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Early Regression in Social Communication in Autism Spectrum Disorders: A CPEA Study

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In a multisite study of 351 children with autism spectrum disorders, 21 children with developmental delays, and 31 children with typical development, this study used caregiver interviews (i.e., the Autism Diagnostic Interview–Revised) at the time of entry into other research projects and follow-up telephone interviews designed for this project to describe the children's early acquisition and loss of social-communication milestones. Children who had used words spontaneously and meaningfully and then stopped talking were described by their caregivers as showing more gestures, greater participation in social games, and better receptive language before the loss and fewer of these skills after the loss than other children with autism spectrum disor-

ders. A significant minority of children with autism without word loss showed a very similar pattern of loss of social-communication skills, a pattern not observed in the children with developmental delays or typical development.

Autism is a developmental disorder characterized by impairments in social skills and communication as well as the presence of restricted, repetitive, or stereotyped patterns of behavior and interest. By definition, these abnormalities must emerge before 3 years of age (American Psychiatric Association, 1994). The focus of this article is early development in autism spectrum disorders (ASD), particularly the phenomenon of early loss or "regression" before age 3. We address the characteristics of the loss, especially those qualities that have to do with social interaction and engagement as well as language. The term *autism spectrum disorders* is used to refer broadly to children with autism, Asperger's syndrome, or pervasive developmental disorder–not otherwise specified (PDD–NOS), whereas the term *autism* or *autistic disorder* are used to refer to the narrower diagnostic concept of children who meet *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994) and International Classification of Diseases–10 criteria (World Health Organization, 1992).

Parents of children with ASD typically report that they first noticed abnormalities of development in the 2nd year of life; De Giacomo and Fombonne (1998) found that the mean age of initial parental concern was approximately 19 months. Parental concerns centered primarily on delays in speech and language development, although many parents were concerned by their child's socioemotional responses.

Although in most cases of autism, onset appears to be characterized by a delay or failure to acquire prosocial communicative behaviors, some parents also report losses of already established skills. This is typically referred to as regression (Goldberg et al., 2003). Regression is a phenomenon that has been documented repeatedly over the past several decades and has been described as occurring in somewhere between 20% and 33% of all cases of autism (Goldberg et al., 2003; Rapin & Katzman, 1998; Rutter & Lord, 1987). It typically occurs in the 2nd year of life and is most commonly identified as occurring between 18 and 24 months (Davidovitch, Glick, Holtzman, Tirosh, & Safir, 2000; Fombonne & Chakrabarti, 2001; Kurita, 1985, 1996; Rapin & Katzman, 1998; Rutter & Lord, 1987; Shinnar et al., 2001; Wilson, Djukic, Shinnar, Dharmani, & Rapin, 2003).

One of the most striking and therefore most easily remembered losses is the loss of words; that is, a child with autism may produce several words and then stop saying them altogether, often for months or even years. Because parents of children with ASD and regression tend to remember word loss more accurately than loss of less well-defined vocalizations (Lord, Shulman, & DiLavore, 2004; Shinnar et al., 2001), studies of regression in children with autism often examine the phenomenon of word loss, comparing children with word loss to those without word loss.

Word loss has been defined differently across studies. For instance, Shinnar et al. (2001), as well as Wilson et al. (2003), defined word loss as any convincing parental report of previously acquired language skills that were subsequently lost (regardless of whether or not prior language development was normal or delayed). Kurita (1985), in contrast, provided a much more stringent definition: early mastery of spontaneous language, then an absolute loss of all spontaneous language occurring prior to 30 months, followed by 6 months in which the child used no language at all. Other researchers have adopted similar definitions, with the period of complete loss varying from 1 month to 6 months (Lord et al., 2004).

Researchers have noted that children with word losses very rarely had a mastery of phrase speech prior to the regression (Kurita, 1996; Kurita, Kita, & Miyake, 1992). One study (Kurita, 1985) found that out of 94 participants with a history of regression, only 3 could use two- to three-word sentences prior to the loss; the other 91 used only single words. Furthermore, most children had a vocabulary containing only a few words, and the highest reported vocabulary in the study was 30 words (Kurita, 1985). Thus, loss of specific words, presumably used in single-word utterances, has typically been the defining feature of regression.

The importance of looking beyond word loss in autism, and more specifically at regression in social interaction and nonverbal communication skills, is emphasized by the common research finding that there are often losses in other areas (Goldberg et al., 2003; Wilson et al., 2003). Lost skills were usually early social-communication skills, such as response to name, as opposed to higher order skills such as elaborate imaginative play or conversational interactions. Motor skills were rarely described as part of these early regressions in children with autism (Kurita et al., 1992), but social skills, nonverbal communication, imitation, self-care, simple pretend play, direct eye gaze, and orienting to name have all been described as decreasing (Burack & Volkmar, 1992; Davidovitch et al., 2000; Goldberg et al., 2003). It remains unclear, however, which skills are most often affected by the loss, to what degree these skills are lost, and whether there are differences between children who experience a word loss or those who lose other social-communication skills.

A further area of inquiry is the significance of regression for trajectories of development both prior to the onset as well as after the regression. The occurrence of a regression does not necessarily indicate prior normal development, nor do early abnormalities preclude a regression (Lord et al., 2004). In fact, Kurita (1985) found that prior to a speech loss, only 12% of participants showed no abnormalities in mental or emotional development. Furthermore, participants who had experienced autism and regression were less likely to have typical development prior to the loss than those who later had more pervasive regressions (e.g., disintegrative psychosis; Kurita et al., 1992). Wilson et al. (2003) found that only 49% of parents of children who had experienced a language regression reported that their child was developing normally prior to the loss. Research has not yet addressed whether there are patterns of early

development in autism that typically precede a loss or early behavioral differences that may indicate that a child is at high risk for a regression.

Little is known about how regression in autism affects outcome, that is, whether children with ASD who have experienced a regression show later effects, in terms of severity and pattern of autistic symptoms, in comparison to children with ASD who have not experienced a regression. Of the few studies that have attempted to address regression and outcome, Kurita (1985) found that children with autism and speech loss had a significantly lower developmental quotient than children without speech loss at 38 months, suggesting that language loss may contribute to poorer outcome at least at younger ages. Brown and Prelock (1995) found that individuals with ASD and a history of regression showed poorer social-communication skills later in life than did individuals with ASD and no history of regression. Several studies have found that at approximately 6 years of age, those children with autism who have a history of a regression had a lower IQ than those children who did not experience a regression (Burack & Volkmar, 1992; Kobayashi & Murata, 1998; Kurita, 1996; Rogers & DiLalla, 1990). Wilson et al. (2003), found that children who had a regression in language early in life exhibited persistent language impairments: 35% of the children who regressed were still nonverbal 2 years later, although the overall number of children categorized as severely impaired had decreased.

A further question is whether there are links between early loss of skills and medical history. One factor that has been linked with autistic regression by some researchers (Wakefield et al., 2000, 1998) is the measles, mumps, and rubella vaccination (MMR). The increasing prevalence of autism and the increasing number of vaccines given to infants has suggested a possible causal relation between vaccines and autism to some researchers, clinicians, and parents (Hornig, Chian, & Lipkin, 2004; for more information, see Woo et al., 2004). However, epidemiological studies have not supported the relation between prevalence of autism and the MMR vaccine (Chen, Landau, Sham, & Fombonne, 2004; Fombonne & Chakrabarti, 2001; Institute of Medicine, 2001; Madsen et al., 2002; Richler et al., in press; Taylor et al., 2002). Consideration has been also given to medical factors, individual susceptibilities, environmental factors, and comorbid disorders or syndromes. The majority of the research has suggested that there is not a clear link between regression and obstetrical risk factors (Davidovitch et al., 2000; Kurita, 1985; Wilson et al., 2003), pregnancy complications or Apgar scores (Davidovitch et al., 2000), or seizures and/or epilepsy (Tuchman & Rapin, 1997; Wilson et al., 2003).

In this article, we attempt to address both the characteristics and immediate consequences of regression for social and communicative development in ASD. This study contributes to the extant literature on regression in ASD through the substantial sample size, which is considerably higher than those found in previous studies on regression in autism, and the standardization of the measures and definitions of loss (Goldberg et al., 2003; Kobayashi & Murata, 1998; Kurita, 1985; Lord

et al., 2004). Furthermore, whereas most studies on regression have used data that were collected when children were school age or older (Goldberg et al., 2003; Kobayashi & Murata, 1998; Kurita, 1996), this study includes measures from standardized parent interviews conducted during the preschool years for most participants. This permits a glimpse of early development through data that were collected either at the point of diagnosis or soon after.

A sample of children with ASD who experienced a regression (defined as the loss of language prior to age 36 months) and a second sample of children with ASD but without word loss were identified through the review of assessment data collected several years earlier, at the time children entered research projects that were part of the program project grants that comprise the National Institute of Child Health and Human Development (NICHD) Collaborative Programs for Excellence in Autism (CPEA). Small samples of children with typical development and children with developmental disorders but not autism were collected to show whether similar patterns of change are described in other populations. Previously collected assessment results from the children with ASD or developmental delays (DDs) as well as the data from this study's caregiver interviews allowed us to investigate the following questions: First, for those children who have and have not experienced loss in the use of words, what associated social-communication skills are lost in the same time period? Also, what skills remain after the child has experienced a loss? Second, what (if any), early medical risk factors seem to be associated with a loss of words or other social-communication skills?

METHOD

Participants

This study is part of a larger project within the nationwide CPEA. Ten CPEA sites were collaborators in this study: the Albert Einstein College of Medicine, Boston University, University of California–Irvine Medical Center, University of California–Los Angeles, University of Colorado, University of Rochester Medical Center, University of Utah–Utah Autism Project, University of Washington, University of Pittsburgh–Western Psychiatric Institute and Clinics, and the Yale Child Study Center. In addition, included in the Yale Program Project are several studies in which families were recruited through the University of Chicago, the University of North Carolina, and the University of Michigan, resulting in 13 geographical sites.

At the time this study began, these sites had collected data on 1,592 participants with ASD over the past 5 years. These data include diagnostic evaluations using the Autism Diagnostic Interview–Revised (ADI–R: Lord, Rutter, & Le Couteur, 1994) and the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000), demographic information, and standardized measures of verbal and nonverbal IQ selected from tests in the following order: Wechsler assessments (Wechsler,

1989, 1991), Differential Ability Scales (Elliott, 1990), Mullen Scales of Early Learning (Mullen, 1995), and any other test. In this study, we used the previously collected information to identify potential participants. For children who had been evaluated more than once, information from the earliest assessment was used to generate the historical variables and from the most recent assessment to generate diagnostic and cognitive data (because many of the children were younger than 4 years old at entry to the research).

Selection of potential participants from the CPEA databases for this investigation was based on a number of criteria. Participants must have been born in Westernized countries between the years of 1987 and 1997, currently reside in the United States or Canada, and received their immunizations exclusively in North America. Children must have received a best estimate diagnosis of autism, PDD–NOS or Asperger syndrome from a site clinician and met criteria for ASD on the ADOS and/or the ADI–R. Children with diagnoses of Asperger's disorder and PDD–NOS were included in the ASD classification; those with diagnoses of child disintegrative disorder (CDD) or Rett's syndrome, as well as children with identified genetic disorders (such as tuberous sclerosis or Fragile X syndrome) were excluded. Participants who had visual, motor, or hearing impairments that precluded the administration of standard study instruments were also excluded. Participants must have had a parent or caregiver (i.e., in a few cases, grandmothers and fathers have served as informants throughout this and earlier studies) who was willing to participate in a phone interview and provide access to immunization records. At the most recent point of data collection, participants were between the ages of 4 and 15 years. Complete ADI–R and ADOS scores and verbal IQ and nonverbal IQ scores from within the last 5 years were available from existing research records. IQ measures varied according to developmental level and CPEA site.

The first step was the review, by all CPEA sites, of ADI–R items pertaining to loss and the identification of those participants who were reported to have experienced a regression or any type of loss in their initial ADI–R (in response to the questions targeting loss of skills). The second step was to identify children within that group who met criteria for word loss. Children with word loss had to have used at least three meaningful words spontaneously on a daily basis for at least a month followed by at least a month in which the child produced no spontaneous language at all. These criteria were determined by checking written notes on the full ADI–R protocol. Each participant in the word-loss group was matched, using a randomized computer program, to a child without word loss on the basis of site, gender, chronological age, ethnicity (White/other), and maternal education. This matching was originally employed as a precursor to an epidemiological study with normal controls who would have been stratified on the same variables. We report results here both for matched pairs and additional participants who were not matched but for whom data were available.

The final sample included 202 participants who were members of matched pairs and 149 participants with ASD who were unmatched. Thus, children with

word loss were deliberately oversampled (e.g., we attempted to recruit all children with ASD known to have word loss in the various samples and a subset of children with ASD whose parents had not reported word loss). Altogether, 273 participants met criteria for autism, 8 met criteria for Asperger's disorder, and 70 met criteria for PDD–NOS or ASD. The racial composition of the ASD sample is as follows: 298 (84.9%) White; 33 (8.6%) African American; 8 (2.1%) Hispanic; 7 (1.8%) Asian; 3 (.8%) Native American; 2 (0.5%) other; and 2 (0.5%) children of unknown backgrounds (see Table 1).

In addition, 21 children with DD who had never had ASD were identified. About half of these children were DD "controls" for a longitudinal study of children referred for possible autism at age 2 years from North Carolina and Chicago. This is a heterogeneous group of children who had nonverbal IQs below 70 and no evidence of autism at age 2 and who continued to fall outside the autism spectrum in assessments at age 9. The other half were children referred for possible autism through the same or other research projects who had not received an ASD diagnosis. As described following, procedures for recruitment were identical to those of the children with ASD.

TABLE 1
Characteristics of the Full Sample

Variable	*ASD*[a]	*DD*[b]	*Typical*[c,d]
Male[e]	300 (85.4%)	11 (52.4%)	22 (71.0%)
Female[e]	51 (14.5%)	10 (47.6%)	9 (29.0%)
White	298 (84.9%)	17 (80.9%)	22 (71.0%)
Other	53 (15.1%)	4 (19.1%)	4 (12.9%)
Chicago/North Carolina/Michigan[e]	211	21	31
Other[e]	140	0	0
Verbal IQ	61.84 (*SD* = 33.05)	65.75 (*SD* = 30.46)	—
Nonverbal IQ	75.30 (*SD* = 29.15)	75.55 (*SD* = 37.02)	—
Age at time of interview (in years)[e]	9.64 (*SD* = 2.68)	12.68 (*SD* =0.90)	8.53 (*SD* = 2.80)
Maternal education[e]			
Graduate/professional degree or bachelor of arts	206	6	13
Some college/associate's degree	101	8	8
High school graduate	31	6	5
GED/less than high school graduate	13	1	4

Note. ASD = autism spectrum disorders; DD = developmental disorder; GED = general equivalency diploma.

[a]$n = 351$. [b]$n = 21$. [c]$n = 31$ [d]Ethnicity information missing for four typically functioning children and maternal education data missing for one typically functioning child. [e]$p < .005$. difference in distributions.

Furthermore, 31 children with typical development were identified through a commercial agency that collated birth records. Letters were sent to 500 families in Chicago and North Carolina because those were the areas from which came the greatest number of children with ASD (due to the overrepresentation of these sites in the initial CPEA sample). Families indicated interest in participating by sending a postcard with their telephone number.

Procedures

After participants were identified through the CPEA databases and other methods, we began data collection for this study. Data indicating response rate was available only for the participants with ASD and DD at the Michigan site: 428 families were initially contacted. Forty-nine families (11.4%) were lost due to incorrect contact information, and 58 (13.6%) refused; approximately half of these refusals were "soft" refusals, with the families expressing a willingness to be contacted but then repeatedly failing to be available at scheduled appointment times. Eighty-four families (20%) were excluded for a variety of reasons that made them ineligible for participation (e.g., a child had been adopted after 12 months of age). Out of all families contacted, 237 (55%) families were included in the final dataset. Chi-square tests indicated that the families who did and did not participate showed no differences on race, maternal education, child's age, child's gender, or child's diagnosis. Parents of the identified participants were sent a packet of information and contacted via telephone to request their permission for participation and to mail in written consents.

Once these forms were obtained, a telephone interview was conducted with caregivers. The interview consisted of four parts: (a) an explanation of the study; (b) a detailed discussion of the child's acquisition of major milestones in communication skills and questions about the acquired words (consisting of administration of items from the ADI–R, Toddler version; see Lord et al., 2004); (c) questions from the MacArthur Communicative Development Inventory (CDI) Words and Gestures (Fenson, 1989), which was adapted with permission from the MacArthur Language Group; and (d) questions about different aspects of both child and family medical history. Medical history items were based on several previous studies (Deykin & MacMahon, 1980; Finegan & Quarrington, 1979; Gillberg & Gillberg, 1983; Lord, Mulloy, Wendelboe, & Schopler, 1991). Items pertaining to autoimmune disorders and gastrointestinal disorders have been reported in other papers (Molloy et al., 2003; Richler et al., in press).

The interview was the primary measure for this study. It included a mix of closed-end, open-end numeric, and open-end codeable responses and took approximately 1 hr to administer. Other measures included in analyses were (a) the loss items from the initial ADI–R and algorithm scores from the most recent ADI–R and ADOS, (b) the standard scores from the Vineland Adaptive Behav-

ior Scales (Lord, Rutter, & Le Couteur, 1994; Lord et al., 2000; Sparrow, Balla, & Cicchetti, 1984), and (c) verbal and nonverbal IQs. In the ADI–R, the item "interviewer's judgment of onset" at the end of the ADI–R allows the interviewer to consider all information provided by the caregiver including both the absence of typically developing milestones (e.g., response to name) as well as the presence of unusual behaviors (e.g., fascination with lint). By using all of the information available from the ADI–R (including caregiver narratives, current level of functioning, and history of development), the interviewer is able to make a best estimate as to the age of the child when he or she began to demonstrate the profile of ASD.

To gather information concerning the children's development prior to the first diagnosis, the CDI was used as a retrospective parent report (which differs from its usual questionnaire format) with permission of the MacArthur Language Group. CDI items denoting the earliest acquired communication skills were selected as well as items likely to be related to autism (e.g., pointing) or not related to autism (e.g., drinking from a cup) as a control. As shown in Table 2, seven sets of questions addressed early development. We asked each CDI item twice: first, whether at some point before 24 months the child had ever shown this behavior spontaneously and consistently for at least a month and then, second, whether the child had ever lost this skill and stopped using it for a least a month before he or she turned 3 (i.e., 36 months). Because of the way in which these questions were phrased, it was only possible to determine what skills were lost between 24 and 36 months; we did not ask about skills initially acquired during this time. Consequently, scores at 36 months were always equal to or lower than scores at 24 months.

TABLE 2
Sample Items Adapted From the MacArthur Communicative Development Inventory–Words and Gestures

Section	*Sample Question*
Prespeech behaviors (9 items)	Responded when name was called (e.g., by turning and looking at source)?
Phrase comprehension (20 items)	Understood "Are you hungry?"
Games and routines (7 items)	Played peek-a-boo?
Actions with objects (12 items)	Ate with a spoon or fork?
Pretending to be a parent (6 items)	Cover doll/stuffed animal with blanket?
First communicative gestures (10 items)	Waved bye-bye on his or her own when someone left?
Vocabulary (19 items)	For the word "doggy," did your child (a) Only understand the word? or (b) Understand and say the word? or (c) Neither say nor understand?

Note. Respondents were asked if these items were present before 24 months of age and whether they were lost or significantly decreased for at least 1 month before 36 months of age. Numbers in parentheses are number of items in the section.

The age range presented in the interview was intended to include the periods of development preceding (i.e., before 24 months) and following a loss (i.e., 36 months), with most of the skills selected attained before 18 months in typically developing samples (Fenson, 1989). The CDI has been shown to have excellent interrater reliability for totals within subscales as well as excellent validity (Stiles, 1994). Furthermore, to help parents remember and respond more accurately, we employed certain methods. For example, to determine the precise age at which the child lost words, the interviewer might ask if the child still had words at his or her second birthday; if so, she or he might then ask if the child still had words at the next major milestone such as Christmas, the birth of another child, or a family move. Finally, we asked parents similar questions about loss at different points in the interview as a way of checking whether they were answering consistently.

Interviewers were blind to the child's ADI–R regression status. Interviewers from all sites recorded the interview and were checked by their site's study coordinator and given feedback. We computed reliability of scores for four pairs of raters on taped interviews; consistent agreement exceeded 90% for all items. When contacted, parents were told that the study focused on early development and both child and family medical history. Immunization records were obtained for all participants. These and other aspects of the interview are the subject of another article (Richler et al., in press).

RESULTS

Differences in Children With ASD, DD, and Typical Development

If parents reported a word loss during the telephone interview that had not been identified in the earlier ADI–R or they did not report a loss that had previously been coded in the initial ADI–R, we rechecked the ADI–R protocols. If word loss had been miscoded in the ADI–R (e.g., if written notes confirmed the loss but had not been coded as such), we included the child in the word-loss group. If, however, there was no indication of a loss of words in the ADI–R notes or codes despite the report of a loss in the interview, we categorized the child in a separate group for nonword-loss (NWL) or word-loss (WL) shifts. Forty-three children (12.3% of the participants with ASD) had discrepant information from the phone interview and initial ADI–R codes such that they were reported to have losses only during the phone interview. On review and discussion, we changed the classification from no word loss to word loss based on the phone interview for 6 of these cases. The remaining 37 cases retained the no word-loss classification. Twenty-three children (6.6%) had originally been categorized as word loss on the ADI–R, but their parents reported no loss during the phone in-

terview; after a reexamination and discussion of previously collected data, we changed the classification from word loss to no word loss based on the initial ADI–R notes and the interview for 5 of these cases.

Thus, over 80% of cases with ASD fell into the same classification based on parents' reports during their earliest ADI–R and the later telephone interview, with approximately 3% reclassified on the basis of new information. Mothers of three children with developmental delays reported a word loss during the telephone interview. None of them had met criteria for a word loss on the ADI–R, and when checked, all remained in the NWL group as did all of the children with typical development.

A chi-square indicated that there was a significant group difference (ASD, DD, or typical) in the rate of reporting a language loss, $\chi^2(4, N = 403) = 29.04, p < .001$. Chi-squares also indicated significant group differences in gender, $\chi^2(2, N = 403) = 18.30, p < .001$ and in maternal education, $\chi^2(4, N = 400) = 20.55, p < .003$ as well as site (all DD and typical children were from Chicago/North Carolina/Michigan), $\chi^2(2, N = 403) = 31.78, p < .001$. There were also significant differences in chronological age, $F(2, 394) = 16.46, p < .001$ but no differences in IQ.

In the first set of analyses, we compared skill mastery at 24 months described during the phone interview for children with autism and ASD, children with DD, and typical children. Multivariate analyses of variance (MANOVAs) indicated a main effect of group (ASD, DD, or typical) on the skills children were described as having at 24 months, $F(24, 1094) = 1.82, p < .02$ covarying chronological age at interview, gender, and maternal education. Univariate analyses of variance (ANOVAs) of skills reported as mastered at 24 months (see Table 3) were significantly different by group in all eight categories (Fs > 14.81, ps < .001). Contrasts revealed that skill mastery at

TABLE 3
Reported Skill Mastery at 24 Months for Entire Sample

Mean No. of Behaviors at 24 Months by Modified CDI Section	*ASD*[a]		*DD*[b]		*Typical*[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Prespeech behaviors	6.08[d]	2.54	6.62[d]	2.01	8.54	0.96
Games and routines	3.85[d]	2.07	4.33[d]	1.71	6.19	1.16
Actions with objects	5.64[d]	2.97	6.62[d]	3.53	10.45	1.69
First communicative gestures	4.69[d]	2.94	5.52[d]	3.08	9.03	1.40
Pretending to be a parent	1.31[d]	1.73	2.24[d,f]	2.19	4.84	1.61
Phrase comprehension	11.61[d]	6.68	13.71[d]	5.94	19.29	1.35
Words understood only	6.31[d]	5.10	8.95[e,f]	6.63	1.55	1.96
Words understood and said	8.11[d]	6.44	7.10[d]	7.11	16.87	2.50

Note. CDI = MacArthur Communicative Development Inventory; ASD = autistic spectrum disorders; DD = developmental delays.

[a]$n = 351$. [b]$n = 21$. [c]$n = 31$. [d]Lower than typical group, $p < .006$. [e]Higher than typical group, $p < .001$. [f]Higher than ASD group, $p < .03$.

24 months was significantly higher, ts < –2.81, ps < .006, in the typical group than in the ASD and DD groups for seven out of the eight skill areas. The exception for both ASD and DD groups was "words understood only" in which the ASD group and DD groups were significantly higher, ts > 5.06, ps < .001 than the typical group (M = 1.55, SD = 1.96). This was an artifact of the higher expressive skills of the typical group such that the typical group understood and said more words, whereas the children with ASD and DD understood only (but did not say) more words than the typical children. Furthermore, the DD group had significantly more words understood only, on average, and had significantly more "pretending to be a parent" skills than did the ASD group, $t(400) = –2.34$, $p < .05$; $t(400) = –2.37$, $p < .02$, respectively. In all remaining areas except "words understood and said," the mean number of skills for the DD group was higher than the ASD group; however, due to the low number of participants in the DD group, these differences did not reach significance.

Differences at 36 months (see Table 4) followed a similar pattern with a significant MANOVA, $F(24, 1094) = 2.56$, $p < .001$, but all three groups were significantly different for all items except words understood and said in which children with ASD and DD were not significantly different. At age 3, children with DD had significantly more communication and social skills in all areas than did children with ASD except for number of words understood and said. Both groups had significantly less skills than did the typical group; the exception was in words understood only in which the ASD and DD groups had more words than the typical group for reasons we described previously.

Due to the infrequency of reported losses in the DD and typical groups and the general difference in the losses that were reported (e.g., having to do with skills not

TABLE 4
Reported Skill Mastery at 36 Months for Entire Sample

Mean Number of Behaviors at 36 Months by Modified CDI Section	*ASD*[a]		*DD*[b]		*Typical*[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Prespeech behaviors	2.99[d,e]	2.80	5.95[d]	2.46	8.16	1.46
Games and routines	2.26[d,e]	2.19	4.10[d]	1.95	6.13	1.26
Actions with objects	4.25[d,e]	2.99	6.14[d]	3.81	10.35	1.76
First communicative gestures	2.65[d,e]	2.67	4.90[d]	3.46	8.84	1.55
Pretending to be a parent	0.83[d,e]	1.43	2.05[d]	2.20	4.71	1.81
Phrase comprehension	7.50[d,e]	6.77	13.10[d]	6.44	19.03	1.60
Words understood only	4.87[e,f]	5.11	8.52[f]	6.90	1.55	1.96
Words understood and said	5.11[d]	6.36	6.52[d]	7.21	16.87	2.50

Note. CDI = MacArthur Communicative Development Inventory; ASD = autism spectrum disorders; DD = developmental delays.

[a]$n = 351$. [b]$n = 21$. [c]$n = 31$. [d]Lower than typical group, $p < .005$. [e]Lower than DD group, $p < .005$. [f]Higher than the typical group, $p < .001$.

typically implicated in regression in autism), they were excluded from the majority of the remaining analyses; we have occasionally included group means as points of reference.

WL and NWL

The sample with ASD included 125 participants classified as having lost words, referred to here as WL, and 226 participants classified as NWL. Chi-squares indicated no group differences in gender, maternal education, ethnicity, site, or diagnosis (note that the majority of the WL participants had been matched to NWL participants on gender, maternal education, ethnicity, site, and birth date, so this is not surprising); *t* tests revealed no group differences in chronological age at the time of the interview.

Within the ASD group, it was found that interviewer's best estimate of onset of autistic symptoms (from the ADI–R) was significantly later for the WL group ($M = 16.86$, $SD = 5.76$) than for the NWL group ($M = 14.13$, $SD = 8.01$), $t(313) = –3.18$, $p < .003$. Age of first word for the WL group (prior to the loss) was 14.96 months ($SD = 9.14$); age of first stable word in the WL group was 39.13 months ($SD = 17.70$) and in the NWL group was 26.64 months ($SD = 17.60$). For reference, the mean age of first word for the DD group was 31.25 ($SD = 22.14$) and 12.84 months ($SD = 4.45$) for the typical group. According to parental report in the telephone interview (on questions derived from the ADI–R), word loss was first noticed at a mean of 20.21 months ($SD = 5.75$) for the WL group. When parents were asked, with hindsight, when their child actually started to lose skills as opposed to when they first described the loss as occurring, they replied with a mean of 18.50 months ($SD = 5.34$).

Distributions of both the number of areas in which losses occurred and the percent of skills in an area that was lost were generated for both the WL and NWL groups. Because of floor effects, the area of pretending to be a parent was excluded as were any areas for individual children in which they scored zero at 24 months. For children in the NWL group, the modal percent and the median percent of skills lost in an area was zero, and the median and modal number of areas of loss greater than 25% was zero. However, 82 parents of NWL children (i.e., 36.3%) reported significant losses of skills in at least one area. Distributions of the percent of loss were skewed so that in any area, about 10% of NWL children lost more than 25% of the skills. For loss of skills in three or more areas, the distribution was flat. Because we were interested in children who did not lose words but lost other social-communication skills, we designated all NWL children who lost more than 25% of skills in three or more areas as NWL–Regression (NWL–R) to carry out further analyses. Using this approach, 38 participants were considered as NWL–R, and 188 remained in the NWL (now called no regression [NR]) group, with the WL group remaining the same. An ANOVA indicated a significant group effect on age of onset, $F(2, 312) = 8.34$, $p < .001$ such that

the NR group had an earlier onset (*M* = 13.54, *SD* = 8.12) than the NWL–R (*M* = 16.94, *SD* = 6.88) and WL groups (*M* = 16.86, *SD* = 5.76), *t*s < –2.53, *p*s < .02.

WL, NR, and NWL–R

As shown in Table 5, of children with ASD, children with WL, NWL–R, and NR did not differ on any demographic variables. Children without losses had significantly higher verbal IQs than children in the WL group, $t(313) = 2.47$, $p < .02$; the difference between the NR and NWL–R groups did not reach significance ($p = .065$). There were no significant differences in nonverbal IQ. As shown in Table 6, the children with WL and NWL–R were also much more similar in terms of patterns of skills mastered by 24 months than the NR children.

A MANOVA comparing number of skills at 24 months in each of the seven areas according to regression status (WL, NWL–R, and NR) was significant, $F(14, 684) = 5.41$, $p < .001$, indicating a main effect of regression status on number of skills at 24 months. ANOVAs were significant in all areas except for number of

TABLE 5
Characteristics of ASD Sample by Regression Category

Variable	*NR*[a,b]	*NWL–R*[c]	*WL*[d]
Male	158 (84.0%)	32 (84.2%)	110 (88.0%)
Female	30 (16.0%)	6 (15.8%)	15 (12%)
White	159 (84.5%)	31 (81.6%)	108 (86.4%)
Other	29 (15.4%)	7 (18.4%)	17 (13.6%)
Chicago/North Carolina/Michigan	115	26	70
Other	73	12	55
Verbal IQ	66.55[e] (*SD* = 32.34)	55.15 (*SD* = 30.55)	56.72 (*SD* = 34.00)
Nonverbal IQ	77.98 (*SD* = 28.68)	71.51 (*SD* =28.68)	72.34 (*SD* = 28.59)
Age at time of interview (in years)	9.97 (*SD* = 2.74)	9.14 (*SD* = 2.28)	9.31 (*SD* = 2.65)
Maternal education			
Graduate/professional degree or bachelor of arts	111	25	70
Some college/associate's degree	46	11	44
High school graduate	22	2	7
GED/less than high school graduate	7	—	4

Note. NR = no regression; NWL–R = children who did not meet criteria for word loss but lost other social-communication skills; WL = word loss; GED = general equivalency diploma.

[a]$n = 188$. [b]Maternal education data missing for two NR participants. [c]$n = 38$. [d]$n = 125$. [e]Higher than the WL group, $t(313) = 2.47$, $p < .02$.

TABLE 6
Reported Skill Mastery at 24 Months for ASD Participants

Mean No. of Behaviors at 24 Months by Modified CDI Section	*NR*[a]		*NWL–R*[b]		*WL*[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Prespeech behaviors	5.21[d,e]	2.61	7.13	1.68	7.07	2.16
Games and routines	3.32[d,e]	2.05	4.39	1.70	4.50	1.98
Actions with objects	5.11[d]	3.08	6.11	3.22	6.30	2.62
First communicative gestures	3.79[d,e]	2.76	6.03	2.73	5.62	2.83
Phrase comprehension	9.79[d,e]	6.98	13.00	5.95	13.94	5.54
Words understood only	5.92	5.24	6.18	5.11	6.94	4.87
Words understood and said	7.20[d]	6.81	8.79	6.61	9.26	5.62

Note. ASD = autism spectrum disorders; CDI = MacArthur Communicative Development Inventory; NR = no regression; NWL–R = children who did not meet criteria for word loss but lost other social-communication skills; WL = word loss.

[a]$n = 188$. [b]$n = 38$. [c]$n = 125$. [d]Lower than WL group, $p < .006$. [e]Lower than NWL–R group, $p < .006$.

words understood only, indicating a main effect of regression status, Fs > 4.18, ps < .02. Overall, the NWL–R and WL groups showed similar profiles, with the NWL–R and WL groups consistently showing a higher number of skills than the NR group in the social interaction and play sections (see Table 6). In the areas of "prespeech," "first communicative gestures," "games and routines," and "phrase comprehension," the contrasts between NWL–R and NR as well as the contrasts between WL and NR were all significant, ts < –2.83, ps < .006. In "actions with objects" and words understood and said, only the contrasts between WL and NR were significant, ts < –2.81, ps < .006, with the contrast between NWL–R and NR in actions with objects falling at $p = .058$ and words understood and said at $p = .162$. There were no group differences in number of words understood only. None of the contrasts between NWL–R and WL were significant. Children with NWL–R and WL were reported to have more skills in six of seven areas, on the average, before age 24 months than children with no loss.

A second MANOVA compared number of skills at 36 months according to regression status; the results were significant, $F(14, 684) = 11.99$, $p < .001$. ANOVAs were significant in all seven areas, Fs > 6.24, ps < .003, indicating a consistent main effect of regression status. Directly opposite the results at 24 months, the NR group had significantly more skills at 36 months in all skill areas as shown in Table 7 (ts > 2.22, ps < .04) than both the NWL–R and WL groups, which were not significantly different from each other in any area.

The percentage of skills lost by the NWL–R ($M = 36.82\%$, $SD = 13.35$) and WL ($M = 40.88\%$, $SD = 23.27$) groups varied across categories, although in all cases, it was significantly higher than in the NR group ($M = 0.05\%$, $SD = .07$; ts > 6.26, ps < .001). The NR group was also reported to lose skills, albeit not at

TABLE 7
Reported Skill Mastery at 36 Months for ASD Participants

Mean No. of Behaviors at 36 Months by Modified CDI Section	*NR*[a]		*NWL–R*[b]		*WL*[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Prespeech behaviors	4.26	2.75	1.28[d]	1.69	1.59[d]	2.12
Games and routines	2.94	2.11	1.45[d]	1.61	1.50[d]	1.93
Actions with objects	4.85	3.13	3.68[d]	2.91	3.52[d]	2.61
First communicative gestures	3.49	2.78	1.84[d]	2.37	1.62[d]	2.11
Phrase comprehension	9.34	7.04	4.76[d]	4.64	5.58[d]	6.11
Words understood only	5.73	5.23	3.26[d]	4.43	4.07[d]	4.89
Words understood and said	6.96	6.89	4.24[d]	5.74	2.61[d]	4.58

Note. ASD = autism spectrum disorders; CDI = MacArthur Communicative Development Inventory; NR = no regression; NWL–R = children who did not meet criteria for word loss but lost other social-communication skills; WL = word loss.

[a]$n = 188$. [b]$n = 38$. [c]$n = 125$. [d]Lower than NR group, $p < .04$.

the rapid rate reported in the WL and NWL–R groups. It is valuable to note that this may partly be an artifact of the methodology: Because caregivers were not asked about their child's acquisition of new skills, it is possible that a child would have appeared to lose skills even if he or she may have concurrently gained other skills. An analysis of the average loss in both the NWL–R and WL groups revealed that in most categories, the percentage of skills lost was quite similar between the two regression groups (see Table 8). The notable exception

TABLE 8
Loss Rate for ASD Participants Expressed in Percentage of Previously Mastered Skills That Were Lost

Difference in Proportion of Behaviors From 24 to 36 Months by Modified CDI Section	*NR*[a]		*NWL–R*[b]		*WL*[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Prespeech behaviors	–11.05[d,e]	17.27	–64.62	21.89	–60.89	34.09
Games and routines	–6.20[d,e]	13.20	–42.11	24.84	–44.27	33.01
Actions with objects	–2.29[d,e]	5.69	–20.72	18.17	–23.39	24.34
First communicative gestures	–3.35[d,e]	10.09	–41.84	23.81	–42.10	30.50
Phrase comprehension	–2.58[d,e]	5.94	–42.30	22.87	–43.22	34.20
Words understood only	–1.25[d,e]	4.68	–17.70	20.50	–16.53	17.59
Words understood and said	–1.81[d,e]	5.57	–27.59[b]	22.10	–38.08	27.27

Note. ASD = autism spectrum disorders; CDI = MacArthur Communicative Development Inventory; NR = no regression; NWL–R = children who did not meet criteria for word loss but lost other social-communication skills; WL = word loss.

[a]$n = 188$. [b]$n = 38$. [c]$n = 125$. [d]Lower loss rate than NWL–R group, $p < .001$. [e]Lower loss rate than WL group, $p < .008$.

to this was in words understood and said (the defining difference between the two groups) in which the WL group had (on average) a significantly more severe loss that the NWL–R group, $t(276) = 2.73$, $p < .008$.

The number of areas in which more than 25% of skills were lost was higher, $t(348) = 2.27$, $p < .03$ in the NWL–R ($M = 4.55$, $SD = 1.27$) than in the WL group ($M = 3.89$, $SD = 2.43$). The modal number of areas in which more than 25% of skills were lost in the WL group was 6. However, there was a broad range of number of areas in which skills were lost including 31% of the WL group who lost more than 25% of skills in two or fewer areas. A closer analysis of the specific items in each category confirmed a general similarity between the two regression groups. Except for loss of understanding and saying words (which reflected the loss of spontaneous words criterion that defined the WL group), NWL–R and WL groups lost the same skills with almost exactly the same frequency (see Table 9). Consequently, we combined the two groups to form a regression group ($n = 163$) and a nonregression (still designated as NR; $n = 188$) group.

Based on the list of skills most frequently lost and the distributions of number of these skills lost, the smallest number of items was found that could be used to accurately identify no regression and regression cases. With the assumption that parents would first be asked directly if their child had lost productive language (thus allowing for the identification of children who would fall in the WL group), an endeavor was made to distinguish the children in the NWL–R and NR groups. Items from the two lists of most commonly lost skills were combined (resulting in a set of nine skills when skills involving expressive language were excluded); it was found

TABLE 9
Most Frequently Lost Skills

Word Loss		*Non-Word Loss–Regression*	
% Who Lost Skill	*Skill*	*% Who Lost Skill*	*Skill*
73.6	*Responds to name*	84.2	*Responds to smiles of others*
68.0	*Eye contact*	81.6	*Eye contact*
65.6	*Responds to parent smile*	78.9	*Responds to name*
62.4	*Babbling*	73.7	Says or understands "Hi"[a]
61.6	*Responds to smiles of others*	71.1	*Responds to parent smile*
60.8	Says or understands "Uh oh"[a]	65.8	*Babbling*
60.8	*Plays Peek-a-boo*	63.2	*Plays peek-a-boo*
60.0	*Understands "Look/Look here"*	63.2	*Understands "Come here/Come on"*[a]
59.2	Says or understands "Mommy"[a]	60.5	*Reacts to "There's Mommy/Daddy"*
58.0	*Reacts to "There's Mommy/Daddy"*	60.5	*Understands "Look/Look here"*

Note. Items in italics were included in the list of nine most commonly lost items, which excludes expressive language items.

[a]Items not shared across groups.

that a minimum threshold of four lost skills was optimal and could identify NWL–R and NR cases with a sensitivity of 92.10% and specificity of 93.62%.

On average, the NR group was reported to have between five and six of these nine skills at 24 months of age and to have lost less than one skill by 36 months of age. The regression group (WL and NWL–R), on the other hand, was reported to have an average of seven to eight of these skills at 24 months and to have lost six of them by 36 months.

Early Medical Risk Factors and Regression

In the next set of analyses, we addressed the proposed association between a history of regression and medical risk factors, the first being seizures. The caregivers of 24 NR children (12.8%) and 22 regression children (13.5%) reported a history of afebrile seizures; chi-square tests indicated no group differences related to regression status.

To examine a possible association between early medical history and regression, items from the telephone interview pertaining to prenatal, birth, and postnatal risk factors were summed to create a total number of risk factors (maximum of 25) experienced in early life. Based on the distribution of total risk factors experienced ($M = 3.93$, $SD = 2.59$), two categories were established. Participants were considered "average risk" if they experienced fewer than seven risk factors and "high risk" if they experienced eight or more (slightly more than 1 *SD* above the mean). Fisher's exact test revealed no differences between regression and NR groups in risk-status classification. Finally, there were also no effects of birth order: 56 (34.36%) participants in the regression group and 67 (35.64%) participants in the NR group were first born.

DISCUSSION

Caregiver reports of early acquisition and loss of skills in children with ASD provide an intriguing picture of trajectories of early social-communicative development that differentiate ASD from other developmental disorders and typical development. As in previous studies (Burack & Volkmar, 1992), although a few parents of children with developmental disorders or typical development reported loss of skills before 2 years, the pattern of loss of words and of loss of other social-communication skills was specific to ASD, supporting the importance of early regression as a specific, although not universal, marker for ASD (Lord et al., 2004). In this study, we deliberately oversampled children with word loss, so over 35% of the children studied used words meaningfully in the first 2 years of life and then stopped doing so for at least a month. In addition, another 17% of children who had not shown word losses also exhibited a pattern of gains followed by losses in the

2nd year. However, the distribution of losses was not continuous, at least as reported by caregivers; rather, a substantial majority of the remaining children did not lose skills at all (see Table 7) but rather showed slow or little early progress in certain areas.

The general pattern of losses described by caregivers in our study was very similar to those that have been reported in other research. Mean age of loss, for the children who lost words, was about 19 months (see Fombonne & Chakrabarti, 2001; Goldberg et al., 2003; Kurita, 1985). Moreover, as described by other authors (Kurita, 1985; Kurita et al., 1992; Werner, Dawson, Munson, & Osterling, in press; Wilson et al., 2003), most children with ASD who experienced a regression before 2 years of age had already demonstrated impairments prior to the loss. Parental reports of age at onset consistently preceded age of word loss for these same children.

Compared to typically developing children, children with ASD, including those with and without a regression, showed deficits in all areas of early social-communication prior to age 2. Compared to a group of children with developmental disorders but without autism, children with ASD showed more severe early deficits in pretense and in receptive language. Thus, based on their caregivers' reports, regression in ASD did not typically follow a pattern of completely normal development but rather occurred in children who had already begun to differ in when and/or how they acquired typical social-communication milestones.

Nevertheless, caregivers of children with regressions described remarkably similar patterns of stronger, more normal, early social-communicative development in their children than did other parents of children with ASD. Children who had word loss were described as having had more gestures, more participation in social games, more understanding of directions, and better nonverbal communication prior to the regression than children with ASD and no loss of words. A small group of children (about 17% of the children without word loss) whose parents had not reported a word loss at earlier ages were reported to show a virtually identical pattern of loss of other social-communication skills (not involving expressive use of words) as the children who lost words. This finding suggests that our focus on clear reports of word loss as the most reliable indication of regression excluded a significant minority of children with ASD who had similar trajectories. This is particularly important to note because our criteria for word loss (i.e., three spontaneous meaningful words used for at least a month and lost for a month) was less conservative than the criteria that are specified in the ADI–R and have been used in several previous studies (Fombonne & Chakrabarti, 2001; Werner et al., in press). Although the children with losses (the WL and NWL regression groups) were described by their caregivers as having more skills than those without losses before 24 months, the loss groups had significantly fewer skills by 36 months across all areas of social-communication than the children with no pattern of loss (see Table 7).

As described by Goldberg et al. (2003), almost 77% of children whose caregivers reported language loss were also reported to lose skills in other areas. In this

study, the areas that were reported to have the most severe loss were those having to do with social interaction and engagement (prespeech, games, gestures and phrases understood). The items most frequently lost in the two regression groups (as in Table 9) were related to deterioration in the quality of interaction between the child and his or her social partners. For future research, we were able to identify nine items from the modified CDI that could be used along with the criteria for loss of words to accurately identify children who experienced either a substantial loss in social-communication, word loss, or both.

Although some earlier studies have suggested that regression may be associated with early insult, seizures, or health complications (e.g., Kobayashi & Murata, 1998), in this study, we found no association between regression and either a history of seizures or prenatal, perinatal, and neonatal risk. This finding is in agreement with several other studies (Davidovitch et al., 2000; Kurita, 1985; Tuchman & Rapin, 1997; Wilson et al., 2003). The absence or presence of early seizures and/or a significant early medical history was not associated with whether or not a child experienced a period of loss; birth order was similarly unrelated.

It is important to acknowledge that all information concerning loss of skills and early milestones in this project was based on caregiver report either through the ADI–R administered at entrance to the various research projects or the telephone interview developed for this project. One recent study (Goldberg et al., 2003) that observed early videos of children with ASD with and without losses showed a difference between groups, and another (Werner et al., in press) did not. In this study, 83% of children were categorized in the same way as having or not having a word loss in interviews, using the same questions, an average of 5 years after the initial ADI–R. About half of the disagreements were accounted for by children who were initially described by their caregivers on the ADI–R as losing several social-communication skills and in many cases, words but who did not meet our criteria for word loss. Thus, on the whole, caregivers provided information about losses that was consistent over time and across sites. Several strategies to aid caregivers' recall (i.e., referring to significant events such as birthdays, family relocations, or school changes) may have contributed to this consistency in describing the losses (Rutter, Le Couteur, & Lord, 2003). On the other hand, longitudinal data suggested that although descriptions of the occurrence of a loss were consistent across time, ages reported were affected by forward telescoping (i.e., the older the child at the time of interview, the later the age reported; Cooper, Kim, Taylor, & Lord, 2001). Thus, even small samples of direct observation of very early development in ASD, particularly between 12 and 24 months, could offer very important additional information about the nature of these changes (Bernabei & Camaioni, 2001; Goldberg et al., 2003; Werner, Dawson, Osterling, & Dinno, 2000).

Although the finding that children who experienced regression had more skills before their losses than children who did not lose skills seems obvious, such a shift is not necessary and in fact was not found by Fombonne and Chakrabarti (2001).

Because autism is defined by significant deficits in skills acquired by most children in the first year or two of life, it is the case that for a child to shift from normal development at age 2 to autism, skills would have to be lost. However, in reality, the development of most of the children with regressions was more accurately characterized by the caregiver recognizing, at least with hindsight, some differences from typical children even in the first 18 months, followed by a deterioration of social-communicative behaviors such that deficits gradually became apparent in the second half of the 2nd year. It could be that when children lost words, these changes were more salient to parents and their timing better remembered than were losses of other behaviors. However, the remarkable similarity across caregivers of the skills that some children were described as having and then losing suggests a definable phenomenon of decreasing social-communication in some but not all young children with ASD. These patterns of development raise important questions about the skills that underlie intentional communication and representation as well as social-cognitive behaviors such as initiating joint attention (Mundy & Neal, 2001). Simple causal explanations are not yet available but will require both accounting for why some children with ASD ever achieved these skills as well as why many of them then lost them.

Perhaps the most striking finding is the indication of considerably different trajectories of early development among children with ASD according to whether or not a regression was reported. Although the NR group showed significantly earlier onset and more severe impairment at age 2, the regression group (despite their later onset) had more severe impairments by age 3. The later onset and poorer prognosis of the regression group is broadly similar to the features of CDD, a pervasive developmental disorder that shares many clinical features with autism (Volkmar, Klin, Marans, & Cohen, 1997). CDD is characterized by relatively normal early development, losses that typically occur in the 3rd and 4th year of life, and a poor prognosis with limited recovery (Volkmar & Rutter, 1995; Volkmar et al., 1997). It is interesting, however, that despite the requirement of a period of normal development in CDD (American Psychiatric Association, 1994; World Health Organization, 1992), a minority of children in the first studies of CDD had some signs of unusual development prior to the marked regression (Evansjones & Rosenbloom, 1978); this is similar to the children with regression in this study.

The characteristics of the regression group may suggest an intermediate position for this group of individuals with ASD, sharing certain features with both an early onset, NR group with ASD and a late onset, regression group of individuals with CDD. To explore the interrelation of these pervasive developmental disorders and the similarities in growth curves, additional studies will need to investigate not only early environmental variables but also familial aspects of children in all three subgroups (regression, NR, and CDD).

The apparent association in the regression group of early assets in social-communication (relative to the NR group) and, at 36 months, more severe impair-

ment (relative to the NR group) runs counter to clinical reasoning that successful early experiences in language and social engagement may have a protective effect on later development. The data we presented here suggest that children who experience a regression may, in the short term, not demonstrate any advantage from having mastered some early social-communication skills prior to the loss. Other studies have suggested that this effect persists in later development (Burack & Volkmar, 1992; Richler et al., in press; Rogers & DiLalla, 1990; Wilson et al., 2003). To determine whether the degree and areas of early acquisition of some behaviors can provide any protective ability in terms of outcome, future research will need to document prospectively early profiles of ability in children who later experience a regression and follow these youngsters through childhood to determine areas of relative strength and impairment.

A possible explanation for the differential patterns of development in the ASD participants with and without a history of regression is that the two groups are distinct genetic subtypes and thus would have dissimilar biological underpinnings. However, recent findings (Lainhart et al., 2002; Parr, 2002) have revealed similar rates of a broader autism phenotype in relatives of probands who had a history of regression and probands who did not have a history of regression, suggesting that the two groups share equivalent genetic backgrounds. This does not, however, rule out the possibility of differing Gene × Environment interactions. However, when the extant literature (including this investigation) has attempted to target environmental features of early development that might be implicated in this potentially dynamic relation, results have been inconclusive. New aspects of the environment would need to be identified to account for these differing paths of development.

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