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Predicting language outcome in infants with autism and pervasive developmental disorder

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Abstract

Background: To examine longitudinal associations between diagnosis, joint attention, play and imitation abilities and language outcome in infants with autism and pervasive developmental disorder.
Methods and Procedures: Experimental measures of joint attention, play and imitation were conducted with a sample of infants with autism spectrum disorder at age 20 months. Language outcome was assessed at age 42 months. A within-group longitudinal correlational design was adopted.
Outcomes and Results: Language at 42 months was higher for children with a diagnosis of pervasive developmental disorder than for children with a diagnosis of autism. Language at follow-up was also positively associated with performance on experimental measures of joint attention and imitation, but not with performance on experimental measures of play and 'goal detection' at 20 months, nor with a non-verbal intelligence quotient, although these associations were not examined independent of diagnosis. However, floor effects on the measure of play at 20 months and the small sample size limit the conclusions that can be drawn.
Conclusions: Individual differences in infant social-communication abilities as well as diagnosis may predict language outcome in preschoolers with autism spectrum disorders. Attention should be directed at assessing these skills in 2- and 3-year-old children referred for a diagnosis of autism spectrum disorder. Imitation and joint attention abilities may be important targets for early intervention.

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Introduction

Knowledge about early-emerging social-communicative impairments in autism has grown substantially over the last decade (Stone 1997, Charman 2000, Rogers 2001, Charman and Baird 2002). The aspects of early social-communicative behaviour that best characterize individuals with autism have been well recognized for some time. The identification of specific impairments in declarative gestures, in contrast to relatively more spared development of imperative gestures, was first noted in the 1970s by Ricks and Wing (1975) and Curcio (1978), and later confirmed by Mundy *et al.* (1986) and Sigman *et al.* (1986). Similarly, it has long been known that individuals with autism produce less functional and symbolic play than controls (Riguet *et al.* 1981, Ungerer and Sigman 1984, Mundy *et al.* 1986). Individuals with autism are impaired in their development of imitation abilities with regard both to body movements and actions on objects (de Myer *et al.* 1972, Curcio 1978, Hammes and Langdell 1981, Dawson and Adams 1984).

Recent research has produced a more fine-grained delineation of the nature and course of the social-communicative impairments in children with autism. In terms of the joint attention impairment, it has been shown that the critical distinction is not at the imperative versus declarative level. Rather it is the degree to which the child is monitoring and regulating the attention (or attitude) of the other person in the relation to objects and events in the outside world (Mundy *et al.* 1994, Phillips *et al.* 1995, Charman 1998). In terms of impairments in play, in unstructured or free-play conditions, children with autism produce significantly less pretend play, but intact functional play, compared with chronological or mental age-matched comparison groups (Baron-Cohen 1987, Lewis and Boucher 1988). Under structured, or prompted, conditions, children with autism produced as many functional and symbolic acts as controls in some studies (Lewis and Boucher 1988), but not in others (Ungerer and Sigman 1984). However, even in structured settings their play may lack the generativity and imaginative quality shown by non-autistic individuals (Lewis and Boucher 1995, Jarrold *et al.* 1996, Charman and Baron-Cohen 1997). Lastly, it has been found that while younger, preschool children with autism are impaired in even simple reproduction of gestures and actions on objects (Charman *et al.* 1997, 1998), older, school-age children can copy such simple actions (Charman and Baron-Cohen 1994, Loveland *et al.* 1994). However, imitation of more complex and novel sequences of actions are impaired in older, school-age children (Dawson and Adams 1984, Rogers *et al.* 1996).

Longitudinal associations between these early social-communicative abilities and later language development have been found in typically developing children. For example, many studies have demonstrated longitudinal associations between joint attention abilities including, protodeclarative pointing, following eye gaze and pointing, and later language ability (Bates *et al.* 1979, Tomasello and Farrar 1986, Mundy and Gomes 1996, Carpenter *et al.* 1998). Bates *et al.* (1980, 1989) found that in typically developing infants, elicited functional play with toy objects was associated with language comprehension and elicited pretend play was associated with language production. Ungerer and Sigman (1984) found that functional play acts at 13 months were associated with receptive and expressive language ability 9 months later. Charman *et al.* (2000) demonstrated that imitation of actions on objects at age 20 months was associated with language ability in the fourth year of life.

Data on longitudinal associations in samples of children with autism are required to test the validity of theoretical claims regarding the mechanisms of psychopathological development in autism (e.g. Rogers and Pennington 1991, Mundy and Neal 2001), as well as the mechanisms of change responsible for demonstrated treatment effectiveness (Mundy and Crowson 1997). Only a handful of longitudinal datasets have been reported. Mundy *et al.* (1990) reported on a longitudinal follow-up of a group ($n = 15$) of children with autism. The children with autism were 45 months of age at the start of the study and were seen 13 months later. Only joint attention behaviour (alternating gaze, pointing, showing and gaze following) measured on the Early Social Communication Scales (ESCS; Seibert *et al.* 1982) was associated with language ability measured at follow-up. Social interaction, requesting behaviour, and initial age, IQ and language ability were not associated with language at follow-up. Sigman and Ruskin (1999) reassessed 54 children with autism 1 year after their initial assessment (initial age 47 months). With initial age and language ability covaried, responding to and initiating joint attention behaviours on the ESCS, and initiating behavioural regulation and responding to social interaction, were significantly associated with later expressive language. A long-term follow-up to age 12 years ($n = 34$) found that responding to joint attention bids was associated with gain in expressive language and initiation of joint attention bids just missed significance, again with initial chronological age and language ability partialled out. Neither measure was associated with receptive language gains. Functional (but not symbolic) play at the initial assessment also predicted improvement in expressive (but not receptive) language skills at time point 3. Stone and Yoder (2001) reported longitudinal data from a cohort of children with autism and pervasive developmental disorder followed longitudinally from age 2 to 4 years. Stone and Yoder found that imitation, joint attention and play abilities measured at the first time point were associated with expressive language ability at 4 years. Stone *et al.* (1997) demonstrated some specificity of longitudinal associations from 2 to 4 years of age between imitation abilities and later language ability. Imitation of body movements but not actions on objects was associated with later expressive language skills.

Thus, longitudinal associations have been demonstrated between aspects of joint attention, play and imitation and later language skills in young children with autism. Further work is required to determine whether these associations are specific or general. Longitudinal data on associations between early social-communication skills and language outcomes also have important clinical applications, including the identification of early indicators of autism, contributing to greater certainty of early prognosis and as possible targets for intervention.

As part of a study prospectively to identify children with autism at 18 months of age (Baron-Cohen *et al.* 1996, Baird *et al.* 2000, Baron-Cohen *et al.* 2000), we assessed a group of 18 children with autism and pervasive developmental disorder (PDD) on experimental tasks of joint attention, imitation and play at 20 months (Charman *et al.* 1997, 1998). Language and IQ were also assessed. The sample was followed up at age 42 months and the language and IQ assessments repeated. The present paper examines the longitudinal associations between these early social-communication abilities, and diagnosis (autism versus PDD) and language competence at follow-up. Although the sample was relatively small, the data provide a unique contribution to the literature by examining longitudinal associations of joint attention, play and imitation measured in infancy to the preschool years, representing a younger cohort of children than has previously been studied.

Methods

Participants

The participants were prospectively identified via utilization of a screen for autism administered at age 18 months (CHAT) (Baron-Cohen *et al.* 1996, Baird *et al.* 2000, Baron-Cohen *et al.* 2000). The participant characteristics are shown in table 1. Non-verbal ability was measured using the D and E scales of the Griffiths Scale of Infant Development (Griffiths 1986) at ages 20 and 42 months. A non-verbal intelligence quotient (NVIQ) was calculated by dividing the age-equivalent score by the child's chronological age (MA/CA). Receptive (RL) and expressive language (EL) abilities were assessed at both time points using the Reynell Developmental Language Scales (Reynell-DLS; Reynell 1985). However, at 20 months, the Reynell-DLS suffered from floor effects. It has a basal age equivalent of 12 months and 15/18 participants fell below this level on the RL scale and 11/18 on the EL scale. To examine language outcomes at 42 months, raw scores at this age were entered into the analyses (one participant was still below basal). At age 42 months, nine participants met ICD-10 (WHO 1993) criteria for autism and nine met criteria for other pervasive developmental disorder (PDD). (See Cox *et al.* (1999) for details of the diagnostic assessments, which included administration of the Autism Diagnostic Interview—Revised (ADI-R; Lord *et al.* 1994) and an interactional, play-based assessment in addition to cognitive and language assessments.)

Experimental measures

Full details of the experimental measures taken at age 20 months are given in Charman *et al.* (1997, 1998). For the present analyses, only the key variables that are to be entered into the cross-sectional and longitudinal analyses are described in detail.

Table 1. Mean (SD) age, NVIQ and language scores of participants at both time points

	Time 1		Time 2	
	Autism ($n=9$) mean (SD)	PDD ($n=9$) mean (SD)	Autism ($n=9$) mean (SD)	PDD ($n=9$) mean (SD)
Age (months)	20.9 (1.5)	20.3 (1.1)	41.8 (4.2)	43.3 (2.8)
NVIQ[a]	81.8 (8.3)	86.0 (7.7)	89.9 (11.9)	94.1 (11.9)
EL[b] raw score	6.7 (2.6)	7.9 (4.3)	19.4 (10.8)	29.2 (8.0)
RL[c] raw score	3.3 (1.1)	6.2 (2.7)	18.6 (7.6)	31.3 (6.6)

[a]Non-verbal IQ score.
[b]Reynell Expressive Language raw score.
[c]Reynell Receptive Language raw score.

Spontaneous play task

When the child entered the room, the following sets of toys were available (all at once), spread out on the floor: a toy teaset; a toy kitchen stove with miniature pots and pans, spoon, pieces of green sponge; and junk accessories (e.g. brick, straw, rawplug, cottonwool, cube, box) and conventional toy accessories (toy animals, cars, etc.). The combination of objects was based on the studies by Baron-Cohen (1987) and Lewis and Boucher (1988). The child's parents and experimenters remained seated and offered only minimal and non-specific responses to child-initiated approaches. Each child was filmed for 5 min. The presence of any functional and pretend play acts on a two-point scale (0 = no functional or pretend play; 1 = functional play, 2 = pretend play) was entered into the current analysis.

Joint attention task

A series of three active toy tasks based on those described by Butterworth and Adamson-Macedo (1987) were conducted. The child stood or sat between their mother and the experimenter. A series of mechanical toys, designed to provoke an ambiguous response, i.e. to provoke a mixture of attraction and uncertainty in the child, were placed one at a time onto the floor of the room 1–2 m from the child. The toys were a robot, which flashed and beeped and moved around in circular sweeps; a car that followed a circular path around the room; and a pig that made 'oinking' noises and shunted backwards and forwards. The experimenter controlled the toys. They were active for 1 min, during which time they stopped and restarted twice. The proportion of trials on which the infant produced the key joint attention behaviour—a gaze switch between the toy and adult (experimenter or parent)—was entered into the current analysis.

Goal detection tasks

A series of task described by Phillips *et al.* (1992) as 'goal detection' tasks were conducted at different times throughout the testing session.

- Blocking task. When the child was manually and visually engaged with a toy, the experimenter covered the child's hands with his own, preventing the child from further activity, and held the block for 5 s. This was repeated four times during the session.
- Teasing task. The experimenter offered the child a toy. When the child looked at it and began to reach for it, the experimenter withdrew the toy and held it out of reach for 5 s. The experimenter then gave the toy to the child. This was repeated four times during the session.

The key behaviour recorded on each trial was whether the child looked up towards the experimenter's eyes during the 5 s immediately after the block or the tease. This response may indicate the child asking a question (What are you doing?) (Phillips *et al.* 1992) or making an imperative gesture (Give me that back!) (Charman 1998). The teasing and blocking scores were highly intercorrelated (Spearman's rho = 0.85, $p < 0.001$) and to reduce the number of variables entered into the analysis, a composite score for the goal detection (teasing score + blocking score) task was calculated for entry into the analysis.

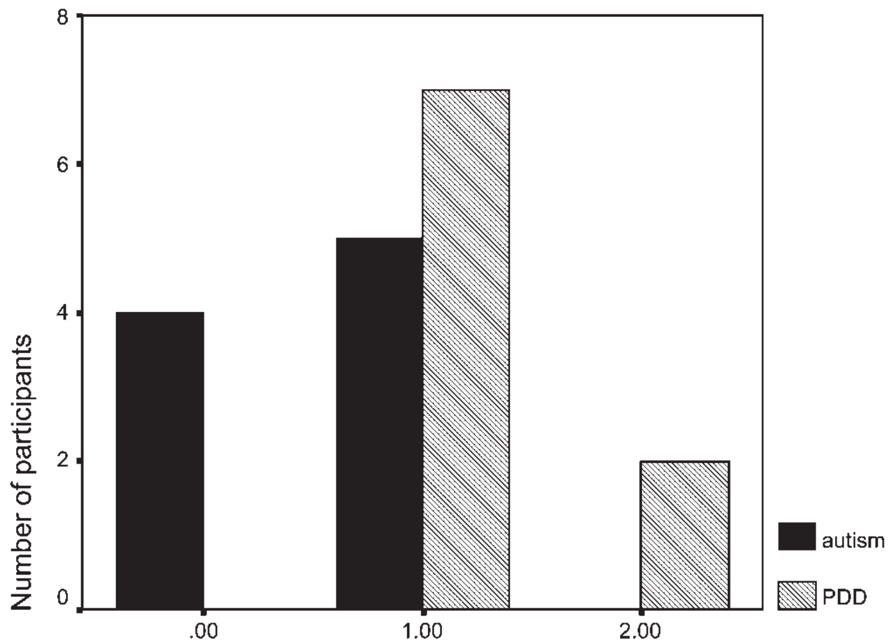
Imitation

The materials and method for the procedural imitation task followed those employed by Meltzoff (1988). The child sat opposite the experimenter. Four actions were modelled, all on objects designed to be unfamiliar to the child. Each act was performed three times. At the end of the modelling period (about 2 min in all), the objects were placed in turn in front of the child. One non-specific prompt (What can you do with this?) was given if the child failed to pick up or manipulate the object at once. The response period was 20 s for each object. The proportion of trials on which the infant imitated the modelled action on the objects was entered into the current analysis.

Results

Performance of the autism and PPD groups on the experimental measures at 20 months

The distributions of scores on the experimental measures are shown in figures 1a–d, separately for children with a diagnosis of autism and PDD. The scores were not normally distributed and a non-parametric analysis was adopted. Performance on the experimental measures was dichotomized into 'high' and 'low' performance around the median split. For the play measure, this was not possible as the majority of participants scored the mode score of 1. The production of no examples of



PLAY20 = play at 20 months. 0=no functional or pretend play; 1=functional play, 2=pretend play.

Figure 1a. Performance on play at 20 months by diagnosis.

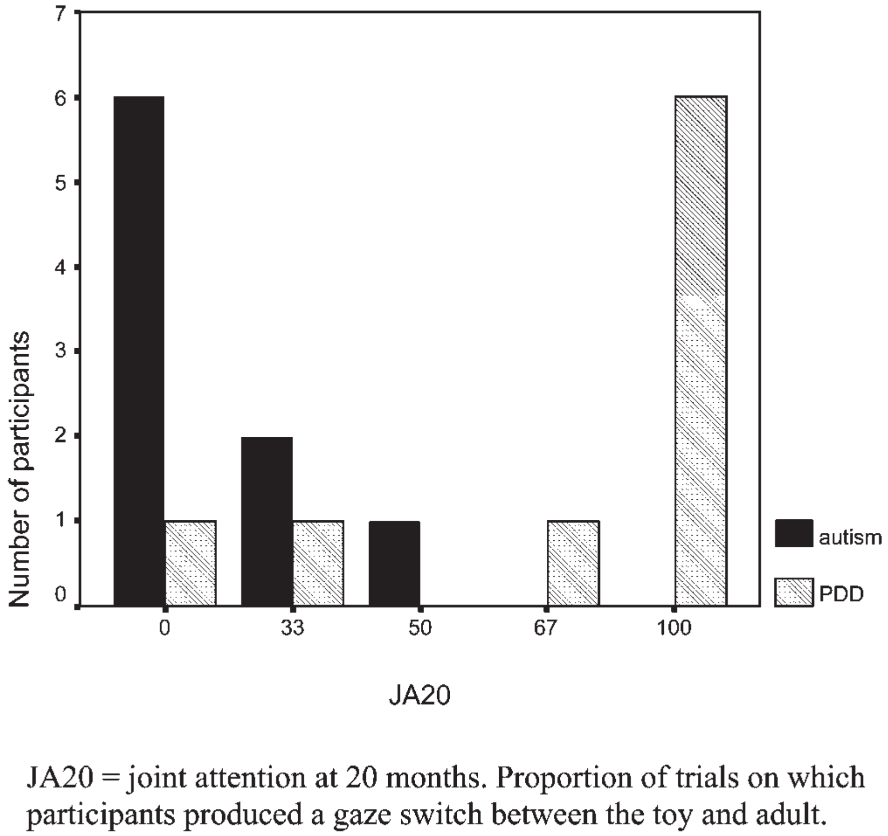


Figure 1b. Performance on joint attention at 20 months by diagnosis.

functional or pretend play (score = 0, *n* = 4) was taken as low play ability and production of either functional or pretend play acts (score = 1 or 2, *n* = 14) was taken as high play ability. For the joint attention measure, gaze switching on 67% or more trials (*n* = 8) was taken as high joint attention ability and gaze switching on 50% or fewer trials (*n* = 10) as low joint attention ability. For the goal detection task, looks to adult on 25% or more trials (*n* = 9) was taken as high goal detection ability and looks to adult on 25% or fewer trials (*n* = 9) as low goal detection ability. For the imitation task, imitating on 50% or more trials (*n* = 10) was taken as high imitation ability, and imitating on 25% or fewer trails (*n* = 8) as low imitation ability. The group was also divided on the basis of 'high' and 'low' NVIQ at 20 months (low NVIQ = less than 85, *n* = 9; high NVIQ = 85 or greater, *n* = 9).

Differences between the autism and PDD participants were compared using Fisher exact comparisons of high versus low performance on each experimental measure and NVIQ. There was a non-significant trend ($p = 0.08$) for the participants with PDD to outperform the participants with autism on the measure of play, reflecting the fact that all four participants who produced no functional or pretend play had autism and both participants who produced pretend play had PDD. The participants with PDD outperformed the participants with autism on the joint attention measure ($p < 0.05$). The diagnostic groups did not differ on the goal detection task or imitation measures or in terms of NVIQ at 20 months.

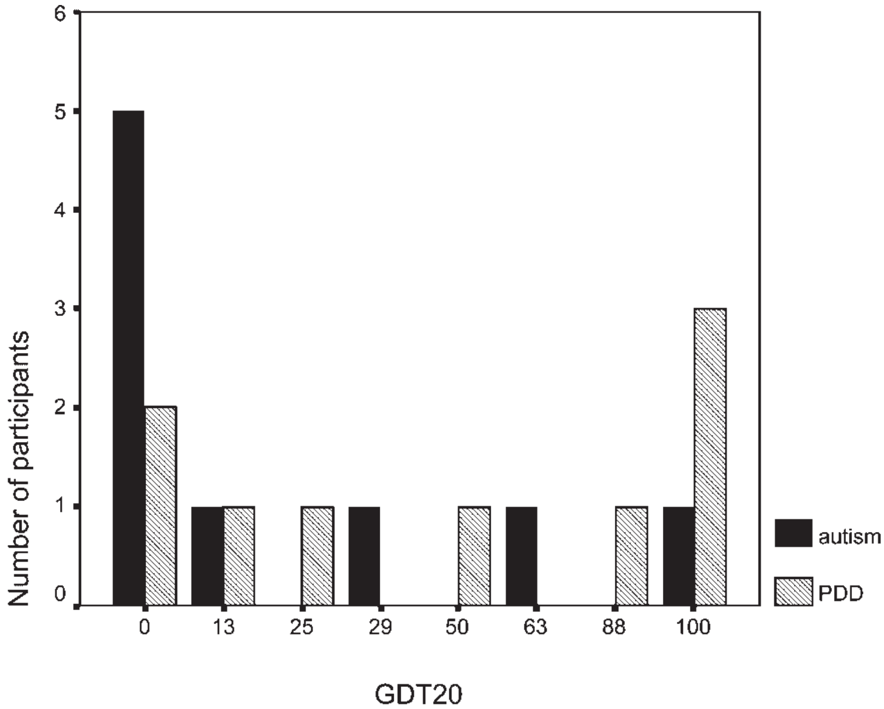


Figure 1c. Performance on goal detection at 20 months by diagnosis.

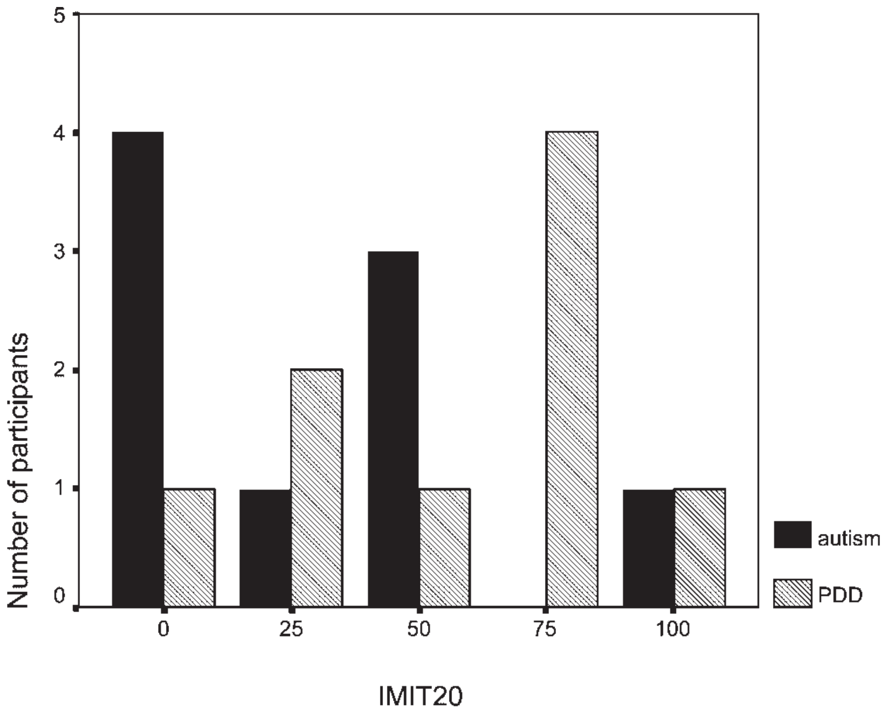


Figure 1d. Performance on imitation at 20 months by diagnosis.

Longitudinal associations between diagnosis and performance on the experimental measures at 20 months and language outcome at 42 months

Table 2 shows the language outcome at age 42 months in terms of raw RL and EL Reynell-DLS scores for the sample divided by diagnosis (autism versus PDD) and low versus high NVIQ and low versus high performance on the experimental measures at age 20 months. Non-parametric Mann–Whitney *U*-tests were conducted, correcting for tied ranks. Both RL and EL were significantly higher at 42 months for the children with PDD compared with the children with autism ($p < 0.01$ and < 0.05, respectively). Language outcome did not differ according to high versus low initial NVIQ. The language scores at 42 months were greater for the high versus low subgroups for all the 20-month experimental measures. However, these differences only reached statistical significance for RL in the high versus low joint attention ($p < 0.05$) and imitation ($p < 0.05$) comparisons.

The present sample size is insufficient to conduct a log-linear analysis to determine separate effects of diagnosis and performance on the experimental measures. However, qualitative inspection of the findings is possible and figures 2a–f shows the individual data for each participant for RL and EL at 42 months according to diagnosis, 20-month NVIQ and high versus low performance on the 20-month experimental measures. Although there is considerable overlap between the autism and PDD groups in EL at 42 months, all but three participants in the PDD group outperformed the participants in the autism group in terms of RL at 42 months (figure 2a). Figure 2b shows that RL and EL outcomes at 42 months were unrelated to NVIQ at 20 months. The presence of only four participants with low play performance at 20 months makes interpretation of figure 2c difficult, but it is notable that the two participants with the lowest language outcomes did produce some (functional) play at 20 months. The EL outcomes for the low versus high joint attention groups overlapped considerably, but the majority of the participants with the highest RL outcomes were in the high joint attention group at 20 months (figure 2d). Note also that only one participant with autism was in the high joint

Table 2. Language outcome at 42 months by diagnostic group and 'high' versus 'low' NVIQ and performance on the experimental measures at 20 months

		EL[a] mean (SD)	RL[b] mean (SD)
Diagnosis	Autism	19.4 (10.8)	18.6 (7.6)
	PDD	29.2 (8.0)*	31.3 (6.6)**
NVIQ	low ability	23.1 (10.8)	23.4 (10.1)
	high ability	25.6 (10.8)	26.4 (9.3)
Play	low ability	18.5 (3.4)	19.5 (3.8)
	high ability	26.0 (11.4)	26.5 (10.2)
Joint attention	low ability	21.1 (11.3)	20.2 (8.2)
	high ability	28.4 (8.4)	30.9 (7.8)*
Goal detection	low ability	20.3 (11.5)	21.9 (11.1)
	high ability	28.3 (8.3)	28.0 (7.0)
Imitation	low ability	21.0 (10.8)	19.9 (8.6)
	high ability	27.0 (10.1)	29.0 (8.6)*

[a] Reynell Expressive Language raw score.
[b] Reynell Receptive Language raw score.
*$p < 0.05$; **$p < 0.01$.

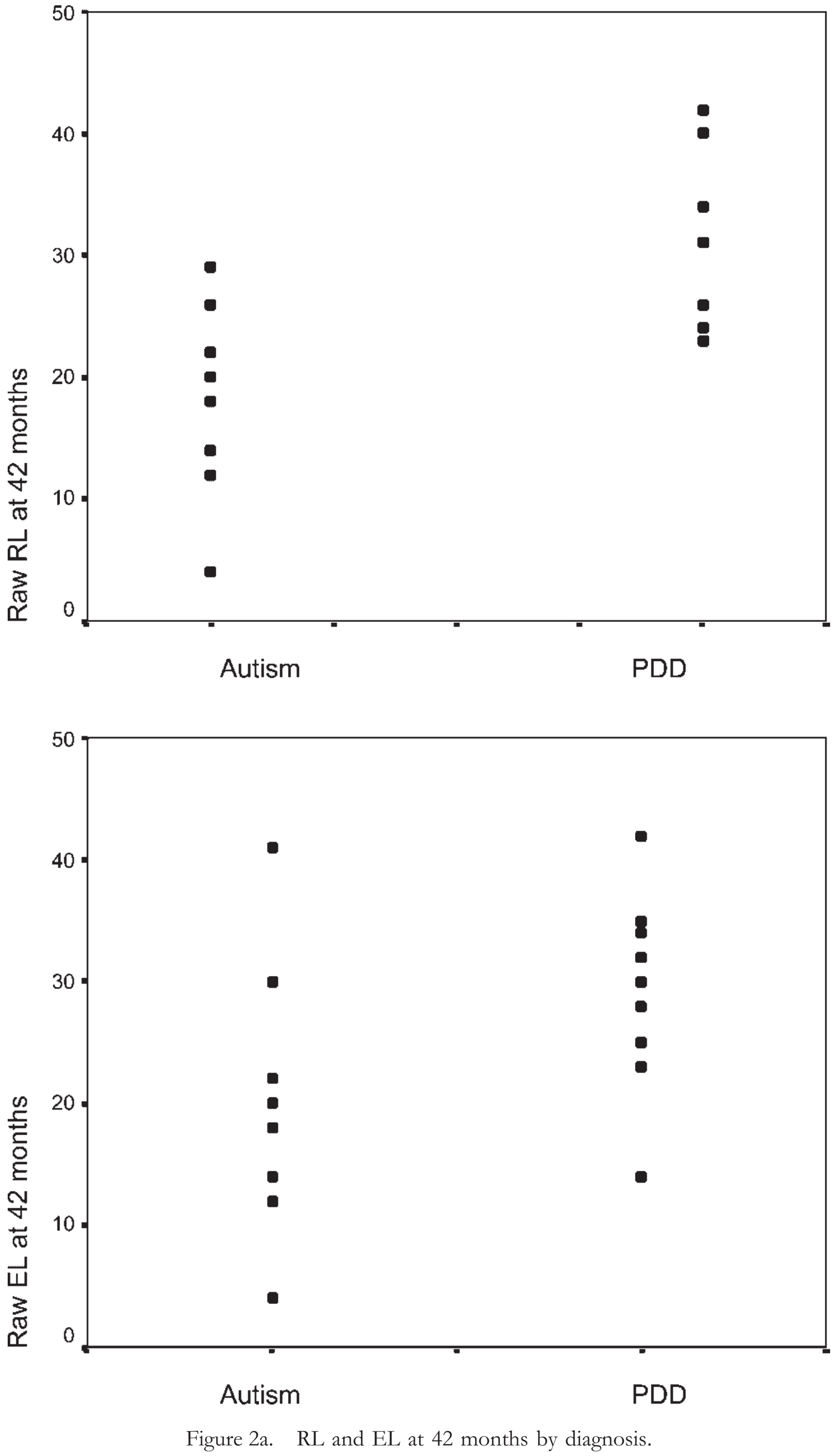


Figure 2a. RL and EL at 42 months by diagnosis.

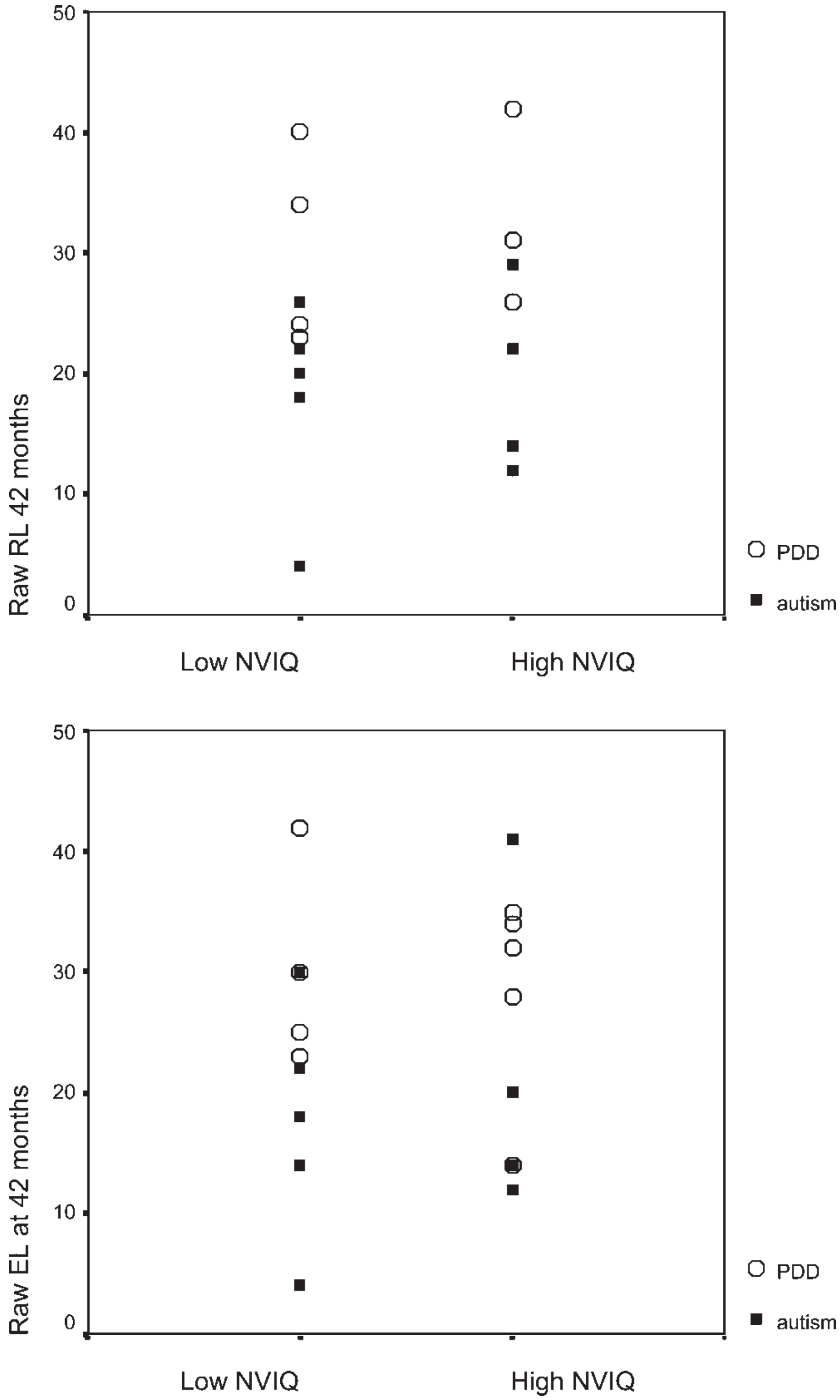


Figure 2b. RL and EL at 42 months by 'high' versus 'low' 20-month NVIQ.

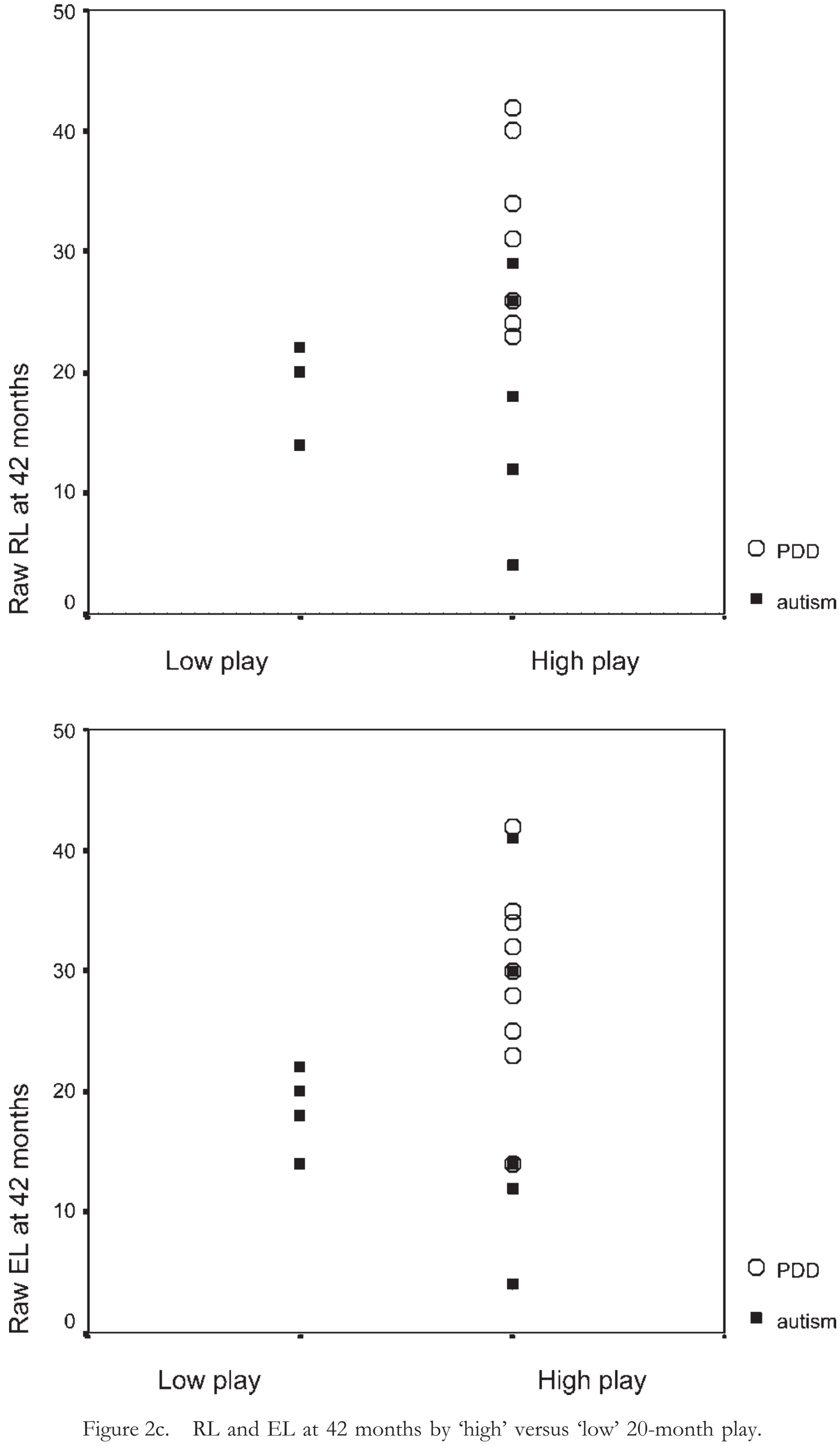


Figure 2c. RL and EL at 42 months by ‘high’ versus ‘low’ 20-month play.

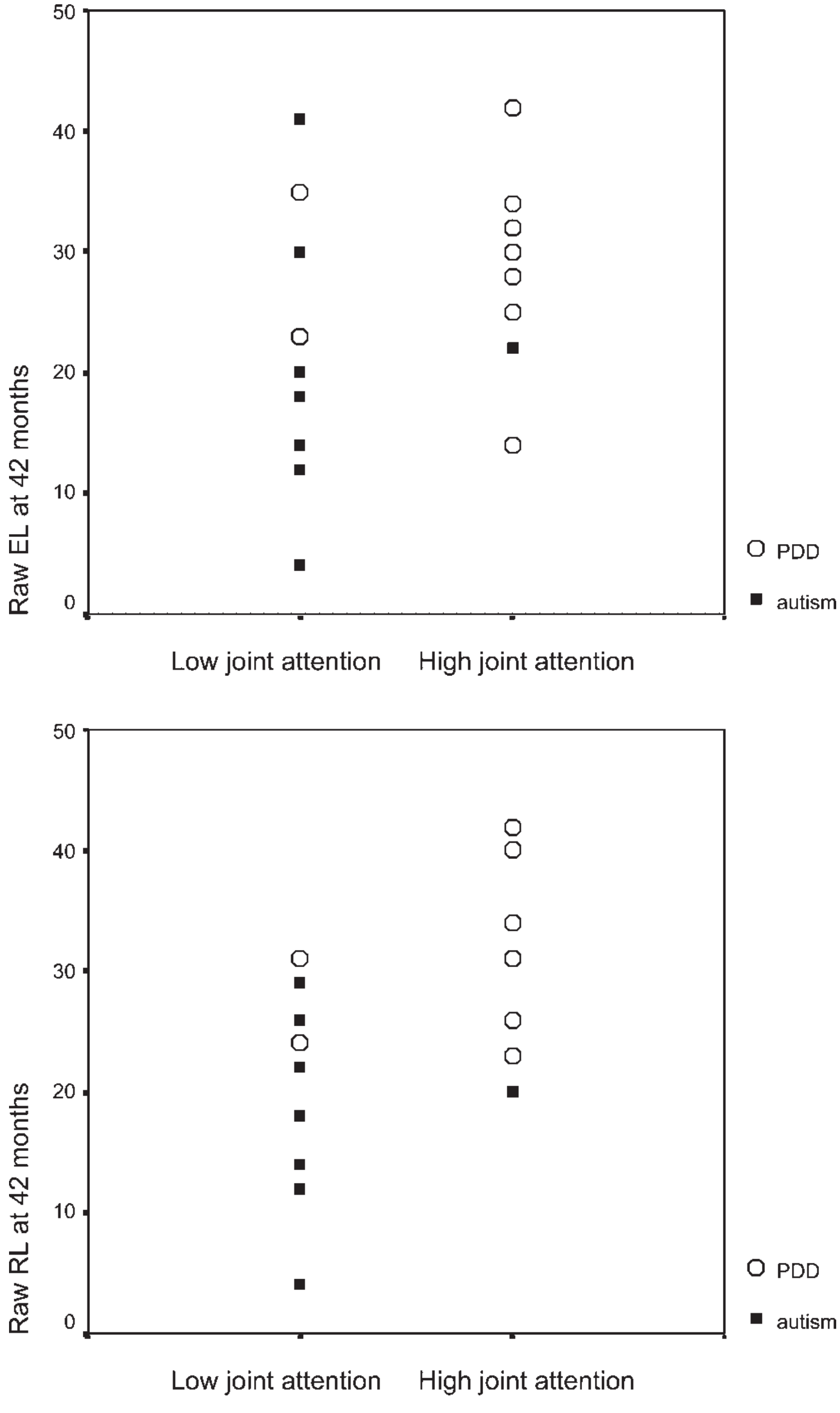


Figure 2d. RL and EL at 42 months by 'high' versus 'low' 20-month joint attention.

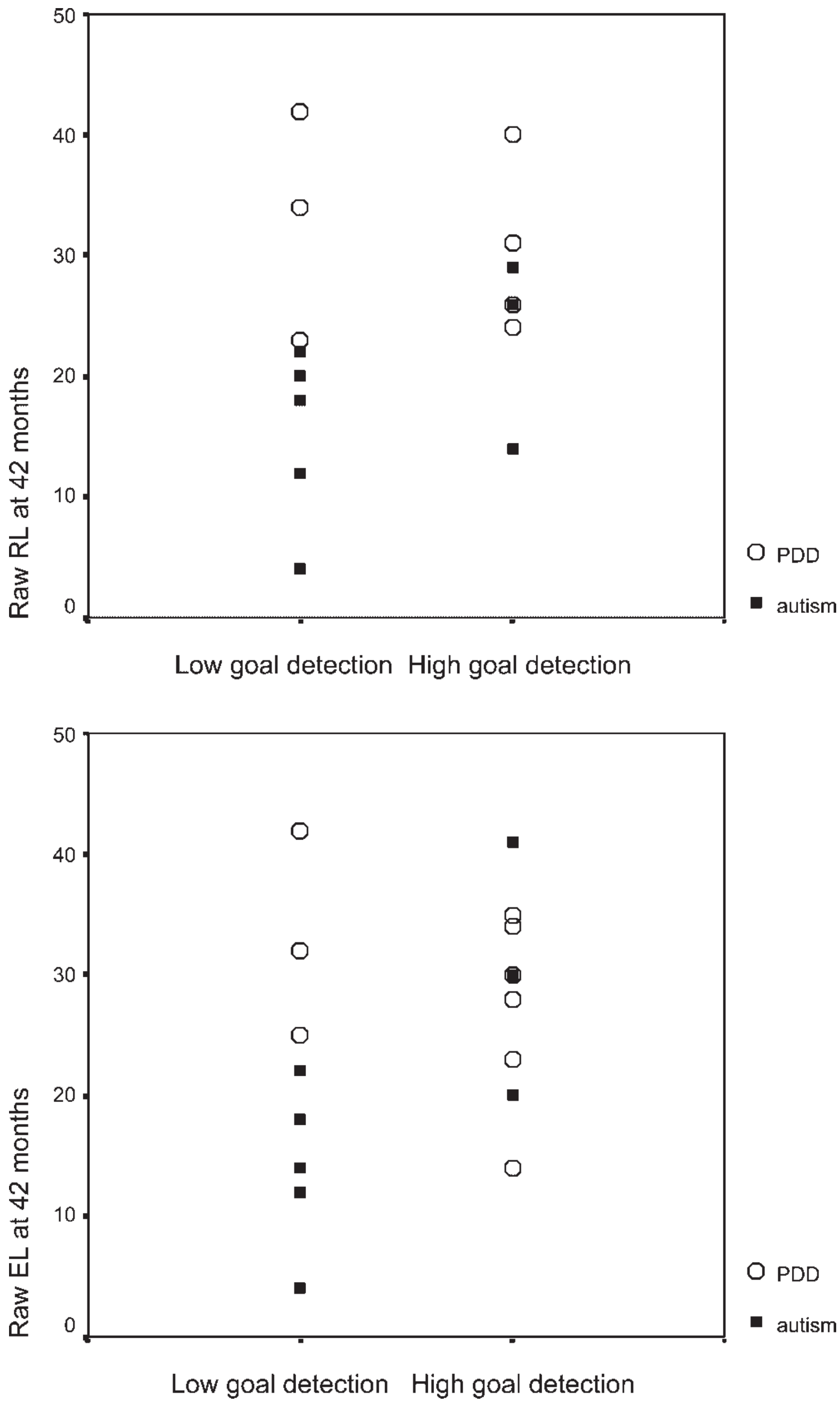


Figure 2e. RL and EL at 42 months by 'high' versus 'low' 20-month goal detection.

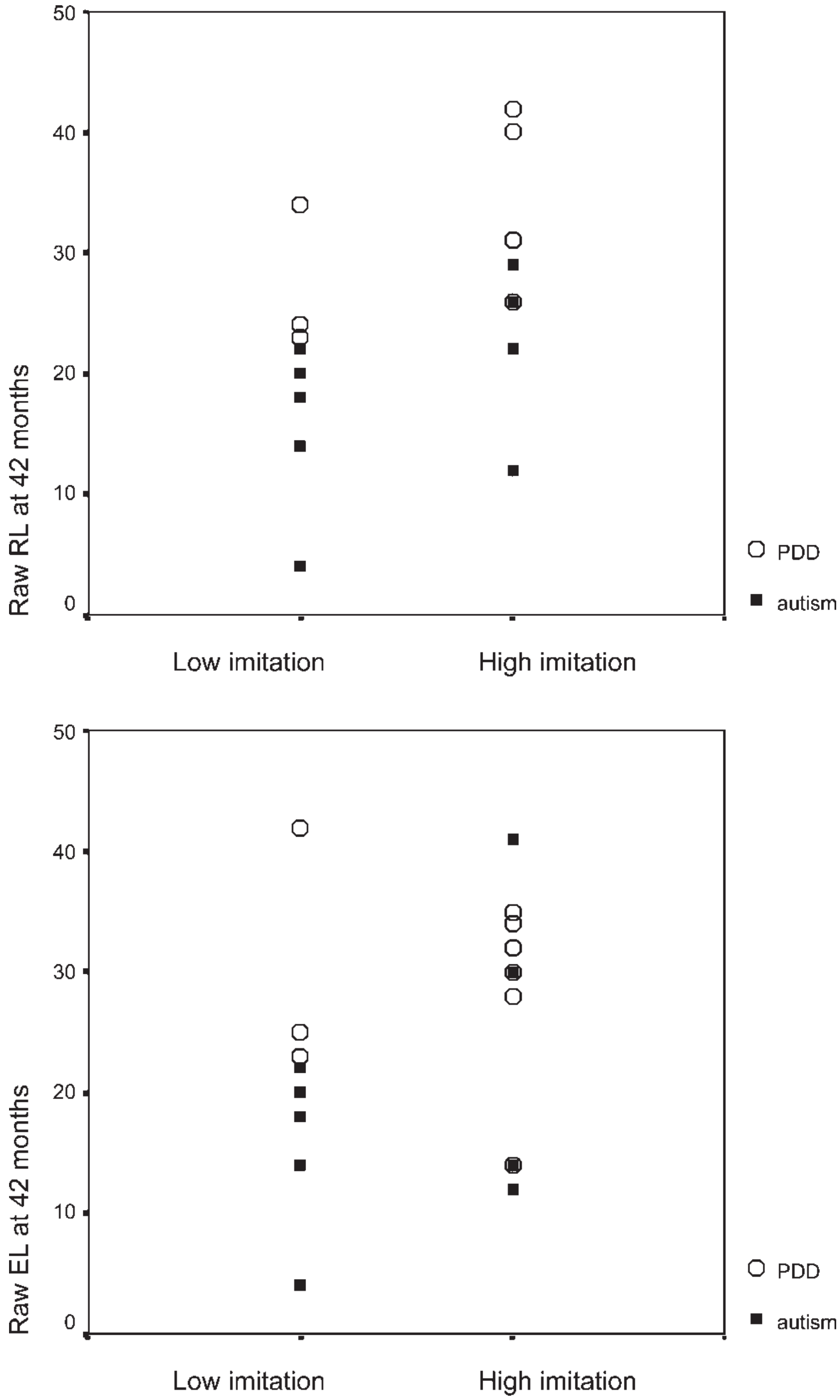


Figure 2f. RL and EL at 42 months by 'high' versus 'low' 20-month imitation.

attention group. Figure 2e shows that the RL and EL outcomes were largely overlapping for the low and high goal detection groups. Although the majority of participants with the highest RL and EL language outcomes were in the high imitation group at 20 months, one participant with high 42 month RL and El scores was in the low imitation group at 20 months.

Discussion

Expressive and particularly receptive language abilities at follow-up were strongly associated with diagnosis. The participants with autism had poorer language outcomes compared with participants with PDD. Although language delay (in tandem with delays in other, non-verbal means of communication) is a defining characteristic of many children with autism spectrum disorders (ICD 1993, Lord and Bailey 2002), language delay may be more severe in children who meet diagnostic criteria for autism than for milder or more atypical presentations that meet criteria for PDD. Neither expressive nor receptive language abilities at follow-up were related in this sample to initial NVIQ, though IQ may still be a significant predictor of overall adaptive and social outcome (Lord and Bailey 2002). Performance on the experimental measure of joint attention (gaze switching) at 20 months was also associated with diagnosis, with the PDD group outperforming the autism group. A similar but weaker and non-significant difference was found for performance on the play task at 20 months. Performance on the goal detection and imitation tasks at 20 months did not differ between the 2 groups (Charman *et al.* 1998).

Receptive but not expressive language outcome was significantly positively associated with performance on the joint attention and imitation tasks at 20 months. That is, greater responsiveness to joint attention bids and imitation of modelled actions was associated with higher levels of receptive language. Although the direction of associations was similar for pretend play and goal detection performance at 20 months, as was the association between all four experimental measures and expressive language, these differences did not reach statistical significance. The present small sample did not allow us to examine the effects of diagnostic group and performance on the experimental measures of early social-communicative on later language ability independently of each other. However, qualitative inspection of the data for individual participants suggests that these effects may be separable at least for some individual children. For example, figures 2e and f indicate that the participant with autism with the best expressive language outcome was in the 'high' goal detection and 'high' imitation group at 20 months. Conversely, although some participants with autism produced some examples of functional (but not pretend) play at 20 months, they had poor expressive and receptive language at follow-up (figure 2c).

The present findings extend those of previous studies by examining longitudinal associations between early social-communication behaviours and later language outcomes in children with autism and PDD. The findings are consistent with some but not all previous studies. Similar to the present findings, Mundy *et al.* (1990) found that joint attention behaviour (alternating gaze, pointing, showing and gaze following) was associated with later receptive and not with expressive language. In contrast, Sigman and Ruskin (1999) found that joint attention ability was associated with gains in expressive but not with receptive language. Further, in Sigman and Ruskin (1999), functional (but not symbolic) play at the initial assessment also predicted improvement in expressive (but not receptive) language skills. The current findings are also consistent with those of Stone and colleagues who found a longitudinal association between imitation and joint attention and later expressive language ability (Stone *et al.* 1997, Stone and Yoder 2001). Stone and Yoder also found that play was longitudinally associated expressive language, again not replicated in the present study. Stone *et al.* also demonstrated specificity in the longitudinal associations between imitation abilities and later language ability in that imitation of body movements but not actions on objects was associated with later expressive language skills. We had intended to include imitation of a series of gestures (Charman and Baron-Cohen 1994) as well as actions on objects. However, the first few participants tested could not be sufficiently engaged in a face-to-face imitative situation (or at least were not socially interested enough to watch the adult or to respond) and this measure was dropped from the study.

The present study has several limitations that limit the interpretation of the findings. One is the restricted sample size that increases the risk of type II errors. Another is the relatively undifferentiated level at which some of the social-communicative behaviours were measured. For example, an ordinal (0-1-2) coding was used to measure the presence/absence of any functional or pretend play acts in the spontaneous play session. In addition to the difficulties with measuring gestural imitation mentioned above, other more differentiated aspects of the social-communicative measures that warrant attention in future studies include the sequence of responses to and initiation of joint attention acts as measured by the ESCS (Seibert *et al.* 1982, Mundy *et al.* 1990, Sigman and Ruskin 1999), and coding of affect during such interactions (Kasari *et al.* 1990). As already indicated, the very young age and difficulty of interacting with the children with autism and PDD forced some of these restrictions upon us. For example, we did code points towards the activated toy and vocalizations in the joint attention tasks but in the autism and PDD participants these behaviours occurred so rarely as to be unanalysable (Charman *et al.* 1997, 1998). We also coded doll and non-doll related play separately, but again the rarity of these behaviours amongst the present sample meant we could only analyse data at the less differentiated level. Another limitation was the long interval between data collection points. Consequently, associations that may have held over one period (e.g. from 20 to 30 months) will have been missed. Future studies should follow children from infancy into the preschool years at shorter intervals. Another limitation was that we had no formal measure of language at 20 months. Although the Reynell-DLS was attempted with each participant at this age, nearly all the sample fell below this basal at age equivalent of 12 months. This reflects a more general difficulty of using formal language assessments with children with autism spectrum disorders at a young age (Charman *et al.* 2003). There is also some circularity to this issue as very early communication behaviours assessed by many language schedules include joint attention and imitation behaviours similar in kind to the experimental tasks of social-communication included in the current study.

On the positive side, prospective identification of infants with autism and PDD using the CHAT screen enabled us to study the associations between early social-communicative ability and later language ability at a younger age than has previously been accomplished. Other recent work has identified social-communicative impairments in children with autism in skills that emerge in typical development earlier than those studied here, e.g. in social orienting (Dawson *et al.* 1998, Baranek 1999).

Future studies should build on such advances in order to study how different aspects of social-communication ability measured in infants with autism spectrum disorder relate to later language and social outcomes. Although the practical obstacles to such studies are considerable, sample sizes should be sufficient to conduct analyses that look at the independent contributions of diagnosis and early social-communication ability that was not possible with the present sample.

Conclusions

The present findings add to our understanding of social-communicative competence in young children with autism. Confirming the majority of previous work, both joint attention and imitation were longitudinal predictors of later language ability, although in contrast to other studies, measures of play behaviour were not—although this may be due to floor effects.

Notwithstanding the gaps that remain in our knowledge, the present study demonstrated that early social-communication skills can be measured in infants with autism spectrum disorder. In clinical assessments of 2- and 3-year olds with autism, many of whom may have little if any language ability, the assessment of these early social-communication abilities may provide important prognostic indicators. Fortunately, several standardized instruments, including the ESCS (Seibert *et al.* 1982) and ADOS (Lord *et al.* 1999, 2000), are available to aid in this process (Baird *et al.* 2001, Charman and Baird 2002 for reviews).

Furthermore, it is widely agreed that non-verbal social-communicative behaviours such as joint attention, imitation and play are an appropriate target for intervention efforts (Dawson and Galpert 1990, Bondy and Frost 1995, Rogers 1998, Drew *et al.* 2002). There is also evidence that experimental manipulation and even individual differences in adults' social responsiveness to a child with autism in turn affects their social interaction (Lewy and Dawson 1992, Knott *et al.* 1995, Willemsen-Swinkels *et al.* 1997, Siller and Sigman 2002). It is increasingly clear that social-communication behaviours that emerge typically in infancy are related to later language and social outcomes in individuals with autism. We need to refine both the measurement and the definition of these abilities and adopt longitudinal and controlled treatment designs to understand what the mechanism of association to later language and social outcomes might be. This will allow us to understand better the course, and develop strategies to ameliorate the effects, of the underlying psychopathology that characterizes autism.

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