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Research Report

Communicative and linguistic development in preterm children: a longitudinal study from 12 to 24 months

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Abstract

Background: Research conducted on preterm children's linguistic skills has provided varying pictures, and the question of whether and to what extent preterm children are delayed in early language acquisition remains largely unresolved.

Aims: To examine communicative and linguistic development during the second year in a group of Italian children born prematurely using the 'Primo Vocabolario del Bambino' (PVB), the Italian version of the MacArthur–Bates Communicative Development Inventory. The primary goal was to compare action/gesture production, word comprehension, and word production, and the relationship between these three domains in preterm children and to normative data obtained from a large sample of Italian children born at term. A second aim was to address the longstanding debate regarding the use of chronological versus corrected gestational age in the assessment of preterm children's abilities.

Methods & Procedures: Parents of twelve preterm children completed the PVB questionnaire at five age points during the children's second year, and scores were compared with those from a normative sample of full-term children and those of 59 full-term children selected as a control group from the normative sample for the PVB.

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Outcomes & Results: Preterm children exhibited a delay in all three aspects of communication and language. In particular, communicative–linguistic age tended to lag approximately 3 months behind chronological age when children were between the ages of 12 and 24 months. When chronological age was used, preterm children's percentile scores for all three components of communication and language fell within the lower limits of the normal range, while scores calculated using corrected age either fell at or above the 50th percentile.
Conclusions & Implications: Findings suggest that despite the significant biological risk engendered by premature birth, early communicative and linguistic development appears to proceed in a relatively robust fashion among preterm children, with tight relations across communicative domains as in full-term children. Employing both chronological and corrected gestational age criteria in the evaluation of preterm children's abilities may provide important information about their progress in language acquisition. This may be especially important during the initial stages of communicative and linguistic development, inasmuch as comparisons of the two sets of scores may provide clinicians with a way to distinguish children who may be at risk for language problems from those who may be expected to progress normally.

Keywords: language development, gesture, vocabulary, preterm.

What this paper adds
Continuation of the debate about the use of chronological and corrected gestational age in preterm children.
Ways are suggested of assessing and measuring the communicative and language development of preterm children during their second year of life across the domains of action/gesture and vocal development.

Introduction

In this research, we focus on early communicative and linguistic development in preterm children from 12 to 24 months of age using longitudinal data. We ask whether and to what extent preterm children differ from full-term children in different aspects of communication and language (action/gestures, word comprehension, and word production). A second goal is to examine different criteria for evaluating early preterm children's abilities (that is, chronological age [CA] or gestational corrected age [GA]) and determine their appropriateness.

A number of studies have examined the developmental consequences of premature birth and related perinatal complications (Hack and Taylor 2000, Aylward 2002, Foulder-Hughes and Cooke 2003), focusing in particular on biological factors such as birth weight, the length of gestation, and the presence of medical complications, as well as on the relationship between preterm birth and long-term patterns of development of motor, cognitive, linguistic, and behavioural adjustment. These studies have reported, for example, that length of gestation tends to be a strong neonatal predictor of subsequent language outcome (Aylward 2002, Foster-Cohen *et al.* 2007, Kern and Gayraud 2007), and that birth weight is related to later language development (Luoma *et al.* 1998, Hindmarsh *et al.* 2000, Sansavini *et al.* 2006).

Although developmental outcomes of preterm children have been a topic of considerable attention, results of these studies have varied and have led researchers to draw different conclusions about the consequences of preterm birth. Thus, for example, some studies comparing the development of full-term and preterm infants have reported that preterm infants tend to have lower developmental quotients, even when their skills are assessed on the basis of corrected GA (Siegel 1982, Crnic *et al.* 1983). Preterm children also exhibit delays in phonological abilities, receptive and expressive language, utterance length, utterance complexity, and phonological short-term memory (Seidman *et al.* 1986, Censullo 1994, Bortolini *et al.* 1996, Briscoe *et al.* 1998, Gallagher and Watkin 1998, Robinson and Gonzales 1999). These delays seem to persist or emerge later in childhood and are apparent well into adolescence (McCarton *et al.* 1997, Taylor *et al.* 2000, Magill-Evans *et al.* 2002).

However, other studies have reported that language development is not impaired in children born preterm (Greenberg and Crnic 1988, Stevenson *et al.* 1988, Menyuk *et al.* 1995, Rvachew *et al.* 2005, Sansavini *et al.* 2006, Stolt *et al.* 2007). For instance, Greenberg and Crnic (1988) used the Peabody Picture Vocabulary Test and the Sequenced Inventory of Communicative Development to examine receptive language abilities in preterm and full-term children at 2 years of age. They found no differences in the scores obtained by children in the two groups. In addition, relative to a matched group of full-term infants, preterm infants at 8 months corrected for GA demonstrated higher levels of performance on receptive language tasks, but performed similarly to full-term children on productive language tasks in a laboratory mealtime setting (Stevenson *et al.* 1988).

In the last ten years, a growing number of studies have utilized the MacArthur–Bates Communicative Development Inventory (MBCDI) to investigate lexical and grammatical development in preterm children from 1;6 and 2;6 years of age, and results have been mixed. Magill-Evans and Harrison (1999) compared 49 healthy preterm and 54 full-term children at 18 months corrected for GA and found that preterm children scored significantly lower than the full-term control group on the number of words produced. Foster-Cohen *et al.* (2007) assessed the language development of 90 children born very preterm (less than 33 weeks gestation and/or birth weight less than 1500 g) and a comparison sample of 102 children born full-term (38–41 weeks gestation) at age 2;0 corrected for GA. Relative to children born full-term, children born preterm tended to perform less well across a range of measures, including vocabulary size and quality of word use, as well as morphological and syntactic complexity.

However, other studies using the MBCDI have not found differences between preterm and full-term children (for example, Dale *et al.* 1989). More recently, Sansavini *et al.* (2006) investigated lexical and grammatical abilities in two groups of children at 2;6 corrected for GA (73 preterm and 22 full-term), using the *Words and Sentences* form of the PVB (Caselli and Casadio 1995) and a test of sentence repetition (Devescovi and Caselli 2001). No significant differences between the preterm and full-term children emerged on either measure. Moreover, the scores for both the lexical repertoire and grammatical abilities fell within the normal range. The authors also analysed possible dissociations between lexicon and grammar and found that these domains were tightly related in the preterm sample, as was observed in the control sample and in the Italian normative sample (Caselli *et al.* 1999). Another study involving French preterm children concluded that the vocabulary size and several grammatical categories of lexicon of preterm children

(between 33 and 36 weeks gestation) at CA 2;0 did not fundamentally differ from full-term children (Kern and Gayraud 2007). However, extremely preterm children (less than 28 weeks gestation) and to a lesser extent very preterm children (between 28 and 32 weeks gestation) consistently had significantly lower scores than full-term children. Similar findings were reported by Stolt *et al.* (2007) who analysed lexical repertoire size in 66 prematurely born very-low-birth-weight and 87 full-term Finnish children at 2;0 corrected for GA, using the Finnish version of the MBCDI. The two groups of children did not differ in vocabulary size, suggesting that preterm children, as a group, acquire their early lexicon quantitatively in a similar way to full-term children. However, these authors speculated that the age correction used in their study for preterm children at 2 years may have overestimated the children's lexical abilities.

The methodological controversy regarding the appropriate criteria for evaluating preterm children's abilities is still ongoing (that is, whether performance should be assessed on the basis of CA or GA; for a recent discussion, see Wilson and Michaeleen Cradock 2004). Although age adjustment is standard in clinical practice until children reach the age of 2 years, the current body of research does not speak to the use of age adjustment, specifically regarding whether and how to apply corrections. This issue was addressed in work by Menyuk *et al.* (1991, 1995), who employed both CA and corrected GA in their longitudinal study of early cognitive and lexical development in preterm and full-term children. Analyses of maternal diary data revealed no reliable differences in the ages at which children in both groups attained developmental milestones in word comprehension and production. However, when preterm children's ages were corrected to their GAs, they were found to be significantly ahead of their full-term peers with regard to the age at which they first comprehended 50 and 100 words. A similar result was obtained with respect to the production of words, with preterm infants reaching the 10 and 50 word milestones at significantly earlier ages than full-term comparison children.

In sum, research to date has provided varying pictures of preterm children's linguistic skills, and the question of whether and to what extent preterm children are delayed in early communicative and linguistic acquisition remains largely unresolved. In the present study we systematically evaluate preterm children's communicative and linguistic abilities longitudinally on the basis of both CA and corrected GA. While most studies have tended to focus on performance on aspects of language that develop in the course of the third year (that is, word production and grammar), we consider three different aspects of communication and language (actions/gestures, word comprehension, and word production) as they develop over the course of the second year. We look specifically at developmental change within each of these components, as well in the relationships among them at five time points from chronological ages 12 to 24 months.

The present longitudinal study had two aims. The first was to examine the course and nature of early development in the domains of action/gesture production, word comprehension, and word production in preterm children and compare them to the norms (that is, data from children of the same CA) for the PVB. We expected to find delays across development in all three domains when preterm are compared with full-term children on the basis of CA. To measure the extent of early communicative and linguistic delay, we analysed differences between preterm children's CAs and their corresponding language ages established using the

PVB norms. We also examined relationships among action/gesture production, word comprehension, and word production over the course of the second year.

Our second aim was to address the longstanding debate regarding the use of CA versus corrected GA in the assessment of preterm children's abilities in two ways. In a within-group analysis, we compared the sets of PVB scores obtained for individual preterm children on the basis of CA with those computed on the basis of corrected GA. In a subsequent between-groups analysis, we examined the course of early communicative and linguistic development in preterm children relative to five different comparison subgroups of full-term children selected from the PVB normative sample whose CAs matched preterm children's corrected GAs at each observation. In line with prior work (Wilson and Michaeleen Cradock 2004, Stolt *et al.* 2007), we expected that the use of corrected GA would reduce or even eliminate group differences because it may provide an overestimate of preterm children's language abilities.

Methods

Participants

Participants in this study were twelve children (six males and six females) born prematurely between 1992 and 1993 at the I.R.C.C.S. 'Burlo Garofalo' Trieste, Italy. Ten of the children were firstborn and two were secondborn; all came from monolingual, intact, lower-middle to middle-class Italian-speaking families. Nine of the mothers had completed at least some secondary school, one had a high school diploma, and two had university degrees. Of the fathers, five had completed some secondary school, three had high school diplomas, and four had university degrees.

Data on the children's newborn medical histories are presented in table 1. The length of gestation for the children ranged from 26 to 34 weeks, and they weighed between 840 and 2790 g at birth. Two children weighted less than 1060 g and the length of gestation was less than 30 weeks. All of the births were uneventful (that is, there was no evidence of foetal distress), and none of the children was born as a

Table 1. Newborn characteristics of preterm children

Child	Gestation (weeks)	Birth weight (g)	Foetal distress	Apgar scores (1–5 minute)	Hospitalization (days)
1	34	1900	None	8–9	17
2	30	1230	None	6–10	55
3	32	1280	None	9–10	40
4	32	2080	None	8–10	25
5	28	840	None	5–8	165
6	34	2700	None	8–9	15
7	32	1860	None	5–7	26
8	33	1860	None	9–10	20
9	34	2600	None	7–9	15
10	26	1060	None	n.a.	85
11	34	2790	None	7–9	38
12	33	1950	None	9–10	21
Mean (standard deviation)	31.8 (2.6)	1845.8 (654.8)	–	–	43.5 (43.4)

Note: n.a., Not available.

result of a multiple pregnancy. With the exception of one child (for whom scores were not reliable), Apgar scores for all children were at or above 5 at the first minute after birth and above 7 at the fifth minute. All of the children were hospitalized for periods ranging from 15 to 165 days.

Following hospital discharge, the children were seen periodically for check-ups at the clinic in the hospital at which they were born. At these visits, all appeared to be free of neurological disorders, mental retardation, or neurosensory deficits, with the exception of one case of Retinopathy of Prematurity that was treated with cryotherapy. One family could not be located for the 24-month data collection, and thus there was a missing data point at the last observation.

A total of 59 full-term children were selected from the normative sample for the PVB to form a matched GA control group. At each observation point, each preterm child was paired with a full-term child whose chronological age matched the gestational age of the preterm child. All children, born between 1990 and 1993 came from monolingual, lower-middle to middle-class Italian-speaking families. Using this procedure, five different groups of twelve full-term children were created for purposes of comparison, one for each age point (eleven children at the last age point).

Materials and procedure

Parents of preterm children were asked to complete the PVB (Caselli and Casadio 1995) on five occasions during their child's second year, when the children were CAs 12, 15, 18, 21, and 24 months, respectively. The PVB was given to parents by a speech therapist, who provided basic instructions for completing the inventory and answered any questions. Parents completed the inventory at home, usually a few days before their child's initial assessment with the speech therapist. Parents completed the *Words and Action/Gestures* form of the questionnaire at the first three age points (12, 15, and 18 months) and the *Words and Sentences* form at the two final observations (21 and 24 months).

The PVB was normed on a sample of 700 full-term, typically developing Italian children between the ages of 8 and 30 months and consists of two forms. The *Words and Action/Gestures* form assesses the onset of communication skills in children between 8 and 17 months of age. The first part of this form consists of a checklist of 408 words; next to each word, the parent is asked to check whether the child only understands or understands and says the word. The second part consists of a checklist of 63 gestures (for example, pointing, waving bye-bye) and actions (for example, putting a telephone to the ear) divided into five categories, and the parent is asked to indicate those that the child produces.

The *Words and Sentences* form of the PVB assesses later-developing communication skills, including grammatical development, in children between the ages of 18 and 30 months. This form includes a checklist of 670 words, and the parent is asked to indicate those words that the child produces. Children's use of certain aspects of morphology (for example, singular/plural noun forms, verb conjugation) and production of simple and complex sentences are also evaluated.

In the present study, we examine the three aspects of early communication that are evaluated by the *Words and Action/Gestures* scale (word comprehension, word production, and action/gesture production). For the *Words and Sentences* form, only data on word production will be considered.

Table 2. Correlations of length of gestation, birth weight, and length of hospitalization for action/gesture production, word comprehension, and word production

		Chronological age (months)				
		12	15	18	21	24
Length of gestation	Action/gesture production	0.05	0.05	0.19	–	–
	Word comprehension	−0.02	−0.33	−0.21	–	–
	Word production	0.27	−0.02	0.03	0.18	0.21
	Total	0.01	−0.29	0.15	–	–
Birth weight	Action/gesture production	0.02	0.09	0.16	–	–
	Word comprehension	0.09	−0.30	−0.32	–	–
	Word production	0.39	0.07	0.14	0.17	0.21
	Total	0.10	−0.25	−0.22	–	–
Length of hospitalization	Action/gesture production	−0.03	0.09	0.14	–	–
	Word comprehension	−0.13	0.57	0.41	–	–
	Word production	−0.34	0.02	−0.11	−0.32	−0.16
	Total	−0.14	0.51	0.33	–	–

Note: *P*s all non-significant.

Results

Preliminary correlational analyses were conducted to assess potential relations between total communication and language scores on the PVB at each observation point and three risk factors: length of gestation, birth weight, and length of hospitalization (table 2). None of these correlations was significant (all *r*s between −0.29 and 0.51, all *p*s>0.05). In addition, partial correlations carried out separately between scores on the three subscales of the PVB (action/gesture production, word comprehension, word production) at each observation point and individual risk factors were all not significant (all *r*s between −0.34 and 0.57, all *p*s>0.05; table 2).

We now turn to data relevant to our two study aims and begin by examining the course and nature of early development in the domains of action/gesture production, word comprehension, and word production in preterm children. We conducted three sets of analyses to address the first aim. The first set of analyses involved between-groups comparisons of longitudinal data on word comprehension, word production, and action/gesture production in the preterm children in our sample and comparable data from full-term children of the same CA from the PVB normative sample. This is a descriptive analysis to depict the course of the developmental trajectories between preterm children and the PVB normative sample. This exploration prepares the ground for the subsequent analyses.

The second and third sets are within-group analyses focusing only on the preterm children. These involve comparisons of the chronological and communicative–linguistic ages of the preterm children and of relative performance across communicative and linguistic domains.

Developmental changes in word comprehension, word production, and action/gesture production as function of CA

Table 3 presents means and standard deviations for action/gesture production, word comprehension, and word production for the preterm children and the normative

Table 3. Means for action/gesture production, word comprehension, and word production at each observation in preterm children (chronological age), matched 'Primo Vocabolario del Bambino' (PVB) normative sample and matched gestational corrected age (GA) sample

Inventory	Sample	Chronological age (months)	Corrected gestational age (months)	Action/gesture production	Word comprehension	Word production
Words and action/gestures	Preterm	12	9.67 (0.7)	15.3 (10.2)	40.2 (31.9)	2.4 (3.1)
	PVB normative	12		29.0 (8.0)	109.0 (57.0)	8.0 (9.0)
	Matched GA	9.67 (0.7)		9.2 (5.2)	23.0 (16.7)	1.3 (2.6)
	Preterm	15	12.67 (0.7)	28.3 (11.2)	102.3 (80.9)	10.3 (10.2)
	PVB normative	15		37.0 (10.0)	141.0 (71.0)	16.0 (17.0)
	Matched GA	12.67 (0.7)		30.1 (11.2)	115.3 (64.7)	5.3 (6.1)
	Preterm	18	15.67 (0.7)	42.6 (8.1)	160.4 (79.3)	25.8 (23.4)
	PVB normative	18		40.0 (9.0)	186.0 (85.0)	32.0 (40.0)
	Matched GA	15.67 (0.7)		38.3 (7.5)	185.1 (75.6)	12.2 (12.0)
Words and sentences	Preterm	21	18.67 (0.7)	–	–	86.2 (88.7)
	PVB normative	21		–	–	130.0 (119.0)
	Matched GA	18.67 (0.7)		–	–	76.58 (53.0)
	Preterm	24	21.67 (0.7)	–	–	190.6 (155.4)
	PVB normative	24		–	–	331.0 (167.0)
	Matched GA	21.67 (0.7)		–	–	103.9 (88.9)

Note: Standard deviations are given in parentheses.

Table 4. Correlations across time points for *action/gesture production*, word comprehension, and word production

	12	15	18	21
Action/gesture production				
12				
15	0.81**			
18	0.70**	0.92**		
Word comprehension				
12				
15	0.53*			
18	0.48	0.93**		
Word production				
12				
15	0.66*			
18	0.71**	0.98**		
21	0.47	0.76**	0.82**	
24	0.38	0.66**	0.69**	0.93**

Note: *$p<0.05$ and **$p<0.01$.

sample of children of the same CAs as the preterm children reported by Caselli and Casadio (1995). Data from this group are included to provide an illustration of developmental change in these scores in the normative sample of full-term children. As is evident in the table, relative to the PVB normative sample, preterm children had smaller action/gesture repertoires at 12 and 15 months, but by 18 months this difference had disappeared. In addition, preterm children on average had smaller lexical repertoires in both comprehension and production at all ages. Interestingly, although the gap between the preterm and normative sample scores for word comprehension decreased over time, that for word production scores increased over time, with preterm children producing about 25% and 50% fewer words than children in the normative sample at 21 and 24 months, respectively.

We next looked across the five observation points to determine whether there were relationships between communicative and linguistic components over time among preterm children. These correlations are presented in table 4. In the action/gestural modality, there was a positive and highly significant correlation between action/gesture production at 12 months and action/gesture production at later ages. In contrast, word comprehension was positively and significantly correlated, but only at contiguous age points ($r=0.53$ for 12–15 months; $r=0.93$ for 15–18 months). Although the correlation between word comprehension at 12 and 18 months was positive, it was not statistically reliable. Word production was positively and significantly correlated across all of the observation points. In particular, the correlations between productive vocabulary size at 15 months and all subsequent observations were highly significant. This suggests that data collected with the PVB at 15 months may serve as a reliable predictor of risk in later stages of language development.

Comparisons of the CAs and LAs of preterm children

In light of the general picture of delay presented by these data, our next step was to examine the size of the gap between preterm children's CA and their levels of

Table 5. Comparisons between chronological age and mean language age for action/gesture production, word comprehension, and word production at each observation

Chronological age (months)	Corrected gestational age (months)	Mean language age (months)	Language component	*t*	Mean difference	*p*-value
12	9.67 (0.7)	10.21 (2.0)	Action/gesture production	−3.06	−1.71	<0.01
		9.58 (1.6)	Word comprehension	−5.30	−2.42	<0.001
		9.63 (1.9)	Word production	−4.34	−2.38	<0.001
15	12.67 (0.7)	12.71 (2.5)	Action/gesture production	−3.20	−2.29	<0.01
		12.04 (3.3)	Word comprehension	−3.12	−2.96	<0.01
		12.42 (2.4)	Word production	−3.68	−2.58	<0.01
18	15.67 (0.7)	16.17 (2.1)	Action/gesture production	−3.04	−1.83	<0.01
		14.62 (0.9)	Word comprehension	−3.91	−3.38	<0.01
		14.54 (0.8)	Word production	−4.58	−3.46	<0.001
21	18.67 (0.7)	17.25 (4.0)	Word production	−3.26	−3.75	<0.01
24	21.67 (0.7)	21.27 (5.1)	Word production	−1.71	−2.68	n.s.

Note: Standard deviations are given in parentheses.
n.s., Not significant.

language and action/gesture development. For this analysis, which focused only on data from the preterm group, we compared preterm children's scores on the three components of communication and language assessed by the PVB (word comprehension, word production, action/gesture production) to the percentile scores from the normative sample. For each component at each observation, we identified the point at which an individual preterm child's score intersected the 50th percentile curve for the normative sample (Caselli and Casadio 1995). We then assigned a 'language age' (LA, expressed in months) to the child, which corresponded to the age at which the child's score was obtained by children in the 50th percentile of the normative sample. Thus, for example, the number of words comprehended by 11-month-old children in the 50th percentile of the normative sample was 60, so a 15-month-old preterm child who comprehended 60 words was assigned a LA of 11 months.

Using this procedure, each preterm child was assigned three LAs at the 12, 15 and 18-month observations (for action/gesture production, word comprehension and word production, respectively) and one LA at 21 and 24 months (for word production only). The mean LAs for action/gesture production, word comprehension, and word production for the preterm children in our sample are presented in table 5.

A series of one-sample *t*-tests were conducted to compare language age with the corresponding chronological age at each observation point in the preterm group, that is, the LA of the preterm children, versus a fixed value corresponding to their CA. As is evident in table 5, preterm children's communicative and linguistic abilities lagged approximately 2–4 months behind their CAs throughout the second year. There were significant differences between CA and LA for action/gesture production, word comprehension, and word production at 12 months, with preterm children's LAs were significantly lower than their CAs. A similar pattern of results was obtained at 15 and 18 months for the three language components. At 21 months, preterm children's LAs for word production continued to lag significantly behind their CAs. By 24 months, however, this difference was

no longer statistically reliable for word production, although LA continued to be lower relative to CA.

Relationships among language components in early communicative development

Our final set of analyses focused on the question of whether there are dissociations among the individual components of early communicative and linguistic development that are measured by the *Words and Action/Gestures* form of the PVB. Is it the case that preterm children exhibit a global pattern of delay in early communicative and linguistic development that is equally evident in action/gesture production, word comprehension, and word production? Or are there dissociations between these components, such that development in some domains is more advanced relative to growth in others?

To address these questions, a series of separate repeated measures analyses of variance (ANOVAs) with Language component (action/gesture, word comprehension, and word production) as the within-subject factor was conducted on preterm children's LA scores at 12, 15, and 18 months respectively. Data from the 21- and 24-month observations were not included in this analysis because the *Words and Sentences* form of the PVB only examines one aspect of communicative development (word production).

There were no statistically significant differences between the LAs obtained for action/gesture production, word comprehension, and word production at 12 months ($F(2,11)=0.77$, n.s.) or at 15 months ($F(2,11)=0.33$, n.s.). At 18 months, there was a tendency for preterm children's action/gesture production scores to be higher than those for word comprehension and production ($F(2,11)=3.17$; $p=0.06$). In summary, these data suggest that preterm children exhibit a global delay in the course of early communicative and linguistic development, a delay that is apparent in all three of the communication domains tapped by the *Words and Action/Gestures* form of the PVB.

In the next section, we present data relevant to our second aim, namely the question of the appropriateness of chronological versus corrected GA in assessment of preterm children. Two sets of analyses were conducted to address this aim. The first is a within-group analysis and involves examination of the sets of PVB scores obtained for individual preterm children on the basis of their chronological versus corrected GAs; and the second is between-groups and compares the communicative and linguistic skills of the preterm children to those of full-term children matched on the basis of preterm children's GA (that is, the Matched GA comparison group).

Comparison of percentile scores obtained on the basis of CA and corrected GA for preterm children

In this section, we begin by examining differences between indices of communicative and linguistic development obtained with respect to CA vs. corrected GA within the group of preterm children. For this analysis, we compared a child's total score in a given component (for example, action/gesture production) at a given observation point to the percentile values obtained from the normative sample of full-term children (Caselli and Casadio 1995). We then obtained two percentile scores from the normative sample for each child: one on the basis of the

Table 6. Mean percentile scores of preterm children for the action/gesture production, word comprehension, and word production sections of the 'Primo Vocabolario del Bambino' (PVB) calculated using chronological and corrected ages and their mean percentile differences

Age (months)	Percentile score: chronological age	Percentile score: corrected age	Percentile difference
Action/gesture production			
12	27.1 (31.8)	65.2 (37.7)	38.04 (29.45)
15	37.3 (35.4)	60.8 (40.0)	23.42 (22.75)
18	33.3 (26.0)	65.0 (27.9)	31.70 (14.95)
Word comprehension			
12	18.5 (17.2)	58.2 (28.6)	39.70 (18.03)
15	29.4 (31.0)	45.0 (34.7)	15.60 (14.27)
18	28.0 (22.3)	47.5 (29.6)	19.48 (12.38)
Word production			
12	27.4 (23.5)	63.1 (28.5)	36.78 (14.62)
15	37.7 (27.3)	58.4 (29.5)	22.10 (7.36)
18	26.5 (22.5)	53.7 (26.9)	28.26 (13.28)
21	25.3 (24.3)	47.7 (34.4)	23.31 (15.27)
24	28.0 (26.4)	47.0 (30.6)	19.05 (14.13)

Note: Standard deviations are given in parentheses.

child's CA and a second on the basis of the child's corrected GA. Thus, for example, a child aged 12 months CA who comprehended 40 words was assigned a percentile score of 15 based on his CA and a percentile score of 65 based on his corrected GA of 10 months. Then, the difference between the two percentiles scores (the corrected GA score minus the CA score) was computed for each child. This procedure was repeated for each of the three communication domains separately at each observation. The mean percentile scores and standard deviations for action/gesture production, word production, and word comprehension obtained using CA and those based on corrected GA are presented in table 6.

With regard to action/gesture production, preterm children's scores at all observations fell between the 27th and 33rd percentiles when they were calculated with regard to CA; those obtained on the basis of corrected GA ranged from the 60th and 65th percentiles. Similarly, word-comprehension and production scores differed at all observation points, with the greatest difference between CA and corrected GA apparent at 12 months. From 15 months onwards, scores calculated on the basis of CA fell between the 25th and 38th percentiles, while those calculated on the basis of GA were near the 50th percentile. Although preterm children's word production and comprehension scores obtained on the basis of CA tended to remain below the means for the normative sample, they nevertheless fell within the normal range (that is, above the 10th percentile).

We investigated the relative size of the gap between the percentiles scores obtained for each child and the extent to which it changed during the second year. The difference scores for each component were submitted to separate repeated measures ANOVAs with Age as the within-subject factor. Comparisons for action/gesture production and word comprehension were conducted at 12, 15 and 18 months, and those for word production at 12, 15, 18, 21 and 24 months. For action/gesture production, difference scores at 12 months were significantly smaller than

those at 15 months, $F(1,11)=6.03$, $p<0.05$, but remained stable from 15 to 18 months, $F(1,11)=2.09$, n.s. For word comprehension, difference scores at 12 months were again significantly smaller than at 15 months, $F(1,11)=41.53$, $p<0.0001$, but did not differ reliably between 15 and 18 months, $F(1,11)=2.09$, n.s. Finally, for word production, difference scores at 12 months were significantly smaller than at 15 months, $F(1,11)=12.31$, $p<0.01$, but did not differ significantly across the remainder of the second year. Thus, when early communicative and linguistic abilities were evaluated with regard to the difference between CA and corrected GA of the gestural and verbal repertoires, the size of preterm children's gap appear to be larger at 12 months of age, but remained consistent from 15 months onwards.

Comparison of the communicative and linguistic abilities of preterm and full-term children matched on the basis of preterm children's GA

We next compared preterm children's early communicative and linguistic abilities to those of the matched GA comparison children selected from the normative sample for the PVB. Data from the five subgroups of matched GA control children are also presented in table 3. A series of separate one-way ANOVAs with Group (Preterm/Matched GA) as the between subjects factor was carried out on the action/gesture use, word comprehension, and word production scores at 12, 15 and 18 months respectively to determine whether preterm children's scores on the individual sections of the PVB differed reliably from those of matched GA comparison children. There were no significant differences between the two groups on any of the components at any of the age points considered. Additional one-way ANOVAs with Group (Preterm/Matched GA) as the between-subjects factor were carried out on the word production data at 21 and 24 months, respectively. Again, there were no statistically significant differences between scores for preterm and the matched full-term children.

Discussion

This research was designed to explore the course of communicative and linguistic development during the second year of life in a group of Italian children born prematurely. The primary goal was to describe developmental patterns in three components of communication and language — action/gesture production, word comprehension, and word production — and compare these with normative data obtained from a large sample of Italian children born at term. Relative to full-term children of the same chronological age (CA), preterm children exhibited global delays in the initial stages of communicative and linguistic development. A comparison of preterm children's scores on the action/gesture production, word comprehension, and word production portions of the 'Primo Vocabolario del Bambino' (PVB) revealed consistent and sizeable differences between their CAs and their communicative–linguistic ages. In other words, communicative–linguistic age tended to lag approximately 3 months behind CA when children were between the ages of 12 and 21 months. By 24 months CA, however, this difference was no longer reliable, suggesting the possibility that at this point, children may have begun to recover from the delay noted at younger ages. However, relative to the PVB

normative sample of children of the same CAs, the scores for word production of preterm children shown in table 3 suggested the delay may persist until 24 months CA. Given the small sample of children in this study and the high degree of individual variability (a wide range of gestational age and birth weight), this finding must be interpreted with caution. Prior reports have pointed to persistent delays and/or of a 'sleeping' deficit into and beyond the toddler years in various aspects of language as well as in other cognitive and academic competences in children born prematurely (Wolke and Meyer 1999, Luciana 2003).

It is important to note here that the delay observed among the children in our sample appeared to be global in nature; comparable delays were evident in all three of the components of communication and language that we examined. Thus, although preterm children's production of action/gestures at 18 months exceeded their word comprehension and production, we nevertheless found a robust relationship between action/gesture production and lexical comprehension and production. This finding is consistent with results from studies of atypical populations, that is, children with Down's syndrome (Caselli *et al.* 1998, Stefanini *et al.* 2007) and late talkers (Thal and Tobias 1994, Bates and Dick 2002) which highlight the absence of dissociation between action/gesture and vocal development.

Consistent with previous studies, we would like to underscore the fact that there were substantial individual differences among preterm children on all of the measures examined in this study. These differences do not appear to be related to factors such as length of gestation, birth weight, or length of hospitalization. Although it is possible that the non-significant correlations are a product of our relatively small sample size and wide variability among children in this study (also Cohen 1992, Foster-Cohen *et al.* 2007), our results are nevertheless consistent with previous studies (Marston *et al.* 2007, Casiro *et al.* 1990) that report no significant association between gestational corrected age (GA) and vocabulary acquisition at age 2 in preterm children.

With regard to our second aim, the goal was to contribute to an ongoing debate in the literature by comparing profiles of preterm children's early communicative and linguistic development when PVB scores were evaluated in terms of CA versus corrected GA. To this end, we examined percentile rankings on the PVB obtained on the basis of CA and those calculated using corrected GA for individual children. Findings were consistent with data reported by Menyuk *et al.* (1991, 1995): when CA was used, preterm children's percentile scores for all three components of communication and language fell at or above the 10th percentile, within the normal range, but nevertheless in an area identified as 'at risk' by a number of authors (Rescorla 1989, Thal *et al.* 2004, Caselli *et al.* 2007). The use of corrected GA, however, appeared to overestimate the size of children's gestural repertoires at all time points, as well as the size of their comprehension and production vocabularies at 12 months. At the remaining time points, the use of corrected GA in the assessment of word-comprehension and production scores placed preterm children at or near the 50th percentile for the normative sample. The size of differences between corrected GA and CA were greatest for children's gestural repertoires and comprehension and production vocabularies at 12 months. From 15 months on, the magnitude of these difference scores remained relatively stable. This pattern of results is generally consistent with that reported by Menyuk *et al.* (1995), who noted that when comparisons between their groups of preterm and full-term children were

made on the basis of corrected age, their sample of preterm infants was significantly ahead of full-term comparison children on a variety of language measures.

However, when we compared preterm children's early communicative and linguistic abilities with those of matched GA comparison children, no significant differences emerged between the two groups on any of the components at any age point. Although our data are not consistent with previous reports of pervasive delays that have used the MacArthur–Bates Communicative Development Inventory (MBCDI) (Magill-Evans and Harrison 1999, Foster-Cohen *et al.* 2007), they are consistent with other studies that have used the same inventory and have reported no differences between preterm and full-term children in vocabulary size at 2;0 (Stolt *et al.* 2007) and at 2;6 (Sansavini *et al.* 2006) when age was corrected for prematurity. It is important to underscore that our data come from observations conducted at much younger ages compared with other work which assessed preterm children at a single observation at 2;0 corrected for GA (approximately 2;3 CA) and beyond.

On the basis of these findings, we suggest that employing both CA and corrected GA criteria in the evaluation of preterm children's abilities may provide important information about their progress in language acquisition (Wilson and Michaeleen Cradock 2004). For example, infants born 3–5 weeks premature, with weight appropriate for corrected GA and with minimal medical complications, seem to have a developmental progression in language and communication similar (though temporarily slower) to that of full-term infants. This group of preterm infants typically catch up to developmental expectations within a year. Thus, age adjustment for these infants may be most appropriate to gauge developmental functioning and prevent unnecessary referrals for early intervention. However, for preterm infants born before 28 weeks, with lower birth weight and/or additional medical complications or biologic risks, age adjustment may overestimate their abilities and make them appear more similar to their full-term peers. The information obtained from both CA and corrected GA criteria may be especially important during the initial stages of communicative and linguistic development, inasmuch as comparisons of the two sets of scores may provide clinicians with a way to distinguish children who may be at risk for language problems from those who may be expected to 'catch up' and progress normally. In particular, our findings suggest that PVB scores obtained at 15 months CA may be especially good predictors of later vocabulary development.

In interpreting the results of this study, some potential limitations should be considered. First of all, the results derive from indirect observations (that is, a questionnaire completed by parents). However, as previously noted, numerous studies (Foster-Cohen *et al.* 2007, Stolt *et al.* 2007) have shown that this is a valid method, nonetheless direct observation would provide a more complete picture of the comprehension and use of language in different modalities (gestural and vocal) and in different contexts. Moreover, this study compared data from a longitudinal sample of preterm children with data from cross-sectional samples of full-term children. Finally, given the small sample of children in our study and the large variability, our findings must be interpreted with caution in making general inferences regarding language development over time.

In conclusion, we have found that in the early stages of communicative and linguistic development, preterm children tend to exhibit global delays relative to full-term peers matched on the basis of CA. However, when comparisons are conducted with full-tem children matched on the basis of GA, preterm children do not exhibit

differences in communicative and linguistic development. Thus, despite the significant biological risk that is engendered by premature birth, early communicative and linguistic development appears to proceed in a relatively robust fashion among preterm children, with tight relations across communicative domains as in full-term children.

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