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LANGUAGE ABILITIES FOLLOWING PREMATURITY, PERIVENTRICULAR BRAIN INJURY, AND CEREBRAL PALSY

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This study compares language abilities in three groups of children who were born prematurely: children with bilateral spastic cerebral palsy associated with perinatal injury to the periventricular white matter of the brain; a group with similar brain injury but no motor impairment; and a group of controls with no brain injuries. Six boys in each group were 36 to 39 months of age at the time of the study. All achieved a standard score above 80 on the McCarthy Scales of Children's Abilities at the same age. Language samples, generated during parent-child interaction, were analyzed using the Child Language Data Exchange System. The size and diversity of the lexicon was assessed using types and tokens per minute. Morpho-syntactic skills were assessed using number of grammatical morphemes, mean length of utterance and the Index of Productive Syntax. Verbal productivity was assessed using number of utterances per minute. No significant differences were observed among any of the groups on any measure. Measures of the lexicon and morpho-syntactic skills were highly correlated with the scores on the McCarthy Scales of Children's Abilities. The data demonstrated that specific language impairments were not associated with cerebral palsy or brain injury after prematurity at this early stage of language development. However, individual children within each of the groups had delays in skill attainment that warranted language intervention.

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INTRODUCTION

Among the neurological complications of prematurity, the lesion most highly associated with developmental morbidity is periventricular leukomalacia (PVL), an ischemic injury that damages the white matter near the ventricles of the brain and the gray matter adjacent or connected to those axons (Banker and Larroche, 1962). PVL is typically detected in the newborn period through the use of bedside ultrasonography; characteristic findings on ultrasound include persistent echodensities or flares in the periventricular region that may progress to cystic degeneration (Hill et al., 1982; Rushton, Preston, and Durbin, 1985). Periventricular damage can also be diagnosed on computerized tomography (CT) as diffuse areas of low density (Adsett, Fitz, and Hill, 1985; Schrumpf et al., 1980; McCarton-Daum et al., 1983) and on magnetic resonance imaging (MRI) as abnormal white matter signal and loss of periventricular white matter tissue (McArdle et al., 1987; Baker, Stevenson, and Enzmann, 1988). The incidence of PVL in studies of infants born prematurely ranges from approximately 5 to 40% (McMenamin, Shackelford, and Volpe, 1984; Bozynski et al., 1985; Graham et al., 1987; Sinha et al., 1990; Volpe, 1989). The highest incidence rates have occurred in infants weighing less than 1000 grams at birth.

The presence of PVL in a survivor of prematurity carries substantial risk that the child will develop bilateral, spastic cerebral palsy (CP) affecting the lower extremities to a greater extent than the upper extremities (DeVries et al., 1985; Guzzetta et al., 1986; Graziani et al., 1986; Graham et al., 1987; Volpe, 1989). Subtypes of CP are associated with a variety of central nervous system injuries in the population of children born at term but bilateral spasticity is highly associated with hypoxic-ischemic injury to the periventricular white matter in children born prematurely (Truwit, et al., 1992; Koeda et al., 1990). PVL is also associated with additional disabilities including mental retardation (McCarton-Daum, et al., 1983; DeVries and Dubowitz, 1985; Weindling et al., 1985; Saliba et al., 1990; Feldman, Scher, and Kemp, 1990) and visual impairment or hearing loss (DeVries and Dubowitz, 1985; Sinha et al., 1990; Feldman, Scher, and Kemp, 1990). However, some children with periventricular injury on neonatal ultrasound or MRI survive free of major handicapping conditions (Feldman, Scher, and Kemp, 1990; Scher et al., 1989). Cognitive and motor outcomes are more favorable when the lesion is unilateral, frontal in location, and when damaged areas do not undergo cystic degeneration (Fawer, Diebold, and Calame, 1987; DeVries and Dubowitz, 1985; DeVries et al., 1988; Monset-Couchard et al., 1988; Appleton, Lee, and Hey 1989; Volpe, 1989; Bennett et al., 1990).

Previous research has shown that language abilities of children with PVL, as measured by formal testing procedures, correlate positively with cognitive abilities, as measured by scores on tests of cognitive functioning (Feldman et al., 1990). Feldman et al., (1992) found that 2-year-old children with PVL

and cognitive delays showed significantly less verbal productivity (that is, fewer lexical items and fewer spontaneous verbal utterances in language samples) than children with PVL and normal cognitive abilities. Other measures of lexical and syntactic abilities did not show significant differences between groups.

The present study describes language abilities in children who developed CP in the aftermath of prematurity and periventricular injury. Studies on the language abilities of children born prematurely using formal testing procedures have generally found that the subjects show delays in language skills compared to controls born at term (Largo, et al., 1986; Vohr, Garcia-Coll and Oh, 1988; Vohr, Garcia-Coll and Oh, 1989). Using language sampling techniques, Field, Dempsey, and Shuman (1983) similarly found that preterm subjects demonstrated shorter sentences and smaller productive vocabularies than full-term controls. However, Manyuk, et al., (1991) reported that patterns of lexical and cognitive development of prematures did not differ markedly from infants born at term. In addition, Craig, et al., (1991) found that the prevalence of language disorders in a group of 3-year-old preterm infants was comparable to the proportion of language disorders in the population at large. Taken together these studies have suggested that children born prematurely may show mild delays in language development that are not sufficiently severe to qualify as language disorders.

Regarding language development in children with CP after prematurity, Largo et al. (1986) found mild language delays in children with CP compared to neurologically unimpaired controls in most measures. However, in some analyses, such as the proportion of children using four-word sentences, the CP group was indistinguishable from the other groups by 36 months of age. It is not clear in this study whether lower scores in the CP group were the result of substantial delays in a few children or mild delays in most children. Levene, et al., (1992) described receptive language abilities as well as motor function in 12 children with CP and 22 children who had abnormal cerebral ultrasounds in the newborn period. Three of the children with CP were completely unable to take the vocabulary test; these same children also scored the maximal level of disability in terms of motor skills. The remaining 9 children achieved an average score on the vocabulary measure that was quite similar to the average performance of all the other groups of children born prematurely, including those with normal ultrasound findings. These results suggested that receptive vocabulary may be relatively spared in children with CP on the basis of prematurity and periventricular injuries, if the injuries are not severe enough to cause profound motor and cognitive impairment.

Surprisingly little has been written about the language abilities of individuals with CP. Individuals with CP may develop dysarthria that in turn may severely compromise their intelligibility (Ansel and Kent, 1992; Hunter, Pring, and Martin, 1991). Bishop, Brown and Robson (1990) observed that

individuals with CP and dysarthria have normal grammatical understanding but smaller receptive vocabularies compared to individuals with CP without dysarthria. These authors suggested that the group with CP and dysarthria may have had poor verbal memory for novel phonological strings, possibly secondary to their inability to easily repeat the strings as they attempt to remember them. Language problems independent of dysarthria have not been described in individuals with CP.

To determine if specific language features characterize children who develop CP after premature birth and periventricular brain injury, this study evaluated three groups of children, all of whom were born prematurely: children with CP after periventricular brain injury; children with comparable brain injuries and no CP; and children with no brain injury and no CP. All of the subjects scored in the normal range on cognitive measures to avoid possible confounding effects of cognitive impairments on language abilities. This comparison permits us to observe if CP is associated with specific language disturbances. If so, children with CP will perform differently from both comparison groups. If, on the other hand, periventricular injuries cause language difficulties whether or not they result in CP, then the children with periventricular injuries with or without CP will perform differently from the preterm controls. We recognize that brain injuries sustained by children with CP are more severe, at least in terms of motor development, than the injuries sustained by children who incur brain injury without developing CP. Nevertheless the study of these three groups permits us to observe whether these brain injuries or the resulting motor impairments also impair language abilities.

In this paper language abilities are studied using language sampling analysis techniques. Language samples offer several advantages in the study of young children. First, they have high face validity, reflecting actual, functional communication abilities rather than test performance. Children tend to show best performance when relaxed with their parents in pleasant play situations. Multiple aspects of language can be analyzed from the same sample, without stressing the young child's abilities to remain seated and pay attention. Computerized analysis programs, such as the Child Language Data Exchange System (MacWhinney, 1991) facilitate the transcription and analysis of language samples.

Several subcomponents of language abilities may be affected by CP or brain injury. First, children with CP may use smaller vocabularies than children in the comparison groups. This prediction follows from the report of Bishop, Brown, and Robson (1990) that individuals with CP and dysarthria, have difficulties with verbal memory, though receptive vocabulary was not substantially impaired in some children with CP after prematurity (Levene et al., 1992). Children with unilateral brain injury to either hemisphere may show lexical deficits (Aram et al., 1985; Aram, 1988; Thal et al., 1991) A second prediction is that the children with CP may use fewer grammatical

morphemes than children in the comparison groups. This prediction is based on the observation that individuals with CP and dysarthria have measurable difficulty in articulating some English morphemes such as sibilants in plural -s (Aronson, 1985). Moreover, children with left hemisphere damage reportedly show morpho-syntactic deficits (Kiessling, Denckla and Carlton, 1983; Kinsbourne and Hiscock, 1983; Aram, Ekelman and Whitaker, 1986; Aram 1988). Third, children with CP may have decreased verbal output; the increased work of production given their spasticity may reduce the number of utterances that the children produce. Given the relationship of cognitive and language abilities found in previous research (Feldman, Scher, and Kemp 1990; Feldman et al., 1992), a final prediction is that the correlation of cognitive scores and language measures will be positive across groups. In addition to group analyses, we evaluated the performance of individual children within each of the groups to determine if any child was significantly delayed and in need of language therapy.

METHODS

Subjects

Children were selected from a larger cohort of 66 children with neural imaging evidence of early non-progressive brain injury. The following criteria were used to select children for the current study: (1) All children were born at or before 36 weeks gestation, satisfying the criterion for prematurity; (2) All were between 36 and 39 months at the time of evaluation. We chose this age for language analysis because it is in the midst of the most rapid developmental changes in language and we believed we were likely to see differences in this age range if differences exist; (3) All subjects were boys, primarily because sex differences have been reported in the early stage of language acquisition and males predominated at this age in our study sample; (4) No children had active seizure disorders or were using anticonvulsants medications. Several studies document the deleterious effects of anticonvulsants on multiple aspects of developmental functioning including language (Vargha-Khadem et al., 1992); (5) All children scored greater than 80 on the General Cognitive Index (GCI) of the McCarthy Scales of Children's Abilities (McCarthy, 1972) at testing on or near their third birthday. We eliminated children at high risk for mental retardation on the basis of a GCI less than 80 because we anticipated cognitive delays would have a deleterious effect on language abilities in this group (Feldman, et al., 1990, 1992); (6) We also eliminated children with moderate or severe hearing loss because of the potential implications for delays of language development.

The children were subdivided into three groups: (1) children with spastic cerebral palsy (CP) from PVL, (2) children with periventricular brain injury (BI) without CP, and (3) preterm controls (PC) without brain injury and

Table 1. Clinical History, Neural Imaging and Neurological Status of Subjects

Subject #		Name	GA	BW	Imaging study: Results	Neurological exam
CP	1	YUC	32	2080	MR: bilateral PV abnormalities	Spastic quadriparesis, independent ambulation
	2	CAS	33	2890	MR: PV abnormalities enlarged ventricles (L > R)	Spastic quadriparesis, central visual impairment, limited independent ambulation
	3	NOW	28	2100	MR: PV abnormalities, enlarged ventricles	Spastic paraparesis, independent ambulation
	4	CES	28	990	US: bilateral cystic lesions	Spastic quadriparesis, ambulation with walker
	5	MEC	30	1500	MR: PV abnormalities, additional L temporal lobe porencephaly	Spastic paraparesis, independent ambulation
	6	HIN	30	1410	MR: PV abnormalities, enlarged ventricles	Spastic quadriparesis, ambulation with walker
BI	1	CHA	36	2030	US: Grade III IVH plus echogenicity CT: PV abnormalities, small hemorrhage, enlarged ventricles	

	2	DEB	25	780	MR: patchy PV abnormalities in frontal lobes, R porencephaly	
	3	MAC	28	980	CT: PV abnormalities	Transient dystonia
	4	WIX	30	1260	US: Periventricular echogenicity	
	5	SUL	29	1260	MR: bilateral PV abnormalities in occipital lobe; L frontal porencephaly	Transient dystonia
	6	GAL	29	1300	MR: Patchy PV abnormalities L frontal porencephalic cyst	
PC	1	WEG	35	2700	No exam	
	2	DNO	32	1250	US: negative	
	3	DAN	32	1870	US: negative	Early developmental delay
	4	BRO	25	750	US: negative	Questionable overactivity, inattention
	5	HAR	28	1250	US: negative	
	6	GAL2	29	1320	Grade I IVH, resolved	

GA = Gestational age; BW = Birth weight; CP = Cerebral palsy; BI = Brain injured; PC = Premature controls; MR = Magnetic Resonance; US = Ultrasound; CT = CT Scan; L = Left; R = Right; IVH = Intraventricular hemorrhage; PV = Periventricular.

cerebral palsy. CP was diagnosed by a child neurologist (MSS) and/or developmental pediatrician (HMF). Confirmatory evidence was that all of the children in the CP group were receiving physical and occupational therapy for their motor impairments. Documentation of periventricular white matter injury was made using ultrasound, CT, or MRI. The children in the BI and PC groups were individually matched to the children in the CP group on the basis of GCI. They had no permanent motor impairment as diagnosed by either of the above physicians. None of these children received physical or occupational therapy; 3 children were enrolled in a county-wide early intervention service but did not have particular goals regarding motor skills. Children in the BI group had evidence of periventricular injury on an imaging study. Table 1 describes the clinical history, imaging study results and neurological examination of all of the children in each group. In this table a 3-letter code name is included to identify the children. This is the name that will identify them in the data archives of the CHILDES system. GAL 2, subject 6 in the PC group, is the twin brother of GAL, subject 6 in the BI group.

Children underwent testing the same day that the language samples were generated. Table 2 displays the standard scores they obtained on the General Cognitive Index (GCI) of the McCarthy Scales of Children's Abilities (McCarthy, 1972), and the age equivalent in months they obtained on the Sequenced Inventory of Communicative Development-Receptive Scale (SICD-R: Hendrick, Prather and Tobin, 1975). One child in the BI group and one child in the PC group had borderline scores on the SICD-R. Thirteen children cooperated for testing with the Peabody Picture Vocabulary Test (PPVT: Dunn and Dunn, 1981). Standard scores for the PPVT are also included on the table. All of the children who were able to complete the test scored within the normal range. Table 2 also includes socioeconomic status for all children calculated using the Hollingshead 2 factor system (Hollingshead, 1965).

We evaluated characteristics of speech and vocal quality on a clinical basis because the children were not uniformly able to cooperate fully with oral-motor testing at this age. Qualitatively, the 6 children with CP all had some combination of the features characteristic of spastic dysarthria (Darley, 1978) including breathy, harsh, or strained voice quality, and/or dampened or monotonous prosodic range. However, all of the children in the CP group were rated as fair to excellent in intelligibility by 2 students of speech and language pathology who independently evaluated intelligibility after listening to the audio portion of the video tapes. In addition, 2 children in the BI group and 1 child in the PC group had strained or breathy voice quality, hyponasality, and/or damped prosodic range. One child in the BI group and 2 in the PC group were judged to have poor intelligibility on the basis of poor articulation. Overall, the groups did not differ in intelligibility.

Table 2. General Cognitive Index, Socioeconomic Status and Receptive Language Abilities of Subjects at 36 Months of Age

Subject		GCI	SES	SICD-R (mos)	PPVT (ss)
CP	1	127	1	40	111
	2	109[a]	2	39	—
	3	110	4	40	109
	4	97	4	40	103
	5	92	4	36	—
	6	85	3	32	—
BI	1	119	2	40	111
	2	110	2	40	109
	3	106	1	40	126
	4	105	4	40	107
	5	91	5	36	102
	6	88	4	28	97
PC	1	122	1	40	—
	2	116	2	36	103
	3	105	2	36	103
	4	105	4	36	—
	5	99	4	36	90
	6	84	4	28	90

[a]Use of Reynell-Zinkin Scales, because of visual impairment.

CP = Cerebral palsy; BI = Brain injured; SES = Socioeconomic status; SICD-R = Sequence Inventory of Communicative Development—Receptive Scale; PPVT = Peabody Picture Vocabulary Test; PC = Premature controls; GCI = General Cognitive Index on McCarthy Scales.

Procedures

Language Samples. Language was assessed from spontaneous language samples collected in the clinic of the Child Development Unit, Children's Hospital of Pittsburgh. To generate the language sample, the children and their parent(s) participated in five separate activities, each lasting approximately five minutes. We attempted to position the children with CP in an upright sitting posture because of the relationship of posture and output in children with CP (McEwen, 1992). The activities were structured only by the materials provided and typically occurred in the following order: (1) warm-up play with a standard set of toys including toy cars, a tea set, puppets, and small human figures; (2) ball play (eliminated for some of the children with CP if their motor impairments seemed to interfere with their enjoyment of the activity); (3) coloring with markers and blank paper; (4) reading a Richard Scarry book; and (5) parents demonstrating an activity book. Parents were asked to play with their child as they would at home. Conversation was simultaneously videotaped and audiotaped for the purposes of transcription and analysis.

Transcription. Approximately 20 minutes of interaction (ranging from 17.0 to 25.9 minutes) were transcribed orthographically directly from both audiotape and videotape to an IBM compatible computer by speech and language pathologists trained as research assistants. Transcription, coding and analysis utilized CHILDES (MacWhinney, 1991), a system of computer programs for automated analysis of language transcripts and an archival data base of such transcripts.

Interobserver Agreement on Transcription and Coding. One activity from every visit (approximately 5 minutes, or 20%), chosen at random, was checked by a second research assistant. Interobserver agreement was calculated as the number of utterances transcribed identically over the total number of utterances in the transcript. Interobserver agreement was greater than 94% for all subjects.

Measures. Language samples were analyzed to provide assessment of the lexicon, morpho-syntactic skills, and productivity of the children. To assess the lexicon, we determined the number of different words used (types) and the total number of words used (tokens) in the transcript. To equate for the differing amounts of time that children engaged with their parents, we divided both types and tokens by number of minutes transcribed. Thus, the measures of interest are the number of types or tokens per minute.

Three measures were used to assess morpho-syntactic skills. The first was mean length of utterance (MLU). Though technically a measure of average sentence length, MLU is a reasonable proxy for syntactic skills because of the high positive correlation between MLU and other syntactic measures in this age range (Miller, 1981). MLU was calculated for all spontaneous utterances on the transcript, eliminating exact repetitions of the previous utterance and yes/no answers to questions. The number of utterances from which MLU was calculated ranged from 73 to 257. The second measure of morpho-syntactic skills was a count of the number of grammatical morphemes from Brown's (1973) list of 14 grammatical morphemes that were present in the transcript. The third measure was the Index of Productive Syntax (IPSYN) score (Scarborough, 1990). This measure is the number of emerging or mastered syntactic constructions in 100 spontaneous utterances from a list of 50 that have been shown to be sensitive to developmental change. The child scores 1 at the first appearance of a designated construction and 2 at any subsequent appearance of the same construction for a maximum score of 100. IPSYN is a measure syntactic complexity rather than sentence length.

To assess verbal productivity, we determined the number of verbal utterances the child used during the session. We did not eliminate exact repetitions or yes/no answers to questions since we were interested in total verbal production. However, none of the children studied here showed excessive reliance on imitation or yes/no responses in their output.

Table 3. Language Measures for Each Subject

Subjects		Types/ min	Token/ min	MLU	# Mor	IPSYN	# Utt min
CP	1	6.76	17.33	3.40	12	59	7.24
	2	6.41	18.47	3.68	9	59	6.82
	3	5.78	23.84	3.58	13	62	8.76
	4	7.34	25.30	3.21	9	58	10.20
	5	3.72	10.38	2.46	9	48	6.28
	6	3.32	8.97	3.93	9	36	2.89
Mean(s.d.)		5.56(1.66)	17.38(6.71)	3.38(.51)	10.17(1.83)	53.67(9.89)	7.03(2.48)
BI	1	6.37	33.55	3.76	13	69	11.90
	2	7.60	23.57	3.35	11	60	8.79
	3	6.64	16.76	2.32	11	63	6.92
	4	6.12	18.31	2.95	11	46	8.58
	5	2.56	6.20	2.03	6	31	4.32
	6	5.08	14.46	2.13	8	39	12.64
Mean(s.d.)		5.73(1.75)	18.81(9.19)	2.76(.71)	10.00(2.53)	51.33(14.95)	8.86(3.10)
PC	1	7.09	20.28	2.75	12	62	9.51
	2	5.41	14.69	3.28	10	62	6.70
	3	4.77	16.91	2.90	10	58	7.20
	4	7.05	22.76	2.79	9	48	8.48
	5	6.72	26.39	3.04	13	55	12.21
	6	3.36	8.28	1.91	8	41	8.24
Mean(s.d.)		5.73(1.50)	18.22(6.40)	2.78(.47)	10.33(1.86)	54.33(8.36)	8.72(1.97)

MLU = Mean length of utterance; # MOR = Number of morphemes; IPSYN = Index of Productive Syntax.

DATA ANALYSIS

The study design matched individual subjects from each group on the basis of GCI. Thus, a data analysis incorporating this one-to-one matching was used. The statistical assumptions were met, including normality, which was assessed using the Shapiro-Wilks test. We compared groups using paired t-tests, using a traditional alpha level of $p < .05$. In addition, language measures were correlated with GCI using the Spearman rank correlation test.

RESULTS

Table 3 provides all language measures for each child in the CP, BI, and PC groups as well as means and standard deviations for the group. The mean number of lexical types/minute for the CP group was not significantly different from the BI group nor from the PC group. Similarly, the BI and PC groups were not significantly different from each other. The number of lexical tokens/minute for the CP group was not significantly different from

the BI group nor from the PC group and the BI and PC were not significantly different from each other. Thus, we observed no significant differences across groups on lexical measures.

The mean MLU was average compared to normative data (Miller, 1981). MLU for the CP group was not significantly different from the BI group nor from the PC group; the BI and PC groups were not significantly different from each other. The mean number of morphemes for the CP group was also not significantly different from the number used by the BI group nor from the PC group; the BI and PC groups were not significantly different from each other. The mean IPSYN scores were slightly below average but within the normal range for IPSYN score based on Scarborough (1990). The IPSYN scores for the CP group was not significantly different from the scores for the BI group nor from the scores of the PC group and the BI and PC groups were not significantly different from each other. Thus, we observed no significant differences across groups on measures of syntactic development.

The number of utterances/minute for the CP group was lower but not significantly different from the number of utterances/minute of the BI group nor from the number of utterances/minute of the PC group; the BI and PC groups were not significantly different from each other. Thus, we observed no significant differences across groups of verbal productivity.

Considering the entire sample ($N = 18$), rank order correlations between GCI and language measures were as follows: types/minute 0.674 ($p < .01$); tokens/minute 0.566 ($p < .02$), MLU .470 ($p < .05$); number of morphemes .693 ($p < .001$); IPSYN score .805 ($p < .001$), number of utterances per minute .190 (ns). Thus, though all of the children functioned in the normal range on the measure of cognitive functioning, their GCI scores positively correlated with 5 or 6 language measures generated from language samples.

DISCUSSION

This study indicates that 3-year-old children who developed CP in the aftermath of preterm birth and PVL and who achieved normal scores of a test of cognitive functioning showed lexical skills, morpho-syntactic skills and verbal productivity that were comparable to the skills of age- and cognitive-matched children who sustained a similar periventricular brain injury but did not develop CP. Moreover, they showed similar lexical skills, morpho-syntactic skills, and verbal productivity as did children who were born prematurely but who did not sustain periventricular brain injury. Regardless of group assignment, lexical and syntactic measures were highly correlated with cognitive scores, even though the cognitive scores of the entire cohort were in the normal range. These results suggest that CP and periventricular brain injury are not associated with specific language impairments in the early preschool years.

The children with CP studied here did not show speech disorders or dysarthria severe enough to impair intelligibility significantly. In fact, intelligibility in the CP children was no worse than the intelligibility in the other groups. There are several explanations for this finding. Dysarthria is less common in individuals with spastic CP than athetoid CP. Moreoever, PVL affects lower extremities to a greater degree than upper extremities because the motor tracks that go to the legs course closer to the ventricles than the motor tracks to the arms. By extension, oral motor functions are even less severely impaired. Finally, even normal children of 3 years of age have difficulties with articulation and speech production. Sibilants and fricatives, sounds that are frequently impaired by spastic dysarthria, are late acquisitions for normal learners. Reevaluation of the children with CP at older ages, when sibilants would be expected to have been mastered, may reveal subtle indications of dysarthria that are obscurred at this young age. Largo et al. (1986) reported that at 5 years of age, a greater proportion of preterm children with CP than without CP had articulation defects. Nonetheless, in the absence of severe dysarthria at age 3, we detected no specific articulatory or language impairments.

In many respects, the results of this study extend the work of Levene et al. (1992) who found that the children with CP who were able to take the receptive vocabulary test achieved the same average score as children with persistent periventricular flares and the prematurely born group who had no abnormal ultrasound findings. This study with a more inclusive test battery had a similar outcome in that children with specific brain injuries who were not neurologically devastated did not perform significantly differently from children born prematurely. Although no full term controls were used here, comparisons of MLU and IPSYN scores of these subjects with normative values showed that MLU was in the normal range but that IPSYN scores fell below average. Given that the language protocol we used might have influenced the variety of morpho-syntactic features that children use in conversation, it is difficult to interpret these findings. Future research should include a full term control group to determine whether preterm subjects function similarly to full term controls. It is likely that non-specific metabolic, neurological or experiential complications of prematurity may have a greater impact on outcome than specific neurological complications (Levene et al., 1992).

The present findings suggest that the type of deep subcortical injury that causes CP is not associated with specific language disorders in the early stages of language acquisition. Language abilities appear to be different from non-verbal intelligence in this regard given that non-verbal intelligence is affected with deep subcortical damage (Dennis 1985a, 1985b). One likely explanation is that early syntactic and lexical skills may be so robust that their early developmental course proceeds relatively normally except under the most severely abnormal circumstances (Tager-Flusberg, 1994). We must

caution that the absence of major language disturbances at age 3 does not rule out subsequent development of language disturbances, when the expectations for levels of organization and syntactic complexity increase (Dennis and Lovett, 1990). In another study in this volume, Hemphill, et al. considered the language skills of children with similar brain injuries at ages 5 to 7 years old on more challenging tasks of language performance and documented differences between these children and normal controls.

High positive correlations between GCI and language measures have been seen in children with PVL (Feldman et al., 1990). We did not think that this positive correlation resulted from assessment of the same underlying skills through two techniques. The verbal subscale of the McCarthy Scales of Children's Abilities at age 3 includes several tasks: receptive vocabulary, the child's ability to formulate definitions, memory for unrelated words and digits, the ability to list members of specific categories, and opposite analogies. The test includes no assessment of lexical diversity, grammatical sophistication nor verbal productivity. The correlation may reflect that the children suffered subtle compromise in cognitive abilities, despite the scores in the normal range. The high positive correlation suggests that the neurological damage associated with subtle declines in cognitive scores may also be responsible for subtle changes in language functioning.

The group data suggest that language disabilities are not associated with CP, periventricular brain injury or prematurity. Nevertheless, we identified children within the cohort who were outliers and whose performance was suggestive of early language problems. CP subject 6, had very limited verbal productivity, a limited number of types/min, and a low IPSYN score despite a high MLU. Inspection of his transcripts reveals that his high MLU resulted from frequent repetitions of a few sentence frames such as "I want to _____.". Conversational responsiveness was very limited. This child would warrant language intervention; appropriate goals would include increasing the rate of conversational initiation and responsiveness and attempting to increase his lexical diversity and syntactic skills. BI subjects 5 and 6, and PC subject 6 had low MLUs, IPSYN scores below the normal range (Scarborough, 1990), and low SICD-R scores. BI subject 5 also had very limited verbal productivity. Given their medical risk status and these early findings, the children would also warrant speech and language therapy.

In summary, 3-year-old children with bilateral, spastic CP and age- and cognitive-matched children with similar brain injuries who did not develop motor impairments were not found to perform significantly differently from premature children on language measures generated from spontaneous language samples. These results suggested that there is no characteristic language impairment associated with CP or deep subcortical periventricular white matter brain injuries. However, individual children with CP, brain injury, or preterm delivery should be screened regularly for language disorders. Because they are at risk for language disorders, children from any of

these populations who fall below age expectations should be referred for language treatment in a timely fashion.

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