



## Prenatal cocaine exposure: Effects on mother- and teacher-rated behavior problems and growth in school-age children

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### ABSTRACT

In this longitudinal study of prenatal cocaine exposure (PCE), school-age physical and cognitive development and behavioral characteristics were examined, while controlling for other factors that affect child development. At this follow-up phase, children were on average 7.2 years old, and their caregivers were 33.7 years old, had 12.5 years of education, and 48% were African American. During the first trimester, 20% of the women were frequent cocaine users ( $\geq 1$  line/day). First trimester cocaine exposure predicted decreased weight and height at 7 years. There was no significant relationship between PCE and the cognitive and neuropsychological measures. Third trimester cocaine use predicted more total and externalizing behavior problems on the Child Behavior Checklist (Achenbach, 1991 [3]) and the Teacher Report Form (Achenbach, 1991 [4]), and increased activity, inattention, and impulsivity on the Routh Activity (Routh et al., 1974 [67]) and SNAP scales (Pelham and Bender, 1982 [55]). Children who were exposed to cocaine throughout pregnancy had more mother- and teacher-rated behavior problems compared to children of women who stopped using early in pregnancy or who never used cocaine prenatally. These detrimental effects of PCE on behavior are consistent with other reports in the literature and with the hypothesis that PCE affects development through changes in neurotransmitter systems. These school-age behaviors may be precursors of later adolescent behavior problems.

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### 1. Introduction

Over the last decade, we have seen a group of well-designed studies, many of which are represented in this Special Issue, tackle the important public health topic of the effects of prenatal cocaine exposure (PCE). Previously, we reported that PCE was associated with infant temperament and motor development [61], and with preschool behavior problems, poorer short-term memory, and decreased head circumference [62]. Our longitudinal study and others have continued to follow cohorts into early elementary school (defined for this review as 6 to 8 years old or first through third grade), investigating the effects of PCE on the domains of growth, cognitive development, and behavior.

Most researchers have reported that PCE was not associated with growth at school age [5,29,37,40,41,50]. By contrast, PCE was found to be associated with decreased height at 7 years, but only for those whose mothers were older than 30 at the time of delivery [21], and with decreased height and weight/height z-scores in 6-year-olds [52].

There have been reports of relationships between PCE and specific areas of cognitive or neuropsychological development and school

functioning in 6- to 8-year-olds, including language development [8,9,11,46], abstract-visual reasoning [12], visual-motor performance [5], learning disabilities [53], and increased frequency of Individualized Education Plans [45]. Eyler et al. [29] found that PCE was associated with executive function tasks at 7 years, but the effects were mediated by the effects of PCE on birth head circumference. In general, PCE has not been found to be associated with deficits in global cognitive development, as measured by scales such as the Stanford-Binet Intelligence Scale (SBIS) [77], the Wechsler Preschool and Primary Scale of Intelligence – Revised [81], the Wechsler Intelligence Scale for Children [82], and the Differential Ability Scales [28] [5,8,37,40,41,53], although Bennett et al. [12] reported that PCE predicted lower SBIS composite scores for exposed boys only.

The literature is also inconsistent in the behavior domain. PCE has been reported to be associated with increased caregiver- and teacher-reported behavior problems, particularly externalizing behavior [6,26,40] and aggression [73], and with poorer attention and processing on laboratory measures [1,51]. Nordstrom-Bailey [54] also found an effect of PCE on aggression, but only in girls who had no prenatal alcohol exposure. Other researchers have reported that there were no significant relations between PCE and caregiver's ratings of behavior problems [2,41,48].

The research presented here is from a longitudinal study of prenatal cocaine use that was designed to address the relations between PCE and

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physical, cognitive, and behavioral development in a sample of women recruited from a prenatal care clinic. We will address the timing of PCE because multiple interviews were conducted to obtain trimester-specific substance use data. Given the longitudinal design of the study, we will evaluate whether earlier effects of PCE mediate later outcomes. We will also test whether there are any moderating effects of maternal age, home environment, or child gender because of previous reports of interactions between PCE and these variables [11,12,15,21,26,73,85]. Based on our findings at the 1- and 3-year follow-ups [61,62] and on those in the literature, we hypothesize that the strongest associations will be with PCE and behavior problems at 7 years of age, and that this relation will remain significant after adjusting for covariates of cocaine use.

## 2. Methods

### 2.1. Study design

The women and children in this sample are participants in a longitudinal investigation of the effects of PCE. Written consent was obtained according to the guidelines of the University of Pittsburgh's Institutional Review Board and the Research Review and Human Experimentation Committee of Magee-Womens Hospital (MWH). A Department of Health and Human Services' Confidentiality Certificate assured participants that their responses could not be subpoenaed.

Women  $\geq 18$  years of age were initially interviewed in the MWH prenatal clinic during their fourth or fifth prenatal month. Women were not enrolled if they did not initiate prenatal care by the fifth month of pregnancy. During the first interview, the women were asked about cocaine, crack, alcohol, tobacco, marijuana, and other illicit drug use in the year prior to pregnancy and during the first trimester. All women who reported any cocaine or crack use during the first trimester were enrolled. The next woman interviewed who reported no cocaine or crack use during both the year prior to pregnancy and the first trimester was also enrolled. The selected sample was interviewed during the seventh prenatal month and at 24 h post-delivery about substance use during their second and third trimesters, respectively. All infants were examined at delivery by study nurses who were unaware of prenatal exposure status. At 1 year postpartum, growth, mental and motor development, and temperament were assessed [61]. At 3 years postpartum, growth, cognitive development, and behavior were assessed [62].

At the 7-year follow-up, mothers and children were seen in our research offices. The child's growth was measured by trained research staff and his/her medical history was obtained from the mother. Cognitive development was assessed with the Stanford–Binet Intelligence Scale – 4th Edition (SBIS) [77], which consists of the following scales: verbal reasoning (VR), abstract/visual reasoning (AVR), quantitative reasoning (QR), short-term memory (STM), and the composite score. Academic achievement was assessed with the Wide Range Achievement Test – Revision 3 (WRAT-3) [83], which yields reading, spelling, and arithmetic scores. The screening version of the Wide Range Assessment of Memory and Learning (WRAML) [70] was used to examine visual and verbal memory and verbal learning. The Grooved Pegboard, in which the child is required to place notched pegs into a board of 25 grooved holes, was used as a test of psychomotor speed and eye–hand coordination [66]. The Progressive Figures Test (PFT) was administered to provide an indication of mental flexibility and impulsivity [57]. The PFT is conceptually similar to the Trail Making Test, but is more appropriate for 7-year-olds because it uses shapes rather than numbers and letters. To measure attention and impulsivity, the Continuous Performance Test – Shapes (CPT-3) [49] was administered. The CPT-3 presents various shapes in different colors and requires the child to respond to a target stimulus. Data include the rate of responding and errors of omission and commission.

The examiners were bachelor's or master's level research staff who had extensive experience administering standardized child assessments. They were trained to reliability and supervised by a developmental psychologist (GAR). All examiners were blind to prenatal and current substance use status. Periodic reliability checks were conducted in order to maintain consistent administration and scoring.

At 7 years, trained interviewers asked the mothers structured questions about their substance use during the last year and about their demographic and psychological characteristics, household composition, and social support (how often have contact with friends and relatives; someone to turn to in times of need; support received in role as a mother; satisfaction with help received). The Center for Epidemiological Studies – Depression Scale (CES-D) [56] was used to assess maternal depression and the Spielberger State-Trait Anxiety Inventory (STAI) [74] was used to measure anxiety and hostility. The interview version of the HOME [7] was used to measure aspects of the home environment that correlate with cognitive development, such as the availability of reading materials, the frequency of television viewing and family meals, and types of discipline tactics. A total score is obtained with higher scores indicating more supportive home environments. An estimate of maternal intelligence was obtained by administering the two-subtest version (block design and vocabulary) [14] of the Wechsler Adult Intelligence Scale – Revised (WAIS-R) [80].

The mother's view of the child's temperament was measured using the EAS Scale [17], in which the mother rates her child in terms of emotionality or distress, degree of activity, sociability, and shyness. Cronbach's alphas for the current sample were 0.79, 0.68, 0.55, and 0.58 for the four dimensions, respectively. The sociability and shyness scales were eliminated from the analyses because of the low alphas. The mothers also completed the Routh Activity Scale [67], an assessment of the child's activity levels in daily situations such as mealtime, bedtime, and playtime, and the SNAP [55], a rating of activity, attention, impulsivity, and peer relations. The alphas in the current sample for the Routh and the four SNAP subscales were 0.91, 0.84, 0.88, 0.85, and 0.66, respectively. As a measure of behavior problems, the Child Behavior Checklist/4–18 (CBCL) [3] was completed by the caregivers at 7 years. In addition, the child's primary teacher completed the Teacher Report Form [4], which parallels the questions in the CBCL.

### 2.2. Sample characteristics

Recruitment occurred between March 1988 and December 1992 and 90% of the women who were approached agreed to participate. Only 5% of a random sample of women who refused to participate had a history of drug use during the current pregnancy, according to a medical chart review. A total of 320 women met the inclusion criteria and were enrolled into the study. Between enrollment at the 4th or 5th month of pregnancy and delivery, 20 subjects were eliminated for the following reasons: home delivery, miscarriage/abortion/fetal death, moved, lost to follow-up, and refused. Thus, delivery assessments were completed on 300 women. Four pairs of twins and one child with Trisomy 21 were excluded from additional follow-up, resulting in a birth cohort of 295 mothers and infants.

By 7 years, 51 subjects were lost to follow-up: 5 children died, 5 mothers lost custody and the children could not be traced, 15 families moved out of state, 14 mothers refused to participate, and 12 were missed. The 244 subjects interviewed at the 7-year follow-up represented 83% of the birth cohort. Ten percent of the children were not in maternal custody at 7 years, in which case the current caretaker was interviewed. The majority of these caregivers were relatives of the child (father, grandparent, or aunt).

One child with a severe disability (Alagille Syndrome) was excluded from the analyses, resulting in an analysis cohort of 243 mothers and children. The mothers who were not included in the 7-year analysis ( $N = 52$ ) were younger (23.2 vs. 25.1 years,  $p < .01$ ) than

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