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MOTHER-INFANT INTERACTION AT 12 MONTHS IN PRENATALLY COCAINE-EXPOSED CHILDREN

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Abstract

This study examined mother-infant interactions of 12-month-old African-American prenatally cocaine-exposed infants and their mothers. Videotaped observations were made during a free-play dyadic interaction, a brief separation, and a reunion period. Videotapes were coded for maternal and child behaviors during each phase of the procedure. Although there were few differences in interactive behaviors between prenatally cocaine-exposed and nonexposed children and their mothers, children who were prenatally exposed to cocaine ignored their mother's departure (odds ratio [OR] = 3.0, $p < .05$) during separation significantly more often than nonexposed subjects. In addition, mothers who abused cocaine engaged in significantly more verbal behavior ($F(2,104) = 7.00$, $p < .001$) with their children than mothers of nonexposed children. These findings indicate that women who used cocaine during pregnancy may not differ from nonusers in their interactions with their 12-month-old infants.

Keywords

Mother-child interaction; Prenatal cocaine exposure

INTRODUCTION

Although children play with their peers, a predominant amount of play in young children is between mother and child. Vygotsky (1) suggests that, for toddlers, play serves as a zone of proximal development in which they can operate at a higher cognitive and social level. As parents play with their children, they can scaffold or promote slightly higher levels of complexity of the child's play, thus encouraging cognitive advances (2–4).

The quality of play between parent and child is affected by the quality of the parenting environment and the educational, cognitive, behavioral, emotional, and social characteristics of the parents. Estimates of maternal use of cocaine during pregnancy range from 8% to 31%, depending on the location, method of ascertaining drug use, and particular population sampled (5–10). Cocaine effects include intense euphoria, followed by a state of severe depression, agitation, disinhibition, hypertension, and, in some cases, paranoid behaviors and anhedonia (11,12). Therefore, the effect of cocaine on parenting behavior needs to be determined.

Mother-child interactions provide a specific environmental situation in which the negative effects of drug use can be examined. For instance, drug-using mothers have been characterized as egocentric with a narcissistic orientation toward their children (13). They tend to be at risk for dysfunctional lifestyles, are rigid and overcontrolling in their parenting styles, and admit to more emotional neglect and abuse of their children (14–16). They are more inattentive, have

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negative perceptions of their children, are more depressed (17,18), and demonstrate limited responsivity in their interactions with their children (13,19–21).

However, despite the findings reported above, it is important to note that several researchers have documented no significant differences on many dimensions that have been used to compare maternal-child interactions in drug-exposed samples (18,20,22–31). For example, using the Nursing Child Assessment Feeding Scale, Neuspiel et al. (28) observed interaction during a mother-infant feeding by cocaine-using and non-using mothers of 2- to 4-month-olds and found no cocaine group differences in the quality of interaction.

Prenatal drug exposure may negatively affect children's development through action on the fetal central nervous system (32). This, in addition to high environmental risk, may explain findings of negative consequences, such as cognitive performance deficits (33–36), negative emotional tone (36–38), and deficient play strategies (18,39,40).

Cocaine exposure has been found to be related to several behaviors that would be expected to disrupt the parent-infant relationship. There is some evidence of abnormal neonatal neurobehavioral functioning, such as tremors, irritability, and abnormal sleep patterns (41, 42). These behaviors may provide mothers with fewer readable cues during interactions and cause difficulty inconsoling their infants, making them feel less than competent during these situations (43).

Metosky and Vondra (40) observed significant group differences on measures assessing the quality of toddler free play and negative affect, with the cocaine-exposed group playing at age-appropriate levels less frequently and for shorter bouts of time, as well as exhibiting more irritability during play than the non-drug-exposed group. Finnegan and Kendall (39) found that 3- to 5-year-old cocaine-exposed children showed significant deficits in interactions outside the mother-infant dyad, such as in play groups and nursery schools. These children tended to be joyless, to have problems participating in structured and unstructured play, to display attention deficits, and to lack fantasy. In addition, the cocaine-exposed group showed lower levels of curiosity than the nonexposed group of children.

In an earlier study, Rodning, Beckwith, and Howard (29) found less optimal play in low-income toddlers prenatally exposed to a variety of drugs. The play of the drug-exposed toddlers was described as disorganized scattering of toys rather than sustained combining of toys. The drug-exposed group further showed lower levels of representational (symbolic) play. This finding was replicated by the same research team in a follow-up study with a different sample (18) in which the drug-exposed group had significantly more immature play and a lower level of sequenced play. These findings suggest that prenatal cocaine exposure may have an impact on attentional capacities, social interactions, and cognitive development of the children themselves, and they may provide poor signals for proper mothering.

Research has shown that most children become distressed when their mothers leave them alone, even for brief periods of time (44–48). According to Cairns (49), many of a child's response patterns develop in the context of the mother's presence. These response sequences become fragmented and inoperative when the child is separated from the mother and lead to crying. Several studies since the 1940s have focused on the relation between the overall quality of the mother-child interaction and separation distress associated with unfamiliar settings (46,50–57). These studies have successfully utilized the free-play/ separation/reunion paradigm to evaluate various social, emotional, and cognitive developmental variables in children. While most children can adjust to mildly stressful situations, highly distressed children may react more quickly to their mother's departure than those who are mildly upset, and they take longer to soothe after her return (55). A study of the reactions of polydrug-exposed toddlers to maternal departure during a separation-reunion procedure found that, rather than showing distress, the children showed indifference to their mothers' departure during separation (58). Almost 75% of these infants showed no apparent feelings of pleasure, anger, or distress in response to the separation. They remained unsettlingly neutral in their emotional responses throughout the entire period of observation.

The present study focused on low-income African-American mothers, some of whom used cocaine during pregnancy. A free-play and separation-reunion paradigm was used to examine the interactive behavior of the parents and 12-month-old children. Based on the work of others, we hypothesized that 12-month-old infants prenatally exposed to cocaine would show a lower quality of play interaction and would have a greater negative emotional tone in the free-play procedure. Further, by 12 months, infants exposed to cocaine as fetuses, especially a high level of cocaine, would be less affected by maternal separation. Finally, we predicted that maternal negative affect would be higher in prenatally exposed children.

Infants of mothers who abuse cocaine tend to be exposed to a number of risk factors, such as prenatal exposure to other substances of abuse and greater environmental risk, and are more likely to have neonatal medical complications (19,59–61). These variables were considered in examining the play interactions of the 12-month-olds and their mothers. Moreover, measures of environmental stress also were taken into account.

METHODS

Participants

Pregnant women attending participating hospital-based prenatal clinics or women who had just given birth in two inner-city hospitals located in Trenton, New Jersey, and Philadelphia, Pennsylvania, were approached for participation. Informed consent was obtained at this time. No women reported any serious medical problems during pregnancy. Infants were excluded from the study if they were born prior to 32 weeks of gestation, required special care or oxygen therapy for more than 24 hours, exhibited congenital anomalies, were exposed to opiates or phencyclidine in utero, or had mothers who were less than 15 years of age or infected with human immunodeficiency virus (HIV). The sample consisted of 112 mother-infant dyads recruited for a longitudinal study of the effects of prenatal cocaine exposure on child outcome.

All mothers were African-American inner-city clinic patients. Participation was voluntary, and incentives were provided in the form of vouchers for use at local stores. Only 2 mothers received no prenatal care. Infant subjects had a mean age of 12.45 months (SD = 0.76) at the time of the study. All subjects lived with their biological mothers.

Procedure

Infants and their mothers were ushered into a playroom with a big basket of toys, upholstered chair, infant table and chairs, television set, and magazine rack. Mothers were instructed to play with their children in the playroom and were told that they could use whichever toys they wanted. Parents were not given any special instructions as to how to play with their children; they were only told to leave the room when they heard a tap on a one-way mirror that separated the playroom from an observation room. The free-play period lasted for 5 minutes. Mothers were then signaled to leave the room and shut the door behind them. This was the start of the separation period, which lasted for 2 minutes, except in the case of subjects who cried excessively. For these subjects, the separation period was terminated early (n = 7). In the reunion period, mothers returned to the room, and free play was observed for 2 minutes. Infants and mothers were videotaped during the entire procedure through the one-way mirror.

Measures

Mother-Infant Interaction—To determine the amount of mother-infant interaction, both maternal and child variables were coded from videotapes using a computerized coding system. Both frequency and duration measures were obtained during the last 3 minutes of free play and the first 2 minutes of reunion by two trained coders, an author (I. U.) and a research assistant. Table 1 presents the definitions of the variables coded during the free-play and reunion phases of the study. During both free play and reunion, verbal, educational, visual monitoring, and structuring behavior of the mothers were coded, as well as indications of warmth and negative affect toward her child. Children's positive affect and anger were coded during free play, while secure/approach, and insecure/avoidant measures were coded during reunion. Secure/approach and insecure/avoidant measures were adapted from Ainsworth's patterns of attachment (44). Secure/approach behavior was calculated by combining scores from Ainsworth's distance interaction and proximity-seeking behaviors, while insecure/avoidant behavior was calculated by combining scores from Ainsworth's resistant behavior and avoidant behavior (44). The maternal behaviors were identical for the free-play and reunion phases. A 95% overall interrater reliability reported for all the measured variables (ranging from 83% to 98%) was established between the two coders on 14% of the subjects.

Maternal Drug Use—Substance use information was obtained through a quantity-frequency-variability interview (62) conducted in an exam room at the hospital, in the mother's room on the maternity ward if she had just delivered, in our laboratories near the hospitals, or in the mother's home within 2 weeks of the infant's birth. The interview was administered by substance abuse counselors or study personnel trained in interview techniques by the counselors and a clinical psychologist. The drug use interview contained questions about the frequency of use of prescription and nonprescription medications; the frequency, amount, and trimester of use of cocaine; the form of cocaine used; the disruptiveness of substance abuse to the person's life; and history of substance abuse.

Substance use interview information was confirmed by analysis of the newborns' meconium, as well as results of prenatal and neonatal urine screens when available. The infants' meconium samples were screened using radioimmunoassay. followed by confirmatory gas chromatography/mass spectrometry for the presence of benzoylecgonine (cocaine metabolite), cannabinoids, opiates, amphetamines, and phencyclidine. Studies to determine the sensitivity, specificity, precision, and drug cross-reactivity of radioimmunoassay analysis of drugs in meconium indicated 100% sensitivity, specificity, positive predictive value, and negative predictive value (63). Information obtained by interview was corroborated by biological markers. Three cases in which women denied cocaine use but had positive meconium screens were eliminated from the study.

In this study, 49 mothers (44%) were determined to have used cocaine during pregnancy, while 63 mothers (56%) did not use cocaine. Further analysis of the cocaine-using group indicated that the majority smoked crack (59%), 16% smoked free-base cocaine, 14% snorted cocaine, and about 11% used cocaine in multiple ways. Of the cocaine-using mothers, 23 (47%) used cocaine during all three trimesters, 12 (24%) used cocaine in only two trimesters, while 14 (29%) used cocaine in only one trimester.

The cocaine-exposed subjects were divided further into those whose mothers reported using cocaine less than twice per week on average (light exposure [LE], $N = 22$) and those whose mothers used cocaine at least twice per week (heavy exposure [HE], $N = 27$). Despite the small cell sizes, with 112 subjects, a medium effect size (partial eta-squared) of 0.09 could be detected with greater than 0.80 power with $\alpha = .05$ for the three-group comparison after controlling for the five covariates. There was thus sufficient power to present a single cocaine exposure group and also both levels of cocaine exposure (light and heavy). Exposure is described in terms of frequency of use during pregnancy rather than amount because the purity and dosage of street drugs are so variable. The definitions of heavy and light exposure have been used in other studies (24,59,64). Alcohol consumption was measured according to the number of daily drinks: 1 drink = 1 ounce (29.57 ml) liquor, 4 ounces (118.28 ml) wine, or 12 ounces (354.84 ml) beer. Cigarette smoking was measured according to the number of cigarettes smoked daily during pregnancy. Marijuana smoking was measured according to the number of daily joints smoked during pregnancy.

Environmental Risk—During a laboratory visit when the subjects were 4 months old, the amount of maternal life stress was measured using an adapted version of the Prenatal Social Environment Inventory (65). This instrument, which has a test-retest reliability of .73, has high internal consistency and assesses major life events and chronic stress. Social support network size was assessed with the Norbeck Social Support Questionnaire (66). This instrument measures the number of people in a woman's social network, the duration of her relationships, and the frequency of her contact with each member. Test-retest reliability ranged from .85 to .92 with high internal consistency.

Other environmental measures obtained were maternal educational level, number of supportive adults living in the home, number of children in the household, current substance use, family history of drug or alcohol use, and family chaos variables. These variables were standardized and combined into a cumulative Environmental Risk Score, which was scaled to have a mean of 50 and standard deviation of 10.

Sameroff and colleagues (67) have shown that cumulative risk, regardless of the individual constituents, is more predictive of cognitive outcome than any individual risk factor. Such aggregate variables are more stable than any individual measure, and there is increased power to detect effects of the environment because errors of measurement decrease as scores are summed (68). Similar cumulative environmental risk measures have been found to account for more variance in child outcome variables than single factors, including socioeconomic status (67,69–72).

Neonatal Medical Condition—To determine if cocaine-exposed infants had a higher number of early medical complications and to control for their effects on outcome, neonatal medical data were abstracted from hospital records by nurses. The data were used to complete a Neonatal Medical Risk Scale consisting of 35 possible complications (73). Variables included general factors (e.g., low birth weight, fetal anomalies, feeding problems), respiratory complications (e.g., congenital pneumonia, apnea, meconium aspiration syndrome), metabolic disorders (e.g., failure to gain weight, hypoglycemia), cardiac problems (e.g., murmur, cardiac anomalies), hematologic problems (e.g., anemia, sepsis), and central nervous system (CNS) problems (e.g., CNS depression, seizures). Variables were weighted and summed to obtain a neonatal risk score that ranged from 0 to 10.

RESULTS

The distributions of the continuous variables were examined for normality. For variables with positively skewed distributions, log transformations were performed. These included maternal warmth and child positive affect during free play and maternal interactive behaviors during reunion. Those with a large percentage of zero counts were dichotomized into zero and one and included maternal negative affect and child negative affect during free play, child crying during separation, and maternal negative affect during reunion. Departure styles were mutually exclusive and were coded as dichotomous variables.

Table 2 presents maternal and child characteristics for the nonexposed and the two cocaine (lightly and heavily) exposed groups. Analyses of variance indicated that there were significant differences among the three groups in the amount of alcohol consumed during pregnancy and the average daily number of cigarettes smoked, with $F(2, 111) = 13.87$, $p <.001$, and $F(2, 111) = 29.01$, $p <.001$, respectively. Post-hoc analyses using the Duncan Multiple Range Test indicated that both light and heavy cocaine users consumed more alcohol and smoked more cigarettes compared with non-cocaine-abusing mothers ($p <.05$ for both), but were not different from each other. There also was a significant difference among the average number of marijuana joints smoked during pregnancy in the three groups, $F(2, 111) = 3.81$, $p <.05$. The light-cocaine-using mothers smoked more marijuana joints than the nonexposed group ($p <.05$), but there were no significant differences in the amount of marijuana joints smoked by the heavy-cocaine-using group compared to the light using or the nonexposed group.

For child characteristics, there was a marginal group difference in the neonatal medical risk score, $F(2, 111) = 3.07$, $p <.06$. Follow-up analyses showed no differences between the nonexposed and either the lightly or heavily exposed groups. However, when the exposed groups were collapsed, cocaine-exposed infants had significantly higher neonatal medical risk scores compared to nonexposed infants ($p <.05$). There was a trend for differences in environmental risk scores, $F(2, 111) = 2.47$, $p <.09$, that indicated that the cocaine-exposed children had higher environmental risk scores than the nonexposed children. Follow-up analyses showed no differences between the nonexposed group and either of the exposed groups.

As a result of the differences observed between cocaine-exposed and non-exposed infants on alcohol, cigarette, and marijuana exposure, neonatal medical risk, and environmental risk, all analyses examining cocaine exposure group effects controlled for these five variables using analysis of covariance. First, analyses were done that compared cocaine-exposed versus nonexposed group, followed by levels of cocaine exposure to determine whether heavy compared to light exposure was more likely to affect the outcome analyses. Linear multiple regression (for continuous variables) and logistic regression (for dichotomous variables) were used to examine the effects of the five covariates—alcohol, cigarettes, marijuana, environmental risk, and neonatal medical risk—on the outcome variables independent of cocaine.

Maternal: Free Play

Table 3 presents the means, standard deviations, and means adjusted for the five covariates or percentage and number for mothers' emotional tone expressions of warmth and negative affect; verbal, visual, and educational interaction; structuring of play; and inattention during free play and reunion, as well as her departure behaviors at the beginning of the separation phase. Analysis of covariance (ANCOVA) of maternal behaviors during free play indicated that the only significant effect of cocaine exposure was on maternal verbal interactive behavior independent of the covariates, $F(2, 104) = 7.00$, $p < .001$. The cocaine-exposed groups had higher mean verbal interactive behavior scores than the non-exposed group. No significant differences were observed between the lightly exposed group and the other two groups.

Multiple regression analysis indicated that, of the covariates, only marijuana had a significant unique effect [$t(104) = 2.36$, $p < .03$], such that mothers who smoked more marijuana during pregnancy had a greater frequency of verbal interaction during free play.

There was a trend for a difference between the nonexposed and the exposed groups for educational interactive behavior [$F(2, 104) = 2.44$, $p < .09$], with only none and heavy being significantly different. Women who used cocaine frequently during pregnancy tended to provide more educational episodes than women who did not use cocaine during pregnancy.

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Among the covariates, neonatal risk had a significant unique effect, such that subjects with lower neonatal risk scores had mothers who showed a greater frequency of educational interactive behaviors during free play [$t(104) = 2.14$, $p < .05$].

Maternal: Separation and Reunion

There were no significant exposure group differences or covariate effects in any of the four maternal departure style variables or the mother's latency to depart at the time of separation nor were there differences in the maternal variables of verbal interaction, educational interaction, visual interaction, structuring behavior, warmth, and negative affect during reunion (see Table 3).

Child: Free Play

Table 4 presents the means, standard deviations, and adjusted means or percentage and number for children's positive and negative emotional expressions during free play, their emotional reaction and level of protest to their mothers' departure during separation, as well as their secure and insecure behavior during reunion. There were no significant exposure group differences or significant covariate effects for either of the two child variables, positive and negative affect, observed during free play.

Child: Separation and Reunion

Five child variables were observed during separation: latency to cry, cry duration, ignore departure, passive, and active protest. Of these variables, there was a significant exposure group difference in the percentage of children who ignored their mothers' departure, [χ^2 (1) = 4.24, $p < .05$]. Children who were prenatally exposed to cocaine ignored their mothers' departure during separation more than children from the nonexposed group (see Table 4). Using hierarchical logistic regression, no covariates had a significant effect on this outcome. Examination of the odds ratio (OR) revealed that children who were exposed to cocaine during pregnancy were three times more likely to ignore their mothers' departure (OR = 3.0, $p < .05$) than nonexposed children. Further analysis to determine cocaine level effect indicated that both the lightly exposed children (OR = 2.9) and those in the heavily exposed group (OR = 3.2) were more likely to ignore their mothers than those in the nonexposed group. There were no significant exposure group differences or covariate effects in the two child variables, secure/approach and insecure/withdrawal behavior observed during reunion.

DISCUSSION

The results of this study indicate that there is very little difference in interactive behaviors with their children of mothers who used or did not use cocaine during pregnancy. This is consistent with the Neuspiel and Hamel (27) finding of no differences from cocaine use in the quality of interactions during a mother-infant feeding study. Even during a free-play/separation/reunion procedure when they were instructed to play with their children, all of the mothers spent a lot of time engaged in other behaviors, such as watching television, gazing, or browsing through magazines, rather than interacting with their children. When they did interact with their children, most of them tended to select two or three of the same common toys to play with, despite the variety of toys provided. This suggests that the women in this study were unfamiliar with these types of activities and materials. In most cases, when they chose an uncommon toy, they tended to engage in parallel play rather than interactive play with their children. Both mother and child simultaneously explored the toys, trying to understand how they worked, resulting in minimal educational interaction within the dyad.

Although there were few interactive behavior differences between groups, mothers who abused cocaine provided more verbal interactive behavior and tended to provide more educational

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interactions. Increased verbal interaction also was noted for mothers who used marijuana during pregnancy. Research has shown that cocaine-exposed children are more likely to be highly passive and inattentive (20,21,43). Increased verbalization and showing how toys worked by parents may be an attempt to compensate for this behavior. In other studies, it has been noted that cocaine-using mothers are deficient in nonverbal skills that would enable them to communicate in this mode with their children (14). It was further noted (73,74) that cocaine-using mothers tend to find their children irritable, putting additional strain on their interactions. One implication of this is that, when these mothers find themselves in a situation requiring them to interact with their children, they may not have adequate nonverbal cues to enhance their interactions or convey their intentions; therefore, they are forced to use more verbal language in their communication. Measures of nonverbal communications, although not examined in this study, may be related to verbal interaction, and this is an area future research studies may need to explore further.

It also is possible that knowing that they were being videotaped affected the mothers' behavior. These mothers may want to prove that they are capable of taking care of their children, and they used their laboratory visit as an opportunity to demonstrate this. It is the case that cocaine-abusing mothers have periods when they are not under the influence of the drugs and appear in control of their situation, are organized, and can coordinate their activities and those of their children. Coming to their lab appointments when they are scheduled is evidence of this ability.

One cocaine exposure group effect found in this study was that children prenatally exposed to cocaine tended to ignore their mothers. This is consistent with other reports of similar behavior (58). These mothers may spend less time playing and interacting with their children at home, which may influence the children's responses to their mothers, making them less engaged with their mothers. During the laboratory visit, while the mothers are able to modify their behavior and to try to engage their children when instructed, their children, who are not used to interacting with them, may not be able to make this adjustment. Another plausible reason for the ignoring behavior observed in cocaine-exposed children is that their mothers may experience difficulty reading social interactive cues (14) or simply neglect their children while under the influence of drugs. Therefore, these children may have a history of their mothers ignoring their signals. Poor development of social cues between mother and child thus may be responsible for the ignoring behavior and minimal protest observed in cocaine-exposed children. Consequently, the departure of their mothers from a room where they are playing will not produce a strong emotional reaction, particularly if engaging in free play with their mothers is a situation to which these children are unaccustomed.

These findings have implications for the development of these infants. The fact that very few differences are noted between the interaction of mothers and their children at 12 months is an indication that, to the extent that the child's developmental trajectory is influenced by maternal interactive behavior, prenatally cocaine-exposed children may not have substantially different outcomes than nonexposed children.

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References

1. Vygotsky, L. *Mind in Society*; Harvard University Press: Cambridge, 1978.
2. Hill P, McCune-Nicolich L. Pretend play and patterns of cognition in Down's syndrome children. Child Dev 1981;52:611–617. [PubMed: 6454543]

3. Tamis-LaMonda C, Bornstein M. Individual variation, correspondence, stability, and change in mother and toddler play. Infant Behav Dev 1991;14:143–162.

4. Tamis-LaMonda C, Bornstein M. Play and its relations to other mental functions in the child. New Dir Child Dev 1993;59:17–28. [PubMed: 8483524]

5. Bendersky M, Lewis M. Prenatal cocaine exposure and neonatal condition. Infant Behav Dev 1999;22:353–366. [PubMed: 16912813]

6. Fantel A, Barber C, Mackler B. Ischemia/reperfusion: a new hypothesis for the developmental toxicity of cocaine. Teratology 1992;46:285–293. [PubMed: 1326132]

7. Gingras J, Weese-Mayer D, Hume R, O'Donnell K. Cocaine and development: mechanisms of fetal toxicity and neonatal consequences of prenatal cocaine exposure. Early Human Dev 1992;31:1–24.

8. Hawley T, Disney E. Crack's children: the consequences of maternal cocaine abuse. Soc Policy Rep Soc Res Child Dev 1992;6:1–22.

9. Olsen G. Potential mechanisms of cocaine induced developmental neurotoxicity: a minireview. Neurotoxicology 1995;16:159–167. [PubMed: 7603637]

10. Ostrea E, Brady M, Gause S, Raymundo A, Stevens M. Drug screening of newborns by meconium analysis: a large scale, prospective, epidemiological study. Pediatrics 1992;89:107–113. [PubMed: 1727992]

11. Howard J. Cocaine and its effects on the newborn. Dev Med Child Neurol 1989;31:255–263. [PubMed: 2661289]

12. Ryan L, Ehrlich S, Finnegan L. Cocaine abuse in pregnancy: effects on the fetus and new born. Neurotoxicol Teratol 1987;9:295–299. [PubMed: 3683347]

13. Burns W, Clark R. Dyadic disturbances in cocaine-abusing mothers and their infants. J Clin Psychol 1991;47:316–319. [PubMed: 2030140]

14. Gottwald S, Thurman S. The effects of prenatal cocaine exposure on mother-infant interaction and infant arousal in the newborn period. Topics Early Child Spec Educ 1994;14:217–231.

15. Mayes L, Bornstein M, Chawarska K, Granger R. Information processing and developmental assessments in 3-month-old infants exposed prenatally to cocaine. Pediatrics 1995;95:539–545. [PubMed: 7700755]

16. Mayes L, Feldman R, Granger R, Haynes M, Bornstein M, Schottenfeld R. The effects of polydrug use with and without cocaine on mother-infant interaction at 3 and 6 months. Infant Behav Dev 1997;20:489–502.

17. Gelfand D, Teti D. The effects of maternal depression on infants. Clin Psychol Rev 1990;10:329–353.

18. Beckwith L, Rodning C, Norris D, Khandabi P, Howard J. Spontaneous play in 2-year olds born to substance abusing mothers. Infant Ment Health J 1994;15:189–201.

19. Bendersky M, Lewis M. Prenatal cocaine exposure and neonatal condition. Infant Behav Dev 1999;22:353–366. [PubMed: 16912813]

20. Black M, Nair P, Schuler M. Prenatal drug exposure: neurodevelopmental outcome and parenting environment. J Pediatr Psychol 1993;18:605–620. [PubMed: 7507525]

21. Hawley, T., Disney, E. Crack's children: the consequences of maternal cocaine abuse. Soc. Policy Rep. **1992**, *4*

22. Mayes L, Bornstein M, Chawarska K, Granger R. Habituation and developmental assessments in three month olds exposed prenatally to cocaine. Pediatrics 1995;95:539–545. [PubMed: 7700755]

23. Hawley T, Halle T, Drasin R, Thomas N. Children of addicted mothers: effects of the crack epidemic on the care giving environment and the development of preschoolers. Am J Orthopsychiatry 1995;26:243–247.

24. Jacobson S, Jacobson J, Sokol R, Martier S, Ager J. Prenatal alcohol exposure and infant information processing. Child Dev 1993;64:1706–1721. [PubMed: 8112114]

25. Chawarska, K., Mayes, L., Reznick, J., Miranda, R. Visual expectations in cocaine and non-cocaine exposed 6-month-old infants. Poster presentation at the biennial meeting of the Society for Research in Child Development, Washington, DC, April 3–6, 1997.

26. Mayes L, Granger R, Frank M, Schottenfeld R, Bornstein M. Neurobehavioral profiles of infants exposed to cocaine prenatally. Pediatrics 1993;91:778–783. [PubMed: 8464666]

27. Neuspiel D, Hamel S. Cocaine and infant behavior. J Dev Behav Pediatr 1991;12:55–64. [PubMed: 2016404]
28. Neuspiel D, Hamel S, Hochberg E, Greene J, Campbell D. Maternal cocaine use and infant behavior. Neurotoxicol Teratol 1991;13:229–233. [PubMed: 2046640]
29. Rodning C, Beckwith L, Howard J. Characteristics of attachment organization and play organization in prenatally drug-exposed toddlers. Dev Psychopathol 1989;1:277–289.
30. Schuler, M., Nair, P. Predictors of 12 month developmental outcomes in infants of substance abusing women. Poster presentation at the biennial meeting of the Society for Research in Child Development, Washington, DC, April 3–6, 1997.
31. Singer L, Farkas K, Kliegman R. Childhood medical and behavioral consequences of maternal cocaine use. J Pediatr Psychol 1992;17:389–406. [PubMed: 1382125]
32. Mayes, L., Bornstein, M. Developmental dilemmas for cocaine-abusing parents and their children. In *Mothers, Babies and Cocaine: The Role of Toxins in Development*; Lewis, M., Bendersky, M., Eds., Erlbaum: Hillsdale, NY, 1995; 251–272.
33. Bendersky M, Lewis M. Arousal modulation in cocaine-exposed infants. Dev Psychol 1998;34:555–564. [PubMed: 9597364]
34. Chasnoff I, Hunt C, Kletter R, Kaplan D. Prenatal cocaine exposure is associated with respiratory pattern abnormalities. Am J Dis Child 1989;143:583–587. [PubMed: 2636852]
35. Doberczak T, Shanzer S, Senie R, Kandall S. Neonatal neurologic and electroencephalographic effects of intrauterine cocaine exposure. J Pediatr 1988;113:354–358. [PubMed: 3397800]
36. Zuckerman B, Bresbahan K. Developmental and behavioral consequences of prenatal drug and alcohol exposure. Pediatr Clin J North Am 1991;38:1387–1406.
37. Bauchner H, Zuckerman B, McClain M, Frank D, Fried D, Kanyne H. Sudden infant death syndrome among infants with in utero exposure to cocaine. Pediatrics 1988;113:831–834.
38. Salamy A, Eldredge L, Anderson J, Bull D. Brain-stem transmission time in infants exposed to cocaine in utero. J Pediatr 1990;117:627–629. [PubMed: 2170611]
39. Finnegan, L., Kendall, S. Maternal and neonatal effects of alcohol and drugs. In *Substance Abuse: A Comprehensive Textbook*; Lowinson, J., Ruiz, P., Millman, R., Eds., Williams Wilkins: Baltimore, MD, 1992; 628–656.
40. Metosky P, Vondra J. Prenatal drug exposure and play and coping in toddlers: a comparison study. Infant Behav Dev 1995;18:15–25.
41. Oro A, Dixon D. Perinatal cocaine and methamphetamine exposure: maternal and neonatal correlates. J Pediatr 1987;111:571–578. [PubMed: 3655989]
42. Schutter L, Brinker R. Conjuring a new category of disability from prenatal cocaine exposure: are the infants unique biological or caretaking casualties? Topics Early Child Spec Educ 1992;11(4):84–111.
43. Gottwald S, Thurman S. Parent-infant interaction in neonatal intensive care units: implications for research and service delivery. Infants Young Child 1990;2:1–9.
44. Ainsworth, M., Bucher, M., Waters, E., Wall, S. *Patterns of Attachment*; Erlbaum: Hillsdale, NY, 1978.
45. Lewis, M., Bendersky, M., Eds. *Mothers, Babies, and Cocaine: The Role of Toxins in Development*; Erlbaum: Hillsdale, NY, 1995.
46. Fleener D, Cairns R. Attachment behavior in human infants: discriminative vocalization upon maternal separation. Dev Psychol 1970;2:215–223.
47. Maccoby EE, Feldman SS. Mother-attachment and stranger-reactions in the third year of life. Monogr Soc Res Child Dev 1972;37:1–86. [PubMed: 4680900]
48. Lewis M, Weinraub M. The determinants of children’s responses to separation. Monogr Soc Res Child Dev 1977;42:1–78. [PubMed: 611417]
49. Cairns, R. Attachment and dependency: a psychobiological and social learning synthesis. In *Attachment and Dependency*; Gewirtz, J., Ed., Winston: Washington, DC, 1972.
50. Connell, J., Thompson, R., Tero, P. Emotion-attachment interrelationships in the strange situation: a structural modeling approach. Paper presented at the meetings of the International Conference on Infant Studies, New York, April 5–8, 1984.

51. Gaensbauer T, Connell J, Schultz L. Emotion and attachment: interrelationships in a structured laboratory paradigm. Dev Psychol 1983;19:815–831.
52. Lewis, M., Sullivan, M. *Emotional Development in Atypical Children*; Erlbaum: Mawah, NJ, 1996.
53. Providence, S., Lipton, R. *Infants in Institutions*; International Universities: New York, 1962.
54. Splitz, R. *The First Year of Life*; International Universities: New York, 1965.
55. Thompson R, Cicchetti D, Lamb M, Malkin C. Emotional responses of down syndrome and normal infants in the strange situation: the organization of affective behavior in infants. DevPsychol 1985;21:828–841.
56. Tizard, J., Tizard, B. The social development of 2-year-old children in residential nurseries. In *The Origins of Human Social Relations*; Schaffer, H. R., Ed.; Academic Press: London, 1971; 147–163.
57. Weinraub M, Brooks J, Lewis M. The social network: a reconsideration of the concept of attachment. Human Dev 1977;20:31–47.
58. Rodning C, Beckwith L, Howard J. Quality of attachment and home environments in children prenatally exposed to PCP and cocaine. Dev Psychopathol 1992;3:351–366.
59. Alessandri S, Bendersky M, Lewis M. Cognitive functioning in 8- to 18-month-old drug-exposed infants. Dev Psychol 1998;34:565–573. [PubMed: 9597365]
60. Mayes L, Granger R, Bornstein M, Zuckerman B. The problem of prenatal cocaine exposure: a rush to judgment. JAMA 1992;267:406–408. [PubMed: 1727966]
61. Woods, N., Behnke, M., Eyler, F., Conlon, M., Wobie, K. Cocaine use among women: socioeconomic, obstetrical, and psychological issues. In *Mothers, Babies, and Cocaine: The Role of Toxins in Development*; Lewis, M., Bendersky, M., Eds.; Erlbaum: Hillsdale, NY, 1995.
62. Day N, Robles N. Methodological issues in the measurement of substance use. Ann NY Acad Sci 1989;562:8–13. [PubMed: 2742287]
63. Romero A, Mac E, Knapp D, Ostrea E. Evaluation of a rapid, meconium drug testing system for clinical use. Pediatr Res 33:68A.
64. Jacobson J, Jacobson S. Methodological considerations in behavioral toxicology in infants and children. Dev Psychol 1996;32:390–403.
65. Orr S, James S, Casper R. Psychosocial stressors and low birth weight: development of a questionnaire. J Dev Behav Pediatr 1992;13:343–347. [PubMed: 1401118]
66. Norbeck J, Lindsey A, Carrieri V. The development of an instrument to measure social support. Nurs Res 1981;30:264–269. [PubMed: 7027185]
67. Sameroff A, Seifer R, Barocas R, Zax M, Greenspan S. Intelligence quotient scores of 4-year-old children: social-environmental risk factors. Pediatrics 1987;79:343–350. [PubMed: 3822634]
68. Wachs, T. Environmental considerations in studies with non extreme groups. In *Conceptualization and Measurement of Organism Environment Interaction*; Wachs, T., Plomin, R., Eds.; American Psychological Association: Washington, DC, 1991; 44–67.
69. Bendersky M, Lewis M. Environmental risk, medical risk, and cognition. Dev Psychol 1994;30:484–494.
70. McGauhey P, Starfield B, Alexander C, Ensminger M. Social environment and vulnerability of low birth weight children: a social-epidemiological perspective. Pediatrics 1991;88:943–953. [PubMed: 1945635]
71. Sameroff A, Seifer R, Baldwin A, Baldwin C. Stability of intelligence from preschool to adolescence: the influence of social and family risk factors. Child Dev 1993;64:80–97. [PubMed: 8436039]
72. Stanton W, McGee R, Silva P. Indices of perinatal complications, family background, child rearing, and health as predictors of early cognitive and motor development. Pediatrics 1991;88:954–959. [PubMed: 1945636]
73. Hobel C, Hyvarinen M, Okada D, Oh W. Prenatal and intrapartum high-risk screening. Am J Obstet Gynecol 1973;117:1–9. [PubMed: 4722373]
74. Crockenberg S, Acredolo C. Infant temperament ratings: a function of infants, mother, or both. Infant Behav Dev 1983;6:61–72.

Table 1

Definition of Interaction Variables

	Definitions
Maternal variable	
Free play/reunion	
Warmth	Frequency of time mother shows enjoyment of the interaction with her child, which could be through smiling, caressing, snuggling, or kissing
Negative affect	Frequency of mother's angry outbrusts (e.g., reprimands, scolds, yanks child, stamps feet, strikes child)
Verbal interaction	Frequency of all mother's speech directed toward child except time mother spends giving verbal instructions or information
Visual monitoring	Frequency of observing, but not communicating with, child
Educational interaction	Frequency of mother's modeling or instructing child on how to use or play with materials/toys or giving information
Structuring play	Frequency of organizing play area by adding or removing toys and arranging or rearranging toys
Inattention	Total duration or activities having nothing to do with child and involving no bodily contact; includes watching TV, looking around room, looking at or reading magazines/books, attending to themselves sleeping
Separation:	
Departure style	
Latency to depart	Total time it takes mother to leave after hearing the signal; includes any time the mother may spend informing or instructing child
Informs child	Mother tells child she is leaving the room, but will return shortly
Just leaves	Mother does not tell child she is leaving the room, but tries to leave without child noticing her
Instructs child	Mother tells child what to do during her absence before leaving room
Structures child's play	Mother either sets up new toys for child to play with, rearranges the toys child is playing with, or puts away some toys child has been playing with or stopped playing with and then leaves (with or without saying anything to child)
Child variable	
Free play	
Positive affect	Total duration child shows enjoyment during interaction with mother; includes time spent smiling, caressing, snuggling, and kissing
Child anger	Total duration child exhibits unhappy behaviors (e.g., hitting toys or mother, stamping feet, fussing or fretting, throwing self on floor)
Separation	
Latency to cry	Time it takes before child starts to cry following mother's departure
Duration of cry	Total duration of all crying episodes the child has following mother's departure
Ignores	Child does not react to mother's departure, but continues whatever she or he was doing prior to mother's departure
Passive protest	Although child does not try to prevent mother from leaving, child frets, cries, or fusses as mother leaves
Active protest	Child tries to prevent mother from leaving by walking or running toward mother as she departs; child may be crying or otherwise verbally expressing distress
Reunion	
Secure/approach behavior	The combination of distance interaction and proximity-seeking behavior, thus secure scores range from 2 to 10. Distance interaction is the rating of positive social behaviors that indicate the child's interest in the adult, although the child is far away from mother. This includes smiling, vocalizing, intent looking, showing of toy, playing through gestures. Proximity-seeking behavior is the rating of the child's efforts to gain (or regain) contact with mother. This includes behaviors such as clambering onto the adult, creeping, crawling, or walking and actually making contact, through his/her own efforts or initiatives.
Insecure/avoidant behavior	The combination of resistant and avoidant behavior, thus insecure scores range from 2 to 10. Resistant behavior is the rating of the resistant behavior evoked by the mother when she comes into contact with or proximity to the child. The child's mood is angry—pouting, petulant, cranky, fussing, angry distress, temper tantrums, repeated hitting, resistance to being held, or pushing mother away. Avoidant behavior is the rating of the child's avoidance of proximity and of interaction even across a distance. The child does not greet mother on return either with a smile or with a protest. Child ignores mother and pays little attention to her efforts to attract his/her attention. If picked up by mother, child remains unresponsive while being held.

Table 2

Demographic Information, Mean (Standard Deviation)

Variables	Nonexposed (*N* = 63)	Light Exposure (*N* = 22)	Heavily Exposed (*N* = 27)
Mother			
Average daily drinks[a]	0.01 (0.04)[b]	0.94 (1.38)[c]	0.77 (1.20)[c]
Average daily cigarettes[a]	1.06 (2.78)[b]	6.54 (6.05)[c]	9.82 (8.19)[c]
Average daily marijuana joints[d]	0.01 (0.03)[b]	0.15 (0.45)[c]	0.09,[bc]
Child			
Neonatal medical risk[e]	0.12 (0.21)	0.23 (0.25)	0.24 (0.28)
Environmental risk[e]	49.77 (8.98)	54.33 (11.73)	53.22 (8.57)
Age at test (months)	12.48 (0.80)	12.35 (0.72)	12.47 (0.73)

[a] $p < .001$.

[b] Significantly different from values with superscript c at $p < .05$ by the Duncan Multiple Range Test.

[c] Significantly different from values with superscript b at $p < .05$ by the Duncan Multiple Range Test.

[d] $p < .05$.

[e] $p < .10$.

Table 3

Maternal Interactive Behaviors by Exposure Group, Means or Percentage (#), (SD), and Adjusted Means

Variable	Nonexposed (N = 63)	Exposed (N = 49)	Light Cocaine (N = 22)	Heavy Cocaine (N = 27)
Free play				
Warmth	5.67 (4.17)[abc]	5.77 (3.99) (5.96)	5.93 (3.64) 6.11	5.63 (4.32) 5.70
Negative, %	24 (15)	27 (13)	14 (3)	37 (10)
Verbal[d]	7.91 (6.01) 6.36[e]	12.31 (10.31) 13.37	10.59 (10.14) 10.69[f]	13.70 (10.4) 15.15[f]
Visual	11.56 (8.85) 10.44	8.29 (6.53) 9.09	7.64 (5.17) 8.28	8.81 (7.52) 9.29
Education[g]	12.78 (7.99) 10.53[e]	13.55 (8.44) 15.17	12.18 (6.2) 13.31,[ef]	14.7 (9.88) 15.79[f]
Structuring	6.40 (4.75) 5.96	6.69 (3.97) 7.02	6.55 (3.56) 6.76	6.81 (4.34) 7.04
Inattention	131.70 (34.7) 124.18	125.88 (36.84) 131.69	129.18 (28.07) 134.03	123.19 (43.03) 125.86
Separation: latency to depart	8.38 (4.17) 7.90	11.71 (12.51) 12.15	13.23 (14.0) 13.43	10.48 (11.2) 10.76
Departure style				
Informs, %	22.2 (14)	36.7 (18)	36.4 (8)	37.0 (10)
Just leaves, %	55.6 (35)	46.9 (23)	45.5 (10)	48.1 (13)
Instructs, %	6.3 (4)	2.0 (1)	0.00	3.7 (1)
Structures, %	15.9 (10)	14.3 (7)	18.2 (4)	11.1 (3)
Reunion				
Warmth	5.48 (4.53) 4.92	5.31 (3.9) 5.75	5.62 (3.64) 5.86	5.07 (4.16) 5.38
Negative, %	29 (18)	33 (16)	32 (7)	33 (9)
Verbal	8.48 (8.20) 8.86	9.71 (8.75) 9.38	8.64 (7.51) 8.71	10.60 (9.69) 10.14
Visual	6.49 (5.90) 6.10	4.90 (4.54) 5.20	5.00 (5.01) 5.33	4.82 (4.22) 4.88
Education	6.73 (4.81) 5.79	6.27 (4.77) 6.98	6.36 (5.08) 6.78	6.19 (4.61) 6.71
Structuring	3.94 (2.98) 3.84	3.94 (2.75) 4.05	4.73 (2.83) 4.98	3.30 (2.55) 3.14
Inattention	86.35 (27.72) 79.60	88.35 (25.49) 93.30	86.18 (21.67) 89.18	90.11 (28.51) 93.87

[a]Mean.

[b]Standard deviation.

[c]Adjusted mean.

[d]$p < .001$.

[e]Significantly different from values with superscript f at $p < .05$ by the Duncan Multiple Range Test.

[f]Significantly different from values with superscript e at $p < .05$ by the Duncan Multiple Range Test.

[g]$p < .10$.

Table 4

Child Interactive Behaviors by Exposure Group Means or Percentage (#), (SD), and Adjusted Means

Variable	Nonexposed (*N* = 63)	Exposed (*N* = 49)	Light Cocaine (*N* = 22)	Heavy Cocaine (*N* = 27)
Free play				
Positive affect	3.42 (3.22) 3.33	3.56 (3.34) 3.63	3.73 (3.28) 3.74	3.41 (3.44) 3.50
Anger	0.94 (1.87) 0.99	0.76 (1.37) 0.72	0.63 (1.21) 0.69	0.87 (1.50) 0.76
Separation				
Latency to cry	64.95 (46.08) 67.11	76.76 (75.09) 75.09	75.68 (40.00) 75.13	77.63 (44.27) 76.03
Cry duration	31.76 (37.66) 26.01	24.67 (35.08) 29.02	25.45 (36.32) 26.90	24.04 (36.05) 28.35
Ignores departure, %[a]	23.8 (15)[b]	51.0 (25)[c]	50.0 (11)[c]	51.9 (14)[c]
Passive protest, %	26.63 (17)	8.16 (4)	4.55 (1)	11.11 (3)
Active protest, %	55.56 (35)	40.82 (20)	45.45 (10)	37.04 (10)
Reunion				
Secure/ approach behavior	6.56 (2.48) 6.52	6.06 (2.21) 6.10	6.27 (2.37) 6.33	5.89 (2.10) 5.86
Insecure/ withdrawal behavior	7.78 (2.49) 7.78	7.73 (2.61) 7.73	7.55 (2.72) 7.54	7.89 (2.56) 7.89

[a] $p < .05$.

[b] Significantly different from values with superscript c at $p < .05$ by the Duncan Multiple Range Test.

[c] Significantly different from values with superscript b at $p < .05$ by the Duncan Multiple Range Test.