

Predictors of motor development in children prenatally exposed to cocaine

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Abstract

The current study examined the pattern of motor development across the first 18 months of life in infants with in utero exposure to cocaine to determine how prenatal drug effects and level of exposure relates to motor development. Motor development was examined at 1, 4, 12, and 18 months of age (corrected for prematurity). Infants were divided into cocaine exposed ($n=392$) and comparison ($n=776$) groups. Exposure status was determined by meconium assay and maternal self-report with alcohol, marijuana, tobacco, and opiates present in both groups. Motor skills were assessed at 1 month using the NICU Network Neurobehavioral Scale (NNNS), at 4 months using the posture and fine motor assessment of infants (PFMAI), at 12 months using the Bayley Scales of Infant Development-Second Edition (BSID-II), and at 18 months using the Peabody Developmental Motor Scales (PDMS). Examiners masked to exposure status performed all assessments. Motor scores were converted to standard (z) scores, and hierarchical linear modeling (HLM) was used to examine the change in motor skills from 1 to 18 months of age. Infants with exposure to cocaine showed low motor skills at their initial status of 1 month but displayed significant increases over time. Both higher and lower levels of tobacco use related to poorer motor performance on average. Heavy cocaine use related to poorer motor performance as compared to no use, but there were no effects of level of cocaine use on change in motor skills.

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Abbreviations: ACYF, Administration of Children, Youth, and Families; BSID-II, Bayley Scales of Infant Development-Second Edition; CSAT, Center for Substance Abuse Treatment; EMIT, Enzyme Multiplied Immunoassay Techniques; MISU, Maternal Inventory of Substance Abuse; MLS, Maternal Lifestyle Study; NNNS, NICU Network Neurobehavioral Scale; NICHD, National Institute of Child Health and Human Development; NIDA, National Institute on Drug Abuse; PDMS, Peabody Developmental Motor Scales; PFMAI, Posture and fine motor assessment of infants; SES, Socioeconomic Status.

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1. Introduction

Findings on the effects of prenatal cocaine exposure and motor function are varied and controversial [17]. However, recent studies conducted on larger samples containing comparison groups appear to find consistent support for motor problems across the first 2 years of life in infants with in utero cocaine exposure [1,2,5,10,15,32–34,38,39]. During the newborn period, infants with cocaine exposure are noted to have neurobehavioral difficulties including motor

problems such as coordination and hypertonicity [5,10,32–34]. Studies examining skills later in the first 2 years of life find that cocaine exposed groups have significantly poorer gross and fine motor skills in contrast to comparison groups [33,38,39].

In utero cocaine exposure is thought to affect the hypothalamic and extrapyramidal systems [8,29,40]. These brain structures are noted to have neural functions associated with both voluntary and involuntary movement. In utero cocaine exposure may also alter fetal brain development and impact motor performance through fetal hypoxia mediated by maternal uterine artery vasoconstriction [28,41].

Previous studies on the impact of cocaine on motor skills have been limited by small samples, lack of masked examiners, and a lack of comparison groups [17]. In addition to these confounding factors, prior studies only examined outcomes at individual age points rather than consider patterns of development over time. The present study seeks to provide a more dynamic description of motor development in infants exposed in utero to cocaine by assessing change in motor development across the first 18 months of life in a large sample containing both exposed and comparison infants. Examining development across these multiple age points is important for two reasons. First, there is a tremendous amount of brain development that occurs during this time period. Second, by assessing growth across time, we can examine if there are initial motor difficulties that may be due to effects of cocaine that may recover vs. ongoing difficulties suggestive of more sustained neurotoxic effects.

The present data provide information on a study conducted in four sites on the largest reported sample in the literature of infants exposed in utero to cocaine as well as a comparison group. Growth models were developed to assess patterns of change across time in motor skills and whether these patterns differed in relation to exposure status. We examined whether cocaine use as well as thresholds of cocaine use related to change in motor patterns over time. Motor development was measured at 1, 4, 12, and 18 months of age (corrected for prematurity). Based on previous studies, we hypothesized that infants with cocaine exposure would not only exhibit initial difficulties but also display less optimal patterns of motor development over time.

2. Methods

2.1. Subjects

The Maternal Lifestyle Study (MLS) investigates the effects of prenatal cocaine exposure on child outcome in a longitudinal follow-up of 1388 children, aged 1 month to 36 months, who were divided into an exposed ($n=600$) and a comparison group ($n=788$). MLS is conducted under the

auspices of the National Institute of Child Health and Human Development (NICHD) Neonatal Research Network at four sites (Brown University, University of Miami, University of Tennessee, Memphis, and Wayne State University). The institutional review board at each site approved the study. A National Institute on Drug Abuse (NIDA) Certificate of Confidentiality was obtained to ensure confidentiality of information regarding subjects' drug use. Written informed consent was obtained for the longitudinal follow-up at the time of the 1-month visit.

The initial sample included 1388 enrolled at 1 month in the longitudinal follow-up. Study participants were >18 years of age, and a majority was African American (78%), had at least a high school education (69%), and received Medicaid benefits (79%). One third of the sample had incomes below the federal poverty line. Exposed and comparison groups were matched on gestational age, race, and gender. The exposed group consisted of infants whose mothers used cocaine during pregnancy, based on maternal self-report at the time of delivery and/or the finding of cocaine metabolites in meconium by gas chromatography [13,25]. The comparison group consisted of infants whose mothers denied cocaine use during pregnancy and with negative meconium analysis. Other substances associated with cocaine use (alcohol, marijuana, tobacco, and opiates) were included in both groups. The decision to include opiate exposure was based on epidemiology at the time that suggested that many cocaine users also used opiates. Exclusion criteria included maternal factors that prevented informed consent (e.g., non-English or non-Spanish speaking) and serious infant medical conditions likely to compromise development (e.g., congenital anomalies, chromosomal abnormalities). For the present study, data were available for 392 (65%) exposed and 776 (98%) comparison infants. From the original cohort of 1388, 220 (16%) cases were excluded. Information about exposure to other substances was unavailable for 131 cases, as biological mothers either failed to complete the interview because the infant had been removed from care at the time of birth or refused to answer the question. Eighty-nine were excluded because meconium assay came back positive but mothers denied use. The issue of selective loss was examined by comparing the 220 excluded cases vs. the 1168 included cases on a number of demographic variables. The attrition due to missing data was significantly greater for the exposed vs. comparison group. Due to the proportionally high number of excluded cases from the exposed group, those excluded were older, had less education, were more likely to be single, less likely to have prenatal care, had babies of lower birth weights, and were less likely to be first time mothers. However, there were no significant differences between included and excluded cases on maternal race, Socioeconomic Status (SES), Medicaid status, gestational age, 1 and 5 min Apgar scores, head circumference, length, sex, or 1 month motor data on the NICU Network Neurobehavioral Scale (NNS) [27].

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