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# Prenatal Cocaine Exposure and Child Behavior

Virginia Delaney-Black, MD\*; Chandice Covington, RN, PhD‡; Thomas Templin, PhD‡; Joel Ager, PhD‡; Susan Martier, PhD§; and Robert Sokol, MD§

**ABSTRACT.** *Objective.* The aim of this study was to evaluate previous teacher reports that children exposed to cocaine prenatally have more problem behaviors.

*Methods.* A historical, prospective design was used. Maternal subjects ( $n = 116$ ) of 6-year-old singleton, term ( $\geq 36$  weeks) children, and the children's first-grade teachers ( $n = 102$ ) agreed to participate. The child's first-grade teacher, blinded to study design and exposure status, rated the child's behavior with the Conners' Teacher Rating Scales (CTRS) and an investigator-developed scale, the Problem Behavior Scale (PROBS 14), measuring behaviors reported by educators to be specific to cocaine exposure. Mothers were interviewed by telephone regarding demographic and socioeconomic factors.

*Results.* Although the cocaine-exposed group had higher (more problem behaviors) for each of the CTRS subscales, the overall multivariate analysis of variance for the CTRS was not significant. Children exposed to cocaine prenatally had higher scores (more problem behaviors) for 11 of the 14 PROBS items and the overall multivariate analysis of variance relating prenatal cocaine exposure to the PROBS was significant (Wilkes'  $\lambda = .775$ ), even after controlling for gender and prenatal exposure to alcohol and cigarettes.

*Conclusions.* This pilot study supports that teachers blinded to exposure status of early elementary students did rate the cocaine-exposed group as demonstrating significantly more problem behaviors than control children. Although an important first step, postnatal factors that also may influence behavior were not evaluated; hence, causation is not addressed. *Pediatrics* 1998;102:945-950; cocaine, behavior, prenatal exposures, teacher assessment, children.

a significant influence on neonatal outcome including behavior. However, few controlled studies have been reported for the period past infancy. Some authors have suggested that the cocaine-exposed infant begins to recover over the first month of life,<sup>9</sup> whereas other persistent differences have been described in reflexes,<sup>10</sup> muscle tone,<sup>11</sup> affect,<sup>12</sup> reactivity,<sup>13</sup> visual memory,<sup>14</sup> and symbolic play behavior.<sup>15</sup> Although global differences in IQ have not been identified, previous work has suggested alterations in subscales of the Stanford Binet IQ test.<sup>16-18</sup> In contrast, Richardson and colleagues report no differences in growth, IQ, or achievement at age 6 among 28 children whose mothers inhaled cocaine during pregnancy.<sup>19</sup> These data are in sharp contrast to the early reports from the educational literature suggesting significant behavioral problems.<sup>20</sup> In a previous publication, we report the behavioral problems that experienced elementary school teachers attributed to prenatal cocaine exposure among their students.<sup>21</sup> Using a consensus approach, an instrument, the PROBS, was developed to assess these problem behaviors. The purpose of this pilot study was first, to evaluate a standardized measure of child behavior and PROBS scores among elementary school children exposed prenatally to cocaine and a control group from a similar socioeconomic background. Second, this preliminary study evaluates previous teacher reports linking prenatal cocaine exposure with an increase in child behavior problems.

## METHODS

### Study Design

This research used a historical, prospective design with maternal-newborn data collected in 1986-1987 to evaluate the relationship between prenatal cocaine exposure and the behavior of 6- to 7-year-old children. African-American women attending a large, urban university maternity center were interviewed at their first prenatal visit and enrolled in a prospective study sponsored by the Fetal Alcohol Research Center (FARC) and approved by the institutional review board.<sup>22</sup> Repeated assessments of maternal prepregnancy and pregnancy exposure to cocaine, alcohol, tobacco, and other drugs were solicited throughout pregnancy. Six years later, this prospective study of early school behavior of the offspring was approved by the institutional review board and parental informed consent was obtained.

### Sample

Liveborn children born from December 2, 1986 through December 1, 1987, to women who participated in the prospective FARC study were considered eligible for this study. This study period was selected based on the urban school cutoff for entry to first grade. Children were excluded from additional study if there were congenital malformations (multiple malformations or chromosomal defects), multiple gestation, or postnatal death. An attempt

ABBREVIATIONS. FARC, Fetal Alcohol Research Center; CTRS, Conners' Teacher Rating Scale.

A substantial body of evidence associates prenatal cocaine exposure with a reduction in birth weight,<sup>1,2</sup> gestational age,<sup>2,3</sup> and birth head circumference.<sup>3,4</sup> Recent publication of a dose-response relationships between prenatal cocaine exposure and neonatal weight,<sup>5</sup> head circumference,<sup>6</sup> and neurobehavioral outcome<sup>7,8</sup> lend additional support to the growing body of evidence that, even after controlling for other substances of abuse, cocaine has

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was made to contact all primary caregivers of children meeting the study criteria for study inclusion ( $N = 270$ ).

## Procedure

Maternal and infant records were reviewed for contact numbers and addresses. The computerized patient logs at both of our maternity and children's hospitals also were searched for the most recent address and telephone number. Families were contacted by telephone or, in the absence of a working contact telephone number, by letter sent to the last known address requesting that they call one of the project personnel. Letters that were not returned were considered a valid address, and a home visit was made by study personnel to explain the project and request consent. A 20- to 30-minute structured interview was conducted with the parent or guardian by telephone or in person. This interview included the family's current address and telephone number, the child's current school and teacher, the number of siblings, the number of children in the home, whether the index child had always lived with the parent, the number of cigarettes smoked in the home per day, and any current health problems or medications taken by the child. Parents and/or guardians were asked to return a signed consent that included permission for the child's teacher to be contacted. Home visits were made by study personnel or a visiting nurse to obtain consent for families who verbally agreed to participate but who did not return a consent. For their time and assistance, each participating family was sent an age-appropriate toy appropriate for the child.

Data from the child's teacher was solicited by mail. A copy of the parent or guardian's consent was included with a letter indicating that the child was participating in a study. A stamped, self-addressed envelope was enclosed for the forms to be returned. The teacher was asked to complete the Conners' Teacher Rating Scale (CTRS) and PROBS. Finally, the teacher was asked to provide information about possible medical problems or medications that the child received routinely. A small stipend was paid to each teacher for his/her participation. A follow-up letter was sent 2 to 3 months later to those teachers who did not return materials. If materials still were not returned, teachers were contacted by telephone and an appointment was made for one of the investigators to meet with him/her at the child's school to retrieve the completed instruments.

## Measures

The CTRS, used to rate child behaviors, consists of 39 items with four possible scores for each item<sup>23</sup> and an investigator-developed visual analog scale, the PROBS, with possible scores of 0 to 10 for each of 14 items.<sup>21</sup> The individual CTRS items are statements of behavior that are rated on a 4-point Likert scale, which permits the teacher to report his/her students' behavior as "not at all like" to "very much like" the descriptive statement. The items define seven subscales. The CTRS has been used extensively in the literature as a short (15-minute) screening tool for most of the behavioral problems encountered commonly in the school setting. Literally thousands of children have been evaluated with the CTRS in the 25 years since its publication.

The PROBS consists of 14 behaviors that teachers identified to be associated with prenatal cocaine exposure. The form is a visual analog scale with a range from 0 to 10. Visual anchors ("not at all like," "just a little like," "pretty much like," and "very much like") were used to delineate values of 0 to 2.5, 2.5 to 5.0, 5.0 to 7.5, and 7.5 to 10.0. The PROBS focuses on the behavior problems reported by veteran teachers and includes among its 14 items appropriateness of social skills, internalization of a personal code, ability to handle transitions, and inconsistency in retention of academic skills. The internal consistency of the items ranged from 0.35 to 0.86 with a Cronbach's  $\alpha$  of 0.96.<sup>21</sup>

## Statistical Analyses

The statistical package SPSS PC was used for all analyses. Based on previous reports, a directional relationship was posited between the independent and dependent measures; thus, one-tailed analyses were performed to avoid the type II error by failing to detect true cocaine effects. A power analysis with the type I error rate of .05 and one-tailed test of significance indicated that a sample size of 100 would detect an incremental cocaine effect accounting for  $\geq 8\%$  of the variance in a continuous outcome measure with power = .80, which is Cohen's requirement for a medium-sized effect.<sup>24</sup> Quantitative estimates of prenatal alcohol exposure and the dependent behavioral measures were examined with correlational analyses. A cluster-analysis-based exposure variable was derived by agglomerative hierarchical cluster analysis of the nine highly correlated measures of alcohol exposure to provide one index of prenatal alcohol exposure. Analysis of covariance was used to determine the relative contributions of the covariates of gender and prenatal alcohol on the relationship between the independent variable, cocaine exposure, on the CTRS and PROBS.

## RESULTS

The study criteria were met by 270 children. Despite efforts to locate families, only 140 of the original sample (52%) were contacted successfully. No significant differences existed in 21 maternal and pregnancy characteristics (including prenatal substance exposure) or newborn parameters (including birth weight, length, head circumference, gestational age, Apgar scores, and intrauterine growth) between those children located and those lost to follow-up. Of the 140 children located, signed consents were obtained for 116 (83%). No significant differences existed in maternal, pregnancy, or neonatal characteristics (including prenatal substance abuse) between those for whom consent was obtained and those not studied (Table 1). Teacher data was obtained for 102 of the 116 children (88%). Teacher data was obtained more frequently for boys (94%) than for girls (80%)

TABLE 1. Pregnancy Data by Exposure Status\*

	Exposed $\pm$ SD $n = 27$	Nonexposed $\pm$ SD $n = 75$	Significance
Mother's age	24.1 $\pm$ 6.4	24.5 $\pm$ 6.4	NS
Mother's hematocrit	34 $\pm$ 3.1	33.5 $\pm$ 3.7	NS
Gravidity	3.3 $\pm$ 1.8	3.5 $\pm$ 2.3	NS
Parity	1.0 $\pm$ 1.1	1.3 $\pm$ 1.1	NS
Spontaneous abortion	.02 $\pm$ .4	.03 $\pm$ .7	NS
Voluntary interruption	1.1 $\pm$ 1.3	0.8 $\pm$ 1.1	NS
Prepregnancy weight	135 $\pm$ 31	140 $\pm$ 38	NS
Prepregnancy cigarette use	11.6 $\pm$ 11.2	6.4 $\pm$ 10.0	.026
Cigarette use during pregnancy	10.4 $\pm$ 10.9	6.2 $\pm$ 9.9	.071
Mother's education	11.5 $\pm$ 2.0	11.5 $\pm$ 1.5	NS
Father's education	11.9 $\pm$ .09	11.9 $\pm$ 1.3	NS
Ever married (%)†	7 (26%)	23 (31%)	NS

\* Pregnancy data for the 27 mothers with known cocaine-exposure (exposed) were compared with the 75 women without cocaine-exposure (nonexposed).  $P$  values are two-tailed.

†  $\chi^2$ .

( $P = .02$ ), and for the cocaine-exposed (100%) than for the control group (81%) ( $P = .027$ ). Additional analyses were performed only on the 102 children for whom teacher data were available.

The study sample consisted of 27 children born to mothers who used cocaine during the pregnancy (exposed) and 75 children born to women who abstained (nonexposed). Only 26% of exposed mothers and 31% of nonexposed mothers reported having ever been married. Exposed mothers reported using more cigarettes before this pregnancy ( $P = .026$ ) but not during the pregnancy. In evaluating zero-order correlations for the sample of 102 children, maternal cigarette smoking (before pregnancy) was significantly negatively related to the infant's birth weight ( $r = -.36$ ;  $P < .001$ ), head circumference ( $r = -.24$ ;  $P < .01$ ), gestational age ( $r = -.41$ ;  $P < .001$ ), and intrauterine growth retardation ( $r = -.32$ ;  $P < .001$ ). Periconceptional alcohol intake had a negative relation to birth weight ( $r = -.21$ ;  $P < .05$ ), birth length ( $r = -.19$ ;  $P = .05$ ) but not head circumference or gestational age. Exposed mothers did not differ from nonexposed mothers in age, gravidity, parity, prepregnancy weight, hematocrit, or education (Table 1). No study mothers reported using either heroin or methadone. Marijuana use was reported in 8 of 27 (30%) of exposed and no nonexposed pregnancies ( $P = .0005$ ). No differences were detected in the alcohol cluster variable (composite variable derived from nine measures of prenatal alcohol exposure) or in any of the nine individual alcohol measures between exposed and nonexposed mothers.

Comparison of the birth weight, length, head circumference, gestational age by dates, and Apgar scores between exposed and nonexposed children revealed no significant differences (Table 2). Furthermore, the infant's gestational age measured by the best obstetric estimate was unrelated to any of the dependent measures of child behavior. More boys were in the exposed group (74% vs 56%), but this difference did not reach statistical significance.

Children were evaluated during the 5th to the 9th month of the school year. Mean age at assessment was 80 months (range, 72 to 90) and did not differ by exposure group. Most children (87% in both groups) were first-grade students, whereas the remainder, although old enough to enter first grade, were in kindergarten. No correlation between age at fol-

low-up and any of the dependent measures of child behavior existed. Raw scores for both the Conners and the PROBS were highly correlated with gender. As expected, teachers reported that boys had more problems on all 14 PROBS items. To account for the expected higher scores for boys in the multivariate analyses, all PROBS measures were also adjusted for gender by including gender as a covariate.

Standardized mean scores for the CTRS subscales by dichotomous cocaine exposure are plotted in Fig 1. For each CTRS subscale, the cocaine-exposed group had higher scores indicating more teacher reports of problem behaviors. Only one subscale, day-dream-attention, was significant (one-tailed  $P = .038$ ). For the overall measure, Wilkes'  $\lambda$  was not significant. Compared with published norms for the CTRS,<sup>25</sup> five of the seven mean CTRS subscale scores were higher than average and one was at the upper limits, whereas mean values for control subjects exceeded the average for one of the seven subscales (hyperactivity index).

The gender-adjusted overall PROBS measure (Fig 2), had a Wilkes'  $\lambda$  of .775 and was significant at  $P = .027$  (one-tailed). For 11 of the 14 items, exposed children were reported to have more problem behaviors; however, none of the univariate tests were significant after controlling for gender.

To better evaluate the effect of potential confounders, the influence of periconceptional alcohol and cigarette exposure status was assessed. Neither prenatal alcohol nor cigarette exposure was significantly related to any of the CTRS subscales or PROBS items. Thus, the addition of these covariates to the prediction models for CTRS and PROBS did not have a significant influence on either overall model. Only prenatal cocaine exposure was significantly and positively related to problem behaviors measured by the PROBS.

## DISCUSSION

In this pilot study, we report that teachers blinded to prenatal cocaine-exposure status identified more problem behaviors among exposed children. The overall CTRS, used as an index for attention deficit hyperactivity disorder,<sup>23</sup> was not statistically significant, however, for each of seven subscales of the CTRS; the children with prenatal cocaine exposure had higher (ie, more problematic) behavioral scores.

**TABLE 2.** Neonatal Characteristics by Exposure Status

	Exposed <i>n</i> = 27	Nonexposed <i>n</i> = 75	Significance
Birth weight (g)	3088 ± 360	3205 ± 553	NS
Birth length (cm)	48.5 ± 2.1	48.2 ± 4.4	NS
Birth head circumference (cm)	34.1 ± 1.3	34.1 ± 1.7	NS
Gestational age (wk)	39.7 ± 1.9	39.6 ± 2.0	NS
GA Cat (SGA/total)*	1 (3.7%)	3 (4.0%)	NS
Apgar 1* 0-3	3	2	NS
* 4-6	3	4	
* 7-10	20	67	
Apgar 5* 0-3	1	0	.063 (NS)
* 4-6	1	0	
* 7-10	25	73	
Gender (male)*	20/27 (74%)	42/75 (56%)	NS

\*  $\chi^2$  or Fisher's exact test.



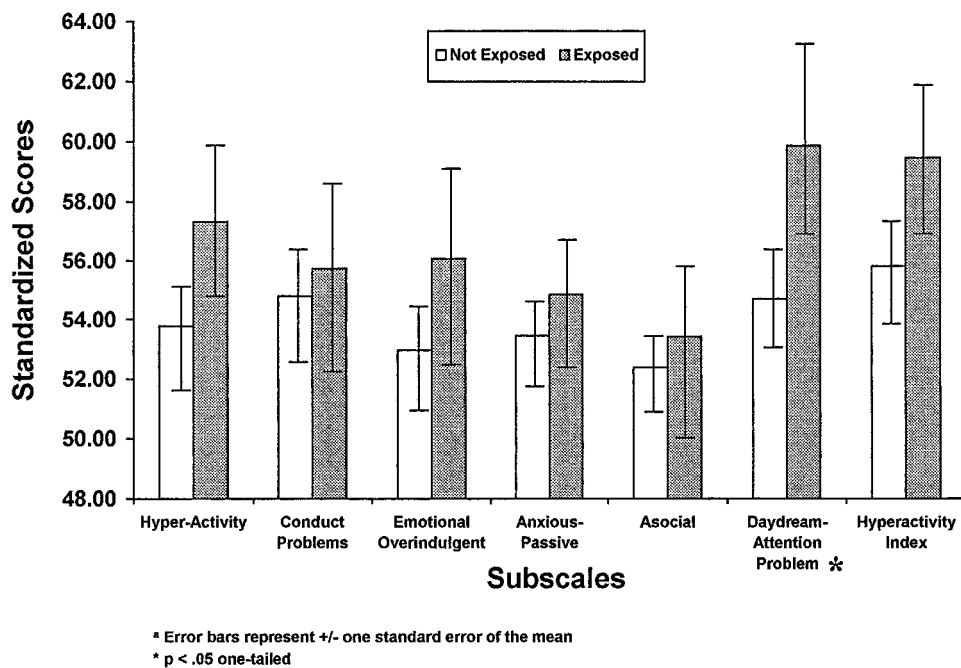


Fig 1. Standardized scores on CTRS by cocaine exposure group ( $N = 102$ ).<sup>a</sup>

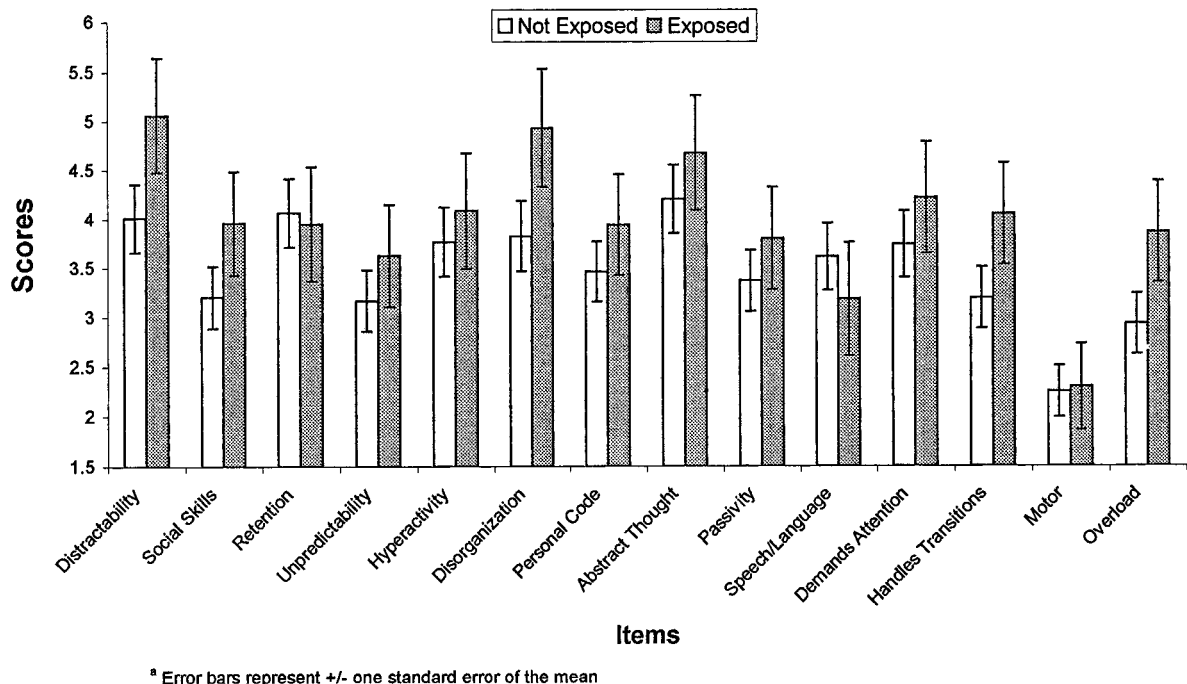


Fig 2. Mean PROBS item scores adjusted for sex by cocaine exposure group ( $N = 102$ ).<sup>a</sup>

The second measure, the PROBS, developed previously using a consensus approach in conjunction with elementary school teachers, focuses on the specific behaviors that educators attributed to prenatal cocaine exposure. In this current sample, children with known prenatal exposure to cocaine had more problematic behaviors on 11 of the 14 PROBS items. Considered as a set, the PROBS items were significantly related to exposure. Clearly, children exposed prenatally to cocaine were at risk for behavioral problems. A 6-year interval occurred between birth and follow-up of this cohort. Although no systematic

bias could be identified and although no perinatal differences were observed between those children who could be located and those lost to follow-up, it is possible that unexplained bias may have occurred inadvertently. Additionally, other postnatal factors associated with prenatal cocaine exposure, including continued drug exposure, were not measured and may be the etiologic factor. Despite these cautions, it is important to recognize that these results do substantiate previous teacher reports of problem behavior.

In this study, evaluation of school-age outcome of children exposed prenatally to cocaine was expe-

dited by the presence of a unique prospectively collected database established by the FARC.<sup>22</sup> Mothers receiving prenatal care at our urban university maternity center were interviewed at their first and recurrent obstetric appointments for alcohol, drug, and cigarette exposure. Repeated urine tests during pregnancy with research assistant interviews for drug use permitted accurate and repeated assessment of exposure. However, all studies of maternal exposure to alcohol are limited by the lack of a biologic marker. As well, studies of prenatal drug exposure that predate the availability of consistent infant meconium testing will underestimate drug exposure. The study reported here, although not likely to overestimate drug or alcohol exposure, may well underidentify affected children. Yet, this sample represents a pilot study of some of the oldest cocaine-exposed children within the FARC study. Use of statistical analyses of overall trends in behavior avoided the difficulties of multiple comparisons in a small dataset. On univariate analyses, however, the direction of all of the Conners' subscales and 11 of the 14 PROBS items identified more problem behaviors among the cocaine-exposed children. Caution must be used in interpreting these results. For example, because no control children were reportedly exposed to marijuana, it was not statistically possible to control for its influence on behavior. Furthermore, because of the small sample size and incomplete control, social risk factors and postnatal drug exposures may play a significant role in the behavior problems observed. Thus, causality cannot be identified. However this study does lend credence to what educators have reported: for whatever reason, the cocaine-exposed child is at risk for problem behaviors.

Although there is accumulated evidence to support a relationship between prenatal exposure to cocaine and early neonatal outcome, few substantive data have been available to evaluate the influence of cocaine exposure to later childhood outcomes. In two prospective blinded studies of children exposed to cocaine, the authors were unable to demonstrate a significant relationship between exposure status and either the Bayley Scales of Infant Development<sup>26</sup> or the overall measures of IQ.<sup>18,19</sup> Although no controlled, blinded study has identified a relationship between prenatal cocaine exposure and IQ, other differences have been identified. Bender and colleagues reported that children prenatally, but not postnatally, exposed to cocaine had lower scores on tests for visual-motor integration and receptive language.<sup>27</sup> Neuromotor development in late infancy also has been reported to be affected adversely among children exposed prenatally to cocaine.<sup>28</sup> Several authors have also described early behavioral abnormalities. Neonatal behavior, using the Brazelton Behavioral Scales, has been investigated by several groups<sup>29-31</sup> including two reports of a dose-response relationship between state regulation and prenatal cocaine exposure.<sup>7,8</sup> Furthermore, other authors have identified differences in learning,<sup>12</sup> emotional response to learning,<sup>12</sup> visual processing,<sup>32</sup> and communication and responsiveness.<sup>33</sup>

Studies also have demonstrated less symbolic play and more negative affect in toddler's exposed prenatally to cocaine.<sup>15</sup> Similarly, at age 2, Beckwith and associates were able to correctly identify 75% of the cocaine-exposed and 84% of controls on the basis of play assessments by observers blinded to the exposure status.<sup>34</sup> The primary caretaker of 3-year-old children exposed prenatally to cocaine also identified their children as more aggressive and having more destructive behaviors.<sup>18</sup>

Not all previous studies report behavioral differences. Among children born to women with light to moderate use of snorted cocaine primarily in the early phases of pregnancy, no teacher-reported behavioral differences at age 6 were observed.<sup>19</sup> However, in this study by Richardson and coworkers, even after controlling for other drug and tobacco exposure, children exposed prenatally to cocaine made more errors of omission on a continuous performance test, suggesting poorer levels of attention.

Although the behavioral reports of this and previous studies are of importance, no studies purport to demonstrate causation between prenatal cocaine exposure and these later behavioral effects. It is quite likely that other maternal and environmental factors play a significant role in determining child behavior. Beechly and Tronick suggest that child outcome is dependent on the interaction of the maternal-child dyad.<sup>35</sup> For example, Gottwald and associates reported differences in maternal behavior related to cocaine-exposure status, with exposed mother spending more time disengaged from their newborns.<sup>36</sup> Barabach and colleagues demonstrated that at birth, mothers of cocaine-exposed children were less sensitive to their infants' cues.<sup>37</sup> Furthermore, among women with severe substance-abuse problems requiring residential treatment, multiple home changes, little participation of the child's father, and foster care placements were common.<sup>38</sup> It is possible that some of the subtle behavioral differences after prenatal cocaine exposure may be related to caregiver or home variables. Supporting this hypothesis is the well controlled study of spontaneous play reported by Beckwith and associates.<sup>34</sup> Among the children with multiple prenatal drug exposures (including cocaine and PCP), those identified as at risk by play behavior had lower developmental quotients, were born to mothers with less education, and were raised in families with less responsive caregiver styles.

Several authors have addressed an important issue: Can the effects of prenatal exposure to cocaine be explained by other drug exposures (including alcohol and tobacco) and environmental factors associated with drug exposure? In our pilot study, neither alcohol nor tobacco had a significant effect on teacher ratings of the child's behavior at age 6. Although no maternal differences were seen in age, gravidity, parity, education, race, or marital status, it is possible that other unmeasured differences in the primary caretaker accounts for some or all of the differences observed in child behavior. However, viewing the cocaine epidemic as illusionary or unimportant undermines the teacher observations; chil-

dren with prenatal cocaine exposure had significant behavior problems at age 6. Larger studies with more comprehensive assessments of the caretaker characteristics are essential. Additional interventions that may ameliorate the behavioral outcomes observed are warranted, based on this study's results.

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## **Prenatal Cocaine Exposure and Child Behavior**

Virginia Delaney-Black, Chandice Covington, Thomas Templin, Joel Ager, Susan Martier and Robert Sokol  
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