

The Effects of Polydrug Use with and without Cocaine on Mother-infant Interaction at 3 and 6 Months

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The face-to-face interactions of 43 polydrug-with-cocaine-using mothers and their infants at 3 and 6 months were compared to 17 non-cocaine-but other-drug-using mothers and 21 mothers who used no drugs during their pregnancy. Coders blind to mothers' drug use status scored 3 min of face-to-face interactions for 16 measures of maternal and infant interactive behaviors. A principal component of 7 behaviors formed a measure of maternal attentiveness; a principal component of 5 behaviors formed a measure of mother-infant dyadic organization; and a principal component of 4 behaviors formed a measure of infant readiness to interact. A measure of maternal interruption was computed as the mean standard score of 3 additional interruptive behaviors. At 3 and 6 months, polydrug-with-cocaine-using mothers were less attentive to interactions, and polydrug-with-cocaine-using mothers and their infants engaged in fewer dyadic interactions than either non-cocaine or non-drug-using mothers. Compared to 3 months, polydrug-with-cocaine-using mothers at 6 months were less attentive to interactions and more frequently interrupted interactions by looking away, redirecting the infant, or withdrawing, whereas non-cocaine-using and non-drug-using mothers showed no change or an improvement in attentiveness to interactions and a decrease in interruptions. No differences emerged in the interactive behaviors of the infants of polydrug-with-cocaine-using, non-cocaine-using, or non-drug using mothers. Cocaine use represents a significant risk for diminished parental attentiveness and responsiveness to infants and for diminished interactiveness in infants.

cocaine/crack cocaine-using mothers mother-infant interaction reciprocity

Cocaine with other drug exposure has been associated with disturbances in attention, information processing, learning, and memory, and with the regulation of states of arousal in human infants and children (Alessandri et al., 1993; Bornstein, Mayes, & Tamis-LeMonda, 1996; Mayes & Bornstein, in press; Mayes et al., 1993, 1995, 1996; Struthers & Hansen, 1992; Jacobson et al., 1993). It has been suggested that the possible self-regulation difficulties of cocaine-exposed infants may also contribute to their being more difficult to care for (Gottwald & Thurman, 1994; Mayes et al., 1995). Less atten-

tion has been paid, however, to how cocaine and related drug use (including typically alcohol and tobacco; Frank, Zuckerman, Amaro, et al., 1988) might specifically affect adults' abilities to parent infants or young children (see Beeghly & Tronick, 1994; Freier, 1994; Mayes, 1995). The purpose of this study was to explore the nature of parent-infant interaction of cocaine-abusing mothers and their infants in a prospective longitudinal way. That parents who are using cocaine and other substances have problems caring for their children is indicated in part by the increased incidence of physical abuse and neglect in such families, and by the proportionately higher-than-national-average numbers of children from substance abusing families who are in foster or other types of care placements (see Lawson & Wilson, 1980; Rogosch, Cic-

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chetti, Shields & Toth, 1995). However, much less is known about the nature of specific interactions between cocaine and other drug abusing mothers and their infants.

In this study, we isolated the effects of cocaine on parenting by comparing polydrug-with-cocaine-using mothers to non-cocaine but other-drug-using mothers and to mothers who used no drugs. Parenting behaviors among cocaine abusing adults have been examined primarily with indirect measures such as surveys of the incidence of child abuse and of the home environment to assess the adequacy of children's physical care (see Mayes, 1995). Other commonly used measures include questionnaires that assess the adult's own experience of being parented (e.g., Bernardi, Jones, & Tennant, 1989) or the parent's perceptions of her or his role (e.g., Wellisch & Steinberg, 1980). On measures such as these, substance abusing mothers report a broad range of parenting difficulties, including reliance on a more disciplinarian, threatening style, and negative reinforcement (Bauman & Dougherty, 1983).

Direct observations of interactions between substance abusing parents and their children have focused on mothers' and children's responses to brief separations and on maternal interactive behaviors in caregiving situations. Studies of separation and attachment patterns indicate an increased incidence of disrupted or disturbed relationships between parents and children and higher rates of disorganized attachment behaviors (group D; Main & Solomon, 1986; Rodning, Beckwith, & Howard, 1989, 1991). Direct observational measures of maternal behaviors have been employed less often, however, and have mainly included measures of parental involvement and intrusiveness (e.g., for cocaine using adults, Burns, Chethik, Burns, & Clark, 1991; Gottwald & Thurman, 1994; for heroin/methadone using families, Bernstein, Jeremy, Hans, & Marcus, 1984, and Bernstein, Jeremy, & Marcus, 1986). Gottwald and Thurman (1994) reported that cocaine-using mothers spent significantly more time disengaged from their 12- to 48-hour-old newborns than did non-drug using mothers. Diminished maternal responsiveness and reciprocity were reported by Burns et al. (1991) in a group of 5 polydrug using mothers, two of whom used cocaine primarily; no comparison group was reported.

Polydrug (including cocaine) using mothers showed a reduction in reciprocal behaviors with their infants, and they infrequently structured and mediated the environment, findings suggestive of problems in dyadic activities and interactions (see Bornstein, 1995).

Normally, in the first year, interactions between parents and their infants support the development of infant attention and state and emotional regulatory capacities as well as developmental competencies (e.g., Bornstein & Lamb, 1992; Fogel & Melson, 1986; Stern, 1985). Specific aspects of interactions that contribute robustly to infant attention and emotional regulation include attention organizing activities, initiating and responding to infant bids, emotional exchanges, and elaborating on infant communications (e.g., Barnard & Martell, 1995; Bornstein, 1995).

Based on both general and specific effects of cocaine on adult parental function, we hypothesized that, compared to cocaine-free mothers or drug-free mothers, cocaine-abusing mothers would be less attentive to their infants, less responsive in interactions, and would more often disrupt or withdraw from interactions. Additionally, cocaine-users typically continue their use through pregnancy and into the postpartum period often with more frequent drug use (Neuspiel & Hamel, 1992; Woods, Eyler, Behnke, & Conlon, 1993). Based on the deleterious effects of continued cocaine use on adults' parenting capacities, we hypothesized that the interactions of cocaine-abusing mothers with their infants would deteriorate over time. We hypothesized that, because of diminished maternal attention and increased disruption in face-to-face interactions among cocaine-abusing mothers, cocaine-abusing mothers and infants would engage in fewer dyadic interactions. Finally, because of the relation between maternal attention and infant interactiveness, we hypothesized that the infants of prenatally cocaine-abusing mothers would be less interactive than their non-cocaine and non-drug-exposed counterparts.

METHODS

Participants

Eighty-one mothers (43 cocaine and other-drug-using, 17 non-cocaine but other-drug-using, and 21 non-drug-using) and their infants were recruited into a study of early cognitive and social development when they presented for prena-

tal care at the Women's Center of Yale-New Haven Hospital or, in the case of no prenatal care, when they were admitted to the postpartum ward. (Three of the 81—2 polydrug-with-cocaine-using and 1 non-cocaine but other-drug-using—were recruited or identified postpartum.)

All mothers were recruited by two research associates specifically trained in interviews regarding substance use. These research associates worked both in the prenatal clinic and in the postpartum ward. During the period in which the present study cohort was recruited, all women coming to the prenatal clinic were screened for substance use by means of both interview and urine toxicology. After obtaining verbal consent for an interview, all women were questioned about substance use in a detailed interview that covered lifetime use of cocaine, tobacco, alcohol, marijuana, and other drugs (e.g., sedatives, opiates), and frequency and amount of use of these agents during the preceding 30 days.

For all women regardless of drug use history, a urine sample was obtained for toxicology. Standard urine screening for drug level or metabolites of cocaine (e.g., benzoylecognine), opioids, benzodiazepines, and tetrahydrocannabinol (THC) was performed using the Abbott TDx system and the recommended cutoff levels (Poklis, 1987). A urine was rated as positive if the quantity of drug or metabolite was > 300 gms/ml. The TDx system is highly sensitive and specific for the detection of illicit drug use, and benzoylecognine is detectable for 3 days after use (Walters, 1987).

Prenatal cocaine-exposure status was determined by a combination of maternal report and urine toxicology from the prenatal or immediate postpartum period. Infants were considered cocaine-exposed prenatally if maternal self-reports were positive, even if urine toxicological results were negative. Conversely, if mothers reported that they did not use cocaine, but clinic or hospital urine toxicological results were positive, infants were also considered exposed. Every mother with a positive history and/or positive urine toxicology for cocaine-use was invited to join the study. Non-cocaine-exposed status was ascertained by negative urine toxicology and a negative maternal history of cocaine during pregnancy and at the time of delivery. The 81 families were recruited over a 9 month period and represent 65%

of those families enrolled in the prenatal and perinatal period. There were no differences in measures of maternal ethnicity, age, education, use of prenatal care, or infant birthweight, head circumference, or measures of perinatal complications between those families who returned for the 3- and 6-month visits and those who did not return. All of the mothers in this sample were seen at both 3- and 6-months.

We were primarily interested in cocaine use and exposure effects. All mothers in the cocaine-user group had used cocaine since the beginning of their pregnancy and did not stop their use before delivery. None had used cocaine before but not during their pregnancy. No mother in the sample had used opiates. Thus, the term "polydrug-with-cocaine-using" refers to the presence of cocaine/crack, and not the use of alcohol, marijuana, or tobacco up to the time of delivery.

Based on the presence or absence of cocaine and other drug use, three study groups were defined. These were (1) No drug use (ND) including no cocaine, alcohol, tobacco, or marijuana during pregnancy; (2) Polydrug-without-cocaine (PD) including no cocaine use but positive history for use of alcohol, tobacco, and/or marijuana; and (3) Cocaine with other drugs (polydrug-with-cocaine-using—PC) including cocaine with combinations of alcohol, tobacco, or marijuana use. Table 1 shows the demographic characteristics of mothers and infants in these three groups. The sample was predominantly African American (ND = 86%, PD = 65%, and PC = 88.4%), and polydrug-with-cocaine-using mothers were older than the non-drug-using group but not the polydrug-without-cocaine group (post-hoc comparison Tukey HSD $p < .05$). There were no mothers younger than age 18 years in the three groups, and 95% of participants were older than 20 years. Over 90% of the three groups were single parents, and all were receiving welfare support. A greater percentage of women in the ND and PD group completed high school than in the PC group (85.7% for ND, 82.4% for PD, and 58.1% for PC, $\chi^2(2) = 6.60, p = .04$). There was no difference in the number of pregnancies for cocaine-dependent and non-cocaine-dependent women. Similarly, there were no differences among the three groups in the proportion of women receiving prenatal care defined as enrollment in a prenatal clinic before the mid to late third trimester (95% for

TABLE 1
Demographic and Perinatal Data for Non-Drug, Non-Cocaine, and Cocaine-Using Groups

Measures	Non-Drug (ND)	Polydrug without Cocaine (PD)	Polydrug with Cocaine (PC)	F (2,78)
Mother				
Maternal Age (yrs)	25.60 (4.40)	26.60 (5.30)	28.80 (5.10)	3.30*
Parity	3.20 (1.90)	3.60 (1.90)	4.50 (2.30)	2.60
Infant				
Gestational Age (wks)	38.90 (1.80)	39.20 (1.90)	38.30 (2.50)	1.10
Obstetric Complications Scale	94.50 (22.90)	105.80 (24.70)	86.60 (19.20)	4.80**
Birthweight (gms)	3358.00 (717.00)	2926.00 (539.00)	2757.00 (514.00)	7.60***
Head Circumference (cms)	34.40 (3.8)0	32.40 (1.80)	32.80 (2.10)	4.80**
Age at 3 months (days)	107.60 (17.8)0	109.30 (16.80)	105.00 (17.40)	.40
Age at 6 months (days)	194.80 (14.9)0	191.50 (14.30)	191.50 (16.70)	.30*

Note: $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

ND, 100% for PD, and 95.3% for PC, $\chi^2(2) = .30$). For those women receiving prenatal care, estimated gestational age at the time of the first prenatal visit was 18.60 weeks ($SD = 7.90$) for polydrug-with-cocaine-using women, 15.70 ($SD = 6.10$) for polydrug-without-cocaine-using women, and 15.6 weeks ($SD = 8.20$) for non-drug-using women, $F(2, 60) < 1.00$. Drug use histories were obtained at the time of this first prenatal visit; thus, histories for each of three drug use groups were obtained at comparable times during gestation.

Comparisons between the polydrug-without-cocaine and polydrug-with-cocaine-using groups showed no differences in the frequency of reporting alcohol, tobacco, and/or marijuana use in the past 30 days during pregnancy (for alcohol use, PD = 64.3% and PC = 67.4%, $\chi^2(1) = .05$; for tobacco, PD = 85.7% and PC = 81.4%, $\chi^2(1) = .10$; for marijuana, PD = 42.9% and PC = 60.5%, $\chi^2(1) = 1.30$). Similarly, estimates of amount of alcohol, tobacco, and marijuana use were obtained for the previous 30 days: No differences obtained in the number of days of alcohol use, PD $M = .60$ days ($SD = 1.60$) and PC $M = 3.10$ days ($SD = 5.50$), $F(1, 54) = 2.70$; number of drinks per day PD $M = .60$ ($SD = 1.20$) and PC $M = 1.70$ ($SD = 2.90$), $F(1, 54) = 2.00$; packs of cigarettes per day, PD $M = 1.30$ ($SD = 1.30$) and PC $M = 1.40$ ($SD = 1.00$), $F(1, 53) < 1$; the number of days of marijuana use, PD $M = 1.40$ ($SD = 4.00$) and PC $M = .90$ ($SD = 2.6$), $F(1, 54) < 1.00$; or the amount (number of joints) of marijuana use per day, PD $M = .40$ ($SD = .74$) and PC $M = .70$ ($SD = 2.00$), $F(1, 54) < 1.00$. Alcohol use was also expressed quantitatively as the number of drinks per day \times the number of days in the last 30 days mothers reported using alcohol (Jacobson, Jacobson, Sokol, et al., 1994). No significant differences were found between the polydrug-without-cocaine group and the polydrug-with-cocaine group, PD $M = 2.10$ ($SD 6.40$) and PC $M = 7.20$ ($SD = 15.40$), $F(1, 52) = 1.50$.

Total years of use of alcohol, tobacco, and marijuana differed between the polydrug-without-cocaine and polydrug-with-cocaine groups (for alcohol, PD M years = 4.20 ($SD = 4.60$) and PC = 8.90 years ($SD = 6.50$), $F(1, 52) = 6.10$, $p = .02$; for tobacco, PD = 6.20 years ($SD = 5.60$) and PC = 10.80 years ($SD = 5.90$), $F(1, 52) = 6.30$, $p = .01$; and for marijuana, PD = 1.30 years ($SD = 2.50$) and PC = 4.50 years ($SD = 5.90$), $F(1, 53) = 3.90$, $p = .05$). Thus, while the polydrug with and without cocaine groups appeared equivalent in their day-to-day use of other drugs and were distinguished primarily on the basis of cocaine use, the polydrug-with-cocaine-using women had a longer lifetime history of other drug use. For those women who used cocaine, the mean number of years of cocaine abuse before their pregnancy with the study infant was 5.60 ($SD = 3.20$) with a range of 0 to 14 years. (Two mothers had started cocaine use in the year of their pregnancy.) Polydrug-with-cocaine-using mothers reported a mean of 4.50 days ($SD = 6.40$) of use in the 30 days prior to their pregnancy with a range of 0 to 30. (Eight women reported no use during the past 30 days but were identified by a history of cocaine use in the months preceding the most recent one and/or by positive urine toxicology.) Thirty-two percent ($n = 14$) of mothers reported using cocaine more than one day a week.

Demographic characteristics of the infants are also shown in Table 1. There was no difference in the proportion of boys to girls in the three groups (10:11 for ND, 3:14 for PD, and 20:23 for PC, $\chi^2 = 4.80$, $p = .09$). There was also no difference in gestational age. Prenatal and delivery course

were summarized at delivery using the *Obstetric Complications Scale* (OCS, Littman & Parmelee, 1978), a measure of the number of optimal conditions during a pregnancy and delivery. Cocaine-exposed infants scored lower on the OCS than non-cocaine-exposed but not than the non-drug-exposed. Cocaine-exposed and non-cocaine-exposed infants had lower mean birthweight and smaller head circumference than the non-drug-exposed group. Eight infants were small-for-gestational age (SGA) defined as birthweight greater than 2 SD s below that expected for gestational age, 2 non-cocaine-exposed and 6 cocaine-exposed, $\chi^2(2) = 3.20$, $p = .20$. There were no differences in age in days of infants at the 3- or 6-month assessments.

For polydrug-with-cocaine-using mothers, interviews regarding drug use were conducted by investigators for the 6 months after the mother's delivery of the infant. Interviewers were blind to the severity of the mother's prenatal drug use as well as to the performance of mother and infant on the measures of mother-infant interaction. Only nine mothers reported either a decrease in cocaine use or a brief period of abstinence between 3 and 6 months postpartum; the remaining 34 continued to use cocaine at the same level or greater than that reported postpartum. The mean number of days of cocaine use in the last 30 days was 7.10 ($SD = 8.20$) suggesting a moderate to high amount of use postnatally, and no mother in this sample showed prolonged abstinence from cocaine after her delivery. Thus, for the present group of polydrug-with-cocaine-using mothers, prenatal cocaine use was associated with continued postnatal use. Importantly, no mother in either the polydrug without cocaine or in the non-drug-using group initiated cocaine use after delivery.

Mothers in the polydrug-with-cocaine-using group consented to the study independent of their participation in any cocaine-treatment intervention services. For each visit, mothers were paid a small amount of money, provided transportation to and from the visit, and given gifts for their child as incentives for participation. All 81 infants were in their mothers' care at 3 and 6 months. In the state of Connecticut at the time of this study, maternal drug use did not automatically require a referral to child protective services.

Mother-Infant Interaction Assessment

Mothers and infants were seen in the same comfortable laboratory setting at 3 months and again at 6 months. At each of these times, after at least half an hour to acclimate to the laboratory, infants were placed in an infant seat facing the mother, and mothers were asked to interact for 3 min with their infant in whatever ways they felt comfortable. Age-appropriate toys were provided, and mothers had between 2 and 3 min of additional warm-up time as they were provided instructions and toys. This procedure is similar in both instructions and length of a coded phase to those used by other investigators studying mother-child interaction and attachment in high-risk samples (e.g., Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Crittenden, 1988; Field, 1977; Freier, 1994; Tronick, Beeghly, Fetters, & Weinberg, 1991). Furthermore, observations of mother-infant interaction in high-risk samples are related predictively to measures of maternal support and stress with mothers experiencing more stressors and less social support showing less responsiveness to their infants cues (e.g., Crnic, Greenberg, Robinson, & Ragozin, 1984).

Interactions were videotaped from behind a one-way mirror, and later coders were instructed to score videotapes for 19 specifically defined maternal and infant behaviors on 5-point Likert-type scales ranging from 1 indicating "low" to 5 indicating "high". Eight of the maternal and infant behavioral indices were adapted from Clark and Seifer's (1983) "Rating Scale of Interactional Style", and an additional 8 indices were developed and validated by one of the authors (R.F.) in a longitudinal study of maternal-infant play between 3 and 9 months (Feldman, Greenbaum, Mayes, & Erlich, 1994). Thus, 16 of the 19 measures had been validated and used in previous studies of both normative and high-risk populations. The three remaining mother measures (maternal resourcefulness, fluency, and breaking contact) were developed for the present study.

Seven of the maternal behaviors were conceptualized as encompassing attentiveness and responsiveness in interactions with infants: acknowledging, showing positive affect and adaptation to the infant's needs, appropriate vocalizing, displaying resourcefulness and fluency in the interaction, and level of anxiety. Five maternal and infant behaviors were conceptualized as indexing dyadic organization:

maternal imitating and expanding on the infant's actions, dyadic reciprocity, and infant vocalizations and efforts to initiate an interaction. Four infant behaviors indexed readiness to interact: level of alertness, fatigue, gaze aversion, and amount of fussiness. In addition, three maternal behaviors were conceptualized as interrupting interactions as indexed by looking away from the infant, interrupting the infant's attention or activity, and breaking the continuity of the interaction. Specific descriptors and sources for each behavior are presented in Table 2. Interactions were scored by coders blind to the mother's drug use status, and 20 sessions were scored independently by two coders. All items showed acceptable interrater reliability, M intraclass $r = .86$ (range .77 to .97).

Principal component analysis performed on maternal, dyadic, and infant interactive behaviors at 3 months supported the hypothesized conceptual groupings of the 16 mother and infant interactive behaviors as indicators of three constructs—maternal attentiveness, dyadic organization, and infant readiness to interact. Loadings for each of the three orthogonally rotated factors at 3 months are shown in Table 3; the three principal components accounted for

TABLE 2
Maternal and Infant Behaviors

Maternal Attentiveness	
1. Acknowledges ¹ :	Mother demonstrates her awareness of the infant's actions through her verbalizations, facial affect, or movement
2. Shows Positive Affect ¹ :	Mother displays positive emotions as indicated by her voice, handling of the infant, verbalizations, or facial expressions
3. Adapts ² :	Mother adjusts the amount of stimulation in accordance with the infant's responses
4. Vocalizes ² :	Mother uses a repetitive, highly pitched, slow voice in talking with the infant
5. Shows Resourcefulness ³ :	Mother creatively adjusts to infant's bids
6. Shows Fluency ³ :	Mother engages infant in a rhythmic, smoothly flowing interaction
7. Shows Anxiety ² :	Mother appears uncomfortable, vigilant, or worried
Dyadic Organization	
1. Imitates ¹ :	Mother imitates the baby's actions, facial expressions, body movements, or direction of gaze
2. Expands ¹ :	Mother adds or enlarges upon the imitated act
3. Dyadic Reciprocity ¹ :	Mother engages in a full give and take interaction
4. Vocalizes ² :	Infant vocalizes during the play
5. Initiates Interaction ² :	Infant initiates bids to the mother during the play
Infant Readiness To Interact	
1. Maintains Alert State ² :	Infant is predominantly alert, actively attending, and interested in the interaction
2. Shows Fatigue ² :	Infant appears tired or sleepy during the play
3. Looks Away ¹ :	Infant looks away from either the mother's face or from an object of joint visual attention
4. Fusses ² :	Infant cries or fusses during the interaction
Maternal Interruptive Behaviors	
1. Averts Gaze ¹ :	Mother looks away from the infant
2. Overrides ¹ :	Mother distracts the infant's attention by vocalizing or making noise
3. Breaks Contact ³ :	Mother interrupts or breaks the continuity of the interaction

Note. ¹From Clark & Seifer (1983). ²From Feldman, Greenbaum, Mayes, & Erlich (1994). ³Defined for the present study

68.7% of the total variance. The individual items loading highest on factor 1 described *maternal attentiveness to interaction* with an item that would interfere with maternal attention (e.g., maternal anxiety) showing a negative loading. Maternal imitating and expanding and infant vocalizations and initiating interaction loaded highest on the second factor which described *dyadic organization*. The third factor described predominantly *infant readiness to interact* and included level of alertness, show of fatigue, direction of gaze, and fussing. The only departure from the a priori conceptual grouping of the variables was the higher loading of dyadic reciprocity on the factor for maternal attentiveness than on the factor representing dyadic organization; perhaps at 3 months, the mother is carrying more of the work of dyadic organization (see Barnard & Martell, 1995).

With the expected factor structure largely supported, measures of maternal attentiveness at 3 and 6 months were formed as principal components of seven maternal behaviors including acknowledging, showing positive affect and adaptation to the infant's needs, appropriate vocalizing, resourcefulness and fluency in the interaction, and level of anxiety. This factor accounted for 64.8% of the variance in the seven behaviors at 3 months and 67.7% at 6 months. A measure of dyadic organization was formed as the principal component of maternal imitating and expanding on infant actions, dyadic reciprocity, and infant vocalizations and efforts to initiate an interaction. This factor accounted for 63.1% of the variance in the five behaviors at 3 months and 59.3% at 6 months. A measure of infant readiness to interact was formed from level of alertness, show of fatigue, show of gaze aversion, and amount of fussiness and accounted for 65.8% of the variance in the four behaviors at 3 months and

54.6% at 6 months. In order to create a single measure for maternal interruptions, means for the three measures of maternal interruptions were expressed as Z scores, and their mean was used as the measure of maternal interruptions. Before transformation into standard scores, the mean score for looking away from the infant at 3 and 6 months, respectively, were 1.80 ($SD = .80$) and 1.30 ($SD = .50$) for ND, 1.80 ($SD = 1.00$) and 1.50 ($SD = .50$) for PD, and 2.00 ($SD = .90$) and 2.30 ($SD = 1.00$) for PC. Similarly the mean scores for interrupting the infant's activity at 3 and 6 months, respectively, were 4.20 ($SD = .90$) and 3.40 ($SD = 1.10$) for ND, 4.30 ($SD = .80$) and 3.10 ($SD = 1.40$) for PD, and 4.10 ($SD = 1.10$) and 2.60 ($SD = 1.00$) for PC. For breaking the continuity of the interaction at 3 and 6 months, mean scores were 2.70 ($SD = 1.10$) and 2.70 ($SD = 6.40$) for ND, 2.50 ($SD = 1.30$) and 2.50 ($SD = 1.20$) for PD, and 2.90 ($SD = 1.00$) and 4.10 ($SD = .80$) for PC.

RESULTS

Scores for maternal attentiveness to interactions, dyadic organization, maternal interruptions, and infant readiness to interact were compared among the polydrug-with-cocaine-using, polydrug-without-cocaine-using, and non-drug-using mothers at 3 and 6 months in repeated-measures ANCOVAs covarying simultaneously for the following demographic and perinatal variables when appropriate: maternal age and education, infant gender, and

TABLE 3
Factor Loadings¹ for Maternal and Infant Behaviors

	Factor 1	Factor 2	Factor 3
Maternal Attentiveness			
Acknowledges	.70	.42	
Shows Positive Affect	.78		
Adapts	.78	.30	.26
Vocalizes	.85		
Shows Resourcefulness	.72	.27	.39
Shows Fluency	.65	.26	.25
Shows Anxiety	-.70		-.40
Dyadic Organization			
Imitates		.86	
Expands	.24	.76	
Dyadic Reciprocity	.68	.39	.36
Vocalizes	.28	.77	.31
Initiates Interaction		.65	.33
Infant Readiness to Interact			
Maintains Alert State	.35	.33	.69
Shows Fatigue		-.77	
Looks Away	-.31	-.37	-.67
Fusses	-.26		-.81

Note. ¹Only factor loadings > .2 are shown. Factors were orthogonally rotated.

years of alcohol, tobacco, or marijuana use. Covariates were included in the MANCOVA if they correlated significantly with the outcome variable at an $\alpha < .10$.

Initially, the four dependent variables (maternal attentiveness, dyadic organization, maternal interruptions, and infant readiness to interact) and four covariates (years of alcohol, tobacco, and marijuana use, and maternal education) were entered simultaneously in a multivariate analysis of covariance (MANCOVA).

In order to examine the contribution of infant characteristics as possible mediators of mother-infant interaction, infant perinatal characteristics (principal component of birthweight, head circumference, and OCS scores accounting for 59.1% of variance) were added as covariates to a follow-up MANCOVA (Baron & Kenny, 1986) if significant multivariate effects for drug exposure were found in the initial MANCOVA. Patterns of group differences were the same in

the initial and follow-up MANCOVA indicating that the effects of drug-use group were not mediated by birthweight, head circumference, or OCS scores. All analyses subsequently reported include infant perinatal characteristics in the considered covariates.

In the MANCOVA, there were significant effects of covariates on the four dependent variables, multivariate, $F(20, 292) = 1.82, p < .02$. The covariates were significantly related to dyadic organization, univariate $F(5, 73) = 2.59, p = .03$, and maternal interruptions, univariate $F(5, 73) = 3.24, p = .01$. In particular, perinatal characteristics were significantly related to dyadic organization and, $t(1, 73) = 3.43, p = .001$; and maternal interruptions significantly covaried with years of alcohol use, $t(1, 73) = 2.33, p = .02$, and maternal education, $t(1, 73) = -2.86, p = .006$. There was no significant effect of covariates on the within-subject measures of age, multivariate $F(4, 74) = 2.45$,

TABLE 4
Relation between Drug-exposure Status and Maternal and Infant Behaviors

Measures	Non-Drug N = 21	Polydrug without Cocaine N = 17	Polydrug with Cocaine N = 43	F for Age (df)	F for Drug Use (df)	F for Drug Use \times Age (df)
Maternal Attentiveness¹ (Factor Scores)						
3 mos	.40 (1.0)	.23 (1.2)	-.28 (.79)	1.0 (1,77)	10.0*** (2,73)	9.5*** (2,77)
6 mos	.75 (.61)	.75 (.97)	-.66 (.64)			
Dyadic Organization¹ (Factor Scores)						
3 mos	.33 (.87)	.28 (1.5)	-.27 (.75)	.4 (1,77)	4.5** (2,73)	1.0 (2,77)
6 mos	.53 (1.2)	.50 (1.0)	-.46 (.61)			
Maternal Interruptions² (Z Scores)						
3 mos	-.05 (.65)	-.09 (.68)	.06 (.54)	.8 (1,77)	2.5 (2,73)	3.7* (2,77)
6 mos	-.26 (.31)	-.36 (.47)	.27 (.54)			
Infant Readiness¹ to Interact (Factor scores)						
3 mos	.42 (.94)	-.07 (1.1)	-.18 (.95)	.4 (1,77)	1.2 (2,73)	3.0* (2,77)
6 mos	.27 (1.1)	.50 (.85)	-.33 (.90)*			

Notes. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

¹Shown are the mean factor scores. ²Shown is the mean of the three Z scores for the three measures of maternal interruptions.

ns. Controlling for these covariates, the overall multivariate model showed significant effects for drug use, multivariate $F(8, 142) = 2.49$, $p = .015$, and for drug use \times age, multivariate, $F(8, 150) = 3.06$, $p = .003$, but there was no effect for age, $F(4, 74) = 0.36$, *ns.* Based on significant multivariate effects, univariate effects were interpreted next. Results of the follow-up univariate ANCOVAs are presented in Table 4.

At the univariate level, a significant drug use \times age interaction emerged for maternal attentiveness, $F(2, 77) = 9.54$, $p < .001$. By 6 months, polydrug-with-cocaine-using mothers were less attentive to their infants than at 3 months, whereas the polydrug-but-non-cocaine-using and non-drug-using groups showed an overall improvement in attentiveness, $t(77) = 3.90$, $p < .001$ and $t(77) = 3.20$, $p = .002$ respectively. In the between-subjects part of the design, there was no overall effect of the covariates, $F(5, 73) = 1.90$, *ns.*; but there was a significant effect of drug use on maternal attention (Table 4). Because there was no crossover in the interaction of age with drug use, we interpreted planned simple contrasts of drug use effects for polydrug-with-cocaine-using mothers against each of the other groups: Collapsing across age, polydrug-with-cocaine-using mothers were less attentive to their infants compared to both polydrug-without-cocaine-using mothers, $t(73) = 4.10$, $p < .001$, and non-drug-using mothers, $t(73) = 3.60$, $p < .001$.

For dyadic organization, at the univariate level, there was no significant drug use \times age interaction. There was an overall effect of drug use on dyadic organization (Table 4), $F(2, 73) = 4.50$, $p = .02$. On the average across 3 and 6 months, polydrug-with-cocaine-using mothers and their infants showed less dyadic organization than polydrug-without-cocaine-using mothers, $t(74) = 2.80$, $p = .006$ but not than non-drug-using mothers, $t(74) = 1.80$, $p = .07$.

At the univariate level, a significant interaction of drug use with age emerged for maternal interruptions, $F(2, 77) = 3.73$, $p = .03$, with polydrug-with-cocaine-using mothers interrupting the interaction more often at 6 months than at 3 months and non-drug-using mothers interrupting less at 6 months than at 3 months, $t(77) = -2.10$, $p < .04$, and polydrug-without-cocaine-using mothers also interrupting less at 6 months than at 3 months, $t(77) = -2.30$, $p < .03$. There

was no overall effect of differences in drug use on maternal interruptions. Because there was no crossover in the interaction of age with drug use, we interpreted planned simple contrasts of drug use effects for polydrug-with-cocaine-using mothers against each of the other groups: Collapsing across age, polydrug-with-cocaine-using mothers interrupted interactions more often than polydrug-without-cocaine-using mothers, $t(73) = -2.30$, $p < .03$, but not more often than non-drug-using mothers, $t(73) = -1.20$, *ns.*

At the univariate level, a marginally significant use \times age interaction for infant readiness to interact emerged, $F(2, 77) = 3.02$, $p = .05$, with infants of polydrug-without-cocaine-using mothers showing an increase in readiness to interact as they grew older when compared to the infants of polydrug-with-cocaine-using mothers, $t(77) = 2.40$, $p = .02$, while infants of non-drug-using mothers and polydrug-with-cocaine-using mothers showed a decline, $t(77) = .02$, *ns.* Planned simple contrasts also showed no difference in readiness to interact in infants of polydrug-with-cocaine-using and non-drug-using mothers, $t(77) = 1.60$, *ns.*, or in infants of polydrug-with-cocaine-using and polydrug-without-cocaine-using mothers, $t(77) = 1.70$, *ns.*

DISCUSSION

The present study suggests differences in the interactive behaviors of polydrug-with-cocaine-using mothers and their exposed infants in comparison with polydrug-without-cocaine and drug-free mothers and babies. Significant changes in maternal behavior associated with polydrug and cocaine use emerged across the first half of the child's first year. At 3 and 6 months, polydrug-with-cocaine-using mothers were less attentive in interactions with their infants, and mother-infant pairs engaged in fewer dyadic behaviors. Between 3 and 6 months, polydrug-with-cocaine-using mothers became less attentive in interactions and more frequently interrupted interactions by looking away, redirecting the infant, or withdrawing, whereas sociodemographically comparable polydrug-without-cocaine-using mothers or drug-free mothers improved in both their attentiveness and in maintaining interactions with their infants. These differences in maternal interactive behaviors occurred in the context of

no differences in infants' readiness to interact. However, by 6 months, the infants of polydrug-with-cocaine-using mothers were less ready to interact than the infants of polydrug-without-cocaine-using mothers. Thus, patterns of diminished parental attentiveness and increased interruptions emerged between 3 and 6 months for polydrug-with-cocaine-using mothers, a finding heretofore not reported. Nonetheless, direct attribution of the patterns of differences solely to the effects of cocaine can only be made with caution inasmuch as all cocaine-using mothers were also abusing other drugs including alcohol and tobacco.

Polydrug abuse including cocaine might affect parenting on at least two levels. One potential path of influence describes more specific effects of cocaine as well as other drugs on neuropsychological functions involved in interpersonal interactions; another reflects pre- and comorbid psychiatric factors associated with cocaine and other substance abuse which may in turn be associated with diminished parental responsiveness to infants. As to the first, neuropsychological functions underlying memory, attention, persistence, and task orientation appear impaired by chronic cocaine abuse (Ardila et al., 1991; Berry et al., 1993; Manschreck et al., 1990; O'Malley, Adamse, Heaton, & Gawin, 1992). Long-term cocaine users show deterioration in task persistence and concentration or attention to a task as well as deficits in short-term memory. Deficits such as these might be expected to influence certain parenting behaviors, such as the capacity to attend to the infant and sustain an interaction (Fleming & Corter, 1995). Also, adults who are cocaine or other drug intoxicated or recovering from intoxication are in a different state of arousal and in this state may exhibit altered and non-normal patterns of interaction with their infants. Unfortunately, very few data are available addressing the question of how combinations of drugs such as cocaine with alcohol and marijuana use may interact with one another to alter adults' behavior and psychological state in ways relevant to their capacity to parent.

The second pathway of influence of effect of polydrug use including cocaine on parenting behaviors involves increased rates of psychopathology: Among substance abusing adults, the incidence of major affective disorders (such as

depression) and recurrent and early psychiatric hospitalizations is higher than in the general population (Latkin & Mandell, 1993; Mirin et al., 1991; Neuspiel & Hamel, 1992; Rounsaville et al., 1991; Strickland, James, Myers, & Lawson, 1993). Cocaine (and other drug) abuse is also associated with acute and chronic exposure to violence, recurrent homelessness with social isolation, early school dropout, single parenting, and extreme poverty (Boyd, 1993; Boyd & Mieczkowski, 1990; Lawson & Wilson, 1980; Mayes, 1995). Moreover, among the parents and families of adult substance abusers, commonly reported family characteristics include marital discord high rates of violence, child abuse, and neglect (Chambers, Hinesby, & Moldestad, 1970; Raynes, Clement, Patch, & Erwin, 1974; Rounsaville et al., 1982); these factors are associated with an increased incidence of later psychiatric dysfunction for the affected children as adults.

These same levels of effect may also contribute to the diminished maternal responsiveness and dyadic behaviors observed in the polydrug-with-cocaine-using dyads from this study between 3 and 6 months. Maternal attention and dyadic responsivity may diminish over time because of continuing polydrug and cocaine use per se or because of the cumulative and debilitating effects of ongoing substance use on overall adult psychological and physical health. Additionally, following the birth of an infant, polydrug-with-cocaine-using mothers often report greater social isolation from peers who might offer help and support parenting (Boyd & Mieczkowski, 1990). Thus, polydrug-with-cocaine-using mothers may differ from other drug users in ways other than their cocaine use that are especially relevant to parenting including more years of overall substance use, greater environmental stress and poverty, and fewer social supports.

The finding of no differences between cocaine-exposed and polydrug-but-non-cocaine-exposed or non-drug-exposed infants on 3-month measures of readiness to interact is reminiscent of other reports of no differences between cocaine-exposed infants and non-cocaine-exposed controls on measures of newborn and infant neurobehavioral performance (e.g., Mayes et al., 1993; Mayes, Bornstein, Chawarska, & Granger, 1995). Findings such as

these suggest that cocaine-exposed newborns and infants may not be generally impaired despite increased perinatal and postnatal risks and stressors. However, it is also important to note that, in their contribution to the dyadic behaviors, cocaine-exposed infants were more impaired than both non-cocaine-exposed and non-drug-exposed infants at both 3 and 6 months, suggesting that cocaine-exposed infants may express more difficulties in the context of social interactions with their parents.

Indeed, while no differences have been reported on standard measures of neurobehavioral or developmental competency, on measures of arousal regulation, differences in cocaine-exposed compared to non-cocaine-exposed infants have been described (Mayes, et al., 1996), a vulnerability that may be manifest in conditions of novel stimulation as well as during social interaction. The vulnerabilities of cocaine-exposed infants to parental dysfunction are suggested by the infants' diminished readiness to interact by 6 months when compared to the polydrug-without-cocaine-using groups. Parenthetically, it is also important to note that by 6 months, polydrug-without-cocaine-exposed infants were at least as ready to interact as they were at 3 months and were more like infants of non-drug-using mothers than infants of polydrug-with-cocaine-users. This finding suggests that exposure to cocaine both prenatally and through impaired maternal behaviors may impose significant additional risks for diminished infant interactiveness beyond those seen clinically in situations of maternal alcohol and other drug use.

Four limitations regarding these provocative interactions merit discussion. First, mothers were asked to play with their infants face-to-face with toys. This condition may have been unusual or constraining to some, and perhaps more so for the cocaine-abusing group who, because of their addiction, may have spent less time in direct contact with their infants. Second, the setting for observing mothers and infants interacting was a laboratory (e.g., Falendar & Mehrabian, 1978). Comparisons between home and laboratory suggest that in the laboratory mothers sometimes stimulate and respond to their children more than at home (Belsky, 1980). If similar patterns of context sensitivity apply to mothers in the present study, then polydrug-

with-cocaine-using mothers may be even less attentive to their infants at home than we observed in the laboratory. Further studies investigating the interactions of cocaine and non-cocaine or non-drug-using mothers in different contexts and interactional situations seem warranted to explore the generalizability of these findings. The coding approach used in the present study is applicable to studies of mother-infant interaction in different contexts and, similar coding approaches have been used in home as well as laboratory based studies and for clinical as well as research purposes (e.g., Clark & Seifer, 1983; Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Crittenden, 1988; Field, 1977; Gusella, Muir, & Tronick, 1988). Furthermore, similar interactive contexts in both length of time observed and in the demands of the tasks have been used by other investigators in studies of high-risk samples (Freier, 1994; Tronick, Beeghly, Fetters, & Weinberg, 1991). Support for the validity of the methods used in the present study as well as the data resulting from these measures comes from clinical observations made of mothers and their children in the context of substance abuse treatment. In these settings, mothers are observed to withdraw from their infants, to be poorly responsive and/or more intrusive during interactions with the infant (e.g., Finklestein, 1994; Luthar & Walsh, 1995).

A third restriction of the present study comes from limitations in the data regarding postnatal drug use. Because the majority of cocaine-abusing women continued their use at least up to 6 months postnatally, the available data cannot thoroughly address the effects of differential drug use postnatally. The women who participated in this study were recruited based on their history of prenatal cocaine use. The natural history of cocaine addiction usually involves years of use (as was true for the present sample) and often continues through several pregnancies. Moreover, obtaining accurate data on continued cocaine-use postnatally is confounded by difficulties in tracking polydrug-with-cocaine-using mothers and by their often chaotic lifestyle. In our sample, only 9 polydrug-with-cocaine-using mothers reported either a decrease in their cocaine use or a period of abstinence between 3 and 6 months postpartum, and analyses revealed no differences in the interactional patterns of

these women compared to the larger group of polydrug-with-cocaine-using women who did not alter their patterns of drug use. However, the number of women changing their pattern of cocaine-use was insufficient to permit adequate examination of differences in patterns of parenting among women whose cocaine use continued postnatally versus those who altered their amount or frequency of use.

A fourth limitation to the present study has been alluded to earlier and reflects the natural history of cocaine abuse among adults. Cocaine-abusing women rarely use cocaine alone; as in the present study, cocaine use is associated with alcohol, tobacco, and marijuana use in varying quantities. Such polydrug use precludes attributing variations in mother-child interaction solely to the effects of cocaine abuse. Similarly, polydrug-with-cocaine-abuse is also a common marker for severe psychosocial stressors including chronic substance use, environmental chaos and poverty, and often chronic psychiatric illness (e.g., depression), any one of which may influence parenting behaviors.

The findings of the present study have at least two applied implications. First, as parental responsiveness interacts with the development of attention and state regulatory capacities in infants, these functions may be specifically impaired in some prenatally cocaine-exposed infants and toddlers (Alessandri, Sullivan, Imaizumi, & Lewis, 1993; Mayes, Bornstein, Chawarska, & Granger, 1995). Developmental trajectories for attention and arousal regulation in infants appear to reflect neuropsychological functions that are biologically based, but they also appear to be sensitive to parental organization, attentiveness, and adaptability (Beeghly & Tronick, 1994; Bornstein, 1985; Bornstein & Lamb, 1992; Bornstein & Tamis-LeMonda, 1990; Tamis-LeMonda & Bornstein, 1989). The degree of sensitivity will be individually variable among infants, but poor maternal attention to shifts in the infant's state, for example, and increased and unpredictable withdrawal of the mother from interactions with the infant may contribute to or exacerbate an infant's difficulties with arousal regulation (Bell, 1968; Bornstein, 1985). Although in this study we found no difference among polydrug-with-cocaine-exposed, polydrug-without-cocaine-exposed, and non-drug-exposed

infants' readiness to interact, by 6 months, polydrug-with-cocaine-exposed infants showed less readiness to interact suggesting the cumulative effect of diminished maternal attentiveness and increased interruptions and/or of continued maternal cocaine abuse. To understand whether maternal cocaine would have lasting effects, longer term follow-up is needed of children growing up in the face of such parental impairments.

The second set of implications of the present findings relates to the nature of interventions for substance abusing parents. Because infants' first 6 to 12 months is a crucial time in their relationship with parents (e.g., Barnard & Martell, 1995; Bornstein, 1995; Stern, 1985), diminished parental responsiveness and attentiveness in the first year suggest that substance abuse treatment programs for mothers of infants and toddlers in this time period should consider intensive parenting interventions that address the several etiologies likely to be associated with changes in parental behavior (e.g., worsening depression, increased substance use).

In conclusion, the present study has revealed degradations in polydrug-with-cocaine-using mothers' attentiveness to interactions and increasing disruptive behaviors during face-to-face play with infants when compared to polydrug-without-cocaine and non-drug-using mothers and their infants. More detailed examination of specific alterations in parenting behaviors associated with substance abuse is required, not only to untangle reciprocal links between changes in maternal behavior and infant development, but also to guide the design of effective interventions for substance-abusing parents. Future studies will need also to address the impact of factors such as maternal depression and social isolation as well as the patterns of continued cocaine use and the psychological effects of chronic substance abuse on adults' capacities to parent infants and young children.

AUTHORS NOTES

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