Effects of Prenatal Exposure to Cocaine and Associated Risk Factors on Language Development

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Abstract:

During the past decade there has been a dramatic increase in the number of children born with prenatal exposure to cocaine. However, there is very little hard data concerning the later development of these children. The purpose of this preliminary study was to compare the language development profiles of 5 children prenatally exposed to cocaine and associated risk factors to the language development profiles of a matched non-exposed control group in terms of analyses of the discourse-pragmatic, semantic, and form components of language. The language evaluation was based on the analysis of a 30-minute language sample. The results suggested differences between the two groups as well as differences within the cocaine-exposed group. The major differences between the two groups were in discourse-pragmatics although less marked differences in syntactic development were also found. The results are discussed in relation to the potential contribution of pertinent medical and environmental risk factors. The study suggests that for children with prenatal exposure to cocaine in combination with multiple associated risk factors, language development may be compromised.

Keywords: prenatal cocaine exposure | language development | risk factors

Article:

During the past decade there has been a dramatic increase in the number of children born with prenatal exposure to cocaine. Estimates of women who have taken cocaine during pregnancy range from 10% to 45% at urban teaching hospitals and in one study was reported to be 6% in a private suburban hospital (Schutzman, Frankenfield-Chernicoff, Clatterbaugh, & Singer, 1991; Volpe, 1992). Although research suggests that prenatal cocaine exposure may result in neurophysiological changes in brain development, retard fetal growth, and have a negative effect on the neurobehavioral development of the newborn, there is very little hard data concerning the later development of these children (Chasnoff, Griffith, MacGregor, Dirkes, & Burns, 1989; Frank et al., 1988).

Cocaine use has been associated with low gestational age at delivery and a higher incidence of preterm labor and delivery (Dombrowski, Wolfe, Welch, & Evans, 1991; MacGregor et al., 1987; Neerhof, MacGregor, Retzky, & Sullivan, 1989). Impaired fetal growth has been reflected in a decrease in birth weight, decrement in length, and smaller head circumference (Chasnoff et al., 1989; Coles, Platzman, Smith, James, & Falek, 1992; Hadeed S Siegel, 1989; MacGregor et al., 1987; Neerhof étal., 1989; Neuspiel, Hamel, Hochberg, Greene, & Campbell, 1991; Zuckerman et al., 1989). Congenital abnormalities (Bingol, Fuchs, Diaz, Stone, & Gromisch, 1987; Chavez, Mulinare, & Cordero, 1989; Hoyme et al., 1990; Little, Snell, Klein, & Gilstrap, 1989; MacGregor et al., 1987), placental abruption (Acker, Sachs, Tracey, & Wise, 1983; Mastrogiannis, Decavalas, Verma, & Tejani, 1990), prenatal infarctions (Chasnoff, Bussey, Savich, & Stack, 1986; Chasnoff et al., 1989), meconium in the amniotic fluid (Hadeed & Siegel, 1989; Mastrogiannis et al., 1990), abnormal electroencephalographic results (Doberczak, Shanzer, Senie, & Kandall, 1988), seizures (Chasnoff et al., 1989; Kramer, Locke, Ogunyemi, & Nelson, 1990), abnormal head ultrasound studies (Dixon & Bejar, 1989), and abnormal brainstem auditory evoked responses (Salamy, Edgredge, & Anderson, 1990; Shih, Cone-Wesson, & Reddix, 1988) have all been described in some cocaine-exposed infants. Neurobehavioral difficulties such as impairment in orientation, motor ability, state regulation, irritability, and abnormal reflexes and sleep patterns have also been reported (Chasnoff, Burns, Schnoll, & Burns, 1985; Chasnoff et al., 1989; Oro & Dixon, 1987). In contrast to this, however, other researchers, using the Brazelton Neonatal Behavioral Assessment Scale (BNBAS), have reported neurobehavioral scores to be within a range that would be considered clinically normal (Coles et al., 1992; Neuspiel et al., 1991; Richardson & Day, 1991).

Although a wide variety of perinatal effects have been described, the question of whether children with prenatal cocaine-exposure demonstrate persistent behavioral, cognitive, and language problems is one that still needs to be answered. The data to date are preliminary, limited in scope and depth, and contradictory. Many of the studies that have looked at the effect of prenatal cocaine-exposure during the first and second years have found no significant differences or severe developmental problems between cocaine-exposed and control groups using the Bayley Scales of Infant Development (BSID) (Chasnoff, Griffith, Freier, & Murry, 1992; Graham et al., 1992; Hurt, Malmud, Brodsky, & Giannetta, 1992; Lewis, Freebaim, & Singer, 1994). When interpreting this research, however, questions that need to be asked include whether the measure used to evaluate development is sufficiently sensitive to identify all possible problems and whether certain problems may only become manifest at later stages of development. In contrast to these studies, other studies have provided preliminary descriptions of developmental problems during the first years of life. These include the absence of strong feelings of distress in response to separation from parent-figures, developmental delays in fine motor and visual motor coordination, and less representational and constructive play than control groups (Dixon, 1989; Howard, Beckwith, Rodning, & Kropenske, 1989; Rodning, Beckwith, & Howard, 1989). A significant effect on cognitive abilities as measured on the Stanford-Binet scale at 3 years of age was reported by Azuma and Chasnoff (1993). However, these authors caution that the effect is complex because the effects of drug exposure (cocaine and other drugs) were also mediated indirectly through head circumference, home environment, and child behavior in terms of level of perseverance at a task.

With regard to language development, only a few studies have been reported, primarily at national conventions. Although the results are inconclusive, they do suggest that language is vulnerable to disruption, particularly in the area of expressive syntax (Baltaxe, D'Angiola, & Simmons, 1992; Bland, Seymour, Beegley, & Frank, 1994; Carrico, Rutherford, Zecker, and MacGregor, 1993; Dixon, 1989; Johnson, Foose, Seikl, & Madison, 1992; Johnson, Gettles, Seikel, & Madison, 1992; Massenberg & Martin, 1993; Rivers & Hedrick, 1992). Carrico et al. (1993) reported significant differences between a cocaine-exposed and non-exposed group of children between the ages of 3:3 and 5:10 years on measures of expressive syntactic and morphological development but not on measures of expressive vocabulary and comprehension. A "mild-to-moderate" delay in syntactic development, as measured by MLU scores obtained from the analysis of a free-play language sample and on the receptive and expressive subtests of the SICD, was reported by Johnson and colleagues (Johnson, Foose, Seikl, & Madison, 1992; Johnson, Gettles, Seikel, & Madison, 1992) in a group of 21 preschoolers aged 13 to 50 months with a history of prenatal cocaine exposure in combination with other drugs. The researchers found no significant deviations between subject age and age-equivalent scores on the mental scales of the Bayley and the PPVT and reported that scores on the HOME scale indicated an "adequate environment for language development." In this study, no control group was used and the MLU results were compared to Miller's (1981) norms. A language delay was also reported by Massenberg and Martin (1993) in a study of 15 children with prenatal exposure to crack cocaine between the ages of 1:9 and 6:0 years as measured on the Preschool Language Scale (Zimmerman, Steiner, & Pond, 1979). The researchers reported that 11 of the 15 children tested demonstrated a language delay but that the subjects with normal language development were all reported to have one or more of the following: poor motor skills, emotional problems, aggressive behavior, and/or hyperactivity. The researchers did not compare their results to a matched control group. Bland et al. (1994) provided a detailed analysis of the syntactic, semantic, and pragmatic (communication functions) development of two 24-month-old children who were prenatally exposed to cocaine. They reported a language delay across all domains of language for 1 of the 2 subjects tested. Problems in the prelinguistic development of infants prenatally exposed to cocaine were reported by Epstein and Gerber (1994). They compared the prelinguistic development of 6 infants prenatally exposed to cocaine to the development of 6 unexposed matched-control infants. They found that the infants with prenatal cocaine exposure consistently produced more social initiations and communication acts than the unexposed infants, but that the communication acts and means-ends behaviors of the exposed infants were less complex than those of the unexposed infants.

Although these findings suggest that exposure to cocaine may place children at risk for impaired language development, the results are preliminary and limited in the range of language behaviors evaluated and depth of analysis. Not all components of language, including the pragmatic, semantic, and form components, have been evaluated in detail and matched control groups have not been used consistently. In many of the studies, standardized language tests have been used and although such measures provide valuable and important information, they do not sample all components of language and may not be sufficiently sensitive to identify the full range of potential problems that cocaine-exposed children may experience. Given these factors it is clear that the language development of children with prenatal cocaine-exposure requires further investigation.

Although research suggests that the use of cocaine during pregnancy may pose a significant risk for the developing fetus and neonate and the later development of the child, the literature needs to be interpreted cautiously. Consideration needs to be given to the confounding effects of maternal, socio-economic, and methodological variables. There are a number of potentially deleterious confounding maternal variables that include the use of alcohol and drugs other than cocaine during pregnancy, poor nutrition, the failure to seek prenatal care, and the transmission to the fetus of infections such as the human immunodeficiency virus (e.g. Mayes, Granger, Bornstein, & Zuckerman, 1992; Neuspiel & Hamel, 1991). Another possible confounding variable that is particularly relevant to language development is the effects of the socio-linguistic environment in which the child is raised. The specific social conditions created by a cocaine-abusing parent, multiple foster placements, or poverty may each have a negative effect on language development. In addition to these factors, it is also important to consider the methods used to determine cocaine exposure and the extent to which results are influenced by the quantity and timing of cocaine use (Hutchings, 1993; Volpe, 1992).

Consideration of these factors suggests that prenatal cocaine-exposure coexists with a range of associated factors that place a child at risk for impaired linguistic and cognitive development. It is important that the maternal and environmental risk variables be considered in combination with prenatal cocaine-exposure as the literature suggests that a negative outcome is more likely in the presence of multiple risk factors (Aylward, 1992; Dunst, 1992; Greenbaum & Auerbach, 1992; Sameroff, Selfer, Barocas, Zax, & Greenspan, 1987). Thus, although it is important to examine the effects of prenatal cocaine-exposure per se on child development, it is equally important to evaluate the combined multiple effects of prenatal cocaine-exposure and associated negative maternal and environmental risk factors on development. The reality is that a high percentage of children prenatally exposed to cocaine are also exposed to a constellation of other risk factors and the specific combination of prenatal cocaine-exposure and multiple risk factors may together substantially increase the potential of a negative outcome. The purpose of the present study was to evaluate the effects of this multiple set of factors on language development.

The data to date suggest that infants with prenatal cocaine-exposure demonstrate impaired fetal growth, altered behavior as newborns, and that at least a percentage of these infants may have sustained some central nervous system damage. This suggests that prenatal cocaine exposure and associated risk factors may place children at risk for later cognitive and language development. However, there is a paucity of data concerning the later development of these children, particularly in the area of language development. Although the limited preliminary work in this area suggests that these children may have impaired language development (Baltaxe et al., 1992; Carrico et al., 1993; Johnson, Foose, Seikl, & Madison, 1992; Johnson, Gettles, Seikel, & Madison, 1992; Rivers & Hedrick, 1992), there is a clear need for further in-depth investigation of this topic. This research has important theoretical implications in terms of the combined effects of prenatal cocaine-exposure and associated risk factors on brain development and later language function. It also has important clinical implications in terms of the early identification and treatment of language impairment. Successful language development plays a critical role in social and cognitive development, and is essential for achieving academic success, and treatment effectiveness is maximized when intervention is initiated early (Guralnick & Bennett, 1987; Miller, 1983).

The purpose of the present study was to compare the language development profiles of 5 children prenatally exposed to cocaine and associated maternal and environmental risk factors to the language development profiles of a matched non-cocaine-exposed control group in terms of analyses of the discourse-pragmatic, semantic, and form components of language. The goal of this preliminary research was to provide a detailed evaluation of the three major components of language. The following questions regarding the language development of the two groups of subjects were addressed:

1. Are there differences in the discourse-pragmatic abilities of the children with prenatal cocaine-exposure and associated risk factors (C-E) compared to those of the non-exposed (N-E) children?
2. Are there differences in the syntactic development of the children with C-E compared to those of the children who were N-E?
3. Are there differences in the semantic development of the children who were C-E compared to those of the children who were N-E?

Method

Subjects

Ten subjects participated in the study, 5 subjects with C-E and 5 matched control subjects who were N-E living in the same community as the subjects with C-E. The subjects with C-E were all recruited from a substance abuse parent-child treatment program that met on a weekly basis. The subjects who were N-E were recruited from a day care center in the same area as the hospital from which the subjects with C-E were recruited and subjects in both groups were members of the same community. All subjects were within the age range of 2:0 to 2:6 years. The mean ages of the subjects with C-E and the subjects who were N-E were 2:4 years (range = 2:2–2:5 years) and 2:2 years (range = 2:0–2:6 years), respectively. Subjects in both groups were monolingual native speakers of American English.

C-E subjects

Evidence of prenatal cocaine exposure was based on positive urine toxicologic screening for both mother and child at delivery and reported drug history information. The mothers of all subjects reported using cocaine throughout their pregnancy. The amount of cocaine used was reported to be either daily or three to four times a week for all subjects except Subject 5 for whom this information was unavailable. The mothers of Subjects 1, 2, 4, and 5 also reported having alcohol on a daily basis and Subject 3's mother reported the daily use of marijuana. The mothers of Subjects 1, 3, & 5 did not receive prenatal care, Subject 2's mother received prenatal care inconsistently, and Subject's 4's mother received regular prenatal care after 5 months. All mothers were between the ages of 22 and 29 years at the time of the subjects' births.
The birthweight for all subjects was within normal limits and all subjects had 1 - and 5-minute Apgar scores of 7 or above. The only exception to this was Subject 5 who was described as "jittery" but for whom an Apgar score was not available. The only significant medical problems reported for the subjects with C-E was a failure-to-thrive diagnosis for Subject 1 and a positive test result for the human immunodeficiency virus (HIV) for Subject 5. Subjects 1, 2, and 4 were

reported to have had a history of middle ear infections. Motor milestones for Subjects 1 & 5 were reported to be delayed and all subjects with C-E were reported to have had delayed language milestones based on medical record documentation. All subjects had received regular pediatric care from birth.

Three subjects (2, 3, and 5) lived with either a paternal or maternal grandmother, although all three mothers were reported to have continued to see their children on an almost daily basis. One subject (4) lived with his biological mother, and one subject (1) had been in the same foster home since birth. Although all mothers who were involved in the caretaking of their children were enrolled in a substance abuse program, the mothers of Subjects 2, 3, and 5 continued to abuse cocaine. This data was unavailable for the mother of Subject 4.

N-E subjects

No subject in the N-E group was reported to have had prenatal exposure to cocaine, alcohol, or other drugs. Negative evidence of drug exposure was based on self-report data. The mothers of Subjects 1, 2, & 5 were between the ages of 25 and 34 years. The birthweight for all subjects was within normal limits and no significant medical problems were reported for any of the subjects. Subjects 2, 3, and 4 were reported to have had a history of middle ear infections. Motor and language milestones were reported to be within normal limits for all subjects. All subjects lived with one or both biological parents.
Individual subject description information for all subjects in both groups is presented in Table 1. Although there was a range in the intelligibility of the subjects, the majority of utterances produced by all subjects were sufficiently intelligible to be accurately and reliably transcribed.

TABLE 1. Individual subject description information for subjects in the Cocaine-Exposed (C-E) and Non-Exposed (N-E) groups.

	C-E subjects					**N-E subjects**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Age	2:4	2:4	2:2	2:3	2:5	2:6	2:2	2:0	2:0	2:2
Sex	F	M	F	M	M	M	F	F	F	M
Maternal variables										
Cocaine use	yes	yes	yes	yes	yes	none	none	none	none	none
# trimesters	all 3	all 3	all 3	all 3	all 3					
amount	daily	3–4 × wk	3–4 × wk	daily	—					
Alcohol use	yes	yes	NR	yes	yes	none	none	none	none	none
amount	daily	daily		daily	daily					
Other drug use	NR	NR	marij	NR	NR	none	none	none	none	none
amount			daily							
Maternal age at delivery	26	23	22	29	29	28	34	25	29	34
Infant outcome/subject variables										
Birthweight	6.4	7.8	6.6	5.1	6.4	8.2	6.0	5.1	6.5	8.5
Apgar	7, 8	8, 9	7, 8	8, 9	“jittery”	—	—	—	—	—
Medical diagnoses	FTT	none	none	none	HIV+	none	none	none	none	none
Middle ear infections	yes	yes	no	yes	no	no	yes	yes	yes	no
Motor milestones	DEL	WNL	WNL	WNL	DEL	WNL	WNL	WNL	WNL	WNL
Language milestones	DEL	DEL	DEL	DEL	DEL	WNL	WNL	WNL	WNL	WNL
Environmental variables Home care										

Home care	FF	PGM	MGM	BM	MGM	BM	BM	BP	BP	BM

Note, wk = week; — = information unavailable; NR = not reported; marij. = marijuana; FTT = failure-to-thrive; DEL = delayed; WNL = within normal limits; FF = foster family; PGM = paternal grandmother; MGM = maternal grandmother; BM = biological mother; BP = biological parents.

Language Evaluation

The language development of the two groups of subjects was compared along measures of discourse-pragmatics, syntax, and semantics. The evaluation was based on the collection, transcription, and analysis of a spontaneous language sample.

Collection and Description of the Language Samples

The language sample consisted of a 15-minute free-play and a 15-minute structured-play condition between the subject and investigator. The structured-play condition was based on procedures adapted from Wetherby and Prutting (1984) in which the investigator performed 12 actions designed to provide the subject with specific opportunities to produce a range of communication functions and structures. The same set of toys was used with all subjects. The interaction was videotape-recorded and later transcribed into standard orthography. The transcriptions were segmented into utterances based on the criteria described by Brinton and Fujiki (1984).

Analysis of the Language Samples

Discourse-pragmatics

Discourse-pragmatics was analyzed in terms of a modified version of the Topic Coherence Analysis developed by Mentis (1991) and the Pragmatic Protocol (Prutting & Kirchner, 1987).

Topic-Coherence Analysis

The major parameters of the Topic Coherence Analysis are presented in Table 2. This analysis was used to evaluate the subjects' discourse pragmatic abilities as it provides a description of the extent to which the child is able to contribute propositional information to the discourse, how the child structures and organizes both new and old information across extended sequences of discourse and play, and the extent to which the communication interaction is negatively affected by the production of inappropriate and problematic utterances. The analysis provides an indication of the extent to which the child is an active participant who contributes to the propositional development of the topic and is able to produce contingent responses. The analysis is based on three major categories, the new information, no new information, and problematic categories, and a set of descriptive subcategories within each major category.

TABLE 2. Parameters of the Topic Coherence Analysis.

New information
Unsolicited novel information

Requests for novel information
Requests for an action or object
Requested information provided
No new information
General (agreement/acknowledgment, exclamations, discourse markers)
Repetitions
Self-repetition with communicative purpose
Self-repetition for turn-taking purpose
Partner repetition with communicative purpose
Partner repetition for turn-taking purpose
Problematic
Inappropriate response
Perseverations

New information category

Utterances that fell into the new information category were utterances that expressed a new concept relevant to the text or context and that added propositional information to the discourse. Within this category, utterances were further analyzed in terms of four descriptive subcategories: (a) unsolicited novel information, (b) requests for novel information, (c) requests for an action or object, and (d) utterances that provided requested information. This information provides an indication of the extent to which the child is able to produce unsolicited novel information and the extent to which the child relies on the partner to contribute propositional information to the topic through solicited contributions. In addition, it provides an indication of the extent to which the child's requests are for concrete, context-related actions and objects as compared to requests for information.

No new information category

Utterances that fell into the no new information category were utterances that did not add new propositional information to the discourse. These utterances were further analyzed in terms of two descriptive subcategories: (a) general and (b) repetitions. The general category included agreement or acknowledgment responses, exclamations, and discourse markers. Repetitions were further analyzed in terms of four subcategories because repetition plays an important developmental role in acquisition and serves a number of functions in discourse. The four subcategories of repetition included the following:

- Self-repetition where the repetition served a clear communication purpose. Such functions included the use of repetition for emphasis or clarification, to demand an answer, to label an action or object, or as part of a game.
- Self-repetition where the only apparent purpose the repetition served was to take a turn at talk.
- Partner repetition where the repetition served a clear communication purpose such as labeling, requesting, protesting, clarification, or rehearsal.
- Partner repetition where the only apparent purpose the repetition served was to take a turn at talk.

Problematic category

Utterances that fell into the problematic category provided an indication of the extent to which the child's utterances were inappropriate responses to partner utterances in terms of the propositional information that was given and the extent to which perseverative utterances were produced. Problematic utterances were analyzed in terms of the descriptive subcategories of (a) inappropriate responses to partner utterances and (b) perseverative utterances. Perseverative utterances were defined as utterances that had the same linguistic form as an utterance previously produced and which were not produced in response to or related to the situational or linguistic context in which they were produced.

Each utterance was analyzed as falling into one of the major categories of new information, no new information, or problematic and then further classified according to the subcategories within each major category. The percentage of utterances falling into each of the three major categories and subcategories was calculated and compared across subjects.

Pragmatic protocol

*The 30-minute play interaction for all subjects was rated on the Pragmatic Protocol (*Prutting & Kirchner, 1987*) to provide an evaluation of the pragmatic ability of the subjects in terms of an appropriate/inappropriate rating scale. Pragmatic behaviors were rated as inappropriate if they had a penalizing or negative effect on the interaction and were not developmental^ appropriate. This evaluation provided a measure of the extent to which the child's pragmatic behavior was judged to be socially penalizing. The protocol consists of 30 pragmatic behaviors that are divided into the categories of verbal, paralinguistic, and nonverbal aspects. The play interaction was rated by the first author. For reliability purposes, a second rater, who was unfamiliar with the subjects and who did not know which group the subjects fell into, rated the play interaction for 50% of the subjects (3 subjects from the C-E group and 2 subjects from the N-E group*).

Syntax

Syntactic development was analyzed in terms of mean length of utterance (MLU) and Brown's (1973) corresponding developmental language stage assignments, and the Language Assessment, Remediation and Screening Procedure (LARSP) (Crystal, Fletcher, & Garman, 1989). Brown's (1973) criteria for computing MLU were used.

The LARSP analysis was used to evaluate syntactic development as it provides a comprehensive analysis of all structures at the clause and phrase levels as well as an analysis of selected inflectional morphemes at the word level. Computerized Profiling (Long & Fey, 1991) was used to perform the initial LARSP analysis and the analysis of each utterance was then checked for accuracy by the investigator. Each utterance was analyzed at the clause, phrase, and word levels and the percentage of each type of clause, phrase, and word level structure was calculated. This provided a measure of the range and frequency of use of structures at each level and a developmental stage assignment at the clause and phrase levels. In addition, a developmental clause structure score was calculated for each subject. This was done by multiplying the percentage of clause structures produced at each stage by that stage number (i.e., multiplying the

total number of Stage I structures by 1, Stage II structures by 2, etc.), adding the totals for each stage, and then dividing the final number by 5. Subjects producing more clause structures at low developmental stages would have low scores on this scale whereas subjects producing more clause structures at higher stages of development would have higher scores.

Semantics

Semantic development was evaluated in terms of vocabulary diversity and relational semantics.

Vocabulary diversity

Vocabulary diversity was analyzed by calculating the number of different words (NDW) used in a sample of 100 utterances. This procedure was based on the measure used by Miller (1981), which was found to be significantly correlated with age.

Relational semantics

The analysis of relational semantics was based on Retherford, Schwartz, and Chapman's (1981) analysis of semantic roles presented by Retherford (1993). The analysis provides an evaluation of the individual semantic roles, residual grammatical categories, and conversational devices or communication routines expressed in single and multiterm utterances. Semantic content is coded in terms of 15 semantic roles and 6 grammatical categories. Utterances that cannot be coded using the 21 semantic roles and residual grammatical categories may be coded as falling into the conversational devices or communication routine categories.

Each utterance was analyzed in terms of the individual semantic roles, grammatical categories, and/or conversational devices/communication routines expressed. In addition, each utterance was analyzed in terms of the semantic role relations expressed. The percentage of individual semantic roles, grammatical categories, and conversational devices/communication routines falling into each category as well as the percentage of semantic role relations expressed was calculated and compared across subjects. This provided a measure of the range and frequency of use of individual semantic roles and grammatical categories and semantic relation combinations.

Overall Data Analysis

Because the purpose of this study was to provide an in-depth preliminary analysis of the language development of a small number of carefully described subjects, individual subject data describing the language development profiles of all C-E and N-E subjects will be presented. As the small sample size would not support exhaustive statistical testing, formal statistical testing was only done on the three major Topic Coherence Analysis variables (new information, no new information, and problematic) and three major LARSP analysis variables (developmental clause structure score, total percentage use of noun phrases [NP], and total percentage use of verb phrases [VP]. The group means of each of these variables were compared using two-tailed *t*-tests.

Reliability

Point by point inter-rater reliability was calculated using the following formula: number of agreements/number of agreements + disagreements × 100. Reliability for transcription accuracy and segmentation into utterances was based on 10% of the language samples (one C-E sample randomly selected) and was calculated to be 96% for transcription accuracy and 98% for segmentation into utterances. Reliability for the Pragmatic Protocol was based on the evaluation of 50% of the play interactions (three play interactions with children with C-E and two play interactions with children who were N-E) by a rater who did not know which group the children were in. Reliability for all the other analysis procedures was based on 20% of the language samples. Two language samples, one from a C-E and one from an N-E subject were randomly selected and analyzed by an independent observer. Scoring agreement for each of the analyses was high and ranged from 83% to 100%. Point-by-point reliability for each of the categories and subcategories of the Topic Coherence Analysis ranged from 83% to 94%. Point by point reliability for the Pragmatic Protocol was 97%, for the LARSP analysis was 93%, for the relational semantics analysis was 89%, and for lexical diversity was 100%.

Results

The results revealed both similarities and differences between the two groups as well as differences within the C-E group.

Discourse-Pragmatics

Topic Coherence Analysis

Individual subject data showing the discourse-pragmatic profiles of each of the subjects with C-E and who were N-E are presented in Table 3. In the new information category, 2 of the subjects with C-E (2 & 4) produced substantially fewer new information utterances than the subjects who were N-E and all the subjects with C-E demonstrated a different discourse-pragmatic profile from the subjects who were N-E in terms of the different types of new information utterances produced. Two subjects with C-E (4 & 5) produced substantially fewer unsolicited novel information utterances than the subjects who were N-E and 3 subjects with C-E (2, 3, & 5) produced substantially fewer utterances that fell into the provision of novel information category. Subjects 1, 3, 4, and 5 with C-E produced substantially fewer requests for novel information than requests for an action or object whereas Subject 2 with C-E produced similar percentages of requests for novel information and requests for an action or object. Two of the subjects who were N-E (3 & 4) produced fewer requests for information than requests for an action or object and 2 subjects who were N-E (1 & 5) produced similar percentages of requests for information and requests for an action or object. One subject who was N-E (2) produced substantially more requests for information than requests for an action or object. These results suggest that within the new information category, Subject 1 with C-E differed from 3 of the subjects who were N-E in her use of substantially fewer requests for information than requests for an action or object. Subject 2 with C-E differed from the subjects who were N-E in his production of substantially fewer new information utterances and within this major category, his production of substantially fewer provisions of requested information utterances. Subject 3 with C-E differed from the subjects who were N-E in her production of substantially fewer utterances that fell into the

provision of requested information subcategory and differed from 3 of the subjects who were N-E in her production of substantially fewer requests for new information than requests for an action or object. Subject 4 with C-E differed from the subjects who were N-E in his production of substantially fewer new information utterances and unsolicited new information utterances than the subjects who were N-E and differed from 3 of the subjects who were N-E in his production of fewer requests for novel information than requests for an action or object. Subject 5 with C-E differed from the subjects who were N-E in his production of fewer unsolicited novel information and provision of requested information utterances than the subjects who were N-E and differed from 3 of the subjects who were N-E in his production of fewer requests for information than requests for an action or object.

TABLE 3. Individual subject data and group means and standard deviations of the percentage of utterances falling into the Topic Coherence categories and subcategories for each of the C-E and N-E subjects.

	NI	**UNI**	**RNI**	**RA/O**	**RIP**	***NNI***	**GEN**	**SRC**	**SRT**	**PRC**	**PRT**	***PROB***
C-E												
1	**70.0**	30.0	0.8	21.5	17.7	**29.2**	14.7	5.4	1.5	7.7	0.0	**0.8**
2	**47.7**	24.6	7.7	6.9	8.5	**33.1**	20.8	2.3	4.6	4.6	0.8	**19.3**
3	**64.8**	40.0	0.8	12.0	12.0	**31.2**	16.8	4.0	4.0	6.4	0.0	**4.0**
4	**55.8**	14.0	4.7	11.6	25.6	**44.2**	32.6	0.0	0.0	11.6	0.0	**0.0**
5	**68.0**	19.4	6.8	31.1	10.7	**27.3**	6.8	6.8	11.7	2.0	0.0	**4.9**
M	**61.3**	25.6	4.2	16.6	14.9	**33.0**	18.3	4.4	3.7	0.2	6.5	**5.8**
SD	**9.7**	10.0	3.3	9.7	6.9	**6.7**	9.5	4.5	2.7	0.4	3.6	**7.8**
N-E												
1	**81.5**	33.9	6.2	5.4	36.2	**17.7**	10.0	0.0	7.7	0.0	0.0	**0.8**
2	**67.0**	30.8	16.2	3.1	16.9	**33.1**	13.9	2.3	10.0	2.3	4.6	**0.0**
3	**77.2**	30.1	6.5	12.2	28.5	**22.8**	13.9	3.3	5.7	0.0	0.0	**0.0**
4	**75.4**	42.3	3.1	13.1	16.9	**24.6**	8.4	0.0	12.3	1.5	2.3	**0.0**
5	**88.5**	27.7	14.6	13.1	33.1	**11.5**	6.2	0.0	3.1	0.8	0.8	**0.8**
M	**77.8***	33.0	9.3	9.4	26.3	**21.9***	10.5	7.8	1.1	1.5	0.9	**0.3**
SD	**8.2**	5.7	5.7	4.8	9.0	**8.1**	3.4	3.6	1.6	2.0	1.0	**0.4**

Note. NI—New Information, UNI—Unsolicited Novel Information, RNI—Requests Novel Information, RA/O—Requests for Action/Object, RIP—Requested Information Provided, NNI—No New Information, GEN—General, SRC—Self Repetition with Communicative Purpose, SRT—Self Repetition for Turn Taking Purpose, PRC—Partner Repetition with Communicative Purpose, PRT—Partner Repetition for Turn Taking Purpose, PROB—Problematic * Significant difference

In the no new information category, 1 subject with C-E (4) produced a substantially higher percentage of no new information utterances than the subjects who were N-E and all subjects with C-E demonstrated a different discourse-pragmatic profile to the subjects who were N-E in terms of the different types of no new information utterances produced. Four of the 5 subjects with C-E (1, 2, 3, & 4) produced higher percentages of partner repetitions that served only a turn-taking purpose than the subjects who were N-E. Subject 5 with C-E produced a higher percentage of self-repetitions that served only a turn-taking purpose than the subjects who were

N-E. Two of the subjects with C-E (2 & 4) also produced substantially higher percentages of general no new information utterances than the subjects who were N-E.

In the problematic utterance category, 3 of the 5 subjects with C-E produced problematic utterances between 4% and 19.3% of the time. Subject 2 with C-E produced the highest percentage of problematic utterances (19.3%); 13.1% of these problematic utterances were perseverative utterances and 6.2% were inappropriate responses. For Subjects 3 and 5 with C-E, 4% and 4.9%, respectively, of their utterances were classified as inappropriate responses. In contrast to these results, problematic utterances were produced by only 2 of the subjects who were N-E less than 1% of the time.

Due to the small sample size and multiple testing issues, formal statistical testing was only done on the major topic coherence categories and not on the subcategories. The group means of the major topic coherence categories were compared using two-tailed *t*tests. The means, standard deviations, and statistical test results for both groups across all major topic management categories and subcategories are presented in Table 3. The results showed significant differences between the means of the two groups in the new information and no new information categories. The subjects with C-E produced significantly fewer new information utterances than the subjects who were N-E, $t(8) = 2.83$, $p < 0.02$. The mean percentages of new information utterances produced by the subjects who were C-E and N-E were 61.66% (*SD* = 9.72) and 77.76% (*SD* =8.20), respectively. In the no new information category, the subjects with C-E produced significantly more no new information utterances than the subjects who were N-E, $t(8) = 2.36$, $p < 0.04$. The mean percentages of no new utterances produced by the subjects who were C-E and N-E were 32.98% (*SD* = 6.65) and 21.94% (*SD* =8.05), respectively. There were no statistically significant differences between the two groups in the problematic utterance category, $t(8) = 1.56$, $p > 0.05$. The percentages of utterances falling into this category were generally small and there was great individual variation within the C-E group.

Pragmatic Protocol

The results from the Pragmatic Protocol (Prutting & Kirchner, 1987) are displayed in Table 4. Whereas all the subjects with C-E received inappropriate ratings on two or more of the pragmatic parameters, none of the pragmatic parameters for the subjects who were N-E were rated inappropriate. Topic maintenance was rated inappropriate for 4 of the 5 (2, 3, 4, & 5) subjects and turn taking response was rated inappropriate for 3 of these 4 subjects (2, 3, & 5). Turn taking contingency was rated inappropriate for 3 subjects (1, 2, & 4), and repair-revision and lexical specificity/accuracy were each rated inappropriate for 1 subject (2 & 4, respectively). All subjects received inappropriate ratings for intelligibility.

TABLE 4. Pragmatic parameters rated inappropriate on the Pragmatic Protocol (Prutting & Kirchner, 1987**) for the C-E and N-E subjects.**

	C-E					**N-E**				
Pragmatic parameter	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Verbal aspects										
Speech acts										

Speech act pair										
Variety of speech acts										
Topic										
Selection										
Introduction										
Maintenance		×	×	×	×					
Change										
Turn taking										
Initiation										
Response		×	×		×					
Repair/revision		×								
Pause time										
Interruption/overlap										
Feedback to speakers										
Adjacency										
Contingency	×	×		×						
Quantity/conciseness										
Lexical selection/use										
Specificity/accuracy				×						
Cohesion										
Paralinguistic aspects										
Intelligibility	×	×	×	×	×					
Vocal intensity										
Vocal quality				×						
Prosody										
Fluency										
Nonverbal aspects										
Physical proximity										
Physical contacts										
Body posture										
Foot/leg hand/arm mvmt.										
Gestures										
Facial expression										
Eye gaze										

Syntax

The results from the MLU and LARSP analyses indicated differences both within and between the groups. Within the C-E group, the syntactic development of Subject 4 was markedly delayed in comparison to the other subjects in both groups. A comparison between the other subjects with C-E and the subjects who were N-E indicated differences between the groups both in terms of MLU and on the LARSP profile, although the differences were not marked.
Individual subject data for MLU and corresponding Brown's (1973) stages are presented in Table 5. Subject 4 with C-E obtained an MLU that fell within Brown's Stage I, Subjects 2, 3, and 5 with C-E obtained MLU scores that fell within Brown's Stage II, and Subject 1 with C-E

obtained an MLU score that fell within Brown's Stage III. In contrast to this, Subjects 2 and 4 who were N-E obtained MLU scores that fell within Brown's Stage II, Subject 1 who was N-E obtained an MLU score that fell within Brown's Stage III, and Subjects 3 and 5 who were N-E obtained MLU scores that fell within Brown's Stage IV. The mean MLU for the subjects with C-E was 2.25 (*SD* = 0.42) and for the subjects who were N-E was 2.71 (*SD* = 0.33).

TABLE 5. Individual subject data and group means and standard deviations of the MLU scores and corresponding Brown's (1973) **stages for the C-E and N-E subjects.**

C-E subject	MLU	Brown's stage	N-E subject	MLU	Brown's stage
1	2.87	III	1	2.54	III
2	2.47	II	2	2.47	II
3	2.05	II	3	3.03	IV
4	1.8	I	4	2 34	II
5	2.08	II	5	3.08	IV
M	2.25	II	*M*	2.71	III
SD	0.42		*SD*	0.33	

The results from the LARSP analysis indicated differences between the subjects with C-E and the subjects who were N-E in both clause structure and phrase structure development. Individual subject data for clause structure development are presented in Table 6. Subject 4 with C-E demonstrated the least advanced clause structure development as the majority of his utterances fell into Stage I. Although he also produced smaller percentages of Stage II and III clause structures and very few Stage IV clause structures, the range of clause structure types within each of these levels was limited. The only Stage III clause structure produced was an SVO/A structure and the only Stage IV structure produced was a QVS structure. Subjects 2, 3, and 5 with C-E were functioning primarily at Stage II with evidence of the emergence of Stage III structures and subject 1 with C-E was functioning primarily at Stage III although there was no evidence of the emergence of Stage IV structures. Within the N-E group, Subjects 1, 3, and 5 were functioning primarily at Stage III and Subject 4 produced similar percentages of Stage II and III clause structures. Subject 2 was functioning primarily at Stage II with evidence of Stage III clause structures. In terms of individual developmental clause structure scores, the lowest score was obtained by Subject 4 with C-E (19) and the other subjects with C-E obtained scores between 23.8 and 32.6. In the N-E group, Subjects 2 and 4 obtained scores that fell within the same range as the 4 subjects with C-E (28.6 & 29.4, respectively) whereas the other 3 subjects obtained scores that were markedly higher than the other subjects (37.4, 44.8, & 42.6 for Subjects 1, 3, & 5, respectively). Individual developmental clause structure scores are presented in Table 6. The group means of the developmental clause structure scores were compared using a two-tailed f-test. The mean developmental clause structure score for the subjects with C-E was significantly lower than the mean score of the subjects who were N-E, $f(8) = -2.39$, $p < 0.04$. Means and standard deviations of the developmental clause structure scores and percentage of clause structures produced by the C-E and N-E groups at each stage of development are presented in Table 6.

TABLE 6. Individual subject data and group means and standard deviations of the percentage of clause level structures produced by the C-E and N-E subjects at each stage of development.

Subject	I	II	III	IV	V	DCSS
C-E						
1	8	20	36	0	0	31.2
2	19	31	12	4	0	26.6
3	26	23	13	2	0	23.8
4	31	13	10	2	0	19.0
5	25	31	16	7	0	32.6
M	21.8	23.6	17.4	3.0	0	26.6
SD	8.8	7.7	10.6	2.6	0	5.5
N-E						
1	7	17	26	5	0	37.4
2	9	25	16	9	0	28.6
3	5	11	29	20	6	44.8
4	17	25	20	5	0	29.4
5	11	18	31	12	5	42.6
M	9.8	19.2	24.4	10.2	2.2	36.6*
SD	4.6	5.9	6.3	6.2	3.0	7.4

Note. DCSS—Developmental Clause Structure Score * Significant difference

Differences between the subjects with C-E and subjects who were N-E were also evident in phrase structure development. Individual subject data for phrase structure development are presented in Table 7. In terms of noun phrase development, Subjects 2, 3, 4, and 5 with C-E produced substantially fewer NPs than the N-E subjects although for all subjects in both groups, the majority of NPs fell into Stage III. There were no clear differences between the groups in terms of verb phrase development as all subjects in both groups produced similar percentages of VPs and primarily Stage III VP structures. The only exception to this was Subject 4 with C-E. There were also no clear differences between the subjects in both groups in the development of inflectional morphemes at the word level except in the production of the contracted and uncontracted copula. Subjects 2, 3, and 4 with C-E produced substantially fewer contracted and uncontracted copulas than the subjects who were N-E. In comparison to both subjects with C-E and the subjects who were N-E, Subject 4 with C-E's phrase structure development was more limited both in the total number of phrase structures produced and in the range of structures produced. The only Stage III NP structures produced by this subject were pronouns and the only VPs produced at either Stage II or III were the copula and auxiliary. He did not produce any of the inflectional morphemes coded on the profile at the word level.

TABLE 7. Individual subject data and group means and standard deviations of the percentage of phrase level structures produced by the C-E and N-E subjects at each stage of development.

	NP					**VP**				
Subject	**TOTAL**	**II**	**III**	**IV**	**V**	**TOTAL**	**II**	**III**	**IV**	**COP**
C-E										
1	**89**	32	56	0	1	**25**	4	18	3	12
2	**59**	24	34	1	0	**25**	7	14	4	4
3	**53**	19	34	0	0	**18**	2	10	6	4

4	**28**	9	19	0	0	**8**	0	6	2	2
5	**61**	10	51	0	0	**22**	0	16	6	9
M	**58.0**	18.8	38.8	0.2	0.2	**19.6**	2.6	12.8	4.2	6.2
SD	**21.8**	9.7	14.9	0.4	0.4	**7.1**	3.0	4.8	1.8	4.3
N-E										
1	**93**	48	45	0	0	**28**	0	25	3	19
2	**70**	34	36	0	0	**19**	3	15	1	11
3	**112**	27	81	4	0	**27**	2	23	2	14
4	**75**	26	47	2	0	**19**	2	17	0	11
5	**81**	23	51	5	2	**29**	9	17	3	10
M	**86.2***	31.6	52.0	2.2	0.4	**24.4**	3.2	19.4	1.8	13.0
SD	**16.8**	10.0	17.1	2.3	0.9	**5.0**	3.4	4.3	1.3	3.7

Note. * Significant difference

The group means of the total number of NPs and VPs produced were compared by using two-tailed *t*-tests. The results showed significant differences between the means of the two groups in the total number of NPs produced. The subjects who were N-E produced significantly more NPs than the subjects with C-E, $t(8) = -2.29$, $p < 0.05$. There were no statistically significant differences between the two groups in the total number of VPs produced, $t(8) = -1.24$, $p > 0.05$. The means and standard deviations of the percentage of phrase level structures produced by the subjects with C-E and the subjects who were N-E at each stage of development are presented in Table 7.

Semantics

Number of different words used

The number of different words used by Subjects 1, 2, 3, and 5 with C-E, and the subjects who were N-E ranged from 69 to 91. There were no clear differences between the groups. The only subject who produced markedly fewer different words was Subject 4 with C-E who produced a total of 39 different words. The individual subject data and group means and standard deviations are presented in Table 8.

TABLE 8. Individual subject data and group means and standard deviations of the number of different words (NDW) used by the C-E and N-E subjects.

C-E subject	NDW	N-E subject	NDW
1	88	1	69
2	91	2	62
3	74	3	81
4	39	4	60
5	69	5	85
M	72.2	*M*	71.4
SD	20.7	*SD*	11.2

Semantic roles and relations

There were no clear differences among the subjects in both groups in the range and relative frequency of use of the different semantic role, grammatical, or conversational devices/communication routine categories. Individual subject data and group means and standard deviations are presented in Table 9. There were, however, differences among the subjects in both groups in the number of semantic role relations produced within an utterance. Only 3% of the utterances of Subject 4 with C-E were utterances in which three or more semantic role relations were coded and between 20% and 23% of Subjects 2, 3, and 5 with C-E's utterances contained three or more semantic role relations. In contrast, between 31 % and 39% of the utterances of Subjects 1, 2, 3, and 5 who were N-E were utterances in which three or more semantic role relations were coded, although 23% of the utterances of Subject 4 who was N-E contained three or more semantic role relations. Individual subject data as well as group means and standard deviations for the percentage of utterances in which three or more semantic role relations were coded are presented in Table 9.

TABLE 9. Individual subject data and group means and standard deviations of the percentage of semantic roles and grammatical categories or conversational devices/communication routines for the C-E and N-E subjects.

	C-E							**N-E**						
Semantic role	**1**	**2**	**3**	**4**	**5**	***M***	***SD***	**1**	**2**	**3**	**4**	**5**	***M***	***SD***
Action	17	15	10	20	33	19.0	8.6	9	10	19	20	13	14.2	5.1
Entity	4	13	14	14	3	9.6	5.6	1	5	1	2	2	2.1	1.7
Entity+	9	11	9	3	9	8.2	3.0	4	19	8	6	10	9.4	5.8
Locative	8	10	4	3	4	5.8	3.0	6	10	7	19	13	11.0	5.2
Negation	1	1	4	2	3	2.2	1.3	4	5	1	15	2	5.4	5.6
Agent	4	2	3	8	5	4.4	2.3	5	10	19	15	5	10.8	6.2
Object	10	10	9	8	16	10.6	3.1	21	7	6	2	6	8.4	7.3
Demon.	13	4	9	9	11	9.2	3.3	21	10	14	16	10	14.2	4.6
Recurr.	2	0	1	0	0	0.6	0.9	0	1	1	0	3	0.9	1.2
Attribute	3	1	1	2	1	1.5	1.0	2	4	2	1	5	2.7	1.8
Possessor	1	3	2	2	8	3.1	2.9	14	6	3	1	2	5.2	5.3
Adverbial	0	1	7	2	0	2.0	2.9	0	0	1	1	0	0.2	0.3
Quantifier	2	7	4	0	2	3.0	2.7	3	0	0	2	1	1.2	1.3
State	8	6	12	0	2	5.6	4.8	1	6	6	0	11	4.7	4.4
Experiencer	6	4	3	0	0	2.6	2.0	1	0	0	0	9	1.9	4.0
Recipient	1	2	0	0	0	0.5	0.9	0	0	1	3	0	0.8	1.3
Beneficiary	1	1	0	0	0	0.4	0.6	0	0	5	0	1	1.2	2.2
Created Obj	0	0	0	0	0	0.0		0	0	0	0	0	0.0	
Comative	0	0	0	0	0	0.0		0	0	0	0	0	0.0	
Instrument	0	0	0	0	0	0.0		0	0	0	0	0	0.0	
G/CD/CR	11	10	5	28	3	11.4	9.9	8	9	7	5	5	6.8	1.8
3+ SR	33	23	22	3	20	20.2	10.9	36	31	39	23	37	33.2	6.4

Note. Demon—Demonstrative, Recurr.—Recurrence, G/CD/CR—grammatical categories or conversational devices/communication routines.

Discussion

The purpose of this preliminary study was to provide a detailed evaluation of the language development of 5 children prenatally exposed to cocaine in terms of analyses of the discourse-pragmatic, syntactic, and semantic components of language and to compare their developmental profiles to a matched non-exposed control group. The results suggested that the language development of the subjects with C-E differed from that of the subjects who were N-E and was more delayed in certain areas. In addition, differences were also found among the subjects with C-E as they presented with different linguistic profiles across a range of discourse-pragmatic, syntactic, and multiple semantic relation categories. The major differences between the subjects with C-E and the subjects who were N-E were in discourse-pragmatics. The subjects with C-E produced significantly fewer utterances that contained novel prepositional information than the subjects who were N-E and demonstrated different discourse-pragmatic profiles in the different types of new and no new information utterances produced. In addition, 3 of the subjects with C-E produced inappropriate responses in terms of the propositional content of the utterance, and 1 subject with C-E produced a relatively high percentage of perseverative utterances. At least two pragmatic parameters were rated inappropriate on the pragmatic protocol for all subjects with C-E, suggesting that the differences in their discourse-pragmatic profiles were socially penalizing. Topic maintenance was rated inappropriate for 4 of the 5 subjects and turn-taking response and contingency were each rated inappropriate for 3 of the subjects. Differences between the two groups were also evident in syntactic development although they were not as marked as those in discourse. There was a significant difference between the groups in their mean developmental clause structure scores. Whereas 4 of the 5 subjects with C-E were functioning primarily at Stage I or II and 1 subject was functioning primarily at Stage III, 4 of the 5 subjects who were N-E were functioning primarily at Stage III and 1 subject who was N-E was functioning at Stage II. In terms of phrase level development, 4 of the 5 subjects with C-E produced substantially fewer NPs than the subjects who were N-E and 3 of the 5 subjects with C-E produced substantially fewer copulas. The only difference between the two groups in semantic development was in the production of multiple semantic relations within a sentence as 4 of the 5 subjects with C-E produced substantially fewer utterances that coded multiple semantic relations than the subjects who were N-E. This result may be a reflection of the more immature syntactic abilities of these subjects with C-E as the production of multiple semantic relations within an utterance is dependent on knowledge of the syntactic form needed to code those relations.

An important finding of the present study was the difference between the two groups in discourse-pragmatics. This is not an area of language development that has been previously investigated in this population and the results from the present study suggest that it may be this area that is particularly vulnerable to disruption. This is suggested by the finding that although there were differences between the subjects with C-E and subjects who were N-E in syntactic development, except for Subject 4 with C-E, the differences were not marked. On the other hand, the results from the discourse-pragmatic analyses suggested that all the subjects with C-E demonstrated problems in the area of topical coherence that were found to be socially penalizing when the subjects' play interaction was rated on the pragmatic protocol (Prutting & Kirchner, 1987). This finding may be particularly relevant when considered in the light of the potential social consequences of reduced pragmatic skills. A number of researchers have emphasized the importance of the role of discourse in the development and maintenance of social relations and in

providing a context for language learning (Brinton & Fujiki, 1993; Gallagher, 1991; Gerber, 1991; Goldstein & Gallagher, 1992; Prutting, 1982). In relation to this, Rice (1993) has discussed the concept of a "negative social spiral" in which the communication problems of young children and the social difficulties they cause compound each other in such a way that both social development and opportunities for language learning are compromised. This is particularly relevant for problems in the pragmatic domain as the results of a social validation study by Mueller (1983) indicated pragmatic deficits to be the most socially penalizing.

The increased difficulty of the subjects with C-E in the area of discourse-pragmatics needs to be considered both from the point of view of the effects of this type of impairment on social development and interaction as well as in terms of the effects of a possibly compromised social-emotional environment on language development. Here, the combined effects of prenatal cocaine-exposure and associated negative maternal and environmental risk factors are particularly important. It may be the specific constellation of these multiple risk factors that places these children at risk for impaired language development. It may also be hypothesized that the domain of language most vulnerable to disruption in a compromised social-emotional environment is discourse-pragmatics. At present, however, there is very little research addressing the issue of a possible link between the environment, parental input, and the development of discourse-pragmatic abilities. Most of the research concerning the relationship between environmental factors and language learning has focused on the relationship between parental language and syntactic development in normally developing children (e.g., Baker & Nelson, 1984; Gleitman, Newport, & Gleitman, 1984; Nelson, Bonvillian, Denninger, Kaplan, & Baker, 1984). More recently, however, researchers have begun to focus more specifically on the relationship between input and such discourse-pragmatic skills as joint reference, the establishment of discourse topic, Ghee's cooperative principle and communicative repairs (Golinkoff, 1986; Tomasello, Conti-Ramsden, & Ewert, 1990). Although this research provides important insights into how interactional factors may influence the development of discourse-pragmatics, the potential negative role that different interactional patterns and environmental conditions may have on the development of specific discourse-pragmatic skills is unknown.

There were several interesting findings that emerged from the results of the discourse-pragmatic analysis. The first was that the subjects with C-E produced utterances that contained significantly less novel propositional information than the subjects who were N-E and produced different discourse-pragmatic profiles in terms of the type of new information utterances produced. This suggests that the subjects with C-E did not contribute as much solicited and unsolicited propositional information to the communication interchange as the subjects who were N-E and that a higher percentage of their utterances were composed of a combination of agreement or acknowledgment utterances, exclamations, discourse markers, and repetitions. Nonproposi-tional and non-novel utterances such as these serve important discourse functions and constitute an essential part of normal discourse. What is interesting in the present results, however, is their higher frequency of use by the subjects with C-E in combination with their production of fewer utterances that contributed to the ideational development of the discourse or play sequence.

The finding that 4 of the 5 subjects with C-E produced more action/object requests than information requests whereas 3 of the subjects who were N-E produced either approximately the same percentage of action/object and information requests or more information than

action/object requests is interesting when viewed from a developmental perspective. There is some indication that the use of language to request an action or object is an earlier emerging communication intention than the use of language to gain information (Griffiths, 1979; Halliday, 1975). This suggests that the communication development of these 4 subjects with C-E and 2 subjects who were N-E may have been characterized by a pattern characteristic of an earlier stage of development.

The results from two other discourse-pragmatic parameters suggested a qualitatively different pattern of development by the subjects with C-E rather than an earlier developmental one. This was evident in the differences between the two groups in the types of repetitions produced and in the production of problematic utterances. Four of the 5 subjects with C-E produced substantially more partner repetitions that did not serve a clear communication function beyond taking a turn at talk than the subjects who were N-E. This suggests that these subjects with C-E may have been using partner repetitions as a strategy for providing at least a minimal response and thereby maintaining the flow of discourse and remaining active participants in the communication interaction. It has been suggested that this is a strategy used by other groups of children with pragmatic problems (Caparulo & Cohen, 1977; McTear & Conti-Ramsden, 1992; Prizant & Duchan, 1981; Shapiro, 1977). The second discourse-pragmatic parameter that suggested qualitative differences between the groups was the production of problematic utterances by 3 of the subjects with C-E. Although the percentages of these utterances were low, they may nevertheless be clinically significant as the production of very few inappropriate utterances can result in an overall impression of inappropriate pragmatic ability with socially penalizing consequences (Prutting & Kirchner, 1987). One type of problematic utterance produced by all 3 subjects was the production of inappropriate responses to partner utterances. These were responses to partner utterances that were inappropriate in terms of the propositional content of the response. Although such responses were not produced frequently, they nevertheless were disruptive to the interaction and this was reflected in both the partner responses and on the ratings on the pragmatic protocol (Prutting & Kirchner, 1987). In most instances the production of inappropriate responses resulted in unsuccessful requests for clarification and/or the abrupt termination of the topic sequence under discussion. The penalizing effects of these responses were reflected on the pragmatic protocol where they contributed to the inappropriate ratings on the topic maintenance and turn-taking response parameters for all 3 subjects and the turn-taking contingency parameter for 1 of the subjects.

Whereas Subjects 3 and 5 with C-E produced only inappropriate responses, Subject 2 with C-E produced both perseverative and inappropriate utterances. Although only 13.1% of this subject's utterances were perseverative this response may be considered clinically relevant because it is highly inappropriate and not produced in normal discourse. An example of a perseverative utterance by this subject was his production of the utterance "the car is running" a number of times in situations where it bore no relation to the situational or linguistic context in which it was produced. The utterance was completely unrelated to the toys, play interaction, discourse, and environmental noises in the instances in which it was produced. The penalizing effect of these utterances was reflected in the inappropriate ratings on the pragmatic protocol for the parameters of topic maintenance and turn-taking response, repair/revision, and contingency for this subject. The production of perseverative utterances by this subject is a potentially interesting finding that needs further investigation and clarification. Such behavior may suggest a possible deficit in

frontally mediated executive function skills, such as set shifting and the ability to inhibit a response or defer it to a more appropriate time (Welsh & Pennington, 1988; Welsh, Pennington, & Grossier, 1991). However, as there were only 5 subjects with C-E in the present study and perseverative utterances were produced by only 1 subject, it is not possible to draw conclusions from the present data. There are a number of factors unrelated to prenatal drug exposure that could account for this subject's perseverative utterances and that need to be eliminated in larger studies.

The results from the syntactic and semantic analyses are consistent with those obtained by Carrico et al. (1993), Johnson, Foose, Seikl, and Madison (1992), and Massenberg and Martin (1993) who reported delayed syntactic development in children with prenatal cocaine-exposure as measured by MLU scores and on standardized tests. The failure to find differences between the C-E and N-E groups in expressive vocabulary (with the exception of Subject 4 with C-E) is also consistent with the results obtained by Carrico et al. (1993). It is important to note, however, that in the present study, although there were differences between the two groups in syntactic development, with the exception of Subject 4 with C-E, these differences were not marked and the syntactic development of the 4 other subjects with C-E still fell within the low end of the normal range.

However, a developmental pattern that did differentiate the subjects with C-E from the subjects who were N-E was the production by 4 of the 5 subjects with C-E of substantially fewer NPs and copulas than the subjects who were N-E. Although this result needs to be interpreted cautiously due to the limited sample size, it may suggest increased difficulty in the acquisition of certain function words. Although there were no clear differences in the acquisition of the 12 inflectional morphemes evaluated on the LARSP profile, all subjects were still at a developmental stage when the frequency of production of these morphemes was not high. Developmental differences may therefore not have had sufficient opportunity to become apparent. The question of whether these results suggest an increased difficulty in the acquisition of certain function words is one that should be further empirically tested. It is interesting to note that a similar specific difficulty in the acquisition of grammatical morphemes has been frequently reported in children with specific language impairment (Bliss, 1989; Johnston & Kamhi, 1984; Khan & James, 1983; Leonard, McGregor, & Allen, 1992; Steckol & Leonard, 1979).

In interpreting the results of this study it is important to consider the potential contribution of all medical and environmental risk factors that were pertinent for each of the subjects. All the subjects with C-E were exposed to multiple risk factors and it is possible that the results are related to the combination of prenatal cocaine-exposure and associated factors. In an open peer commentary, a number of researchers cautioned against premature conclusions regarding whether or not cocaine is a prenatal toxicant (Chasnoff, 1993; Church, 1993; Frank & Zuckerman, 1993; Hutchings, 1993; Koren, 1993; Neuspiel, 1993; Spear, 1993). A major issue raised by many of these researchers was the potential contributing role of other risk factors when negative effects are found. Although the results of the present study suggested differences in the language development profiles of the C-E and N-E groups, there were also clear individual differences among subjects in the C-E group. For all the subjects, factors other than cocaine-exposure could potentially account for the findings, or alternatively, the critical issue could be the specific combination of prenatal cocaine-exposure and associated risk factors.

The potential contributing role of environmental factors is particularly relevant. For Subject 4 with C-E, who demonstrated the most severe problems in language development across all the major domains, relevant factors included being homeless for periods of time and the serious prolonged illness of his mother. Three of the other subjects with C-E had been placed in the care of their grandmothers as a result of their mothers' addiction. Only 1 subject in this group had been raised in a completely drug-free environment. It is also important to consider the potential effects the other drugs, either singly or in combination, may have had on the language development of the subjects with C-E. Parent report data suggested that all subjects with C-E were exposed to alcohol and possibly tobacco in utero, and at least 1 subject was exposed to marijuana. There is some indication that these drugs both singly and in combination may have an effect on cognitive and language development (Fried & Watkinson, 1990; Streissguth, Barr, Sampson, Darby, & Martin, 1989). Other potential intervening medical risk factors included the failure-to-thrive diagnosis and positive HIV diagnosis for 2 of the subjects. Although Subject 4 demonstrated the most severe problems in overall language development, there were no significant medical risk factors reported in his medical charts apart from maternal drug abuse during pregnancy of at least cocaine and alcohol on a daily basis.

Although this research is preliminary and the results cannot be used to support a direct causal link between prenatal cocaine-exposure and language development, they are nevertheless important because they suggest that the language development of these children may be vulnerable to disruption, and that the component of language most significantly affected may be discourse-pragmatics. This suggests that the further investigation of this topic needs to examine whether and to what extent this is a direct result of the effects of cocaine on fetal brain development, and to what extent the results could be accounted for by intervening medical problems resulting from the cocaine exposure, or the specific combination of this exposure and the effects of other toxicants, and/or specific environmental factors. The results of this preliminary investigation suggest that for children with prenatal exposure to cocaine in combination with multiple associated risk factors, language development may be compromised.

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