Prenatal Drug Exposure: Neurodevelopmental Outcome and Parenting Environment¹

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Examined neurodevelopmental patterns and caregiving environment among 20 infants prenatally exposed to cocaine and 20 drug-free infants. The Brazelton Scale was administered 4 times. Drug-exposed infants had less optimal neurodevelopment than comparison infants at birth, but by 6 weeks only differences in autonomic stability were apparent. Neurodevelopmental performance was related positively to the child-centered quality of the environment. Though support buffered stress in both groups, the effect was more robust among drug-free mothers. Findings support the need to consider neurodevelopmental recovery and the caregiving environment in evaluations of developmental outcome among drug-exposed infants.

KEY WORDS: prenatal drug use; neurodevelopmental outcome; Brazelton Neonatal Behavioral Assessment Scale; parent-infant interaction; parenting stress; support.

With the recognition that cocaine, opiates, and other illicit drugs cross the placenta, the epidemic of drug abuse in the United States has entered neonatal nurseries. Patterns of drug use have changed rapidly within the past decade, with a substantial increase among women of child-bearing age (Chasnoff, 1988; Chasnoff, Landress, & Barnett, 1990; Chavkin & Kandall, 1990; Ryan, Ehrlich, & Finnegan, 1987).

Cocaine and other drugs that cross the placenta often have a longer half-life

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in the fetus than in the adult due to the immaturity of the fetal metabolic, hepatic, and renal systems (Chasnoff, 1984). Cocaine can affect the fetus through alterations in the maternal or fetal blood flow. At the nerve terminals cocaine prevents the reuptake of norepinephrine and dopamine, thereby increasing extracellular levels of these catecholamines, and potentially interfering with the supply of nutrients and oxygen to the fetus.

The effects of prenatal exposure to cocaine appear to include increased incidence of prematurity and intrauterine growth retardation (Chasnoff, 1988; Hadeed & Siegel, 1989; Madden, Payne, & Miller, 1986; Ryan et al., 1987). Although babies exposed to cocaine prenatally do not usually demonstrate classic signs of withdrawal or neonatal abstinence syndrome, they do have an increased probability of convulsions, vomiting, tremors, poor feeding, hypertonia, abnormal sleep and cry patterns (Cherukuri, Minkoff, Felman, Parekh, & Glass, 1988; Lester et al., 1991; Oro & Dixon, 1987; Ryan et al., 1987). In summary, cocaine-exposed babies appear to be at risk for poor medical and behavioral outcomes.

The presumed developmental vulnerability of drug-exposed infants highlights the need to assess early developmental status (Singer, Garber, & Kliegman, 1991). Neurodevelopmental status is often assessed with the Brazelton Neonatal Behavioral Assessment Scale (BNBAS; Brazelton, 1984). In comparison to drug-free babies, cocaine-exposed babies have poor state control, depressed interactive behavior (Chasnoff, Burns, & Burns, 1986; Chasnoff, Burns, Schnoll, & Burns, 1985; Chasnoff, Griffith, MacGregor, Dirkes, & Burns, 1989), abnormal reflexes, (Chasnoff et al., 1989; Coles, Platzman, Smith, James, & Falek, 1992), motor abnormalities (Chasnoff et al., 1989; Neuspiel, Aamel, Hochberg, Greene, & Campbell, 1991), and limited habituation skills (Eisen et al., 1991). However, most of these studies were done shortly after delivery when the infants may have been recovering from the effects of delivery. Although these behavioral patterns suggest that cocaine-exposed babies do exhibit developmental problems shortly after birth, there are only limited data available on the recovery process or the effects of cocaine on later development (Chasnoff, Griffith, Freier, & Murray, 1992; Coles et al., 1992; Neuspiel et al., 1991). Thus, there is a need for careful investigations of early development that extends beyond the immediate neonatal period.

PARENTING ENVIRONMENT

Though there is ample evidence that parenting sensitivity influences children's behavior and development (Dix, 1991; Maccoby & Martin, 1983), minimal attention has been directed toward the early parenting behavior of drug-using women. If a child with a history of prenatal drug exposure exhibits behavioral or

developmental problems, those aberrations are usually attributed to the drug exposure, with little, if any, consideration given to the caregiving environment (Singer et al., 1991).

Parenting behavior is influenced by infant, maternal, and environmental factors (Dix, 1991). Caring for a temperamentally challenging infant can be extremely difficult and minimally rewarding. Furthermore, there is evidence that drug-using women experience elevated levels of violence and stress in relation to drug-free women (Regan, Ehrlich, & Finnegan, 1987), and may have difficulty coping with available resources.

Infants who are raised by highly stressed mothers are at substantial risk for subsequent developmental and emotional problems (Downey & Coyne, 1990). Although support is often presented as an effective buffer against stress (S. Cohen & Wills, 1985), there is no information available on the ability of drugusing mothers to use support effectively. In addition, drug-using women may be involved in a network that supports a life-style of drug acquisition and affords little time or motivation for either personal or infant care. Without information on the early parenting environment available to infants born to drug-using women, conclusions cannot be drawn about the relationship between prenatal drug exposure and developmental outcome.

This project was designed to assess the impact of prenatal exposure to drugs on early infant development and to examine early parenting among drug-using women. We hypothesized that cocaine-exposed infants demonstrate less optimal neurodevelopmental performance than drug-free infants throughout the first 6 weeks of life. We also hypothesized a relationship between parenting behavior and early neurodevelopmental patterns, such that nurturant, child-centered parents have infants with better neurodevelopmental performance. The final hypothesis was that drug-using women display less warmth, provide a less child-centered environment, and are less able to use resources than drug-free women.

METHODS

Subjects

Participants were 20 drug-exposed and 20 comparison infants and their mothers recruited at birth from a large inner-city hospital. Infants were eligible if they were born beyond 36 weeks gestation, had a birth weight appropriate for gestational age, had no identified medical problems beyond those associated with prenatal drug exposure (no congenital abnormalities or handicapping conditions) and were scheduled to be discharged in the care of their mother. To control for possible age and social class differences, mothers had to be at least 18 years of age and only families who received Medical Assistance or had no health insurance were recruited.

Drug use was determined by chart review, maternal report, and a urine toxicology screen. Infants in the drug group had evidence of prenatal drug exposure based on at least one of these criteria, whereas infants in the comparison group met none of the criteria. All women in the drug group had evidence of cocaine use, 45% had used heroin, and 35% had used marijuana. In addition, many had exposure to other substances, including higher rates of cigarette and alcohol use than women in the comparison group (p < .001 and p < .05, respectively).

Early growth was measured by birth weight, birth length, and ponderal index. Although birth weight for gestational age is often used as the primary assessment of fetal growth, weight and length are confounded (Keller & Fillmore, 1978). Thus, relying on birth weight without consideration of birth length is not adequate to assess atypical patterns of fetal growth. Since prenatally exposed infants may be at risk for growth deficits and since atypical patterns of fetal growth have been associated with less optimal scores on assessments of infant neurodevelopment (Lester, Garcia-Coll, Valarcel, Hoffman, & Brazelton, 1986), we included measures of birth length and ponderal index. The ponderal index provides information on leanness or obesity. The formula we used (birth weight in grams/length in cubic centimeters × 100) does not appear to be affected by race, gender, or gestational age among full-term infants (Miller & Merritt, 1979).

Procedure

Eligible women were approached during their hospitalization shortly after giving birth. There were 99 mothers and babies who met enrollment criteria and were invited to participate. However, 36 refused to sign the Consent Form approved by the University's Institutional Review Board, and 23 initially agreed to participate, but passively refused through noncompliance with appointments. Forty mothers signed the Consent Form and completed the procedures, which spanned 6 weeks. The three groups of mothers did not differ on maternal race, age, education, or marital status; or on infant birth weight, Apgar score, or gender.

The BNBAS was administered to each infant by a nurse or psychologist who had been certified and tested for reliability in administration of the BNBAS within 1 year of data collection. The examiners were unaware of the infant's drug status. In the hospital the infants were evaluated on the 2nd or 3rd day of life. BNBAS evaluations were repeated in the home at 2, 4, and 6 weeks after birth. Although the BNBAS is not standardized beyond 30 days, it was extended to 6 weeks to assess the developmental recovery of drug-exposed infants. Standard administration procedures were used with the mother present.

Two evaluators were present at the 2-week home visit—one to administer the BNBAS and the other to conduct the interview and run the video camera. Following administration of the BNBAS, an interview was conducted with the mother, and a videotape was made of the mother playing with her baby.

At the 4-week home visit, the BNBAS was repeated and mothers were given a copy of their videotape. At the 6-week home visit, the final BNBAS was administered and mothers were compensated for completing the project. Since the families resided in high-crime neighborhoods, a nonuniformed, armed escort from a protection service accompanied the evaluator on each visit.

Measures

The BNBAS was scored using the cluster scores developed by Lester, Als, and Brazelton (1982) (orientation, motor behavior, range of state, regulation of state, autonomic stability, and abnormal reflexes). The habituation cluster was not scored since the items were often missing. The items from the BNBAS were also scored using the excitability and depression clusters developed by Lester (1990) for drug-exposed infants.

Parent nurturance was measured by rating the videotaped interaction of mothers and infants during play. A modified version of the Parent Child Early Relational Assessment (PCERA; Clark, 1985; Farran, Clark, & Ray, 1990) was used to rate the videotapes. This scale was chosen because it focuses on the affective quality of the parent—child relationship. The videotapes were scored by two raters who were blind to the status of the families. Raters were trained until they reached greater than 90% agreement across items on 10 observations. Reliability was maintained through weekly reliability checks.

Six items from the PCERA were selected to represent a Nurturance score: lack of depressed mood, enthusiastic mood, amount of verbalization, high quality verbalization, social initiative, and creativity/resourcefulness. The internal consistency of this score, as determined by Cronbach's alpha, was .91.

The child-centered quality of the environment was measured through the Home Observation for Measure of the Environment (HOME scales; Caldwell & Bradley, 1978). The HOME is an observation scale that has been widely used in child development research and has shown a strong relationship with subsequent intellectual and achievement performance (Bradley & Caldwell, 1984). It consists of 45 items that describe the quality of the home environment for the child.

Parenting stress was measured by the parent domain of the Parenting Stress Index (Abidin, 1990). This questionnaire consists of 54 items related to parenting and employs a 5-point Likert scale ranging from strongly disagree to strongly agree, with high scores representing elevated levels of stress. High rates of reliability and validity are reported from the normative sample.

Support was measured with two scales. The Family Support Scale is an 18-item scale that measures the intensity of perceived support received from both informal and formal sources within the social network (Dunst, Jenkins, & Trivette, 1984). Respondents use a 6-point scale (ranging from not available to extremely helpful) to rate the support they receive.

The Social Provisions Scale was used to supplement the Family Support Scale because it addresses the multiple provisions or functions of support, regardless of the size of the network (Russell & Cutrona, 1984). Respondents used a 4-point scale, ranging from strongly disagree to strongly agree, and are asked to rate the degree to which others depend on them as well as the amount of support they receive in each of 6 provisions. (Cutrona, 1984). In both scales high scores represent high levels of support.

RESULTS

Maternal and Infant Characteristics

Group comparisons between drug-using and comparison mother-infant pairs revealed that there were no significant differences in maternal age, race, or marital status; or in infant birth length, ponderal index, Apgar score, or gender. However, the mean birth weight was lower for drug exposed infants (p < .05) and drug-using women began prenatal care later in their pregnancy (p < .003) (see Table I). All infants were bottle-fed.

Table I.	Demographic Data on Mother-Infant Pairs
	Who Completed the Study

	Drug	Comparison	F
Maternal characteristics			-
M age (years)	27.2 (6.4)	24.5 (5.0)	2.20
M education (years)	11.2 (1.2)	11.6 (1.0)	1.27
M month prenatal care initiated	4.8 (1.8)	3.0 (1.8)	10.164
M no. of children	2.6 (1.3)	2.0 (1.1)	2.33
% single (not cohabiting)	95%	90%	
% African American	85%	90%	
Infant characteristics			
M birth weight (grams)	2936 (357)	3238 (514)	4.67
M birth length (cm)	49.2 (2.25)	50.1 (2.73)	1.34
M ponderal index	2.47 (0.28)	2.56 (0.26)	1.22
M Apgar (1 minute)	7.7 (1.4)	7.7 (1.1)	0.01
M Apgar (5 minutes)	9.0 (0.3)	8.8 (0.5)	2.11
% male	55%	60%	

 $^{^{4}}$ n = 20 for each group. Numbers in parentheses are standard deviations.

 $^{^{}b}p < .05.$

 $[\]dot{p} < .01$.

Standard BNBAS Cluster Scores

The behavior cluster scores from the BNBAS administered within the first 3 days of life, and at 2, 4, and 6 weeks are presented in Table II. The changes in BNBAS scores between drug-exposed and comparative infants over the first 6 weeks of life were analyzed by two repeated measures multivariate analyses of covariance (RMANCOVA). These analyses account for preceding scores when analyzing later scores and enable us to examine differences in recovery patterns as the babies' developmental skills change over the first 6 weeks of life. In the first RMANCOVA, the independent variables were the infant's drug status and the interval between administrations of the BNBAS (birth, and 2, 4, and 6 weeks). The cluster scores from the BNBAS were the dependent variables. Birth weight was used as a covariate since it differed between groups.

The results from the RMANCOVA using Wilks's criterion show that there were significant main effects of Group (F = 3.11, p < .02) and Time (F = 7.60, p < .001), and a significant Group X Time interaction (F = 1.87, p < .02). These results indicate that the drug-exposed and drug-free babies obtained different scores, that the scores changed significantly over time, and that the pattern of the changing scores differed by the drug status of the baby.

To determine the location of significant findings from the RMANCOVA, univariate analyses of covariance (ANCOVA) were performed to assess group differences on cluster scores during each administration of the BNBAS. Again, birth weight served as a covariate since it differed between groups. The results from the ANCOVAs indicate that at the first administration of the BNBAS the drug-exposed babies demonstrated less favorable scores than the comparison babies in three of the six scales (see Table II). By 2 weeks of age, the drug-exposed babies continued to exhibit marginally more abnormal reflexes (p = .07) and more difficulties in autonomic stability, while there were no differences in the other clusters. At 4 weeks no differences could be detected, but at 6 weeks the drug-exposed babies again displayed more difficulties in autonomic regulation than the comparison babies.

Depression and Excitability Cluster Scores

A second RMANCOVA examined differences in BNBAS performance using drug status and time between administration of the BNBAS as independent variables and the excitability and depression clusters proposed by Lester (1990) as dependent variables (see Table II). Based on Wilks's criterion, there was no significant main effect of Group, but there was a significant main effect of Time (F = 5.67, p < .001), and a significant Group X Time interaction (F = 4.35, p < .001). These results indicate that although all scores changed significantly over time, the pattern of those changes differed by the drug status of the baby.

Table II. Mean BNBAS Cluster, Excitability, and Depression Scores Over the First 6 Weeks*

	Drug		Comparison		
Behavior cluster	M	SD	M	SD	F*
Orientation				·	
Birth	4.28	2.16	6.22	2.00	6.50⁴
2 weeks	6.32	1.98	6.99	1.82	0.31
4 weeks	7.29	1.05	6.74	2.36	0.28
6 weeks	7.57	1.02	7.77	0.95	0.17
Motor performance					
Birth	4.83	0.72	5.37	0.66	3.08¢
2 weeks	5.75	0.60	5.62	0.62	0.91
4 weeks	5.90	0.29	6.13	0.55	2.10
6 weeks	6.16	0.44	6.33	0.54	0.55
Range of state					
Birth	3.77	0.66	4.10	0.77	1.40
2 weeks	3.85	0.62	3.79	0.85	0.34
4 weeks	4.14	0.52	4.10	0.67	0.01
6 weeks	4.01	0.95	4.17	0.71	0.12
State regulation					
Birth	4.96	1.42	5.88	1.00	4.50
2 weeks	5.28	0.92	5.06	1.41	0.03
4 weeks	4.45	1.29	4.39	1.11	0.17
6 weeks	4.18	1.18	4.30	0.80	0.02
Autonomic regulation					
Birth	5.90	0.90	، 6.70	0.91	4.00
2 weeks	6.47	0.83	7.32	0.88	9.28*
4 weeks	6.77	0.89	7.18	0.76	0.96
6 weeks	6.77	0.90	7.43	0.77	5.04
Abnormal reflexes					
Birth	2.15	1.53	1.15	1.09	3.79€
2 weeks	1.95	1.51	1.20	1.24	3.514
4 weeks	1.83	1.22	1.64	1.21	0.59
6 weeks	2.47	1.84	2.55	1.85	0.03
Excitability			•		
Birth	1.30	1.42	1.00	1.38	0.17
2 weeks	1.15	0.93	0.85	1.23	0.67
4 weeks	1.00	1.26	0.55	0.94	1.32
6 weeks	1.00	1.17	0.45	0.83	1.84
Depression					
Birth	3.65	2.68	1.30	1.56	8.51*
2 weeks	0.90	1.41	1.35	1.56	2.08
4 weeks	0.65	0.81	1.50	1.85	1.23
6 weeks	0.90	1.00	0.95	0.76	0.43

an = 20 for each group.
 Univariate ANCOVAs to compare scores of drug-exposed and comparison infants at each time period.

p < .10. p < .05. p < .01.

11carouc veropinemat Status				
Neurodevelopmental	Parent behavior			
status	Nurturance	Home		
Orientation	.28	.49*		
Motor performance	.48*	.59*		
Range of state	.08	.18		
State regulation	.16	.35•		
Autonomic regulation	.19	.22		
Abnormal reflexes	11	05		

-.26

-.16

-.34

-.37

Table III. Correlation Coefficients Between Parent Behavior and Infant Neurodevelopmental Status

Excitability

ANCOVAs were used to probe for group differences at each time period. The depression and excitability cluster showed a pattern of resolution similar to the standard cluster scores (see Table II). During the initial administration of the BNBAS the drug-exposed babies had higher depression scores than the comparison babies (p < .01). The excitability scores did not differ at the initial administration. By the 2nd week of life there were no differences between either excitability or depression scores and this pattern held through the first 6 weeks of life.

Parenting Environment

To test if there was a relationship between parenting behavior and neuro-development, a correlation analysis was run. Parenting behaviors were represented by nurturance during play and by the quality of the child-centered environment, as measured by the HOME scale. Neurodevelopmental status was represented by averaging the four scores for each of the categories of the BNBAS. This procedure has been recommended to achieve stability and to reduce individual error variance (Kaye, 1978).

The correlation matrix between parent behavior and infant neurodevelopmental showed positive relationships between parental nurturance during play and infant motor performance, and between scores on the HOME scale and three of six scores from the BNBAS (see Table III). Infant excitability and depression were not related to parental nurturance, but they were inversely related to the HOME scale. This pattern indicates that infants with lower levels of excitability and depression lived in more child-centered environments.

The parenting environment for the drug-exposed and comparison infants was examined using univariate analyses of variance with group status as the

Depression p < .05.

p < .01.

independent variable and scores on the nurturing, child-centered environment, parenting stress, and support variables as outcome variables. There were no significant group differences in nurturance, child-centered stimulation, or parenting stress. Furthermore, the indices of parenting stress did not differ from the normative data reported by Abidin (1990) (t = 1.43, p > .10). Although there were no significant differences in the Family Support Scale, there were differences in the Social Provisions Scale, with the women in the drug group reporting higher levels of support than the women in the comparison group (p = .03).

A hierarchial multiple regression analysis was run to assess the relationship between stress and support and to determine if the relationship differed by group. The group variable (drug-use vs. drug-free) was entered first, followed by the two support variables, and finally the two support by group interaction terms. There was no main effect of group (Table IV). Family support was a significant determinant of parenting stress, accounting for 11% of the variance. Social provisions contributed 7% of the variance of parenting stress, but did not reach significance. The two support scales worked in opposite directions. High scores on the Family Support Scale were associated with low levels of parenting stress, but high scores on the Social Provisions Scale were associated with high levels of parenting stress. The interaction between group membership and the Family Support Scale was significant, indicating that the effect of family support on parenting stress differed by group, but the interaction between group and the Social Provisions Scale did not reach significance.

Within-group correlations between family support and parenting stress help clarify the nature of the interaction (J. Cohen & Cohen, 1983). Both correlations reached significance but differed in their strength. Among the mothers in the drug group, there was a weak negative association between family support and parenting stress (r = -.32, p = .05) with low levels of support associated with high levels of parenting stress. Among mothers in the comparison group, the negative association between the two variables was stronger (r = -.55, p = .007).

Step	Variable	Beta at entry	Multiple R ²	F change
1	Group	0.02	.00	.01
2	Family support	-0.34	.11	4.50c
3	Social provisions	0.29	.18	3.12*
4	Group X Family support	-1.11	.26	4.10 ^c
5	Group X Social provisions	0.51	27	.08

Table IV. Hierarchial Multiple Regression to Predict Parenting Stress*

^{*}Total multiple $R^2 = .27$, F(5, 34) = 2.48, p = .05.

p < .10.

p < .05.

DISCUSSION

This study examines the developmental recovery and the early parenting environment for cocaine-exposed infants and illustrates the importance of including both constructs in the study of early developmental outcome.

Developmental Recovery

The drug-exposed infants in this sample demonstrated developmental vulnerability shortly after birth, a finding that has been reported by others (Chasnoff et al., 1985, 1986, 1989; Coles et al., 1992; Neuspiel et al., 1991). However, behavioral resolution began almost immediately after birth. At 4 weeks of age no significant differences between drug-exposed infants and comparison infants could be detected, but at 6 weeks the drug-exposed infants demonstrated more autonomic instability. These findings are generally consistent with those reported by Coles et al. (1992), who found differences in autonomic stability at 4 weeks of age among cocaine-exposed babies. Moreover, they illustrate the importance of examining behavior over the first 6 weeks, rather than relying on results obtained shortly after birth.

A pattern of developmental recovery also emerged when the data were scored using the excitability and depression clusters. Although the drug-exposed infants had higher depression scores at birth and were more difficult to arouse than were the comparison babies, by 2 weeks of age there were no group differences. These findings suggest that in this sample the effects of prenatal exposure to drugs were largely transient, at least as measured by the BNBAS.

In addition to cocaine, many of the infants in this sample were exposed to heroin, alcohol, and cigarettes—substances known to affect fetal outcome. Unfortunately, the sample was too small to attempt to disentangle the effects of different substances on early infant behavior. Yet, even this polydrug exposure did not produce dramatically different behavior beyond the newborn period.

Parenting Environment

The infants in this project went home from the hospital to families that were headed by single women in their 20s who had limited education, few economic resources, and several other children. Despite these apparent stressors, the women reported levels of parenting stress that did not differ from normative samples. Furthermore, there were no differences in stress as a function of the women's drug status. However, the women's ability to access resources and to use support to buffer parenting stress differed by group.

Resource Utilization. Women in the drug-using group may have more difficultly accessing formal resources than women in the comparison group, as evidenced by their delay in seeking prenatal care and the low rate of involvement in drug treatment programs (2 of 20 drug-using women). The elevated Social Provision scores among women in the drug-using group suggest that they view themselves as part of a reciprocal network in which they are both recipients and providers of support. However, the demands of a reciprocal network may be counterproductive, particularly when women are faced with the challenges of pregnancy and a newborn. Women may develop a false sense of security within the network that obviates their perceived need for formal resources. Although the delay in registering for prenatal care may reflect denial, inattention to personal care, or a fear of reprisal for illegal behavior, it may also reflect a distrust or hesitancy to rely on formal resources.

Support and Stress. A major finding of this study was the differential relationship between social support and parenting stress. Both groups of mothers used social support to offset parenting stress, but the relationship was more robust among mothers in the comparison group. There are at least three possible explanations for the diminished buffering effect of support against parenting stress in the drug group. First, the support may not have been directed toward parenting and thus could not offset stress. If the support were directed to nonparent roles or to the drug-using life-style, the mothers may have felt stress, rather than support, from the expectations of others in their "supportive" network. A second possibility is that although the women received support, they may not have been able to use it effectively. Women who use drugs may be less able to employ coping strategies that do not have immediate effects. A third alternative is that factors that contributed to parenting stress could not be altered by support. For example, the violence that exists within drug-using cultures (Regan et al., 1987) may contribute to stress, but may not be alleviated by social support. Regardless of the explanation, the findings illustrate group differences in the mechanisms mothers use to offset stress.

Parent-Infant Interaction. During the videotaped interactions, both groups of mothers directed very few verbalizations to their infants. At times the mothers appeared uncomfortable holding their babies, as though they were unsure how to play with them. Though the group differences did not reach significance (.13 > p > .10), there was a slight trend for mothers in the comparison group to provide a more child-oriented home environment and to be more nurturant than mothers in the drug group. Children who are raised by parents who lack warmth or who are minimally responsive are at increased risk for poor developmental outcome (Dix, 1991; Maccoby & Martin, 1983). In the present study, regardless of prenatal drug exposure, those children who were most vulnerable, as indicated by their low BNBAS scores, were least likely to be living in a child-centered environment. Although direction of effect cannot be determined in a cross-sectional study, the combination of developmentally challenged infants and a minimally responsive home environment gives rise to a vulnerable developmental prognosis. Studies of

early child development that do not consider the parenting environment may be missing a critical determinant.

Methodological Considerations

There are numerous methodological biases that can undermine empirical investigations in early child development (Drotar, 1991), particularly when attempts are made to relate prenatal substance exposure to neonatal outcome (Chasnoff, 1991).

The selection criteria used to enroll infants is a potential source of bias in investigations of prenatal drug exposure. By limiting our sample to full-term infants with no medical problems and a birth weight appropriate for gestational age, we excluded those infants with the highest likelihood of demonstrating developmental abnormalities. If preterm or ill infants are included, it is difficult to separate the drug effects from the effects of prematurity. We attempted to reduce the possibility of a selection bias by recruiting both drug-using and drug-free mothers from the same site, and controlling for neonatal and socioeconomic variables.

Compliance presents another source of bias. Researchers rarely report data on compliance, yet in our study there was a 40% completion rate. Although there were no differences in maternal or infant demographic factors between those who completed the study and those who refused or withdrew, the groups may have differed in their exposure to drugs. Since we did not have access to comprehensive data on drug use at recruitment, we could not compare patterns of drug use for those who refused to participate or were noncompliant. It is likely that active drug users may have been resistant to home visits.

Another concern is the dependent variable. Although the BNBAS is an enduring, well-recognized assessment of infant behavior that can only be administered by a certified examiner, it may lack the sensitivity to detect subtle differences in infants resulting from prenatal drug exposure. Researchers have begun to recommend alternative scoring procedures for the BNBAS, such as the excitability and depression clusters (Lester, 1990); multiple administrations of the BNBAS (Kaye, 1978); alternative scales, such as the stress index used by Eisen et al. (1991); and systematic clinical observations. We attempted to counteract the potential limitations of the BNBAS by administering it four times and examining the infants' developmental recovery over time rather than relying on a single administration. However, developmental differences associated with prenatal drug exposure may be more apparent during later years when development is more differentiated.

A final source of bias is the problem of exposure to multiple substances. As our data have shown, women who use cocaine often use other substances known to adversely affect their infant's growth and development. Large samples, careful

definitional criteria, and multivariate analysis are necessary to assess the potentially confounding effects of exposure to multiple substances (Coles et al., 1992).

Conclusions

The developmental findings in this sample confirm previous findings documenting an association between prenatal drug exposure and neurodevelopmental vulnerability, at least within the first few days after birth. However, the effects appeared to be relatively transient and resolution was well underway within the first few weeks of life. Nevertheless, drug-exposed infants continued to show subtle signs of vulnerability and at 6 weeks they were less able to regulate their autonomic functioning than nonexposed infants and therefore may have been more temperamentally challenging to their caregivers. These findings are encouraging, given the severe negative developmental outcome often attributed to drug-exposed infants (Singer et al., 1991). As longer term follow-up data begin to be available, the developmental risk associated with prenatal drug exposure may be clarified (Chasnoff et al., 1992).

Findings from the early parenting environment demonstrate that the relationship between support and perceptions of parenting stress differ for drug-using and comparison mothers. Mothers of newborns exposed to drugs prenatally may require additional assistance during the neonatal period. Not only are they confronted with an infant who may be temperamentally challenging, but they may have limited coping skills and a support network that is more aligned with the life-style of drug acquisition and drug use than with the life-style of parenting.

Since we have documented that infants of drug-using mothers are exposed to different parenting environments than infants of drug-free mothers, a critical next step is an examination of the link between parenting environment and developmental recovery. Effective intervention programs for drug-using women and their infants depend on our ability to understand optimal parenting practices within the drug culture.

As the epidemic of drug use continues, attention must be directed toward prevention and toward the caregiving environment available to drug-exposed children. Although there is evidence that drug-exposed babies demonstrate early neurodevelopmental recovery, there is a need for longitudinal research on the relationship between prenatal substance exposure and developmental outcome that considers the caregiving environment (including the mechanisms mothers use to offset stress), avoids the known biases, and adheres to rigorous methodological designs.

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