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Effects of Prenatal Cocaine/Polydrug Use on Maternal-Infant Feeding Interactions During the First Year of Life

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ABSTRACT. The effects of prenatal cocaine use on quality of maternal-infant interactions were evaluated using the Nursing Child Assessment Feeding Scale (NCAFS). A total of 341 (155 cocaine using; 186 non–cocaine using) low socioeconomic, primarily African-American dyads were evaluated longitudinally at birth, 6.5, and 12 months. Group differences over time were examined, controlling for covariates, using a mixed-model linear approach. Women who used cocaine during pregnancy were less sensitive to their infants than non–cocaine-using women at 6.5 and 12 months. At 6.5 months, heavier prenatal cocaine users were less responsive to their infants than lighter users. In infants, prenatal cocaine exposure was related to poorer clarity of cues. There were no significant cocaine effects on maternal social-emotional growth fostering, cognitive growth fostering, or infant responsiveness to mother. Controlling for covariates, concentration of cocaine metabolites predicted maternal sensitivity to infant cues and infant clarity of cues at 1 year. Maternal cocaine use during pregnancy and other pre- and postnatal factors adversely affect maternal-infant interactions during the first year of life. *J Dev Behav Pediatr 26:194–200, 2005.* Index terms: *prenatal, cocaine, mother-infant interaction.*

Prenatal cocaine use remains prevalent among urban women of low socioeconomic status,[1] raising serious concerns about the affected mother-infant dyad's ability to participate in quality interactive behavior. It has been hypothesized that changes in the behavior of cocaine-using mothers due to increased psychological symptoms,[2–5] cognitive deficits,[6–8] and preoccupation with drug seeking may compromise mother-infant interactions.[9–11] Reciprocally, deficits in arousal,[12–14] regulation,[15,16] and attention,[17] in cocaine-exposed infants may elicit suboptimal maternal responses. As an act of caregiving, feeding provides an opportunity to observe the quality of reciprocal interaction of high-risk mother-infant dyads during early infancy. Behaviors that are readily observable during feeding interaction such as sensitivity to infant cues, responsiveness, and active cognitive and social stimulation, play a central role in mediating infant cognitive and linguistic development.[18–20] Studies of other at-risk and normal infant groups have shown an association between better cognitive and social outcomes and sensitive, responsive, and contingent maternal interactions during feeding and other contextual interactions[21–23] and highlight the importance of investigating the effects of prenatal cocaine use on the quality of early maternal-infant feeding interaction. Therefore, the purpose of this study was to compare women who used cocaine prenatally and their infants to a socially and economically at-risk control group on quality of maternal-infant feeding interaction during the first year of life.

Many studies that assess maternal-infant interaction among cocaine/polydrug-using mothers and their infants are weakened by considerable methodological limitations that compromise internal validity of the inferences drawn. These limitations include small sample size, inadequate evaluation of prenatal substance use, lack of an adequate control group, and failure to control for confounding variables. Further, few studies have comprehensively evaluated influences of maternal cocaine use on maternal-infant interaction longitudinally during infancy, limiting our

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understanding of the developmental course and timing of compromised interactive behavior.

Early research, generally lacking adequate sample size and control for covariates, failed to find consistent results. In one study, mother-infant feeding interactions were assessed in 30 dyads using the Nursing Child Assessment Feeding Scale (NCAFS). Cocaine-using mothers were found to be less sensitive to their infants' cues[24] than non–cocaine-using controls with nonsignificant trends for poorer maternal response to distress, less clear infant cues, and less responsiveness to parents. In another study assessing play interaction (N = 20), polydrug-using women had significantly less maternal enthusiasm and responsiveness to infant cues than non–drug-using women, while drug-exposed infants showed less happiness.[25] To evaluate the effects of current cocaine use on mother-infant interaction, drug-dependent women in treatment and their infants were compared to those not in treatment (N = 24)[26] on interactive quality. Women receiving drug treatment were found to use significantly more verbalizations, displayed greater capacity to structure and mediate the environment, and expressed more enjoyment and pleasure during interactions than women not in treatment. Two other studies failed to find significant differences between cocaine-using and non–cocaine-using women and their infants[27,28] in mother-infant interactive behavior. More recently, greater attention has been paid to methodological concerns that have limited the interpretation of previous research. While patterns of mother-infant impairment have emerged, additional information about significant covariates and the nature and timing of mother-infant disruptions is still needed. For example, one study made methodological improvements by investigating mother-infant interaction longitudinally, while controlling for demographic factors and other prenatal drug exposure. Mayes et al[29] evaluated 43 cocaine with polydrug users, 17 polydrug only, and 21 nonusing mothers and their infants, identified through self-report and urine toxicology during pregnancy, and at age 3 and 6 months. At 6 months, polydrug- with cocaine-using mothers were less attentive and interrupted more frequently than at 3 months compared to non–drug-using or polydrug-/non–cocaine-using women whose quality of interactions did not decline. Two prospective, cross-sectional studies with large samples classified cocaine exposure status using multiple techniques including meconium screening, urine toxicology, and maternal self-report.[30,31] In the first study, Johnson et al[30] found mother-child interactions to be most impaired in maternal intrusiveness, hostility, quality of instruction, maternal confidence, and child persistence at 3 years of age among women who continue to report current cocaine use (N = 343). In the second study, LaGasse et al[31] found cocaine-using mothers to be less flexible and engaged and to have shorter feeding sessions at 1 month of age (N = 922) than controls.

The present study adds to the extant literature by addressing methodologic limitations of previous studies and providing detailed information about the nature and timing of dyadic disruptions during early infancy and over the first year of life. The relationship of maternal cocaine/polydrug use to maternal-infant behaviors during feeding, controlling for multiple covariates, was evaluated using the Nursing Child Assessment Feeding Scale (NCAFS) in a large cohort. It was hypothesized that women who used cocaine during pregnancy and their prenatally exposed infants would have poorer quality interactive behaviors than nonusing mothers. The quality of both maternal and infant interactive behaviors was hypothesized to deteriorate over the first year of life due to the cumulative effects of poor interaction and other exacerbating factors such as continued maternal drug use. More negative effects for heavier cocaine use/exposure, compared to light use or no use, were also hypothesized.

METHOD

Participants

Four hundred fifteen mother-infant dyads (218 cocaine-using women, 197 non–cocaine-using women) were recruited from a large, urban county teaching hospital between June 1994 and October 1996. Urine samples were obtained before or after labor and delivery for all women considered at high risk of substance abuse and analyzed for the presence of drug metabolites. A nurse recruiter approached all screened women, 647 mother-infant pairs. Of those identified, 155 declined to participate (49 cocaine positive, 106 cocaine negative), 54 were excluded (20 cocaine positive, 34 cocaine negative), and 23 did not attend the enrollment visit. On agreement to participate in the study, women signed a consent form approved by the hospital's institutional review board.

Infant meconium was collected at birth for analyses for cocaine and its metabolites: benzoylecgonine (BZE), meta-hydroxybenzoylecgonine (m-OH-BZE), cocaethylene, and other drugs of abuse.[32–34] For control subjects, all the measures were negative except for 11 (6%), for whom meconium was unavailable. Cocaine-positive dyads were identified by a positive response on any of the following measures: infant meconium or urine, maternal urine, maternal self-report of cocaine use to hospital or research staff. Cocaine-using women were further subdivided into heavier and lighter cocaine users. Heavier users of cocaine were defined as those who, from either self-reported cocaine use or from their infant's concentrations of cocaine metabolites in meconium, were above the 70th percentile for the cocaine-using sample (37 ng/g cocaine, 54 ng/g, m-OH-BZE, 216 ng/g BZE, or 17.5 units per week of self-reported prenatal cocaine use). Lighter users of cocaine were at the 70th percentile or below for all measures.

Sixty-three mother-infant dyads in the cocaine using group and 11 in the non–cocaine-using group were not assessed during a feeding session with their biologic mothers at any time point for the following reasons: (1) 44 infants were brought by an alternative caregiver (two non–cocaine using, 42 cocaine using), (2) the Nursing Child Assessment Feeding Scale (NCAFS) data on 30 subjects were not collected because of infant death (eight infants) or lack of time or technical problems at the visit (22 infants). Of the 30 subjects without NCAFS data, nine were classified as non-cocaine exposed and 21 as cocaine exposed.

Three hundred forty one (155 cocaine exposed and 186 non–cocaine exposed) biological mother-infant dyads were observed during feeding on at least one follow-up visit. The following number of subjects seen at each time point: neonatal, 290 subjects (131 C+, 159 C−); 6.5 months, 200 subjects (83 C+, 117 C−), 12 months, 232 subjects (100 C+, 132 C−).

Procedure

At each assessment, perinatal and 6.5 and 12 months, substance use history, socioeconomic,[35] educational, psychological, and environmental data were collected. Infant and maternal medical data were extracted from hospital records at the time of delivery and included APGAR scores and Hobel Neonatal Risk Scores.[36] An adaptation of the Maternal Post-Partum Interview[37] was used to quantify prenatal and postnatal maternal drug use. For each drug, the frequency and amount were recorded to compute a severity score for the previous month and each trimester of pregnancy and for follow-up at 6.5 and 12 months postpartum.

The Peabody Picture Vocabulary Scale-Revised (PPVT-R),[38] the Block Design and Picture Completion subscales of the Wechsler Adult Intelligence Test (WAIS-R),[39] and the Brief Symptom Inventory (BSI)[40] were used to assess maternal vocabulary, nonverbal intelligence, and psychological distress, respectively.

At follow-up, mother-infant dyads were videotaped during a complete feeding session. At a later date, a research assistant blinded to subject group, rated the feeding interaction using the Nursing Child Assessment Feeding Scales (NCAFS).[41,42] The NCAFS yields four parent subscales (sensitivity to cues, response to distress, social-emotional growth fostering, and cognitive growth fostering), and two child subscales (clarity of cues and responsiveness to parent). Subscale items were rated 1 for presence of positive interaction and 0 for absence of positive interaction. NCAFS scoring was completed by two raters with double scoring occurring 7% of the time. The following combined subscale intraclass correlations for NCAFS feeding interaction subscales were found; perinatally (mean = 0.48, range = 0.20–0.67), 6.5 months (mean = 0.71, range = 0.39–0.97), 1 year (mean = 0.78, range = 0.60–0.90). Intraclass correlations indicate the proportion of variance measured in NCAFS scores that can be attributed to differences between subjects as a proportion of total variance, which includes systematic differences between raters and interactions between raters and subjects (error).

Statistical Analysis

Positively skewed data, the Global Severity Index of the BSI, and self-report drug data were normalized using a log (X +1) transformation prior to analyses. One subscale of the NCAFS (maternal responsiveness to infant distress) was negatively skewed. It was normalized by taking the logarithm after the scale was reversed, such that lower scores are good. Means and standard deviations are reported by the variables' original distribution.

Group differences (prenatal cocaine use vs non–cocaine use; observed vs non-observed subjects) were compared on demographic, prenatal substance use, and birth outcome measures. All comparisons were made using t tests for continuous data and χ^2 analyses for categorical variables.

To evaluate potential covariates, Pearson and Spearman rank order correlations were used to assess the relationship of NCAFS subscale scores at each age to maternal demographic, drug use, and infant factors. NCAFS longitudinal outcomes for maternal and infant subscales were compared using mixed model analyses (SAS Proc Mixed version 8.2; SAS Institute Inc., Cary, NC) considering both cocaine status (positive vs negative) and use (none, lighter, and heavier use), age of testing, and the interaction between cocaine status and age at testing for all subscales, controlling for confounders. All results are reported by cocaine status only unless analyses showed cocaine exposure level to be significant. Confounding variables were entered into the model stepwise if they were significantly different between exposed and nonexposed groups ($p < .25$) and related to the outcome at $p < .25$. PPVT-R and WAIS-R performance scores were consistently evaluated in each model based on previous findings that maternal cognitive factors are significant predictors of maternal interactive behavior[43] in high-risk populations. Prenatal benzodiazepine, heroin, and phencyclidine use occurred at a very low rate, only among cocaine users, and therefore, could not be evaluated as covariates.

Demographic and prenatal factors were entered into the model first, followed by measures of maternal cognitive performance and prenatal drug exposure. This method, consistent with the teratogenic model,[44] accounts for environmental factors first, before considering prenatal and postnatal drug effects and therefore reduces the number of correlated variables in the model (for additional details on order of entry, see Singer et al[17,33]). If, on entry, covariates were significant at $p < .10$, they remained in the model. If prenatal cocaine status was significant, infant birth parameters, known to be affected by cocaine exposure, including birth weight, head circumference, and gestational age, were evaluated as mediators. Current maternal psychological status, which can be an effect of cocaine use, was also evaluated as a mediator[45] by entering it into the model last.

To examine the effects of postnatal cocaine use on interactive behavior at 6.5 and 12 months, a current cocaine use variable (nonprenatal exposure, prenatal cocaine exposure without current cocaine use, and prenatal exposure with current cocaine use) was created. Analysis of covariance models, with current use as the independent variable, were completed for each NCAFS subscale, controlling for covariates. Post hoc pairwise comparisons were tested using the method of Tukey.

Spearman correlations were used to assess the relationship between cocaine metabolites and NCAFS subscales at 12 months. Significant correlations were examined using regression analyses, controlling for covariates.

RESULTS

Sample Characteristics

Maternal demographic data are presented in Table 1. Women who used cocaine prenatally were significantly older and more likely to be unemployed and single and

Table 1. Sample Characteristics at Birth

	Cocaine (n = 155)		Non-cocaine (n = 186)			
Maternal	Mean	SD	Mean	SD	*t*	*p*
Years of education	11.7	2	12.0	1	1.9	.0617
Age (yr)	29.3	5	25.8	5	−6.45	<.0001
Parity	3.3	2	2.7	2	−3.07	.0023
Gravida	5.0	2	3.7	2	−4.70	<.0001
No. of prenatal visits	6.0	5	8.7	5	5.31	<.0001
PPVT-R score	75.3	16	77.6	15	1.40	.1622
WAIS-R BD score	7.1	2	7.2	2	0.46	.6426
WAIS-R PC score	6.7	2	7.0	2	1.44	.1500
Global severity index	0.74	0.7	0.5	0.5	−4.22	.0002
Average no. of cigarettes/day	10.5	8	4.3	8	−7.0	<.0001
Average alcohol use/wk	8.5	17	1.2	4	−5.05	<.0001
Average marijuana/wk	1.2	3	0.6	3	−1.92	.0555
Cocaine use/wk	18.0	28				
	n (%)		n (%)		χ^2	*p*
Race (nonwhite)	125 (81)		150 (81)		0	.9999
No prenatal care	21 (14)		16 (9)		2.14	.1437
Maternal employment	9 (6)		41 (22)		17.80	<.0001
Married	15 (10)		34 (18)		5.08	.0241
Low socioeconomic status	152 (98)		183 (98)		0.06	.8107
Alcohol use	133 (87)		119 (66)		2.01	<.0001
Marijuana use	81 (53)		23 (13)		62.6	<.0001
Tobacco use	136 (89)		76 (42)		78.7	<.0001
Amphetamine use	1 (1)		2 (1)		0.19	.6597
Barbiturate use	1 (1)		1 (1)		0.01	.9050
Benzodiazepine use	17 (14)		0 (0)		22.5	<.0001
Heroin use	4 (3)		0 (0)		4.8	.0286
PCP use	10 (7)		0 (0)		12.1	.0005

PPVT-R, Peabody Picture Vocabulary Test-Revised; WAIS-R BD, Wechsler Adult Intelligence Scale-Revised Block Design Score; WAIS-R PC, Wechsler Adult Intelligence Scale-Revised Picture Completion Score.

have more children and psychological distress and fewer prenatal care visits than non–cocaine-using women. Cocaine-using women were also more likely to use alcohol, marijuana, tobacco, benzodiazepines, heroin, and phencyclidine and averaged more cigarette and alcohol use during their pregnancy. Groups were not significantly different in race, socioeconomic status, or vocabulary, block design, and picture completion scores. Infant medical and birth characteristics are presented in Table 2. Prenatally cocaine-exposed infants were more likely to be small for gestational age and have lower birth weight and smaller length and head circumference, after control for gestational age, than non-exposed controls but not different for very low birth weight (<1500 g).

Women who used cocaine prenatally and who were not observed feeding their infants (n = 63) had more children and fewer prenatal care visits, were more likely to be single, and have lower vocabulary scores, Wechsler Adult Intelligence Test (WAIS-R) block design scores, and higher psychological distress scores than similar women who were observed (n = 153) (all *p* values <.05). There was significantly more prenatal cocaine ($p < .04$) and amphetamine use ($p < .005$) among cocaine using women who were not observed during a feeding interaction than those observed. Nonobserved cocaine-exposed infants were significantly more likely to have lower gestational ages ($p < .02$).

Non–cocaine-using women observed during a feeding interaction (n = 185) versus nonobserved (n = 11) were more likely to be non–African American, have more prenatal care, and be of a higher socioeconomic status (all *p* values <.05). The groups did not differ on all other demographic, growth, and prenatal drug exposure factors.

Feeding Interaction Outcome

Parent Subscales. Maternal sensitivity to infant cues and maternal response to infant distress had significant cocaine effects after controlling for confounding variables. While women in the non–cocaine-using group did not significantly change in their sensitivity to infant cues over time, cocaine-using mothers became less sensitive toward their infants during the first year ($p < .03$) with differences from nonusing mothers at 6 months (mean [SD]) = 12.1 [0.2]; cocaine vs 12.6 [0.2] non–cocaine using; $p < .05$) and 12 months (mean [SD]) = 11.5 [0.2] cocaine vs 12.4 [0.1] non–cocaine using; $p < .0002$) (see Table 3).

A significant cocaine effect for maternal response to infant distress was found when evaluated by no, lighter, and heavier cocaine use but not by cocaine exposure status. At 6 months of age, the heavier cocaine-using group was significantly less responsive to their infants than the lighter cocaine-using group, with the lighter cocaine-using group not differing from the non–cocaine-using group (mean [SD] = heavier 9.6 [0.1]; lighter 10.3 (0.1); non–cocaine using 10 [0.1]; $p < .04$). Infant age was a significant predictor of maternal responsiveness to infant distress for all exposure groups (all *p* values <.0001) with no, lighter, and heavier

Table 2. Infant Birth Characteristics

	Cocaine (n = 155)		Non-cocaine (n = 186)			
	Mean	SD	Mean	SD	*t*	*p*
Gestational age (wk)	38.1	2	38.5	3	1.7	.0923
Birthweight (g)[a]	2795.0	607	3102.0	688	21.6	<.0001
Birth length (cm)[a]	47.7	4	49.1	4	9.6	.0021
Head circumference[a] (cm)	32.5	2	33.5	3	14.1	.0002
Apgar (1 min)	8.1	1	7.9	2	−1.31	.1903
Apgar (5 min)	8.8	1	8.8	1	−0.65	.5170
Hobel Neonatal Risk score	5.5	11	5.6	16	0.06	.9495
	n (%)		n (%)		χ^2	*p*
Gender (male)	73 (4)		92 (50)		0.19	.6634
Prematurity (<37 wk gestational age)	42 (27)		33 (18)		4.3	.0378
Low birth weight (<2500 g)	51 (33)		33 (18)		10.5	.0012
Very low birth weight (<1500 g)[b]	5 (3)		7 (4)		0.7	.1648
Small for gestational age	19 (12)		3 (2)		16.0	<.0001

[a] *p* values adjusted for prematurity.
[b] Groups balanced for very low birth weight.

Table 3. Adjusted Effects of Cocaine Exposure on NCAFS Indices

	df	F	*p* Value
Sensitivity to infant cues			
Prenatal cocaine exposure	1, 298	10.36	.0014
Infant age	2, 252	13.12	<.0001
Prenatal cocaine exposure × infant age	2, 252	3.44	.0335
Maternal age at infant birth	1, 285	1.06	.3048
Maternal education	1, 271	5.02	.0259
Tobacco use/day 1st trimester	1, 300	1.87	.1721
Average alcohol dose/wk	1, 294	2.87	.0914
Maternal response to infant distress			
Prenatal cocaine exposure level (none, light, heavy)	2, 279	3.10	.0467
Infant age	2, 271	39.56	<.0001
Prenatal cocaine exposure × infant age	4, 274	1.11	.3538
Maternal age at infant birth	1, 294	4.43	.0361
Mother currently employed	1, 281	3.11	.0788
Clarity of infant cues			
Prenatal cocaine exposure	1, 311	4.16	.0422
Infant age	2, 282	114.53	<.0001
Prenatal cocaine exposure × infant age	2, 283	0.12	.8879
Social economic status	1, 310	2.92	.0884

NCAFS, Nursing Child Assessment Feeding Scale.

groups decreasing in maternal responsiveness during the first year of life. There were no independent cocaine effects for social-emotional or cognitive growth fostering. Higher maternal vocabulary scores ($p < .02$) and higher average marijuana use prenatally ($p < .04$) predicted greater use of social-emotional growth fostering. Non–cocaine-using women significantly increased social-emotional growth fostering over the first year of life ($p < .002$), while there was only a trend for cocaine-using women ($p < .09$).

Higher cognitive growth fostering scores were predicted by older maternal age at infant birth ($p < .02$), education ($p < .02$), vocabulary scores ($p < .02$), and higher infant age ($p < .0001$), with positive cognitive growth fostering increasing during the first year of life for both cocaine- and non–cocaine-using groups ($p < .0001$). There were nonsignificant trends for higher performance IQ scores (block design [$p < .06$] and picture completion [$p < .07$]) and fewer children ($p < .06$) to predict better quality cognitive growth fostering.

Infant Subscales. Cocaine exposure was related to lower infant clarity of cues in the overall model ($p < .05$), (see Table 3) although comparisons of group means at each age were not significantly different. Quality of infant cues increased over time, with both cocaine-exposed and non–cocaine-exposed infants giving clearer cues to their mothers during the first year of life (p values <.0001). In a final step, current maternal phobic anxiety, evaluated as a mediator of cocaine's effect, predicted poorer infant clarity ($p < .03$), while cocaine's previous effect was no longer significant. Higher quality infant responsiveness was independently predicted by older infant age ($p < .0001$), higher maternal WAIS–R block design score ($p < .01$), and greater marijuana use during pregnancy ($p < .04$) but not cocaine exposure. Infant responsiveness increased with age for both groups (p values <.0001). Follow-up analyses of current cocaine use on all NCAFS subscales at 6.5 and 12 months, controlling for covariates, indicated no significant differences between prenatal cocaine users who report current cocaine use and those who abstain.

Association of Meconium Metabolites to Nursing Child Assessment Feeding Scale (NCAFS) Subscales. Controlling for covariates, associations of cocaine metabolites concentrations (ng/g) in infant meconium with maternal sensitivity to cues and infant clarity of cues at 12 months are presented in Table 4. Higher concentration levels of cocaine and benzoylecgonine (BZE) in meconium predicted poorer parental sensitivity to cues and clarity of infant cues. Higher concentration levels of meta-hydroxybenzoylecgonine (m-OH-BZE) also predicted poorer quality infant clarity of cues. Meconium metabolites were not related to other NCAFS subscales.

DISCUSSION

This study evaluated mother-infant interaction during feeding during the first year of life in a large sample of prospectively recruited cocaine/polydrug-using women and a comparison group of non–cocaine-/polydrug-using women who did not differ significantly in race or social class. Prenatal and postnatal substance use, maternal cognitive factors, and a range of sociodemographic variables were evaluated as covariates in the analyses. The effects of current cocaine use on feeding interaction behavior at 6.5 and 12 months were examined. Mothers who used cocaine while pregnant exhibited decreasing sensitivity to infant cues during the first year as hypothesized. These results add to a growing body of research[25,26] that has found women who use cocaine during pregnancy to be less sensitive caregivers but contrasts to other studies that found minimal[27,28] or different effects.[29–31] Results suggest higher maternal education enhances maternal sensitivity to infant cues and older infant age decreases maternal sensitivity in this sample. An overall effect of cocaine on infant clarity of cues was also found in

Table 4. Association of Maternal Sensitivity to Infant Cues and Infant Clarity of Cues to Concentration of Cocaine Metabolites (ng/g)

	Sensitivity to Infant Cues[a]		Infant Clarity of Cues[b]	
	Parameter Estimate	SE	Parameter Estimate	SE
Cocaine	−.19	.09**	−.28	.08*
Benzoylecgonine	−.16	.08***	−.16	.06*
m-OH-Benzolylecgonine	−.10	.09	−.18	.07*

[a]Adjusted for maternal age at infant birth, maternal education, average number of cigarettes smoked first trimester of pregnancy, and average drinks per day of alcohol during pregnancy.
[b]Adjusted for socioeconomic status.
*$p < .02$; **$p < .005$; ***$p < .001$.

this sample and may have obscured group differences in maternal interactive behavior at the perinatal assessment. These data extend our knowledge of mother-infant interaction of prenatally cocaine-/polydrug-exposed infants and suggests periods of vulnerability during which intervention services targeting improved feeding interaction provided prior to decline in interactive quality may be preventive.

At 6 months postpartum, heavier prenatal cocaine users were less responsive to their infants' distress than lighter users, consistent with previous findings.[29] Heavier prenatal cocaine exposure has been found to have a more negative effect on neurobehavioral outcomes of infants[17,46] than lighter or no cocaine exposure. Neurological impairment may in turn negatively influence maternal responsiveness toward her infant with cumulative differences appearing after perinatal observations.

Differential infant risks may result in specific interactive deficits. For example, in a preterm sample,[43] maternal cognitive growth fostering behaviors were negatively affected in a very low birth weight sample compared to term controls at 12 months of age. These findings are in contrast to poorer response to infant cues and responsiveness to infant distress found in this cocaine-exposed sample.

Surprisingly, average prenatal marijuana exposure predicted maternal social-emotional growth fostering and infant responsiveness. On investigation, a positive correlation between higher marijuana use during pregnancy and higher maternal vocabulary ($r = 17$; $p < .02$) was found. Therefore marijuana's positive association with social-emotional growth fostering and infant responsiveness may in fact be more related to overall higher maternal intellectual functioning than marijuana exposure. These results are supported by the research of Dreher et al,[47] who found a positive effect of heavy prenatal marijuana exposure on infant neurobehavioral status and rewarding caregiving.

Consistent with the literature,[43] the level of maternal cognitive function was shown to be a stable influence on maternal-infant interaction quality in this sample. In addition, maternal phobic anxiety was found to be a mediator of cocaine's effect on clarity of infant cues, indicating that specific types of psychological symptoms may predict maternal interactive behavior more precisely than more general measures of psychological distress.

The significant relationships between the concentration of cocaine metabolites found in infant meconium at birth and parental sensitivity to cues and infant clarity of cues at 12 months provide additional evidence of cocaine's detrimental effects on maternal infant interactive quality and provides biological confirmation of the self-report data.

This study offers several advantages over previous studies including large numbers of subjects, prospective recruitment, longitudinal follow-up during the first year of life, and control for covariates including current substance use. Quantifiable drug use data collected perinatally allowed for reliable grouping of subjects into non–cocaine, lighter, and heavier users of cocaine.[49] Due to the lack of random screening for substance use, however, there may have been a bias toward recruitment of the heaviest, most disadvantaged cocaine users.

Subjects for which there were no Nursing Child Assessment Feeding Scale (NCAFS) data were heavier cocaine users with more maternal and infant risk factors than those observed. The findings presented, therefore, can be considered conservative, and group differences can be attributed to maternal prenatal cocaine use with confidence. It is unclear, however, why there were no significant effects of current cocaine use on maternal interactive behavior as has been found in other studies.[26,31] Possible explanations may include underreporting of continued drug use and reduced power to detect a current cocaine use effect due to reduced sample size.

As compromised maternal-infant interactive behaviors have been related to poorer cognitive development,[21] behavioral problems,[48] and negative social outcomes in infants and youths (i.e., insecure attachments, poor social skills), implications for clinicians working with cocaine-exposed infants and their mothers are clear. Early, regular observation of mother-infant feeding interaction and ongoing assessment of maternal behaviors and psychopathology will allow clinicians to tailor intervention programs that target improvements in interactive feeding behavior with the potential to positively affect child outcomes.

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