullen EL DQ	57 (27)	60 (23)	49 (18)		
ADOS Soc/Com	16.1 (3.9)	16.3 (4.5)	18.5 (3.2)	.07	
ADOS Play	2.93 (1.4)	3.33 (1.0)	3.39 (.93)		
ADOS SB	2.9 (1.8)	3.4 (1.9)	3.9 (1.8)		
Vineland Com	73 (12)	72 (9)	69 (8)		
Vineland DSL	71 (11)	71 (9)	67 (6)		
Vineland Soc	67 (11)	67 (9)	65 (8)		
Vineland Motor	82 (15)	83 (13)	80 (12)		

^a Risk status included diagnosis of ASD, learning or language difficulties, sensory issues, and other delays

groups 1 (mean = 26.5 months, *SD* = 5.4) and 2 (mean = 27.5 months, *SD* = 5.5) did not differ from one another, but the AOR3 group was tested at a slightly older age (mean = 29.7 months, *SD* = 4.2), $F(1, 72) = 4.46, P < .05$ than the AOR1 group. Thus, the age at Time 1 assessment was included in subsequent analyses as a covariate. A series of between-group ANOVAs was conducted with planned contrasts whenever applicable (see Table 3).

Children in the AOR1 had delays in the emergence of social smiling ($d = .85$) and were more likely to start walking independently at a later age ($d = .65$) as compared to the two other AOR groups (see Table 3). Children in the AOR3 group had mothers who were older than mothers of children in AOR1 ($d = 1.13$) and AOR2 ($d = .88$). These mothers were also more likely to have a history of infertility treatment either with this or previous pregnancies as compared with mothers in the AOR1 ($\phi = .34$), but not the AOR2 group. Children in the AOR3 group also had significantly lower scores on the Mullen Receptive Language scale than children in AOR1 and AOR2 ($d = .77$ and $.67$, respectively). Effect sizes ranged from medium to large. Factors that were not related to the AOR grouping were gestational age and birth weight, non-verbal levels of functioning (Visual Reception and Fine Motor scales of the Mullen), level of play skills and stereotyped behaviors as measured by the ADOS, as well as adaptive levels of functioning. There was a

marginal increase in the ADOS social-communication scores in the AOR3 group, but the results failed to reach statistical significance. There were no differences between the AOR groups in terms of the percentage of children with older siblings with developmental problems. In the AOR1, 2, and 3 there were approximately 45%, 58%, and 36% of children with older siblings experiencing some problems, respectively. These percentages dropped to 27%, 36%, and 36%, respectively, when only older siblings with ASD were considered.

Age of Recognition and Clinical Diagnosis

Whereas the average AOR did not differ between groups, examination of the frequency distributions of the cases in the three recognition groups (AOR1, AOR2, AOR3) indicated that approximately 50% of children diagnosed at 4 years with autism triggered parental concerns at or after 18 months. However, in the group diagnosed with PDD-NOS, 54% of parents reported concerns between 11 and 18 months. Three one-way χ^2 -tests for proportional distribution of the frequencies within each of the groups indicated that in AOR1 group there were significantly more children who received the eventual diagnosis of autism (12 of the 15, 80%) than PDD-NOS (3 of the 15, 20%), $\chi^2 = 5.4, P < .02$. The proportion of children diagnosed with autism and PDD-NOS was very similar in the AOR2 group (14 of the 27, or 52% AUT, 13 of the 27,

or 48% PDD-NOS), but in the AOR3 group, there were again significantly more autism (25 of the 33, 76%) than PDD-NOS (8 of the 33, 24%) cases, $\chi^2 = 8.75$, $P < .003$. These findings suggest an association between severity of the social disability as judged by an experienced clinician and the AOR. The likelihood of receiving a diagnosis of autism at the age of 4 was very high for those children whose parents noted concerns very early, as well as for those who noticed abnormal behaviors after 18 months. Children whose parents expressed first concerns between 11 and 18 months were equally likely to receive diagnosis of autism or PDD at the age of 4.

Relationship between Age of Recognition, Loss of Skills, and Clinical Diagnosis

Parents reported a loss of skills in 30.6% ($N = 23$) of cases. The loss tended to occur more frequently in the second year of life, with 35% ($N = 8$) occurring between 11 and 18 months and 52% ($N = 12$) at 18 months or thereafter. Prior to 11 months there were only 3 (13%) cases of reported loss of skills. Parents of children with autism reported loss (87%, $N = 20$) significantly more frequently than those with PDD-NOS (13%, $N = 3$; $\chi^2 = 5.47$, $P < .019$, $\phi = .27$). Whereas children whose parents reported regression in the preverbal (AOR1) and early verbal (AOR2) phases were not significantly different with regard to diagnosis, in the AOR3 group 48% ($N = 12$) of cases with autism reportedly experienced loss of skills as compared to 0% of the PDD-NOS cases, ($\chi^2 = 6.03$, $P < .014$, $\phi = .43$).

To further examine the relationship between loss of skills and age of reported abnormalities, we conducted a series of analyses comparing children diagnosed with autism with and without reported loss of skills. The leading question was whether those with reported regression differed in terms of verbal, nonverbal, social-communicative, or adaptive functioning from children without regression. The numbers of children in the younger AOR groups were insufficient to warrant a full-model analysis so we examined this question only for the AOR3 group. A series of ANOVAs with loss as a between-group factor revealed that children with autism with ($N = 12$) and without loss ($N = 13$) in the AOR3 group performed comparably on the Mullen and Vineland scales (see Table 4), and received very similar scores on the ADOS socialization and communication scales combined. They also had comparable scores on the Play and Stereotyped Behaviors scales on standard assessment instruments. Thus, children whose parents registered concerns at or

Table 4 Mean (*SD*) Mullen, ADOS-G, and Vineland scores of children with autism with and without reported loss of skills at 18 months or thereafter

Scale		Autism: no loss <i>N</i> = 13, <i>M</i> (<i>SD</i>)	Autism: reported loss <i>N</i> = 12, <i>M</i> (<i>SD</i>)
Mullen	VR	67.4 (15.1)	67.5 (12.3)
	FM	69.8 (12.0)	66.3 (10.5)
	RL	29.2 (12.2)	33.5 (14.2)
	EL	40.6 (12.7)	46.2 (17.9)
ADOS	Social & Comc.	19.7 (1.7)	18.8 (3.2)
	Play	3.8 (0.4)	3.3 (1)
	Stereotyped Beh.	4.4 (1.7)	4.3 (1.5)
Vineland	Communication	64.6 (5.5)	67.5 (6.6)
	DLS	65.5 (7)	66.4 (5)
	Socialization	64.2 (7.0)	61.7 (6.7)

after 18 months were comparable in terms of their performance on the standard assessment instruments and received the same clinical diagnosis, regardless of the presence or absence of a perceived loss of skills.

Relationship between the Age of Recognition and Functioning at 4 years

Children were re-evaluated on average at the age of 52 months ($SD = 5$), 50 months ($SD = 4$), and 51 months ($SD = 4$) in the AOR groups 1–3, respectively. To examine the association between AOR and the level of functioning at the age of 4 we computed a series of Pearson r correlations. No significant correlation was found for the indices of adaptive functioning as measured by the Vineland standard domain scores or the Mullen expressive and receptive language as well as fine motor scores. However, there was a medium but significant positive association between the AOR and the ADOS social and communication scores ($r = .27$, $P < .02$), ADOS-G Play and Imagination score ($r = .28$, $P < .02$), and Mullen Visual Reception scores ($r = -.23$, $P < .05$). The results suggest that later age of parental recognition was associated with worse outcome in terms of social and communicative functioning as measured by the ADOS and poorer nonverbal cognitive skills as measured by the Mullen Visual Reception scale.

Discussion

In this study we report on the factors related to parental recognition of developmental problems in the group of children diagnosed with ASD prior to the age

of 36 months. Consistent with other reports (Hoshino et al., 1987; Rogers & DiLalla, 1990), parental AOR did not appear to simply represent the time that parents become aware of the difficulties. There were tangible differences among children who, according to their parents' report manifest abnormalities in the three phases of development we identified: preverbal/dyadic interaction (birth-11 months); emerging verbal/triadic social interaction (12–17 months); and symbolic thought and verbal communication (18 months and older).

Parents first noticed abnormalities on average around 14 months, which is a somewhat earlier age than reported in other studies (Baghdadli et al., 2003; DeGiacomo & Fombonne, 1998; Rogers & DiLalla, 1990; Volkmar et al., 1994). This is likely to be due to a relatively short lag between recognition and assessment leading to a diminished impact of 'forward telescoping', a phenomenon reported by others (Cooper, Kim, Taylor, & Lord, 2001). We expected that ascertaining information regarding AOR relatively shortly after the onset of concerns would result in a greater proportion of parents reporting concerns in the first year of life. However, consistent with reports on older children (e.g., Baghdadli et al., 2003; Rogers & DiLalla, 1990), the AOR was distributed across the first 2 years, with 56% of parents noticing some abnormalities prior to 18 months. This finding may suggest that we tapped the upper limit of the parents' ability to recognize more subtle signs of ASD early in development (see Chawarska, Klin, Paul, & Volkmar, 2007), highlighting the necessity for development of highly sensitive behavioral and biological measures of markers for ASD in the first year of life. However, it is also possible that some children with ASD do not show signs of the disorder in the first year of life; instead, ASD-specific symptoms appear in the second year at critical point in development at which earlier developmental trajectories need to become integrated in order to enable the emergence of higher levels of social and symbolic behaviors.

Consistent with other studies (De Giacomo & Fombonne, 1998), parents of children with autism and PDD-NOS alike were most often concerned about their child's social development and speech difficulties. However, parents of children who were later diagnosed with autism had more concerns related to problems such as delayed motor milestones and the presence of unusual sensory and stereotypic behaviors than parents of children diagnosed with PDD-NOS. In contrast, concerns regarding problems not specific to autism, such as problems with sleep, feeding, and overall activity level were more frequent in the PDD-NOS

group. While this finding is intriguing and might suggest differences in the earliest expression of social disability in autism and PDD-NOS, it is also possible that more severe social, communication, and developmental difficulties overshadowed reporting of co-existing but perhaps less pressing problems in these domains. The finding however, identifies potential areas of functioning related to arousal regulation and temperamental qualities that should be monitored closely in prospective studies of younger siblings at risk for ASD.

In addition, primary concerns differed depending on the timing of parental recognition. Children with symptoms recognized the earliest tended to have delayed onset of social smiling and independent walking. The exclusion of children with a history of prematurity, seizures, and sensory impairments possibly diminished the relationship between AOR and factors related to pre- perinatal or health issues. Consistent with other reports (Baghdadli et al., 2003; De Giacomo & Fombonne, 1998) birth order was not associated with the age of recognition. Moreover, having an older child with developmental difficulties, including ASD, did not result in an earlier onset of concerns in our sample. The latter finding is surprising, as these parents should be particularly sensitized to developmental vulnerabilities in younger siblings. It is possible that at the time that our sample was first collected between 2000 and 2003, the issue of an increased genetic risk for ASD in younger siblings had not been yet widely publicized, hence, its limited effect on the AOR.

The oldest AOR group differed from the two other groups in several important ways. Mothers of children in the AOR3 group were significantly older than in the two other groups; they were also more likely to have a history of infertility treatment. To the best of our knowledge, this is the first study reporting a relationship between later recognition and higher maternal age. While intriguing, the significance of this finding is not clear. On the one hand, older mothers, especially those who faced infertility problems, might be more tolerant of the child's developmental incongruities, and thus, to register the signs of difficulties later than younger mothers. On the other hand, maternal age of 35 or higher has been associated with a greater risk for autism (Croen, Grether, & Selvin, 2002; Gillberg et al., 1990; Glasson et al., 2004). This relationship is often conceptualized as reflecting an interaction between an increased risk of complications during labor and delivery in older mothers and the child's inherent genetic vulnerabilities (Glasson et al., 2004), and thus represents aspects of a complex gene-environment interaction in ASD (Rutter, 2005). The clarification of

the relationship between parental factors including childbearing age as well as pre- and perinatal factors and possible endophenotypic variations within the autism spectrum would be best addressed prospectively through studies of infants at risk for ASD and other developmental disorders.

One of the important questions often posed in the context of studies of ASD recognition is whether children with recognizable abnormalities early on end up with more profound social and other difficulties as compared to those with later manifestations of the disorder. This hypothesis is based on the assumption that an earlier disruption of the developmental sequence leads to a greater impairment downstream in development. On the other hand, these children might have more time to develop alternative compensatory strategies as compared to those with later onset, and thus, on a short run, outperform those with the later onset, and consequently, a shorter period of time between the 'onset' and assessment. Still another possibility is that different subtypes of ASD follow their individual developmental trajectories reflected, amongst other factors, in the time when problems begin to manifest behaviorally. We addressed the issue of the relationship between AOR and the clinical presentation on several levels.

First, we examined the association between the timing of the AOR and clinical diagnosis at the age of 4. In ASD, expert clinical opinion constitutes the diagnostic gold standard, especially in younger children. The diagnosis relies on integration of information from multiple sources and examining the child's profile of skills across a number of key areas (Chawarska & Volkmar, 2005; American Psychiatric Association, 1994; Klin, Chawarska, Rubin, & Volkmar, 2003). The results indicate that children who were identified by their parents as having problems between birth and 10 months were four times more likely to be later diagnosed with autism than with PDD-NOS. However, those manifesting abnormalities identified by parents between 11 and 18 months were equally likely to receive a diagnosis of autism as PDD-NOS at 4 years. Finally, all children in the group with concerns arising at or after 18 months received a diagnosis of autism at the age of 4. This finding suggests a strong and nonlinear relationship between the age of parental recognition and clinical diagnosis assigned 2–3 years later.

Second, we examined the relationship between the time of recognition and the child's cognitive, social-communication, and adaptive skills at the age of 2 years. There were relatively few differences between the AOR groups in performance on standard assessment measures. Consistent with other reports on young

children (Rogers & DiLalla, 1990), the three groups did not differ in terms of nonverbal cognitive skills or the levels of adaptive functioning in the areas of communication, socialization, daily living, and motor skills. The vast majority of children in our study had very significant delays in expressive language so the differences between groups were not statistically significant. However, the oldest AOR group had significantly lower receptive language skills based on the Mullen assessment. The Receptive Language scale of the Mullen taps into understanding of verbal communication; however, at earlier ages it focuses on pre-verbal development, including attention to speech, response to name, as well as understanding of communicative gestures. These behaviors are typically associated with social-communicative abnormalities in ASD in the second year of life.

Third, we found a moderate relationship between AOR and the level of functioning at 4 years. Children whose parents reported later onset of abnormalities tended to have worse outcome in terms of social and communicative functioning, symbolic play skills and nonverbal cognitive levels. These results are inconsistent with those reported by Baghdadli et al. (2003) where earlier age of recognition was modestly associated with more severe autistic symptoms (measured by the CARS), lower adaptive skills (Vineland) and greater deficits in speech (ADI-R). However, their sample was older at the time of assessment, but more importantly, consisted of 39% of cases with neurological, genetic, perinatal conditions, and auditory deficits, leading to a presumably higher rate of cognitive impairments and an inverse relationship between AOR and the outcome. On the other hand, Tolbert and colleagues (Tolbert et al., 2001) reported no association between age of onset and clinical presentation, as measured by the CARS and the Aberrant Behavior Checklist (ABC) in a cohort of older institutionalized adults. Studies that focus on younger children, however, report findings that are more in line with ours. Rogers and DiLalla (1990) reported poorer language outcome in children recognized in the second but not in the first year of life. More pronounced impairment in social-communicative skills were also reported at 36 months in children with later onset combined with regression as compared with those manifesting symptoms earlier and not experiencing regression (Luyster et al., 2005).

The vast majority of studies on regression focus on comparing children with and without loss of skills (however defined), with less regard to the age when the reported regression occurred. In the present study we were able to examine whether children whose parents

reported regression at 18 months or thereafter, differed from those who reported onset of problems during this time period, but without any loss of skills. The results suggest that the two groups were indistinguishable in terms of clinical diagnosis (all were diagnosed with autism), verbal and nonverbal cognitive skills, social and communication skills, play, stereotyped behaviors, and adaptive skills. Similar findings with regard to adaptive functioning (Vineland) and constellation of symptoms (ABC) have been recently reported in a retrospective study of older children (Siperstein & Volkmar, 2004). This suggests that while there is a strong association between this age period and reports of regression, behaviorally, these children are not distinguishable at the age of 2 from those with an identical AOR but without reported loss of skills.

This finding posits an interesting question whether cases with and without reported loss in fact represent different phenotypic variations. The time when parents report regression most frequently coincides with a period of important transitions across a number of key developmental areas including a change from prelinguistic to primarily verbal expression of intentions, expansion of expressive and receptive vocabulary, the development of representational, memory, and imitation skills, categorization, symbolic play, social interactions, and development of sense of self (see Courage & Howe, 2002 for a review). It may be possible that some children with autism do not show striking developmental delays and abnormalities early on (though some delays might be present), but they fail to successfully complete the stage of development at which the early emerging skills become integrated and transformed. For instance, in some children with autism the early social behaviors such as smiling and mutual gaze may emerge typically (Werner & Dawson, 2005), but around 18 months these skills fail to connect to more specific communicative patterns when language and symbolic thought begin to mediate the early purely affective interaction and enmesh them in a more symbolic context (Bloom, 1997). This transition from affective to symbolic communication may constitute a pivotal point in development that is uniquely vulnerable to the kind of disruption that characterizes a later-emerging form of autism. The later-emerging form of autism may be an example of a failure to link emerging skills into a meaningful network that comprises social-symbolic communication. This perspective may help to understand the phenomenon of regression, which is most often defined as loss of expressive skills. That is, expressive skills may emerge through basic developments such as the ability to produce speech-like vocalizations, which

appears to be a highly buffered and not easily disturbed developmental system. For instance, infants with hearing loss vocalize and babble like typical babies; however, they lose these skills at the point in development at which production becomes linked to perception and deaf infants lack the auditory feedback linked to their own productions (Oller, Levine, Cobo-Lewis, Eilers, & Pearson, 1998). The loss of early-acquired speech-like productions in toddlers with ASD may occur in a similar way when the connections necessary to link these expressions to a network of symbolic communication fails. Thus, the actual number of true regression cases might be much lower than previously reported (Siperstein & Volkmar, 2004), and their relationship with Childhood Disintegrative Disorder needs to be clarified.

Taken together, these findings suggest that there might be several distinct pathways to a diagnosis of autism and PDD-NOS. Further identification of the various developmental trajectories, their relationship with phenotypic subtypes, and the role of underlying neurobehavioral and genetic mechanisms in the pathogenesis of ASD will have to be addressed through large prospective longitudinal studies of high-risk cohorts of infant siblings.

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