



Prenatal cocaine exposure: The role of cumulative environmental risk and maternal harshness in the development of child internalizing behavior problems in kindergarten



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ABSTRACT

This study examined the associations between prenatal exposure to cocaine and other substances and child internalizing behavior problems at kindergarten. We investigated whether maternal harshness or cumulative environmental risk mediated or moderated this association. Participants consisted of 216 (116 cocaine exposed, 100 non-cocaine exposed) mother–infant dyads participating in an ongoing longitudinal study of prenatal cocaine exposure. Results indicated that, as hypothesized, maternal harshness moderated the association between prenatal cocaine exposure to child internalizing in kindergarten such that prenatal cocaine exposure increased risk for internalizing problems at high levels of maternal harshness from 7 to 36 months and decreased risk at low levels of harshness. Contrary to hypothesis, the association between prenatal cocaine exposure and child internalizing in kindergarten was not mediated by maternal harshness or cumulative environmental risk. However, cumulative environmental risk (from 1 month of child age to kindergarten) was predictive of child internalizing behavior problems at kindergarten. Results have implications for parenting interventions that may be targeted toward reducing maternal harshness in high risk samples characterized by maternal substance use in pregnancy.

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1. Introduction

Prenatal cocaine exposure (CE) has an inhibitory effect on the reuptake of monoamines in the presynaptic junction, leading to an increased concentration of these neurotransmitters in the synaptic cleft and higher activation in the central catecholaminergic systems (Gawin and Ellinwood, 1988; Mayes, 2002). It has been noted that these physiological consequences may be one mechanism for the association between prenatal CE and alterations in arousal, attention, and reactivity to stress. Indeed, recent studies of functional neural activity indicated significantly greater prefrontal activation for CE children compared to controls during a working memory task in the context of high negative emotional arousal, but not under emotionally neutral conditions (Li et al., 2009; Li et al., 2011), suggesting alterations in attentional or regulatory mechanisms in response to negative emotional arousal. Given the risk for prenatal cocaine exposure to alter arousal regulatory systems, a number of studies have hypothesized direct associations between prenatal CE and the development of internalizing behavior problems (Bada et al., 2011; Richardson et al., 2009). However, with the exception of one study reporting a significant

association between first trimester cocaine use and internalizing behavior problems at 3 years of child age (Richardson et al., 2009) and one reporting associations between level of cocaine use (none, some, high) and internalizing problems at 3 and 5 years (Bada et al., 2007), most studies have reported non-significant associations from 4 to 13 years of child ages (Accornero et al., 2002; Accornero et al., 2006; Bada et al., 2011; Bennett et al., 2002; Lester et al., 2009; Yumoto et al., 2008).

Instead, most have reported associations between internalizing symptomatology and other environmental risk variables such as maternal psychological distress (Accornero et al., 2002), caregiver depression (Bada et al., 2011; Bennett et al., 2002), violence (Bada et al., 2011), and cumulative environmental risk (Yumoto et al., 2008) among cocaine exposed cohorts. However, these risk factors often co-occur (Sameroff et al., 1993) and may be best characterized as cumulative environmental risk for internalizing behavior problems among children. This cumulative environmental risk could be conceptualized as a mediator or intervening variable between the association between prenatal CE and internalizing behavior problems or alternatively as moderating the association between CE and internalizing behavior problems.

With respect to mediation, the literature on maternal substance use indicates that these women are at particularly high risk for experiencing greater psychological distress (Eiden et al., 2007) and violent encounters

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due to vulnerability to victimization (Eiden et al., 1999), unstable relationships (Lynch and Cicchetti, 1998), and residence in high-risk neighborhoods (Osofsky et al., 1993). Child exposure to violence is subsequently associated with higher risk for internalizing behavior problems across multiple studies (Huang et al., 2010; Oravecz et al., 2011). Similarly, higher maternal psychological distress is a robust prospective predictor of children's internalizing behavior problems (Connell and Goodman, 2002). Further, the risk of developing internalizing behavior problems in early adolescence has been found to rise with the accumulation of risk factors, such as family psychopathology (Ashford et al., 2008). Finally, cocaine exposed children are more likely to experience inconsistent and unstable caregiving with greater likelihood of major separations from primary caregivers and lack of stable caregiving routines compared to non-exposed children (Platzman et al., 2001). The importance of caregiving stability and reliable family routines for children's well-being has been well established (Zeanah, 2009). Taken together, these aspects of the caregiving environment are likely to co-occur, are likely to vary as a function of maternal substance use, including cocaine, and are known to have a significant impact on children's internalizing behavior problems.

In addition to cumulative caregiving environmental risk, the quality of parenting experienced by the child may serve as a proximal mediator or moderator of risk. Maternal cocaine use has the potential to alter parenting behavior. Both animal and human studies indicate that mothers with CE had lower plasma oxytocin (sometimes called the "bonding hormone") compared to non-substance using mothers (Johns et al., 1997; Light et al., 2004; McMurray et al., 2008a). This has been demonstrated to be one mechanism for cocaine effects on maternal caregiving or parenting behavior (Light et al., 2004; McMurray et al., 2008b). Animal studies examining the effects of cocaine administration on maternal caregiving behavior consistently report lower caregiving quality across multiple domains (Morrell, Basso, & Pereira, 2011). Similarly, a number of parenting dimensions have been examined in the human literature on CE. Results indicate that cocaine using mothers use fewer positive reinforcements and more threats of physical discipline in the toddler/preschool period (Bauman & Dougherty, 1983); display more harshness during different laboratory based interactions at 2 years of age (Eiden et al., 2011a); and are more hostile and intrusive in a structured teaching situation at 3 years of age (Johnson et al., 2002). This aspect of maternal hostility/harshness has also been associated with higher internalizing problems in childhood and adolescence (Bender et al., 2007; Easterbrooks et al., 2012). Thus, maternal hostility or harshness across infancy and toddler years may mediate the association between prenatal CE and internalizing behavior problems in kindergarten.

Environmental risk and maternal harshness may also moderate risk for internalizing behavior problems. Theoretical models such as diathesis-stress or dual risk models of development (Ingram and Luxton, 2005) would suggest that the vulnerability posed by prenatal CE would result in higher internalizing behavior problems only in the context of high environmental risk or high maternal harshness. In addition, theories such as differential susceptibility (Belsky and Pluess, 2009) are particularly useful when considering potential protective effects. This theory would suggest that vulnerability due to prenatal substance exposure may not only increase risk for internalizing behavior problems under conditions of high environmental risk or maternal harshness, but also increase the probability for low internalizing behavior problems in positive environmental and parenting contexts.

Finally, it is important to note that maternal cocaine use is a poly-drug issue. The majority of mothers using cocaine also use other substances such as alcohol, cigarettes, and marijuana (Lester et al., 2003). Cocaine is often used in combination with marijuana and nicotine and cocaine use is often accompanied by drinking during pregnancy. All of these substances have the potential to alter developmental outcomes (Irner, 2012). Thus, the potential effects of cocaine use can only be examined in the context of other substance use during pregnancy by including exposure to these other substances in model testing.

Thus, we examined a conceptual model for development of internalizing behavior problems among cocaine-exposed and demographically similar non-exposed children that included the role of cumulative environmental risk and maternal harshness. In addition to examining potential direct effects of CE on internalizing behavior problems at kindergarten age, two indirect or mediational pathways linking maternal cocaine use to children's internalizing problems were examined in this study: first, the path from maternal cocaine use → higher maternal harshness from 7 to 36 months → higher internalizing problems in kindergarten or mediation via maternal harshness. Second, the path from maternal cocaine use → higher environmental risk from 1 to 54 months → higher internalizing behavior problems in kindergarten or mediation via environmental risk. Finally, we examined moderation by examining if the association between CE and internalizing problems would be stronger under conditions of higher compared to lower cumulative environmental risk or harsh parenting behavior. We hypothesized that the association between CE and internalizing behavior problems would be stronger under conditions of high environmental risk or high maternal harshness. We examined the role of child gender as a potential moderator of the direct association between CE and internalizing behavior problems. Given the mixed results in prior literature, we did not hypothesize a direction of effect.

2. Material and methods

2.1. Participants

The sample consisted of 216 mother–infant dyads participating in an ongoing longitudinal study of CE (116 cocaine-exposed or CE, 100 not cocaine-exposed or NCE). An outreach worker on the project staff recruited all participants after delivery from two local area hospitals. Mothers ranged in age from 18 to 42 years ($M = 29.53$; $SD = 6.06$). The majority of mothers were African American (72%), were receiving Temporary Assistance for Needy Families (76%) at the time of their first laboratory visit (Years 2001–2004), and were single (66%). Of the 216 children, 106 (49%) were male. All families were recruited from two hospitals serving a predominantly low-income population and the two groups were matched on maternal education, maternal race/ethnicity, and infant gender. Maternal and child assessments were conducted at delivery, 4–8 weeks, 7, 13, 24, 36, and 48 months of child ages, and at kindergarten age. Children born at or before 37 week gestation were scheduled for their appointments at chronological age corrected for prematurity until the 24 month assessment. By kindergarten, 55 children in the CE group and 9 children in the NCE group had been removed from parental care and placed in non-parental care at some point between recruitment and kindergarten. All assessments were conducted with the primary caregiver of the child at that time, with the exception of the first assessment when biological mothers were interviewed in addition to the primary caregiver to obtain accurate information about prenatal substance exposure. However, for ease of presentation the terms mother and maternal are used throughout the manuscript when referring to the primary caregiver who was identified as the adult who had legal guardianship of the child and accompanied the child at all appointments. The average child age at kindergarten was 5.52 years ($SD = .36$, range = 4.8–7.0 years).

2.2. Procedure

All mothers were screened after delivery using a self-report screening form for initial eligibility and matching criteria followed by medical record review. About 2 weeks after delivery, mothers were contacted and scheduled for their first laboratory visit, which took place at the time that their infant was approximately 4–8 weeks old. In the circumstance of a change in custody arrangements, the person who had legal guardianship of the child was contacted and asked to participate. Once a family was recruited into the cocaine group, the closest matching

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