Exposure to Cocaine: Behavioral Outcomes in Preschool and School-Age Children

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Within the last 5 years, increasing numbers of children exposed prenatally to cocaine and crack have been evaluated in the preschool and school-age years. Although there are few published reports to date about the findings of longitudinal followup efforts beyond the first 12 to 24 months of age (Chasnoff et al. 1992; Griffith et al. 1994), sufficient data are beginning to emerge from animal and human studies to allow some refinement of hypotheses and more informed choices of measures for studying such children.

In early reports, cocaine exposure was predictively linked to moderate to severe developmental delays across all domains. Subsequent studies have reported mild to no impairments in overall developmental functioning in cocaine-exposed children compared with noncocaine-exposed groups. Most recently, the developmental profiles of a group of 106 cocaine/ alcohol-exposed 24-month-olds followed from birth were compared with the performance of 45 toddlers exposed to marijuana and/or alcohol but notcocaine and 77 nondrug-exposed children (Chasnoff et al. 1992). Mothers of infants in the two comparison groups were similar to the cocaine-using mothers in socioeconomic status (SES), age, marital status, and tobacco use during pregnancy. On repeated developmental assess-ments using the Bayley Scales (Bayley 1969) at 3,6, 12, 18, and 24months, albeit with a high rate of attrition from the original cohort, there were no mean differences in either the mental or motor domains, although the investigators cautioned that a higher percentage of cocaine-exposed infants scored two standard deviations (SD) below the mean (Chasnoff et al. 1992). Cocaine-exposed children from this cohort followed through age 3years continued to show no differences on overall performance on the Stanford-Binet Intelligence Scale from the noncocaine-exposed controls (Griffith et al. 1994), although the cocaine-exposed group scored significantly lower on verbal reasoning.

Three other investigative groups have reported similar failures to find differences among cocaine-exposed groups on general measures of developmental competency in the first, second, and third years of life (Anisfeld et al. 1991; Arendt et al. 1993; Billman et al. 1991).

Findings such as these have required a reevaluation of earlier concerns about global developmental delay in cocaine-exposed children. Conversely, as more children who were prenatally exposed have been evaluated in a variety of research and clinical contexts, more evidence has accumulated about the insensitivity of measures such as the Bayley or the Stanford-Binet to the types of clinical problems displayed by many cocaine-exposed children.

When specific developmental domains or neurodevelopmental functions have been studied, mild to moderate impairments have been reported in the following areas (albeit based on one or two studies for each area): recognition memory, visual habituation, language development, and capacity for symbolic play. In addition, concern has been raised about impaired parent-child interactions and distorted or impaired attachment. More generally, studies dealing with the parenting, home, and community environments of cocaine-exposed children suggest increased incidence of physical abuse, neglect, abandonment, and foster placement, events that also carry implications for later psychological and developmental dysfunctions.

The findings related to attention and reactivity functions among cocaine- exposed children reflect, at least in part, links with central nervous system (CNS) monoaminergic systems and contribute to the emergence of language, play, and capacities for social interaction (Mayes 1992). The central question for outcomes such as language, symbolic play, attachment, and parent-child interactions that are more multidetermined and socially embedded is whether or not the possible increased incidence of impair-ments in preschool cocaine-exposed children is uniquely different from that seen in children from dysfunctional or multirisk families not affected by substance abuse. Additionally, continued parental cocaine use postnatally provides another level of cocaine exposure for the young child and may or may not have unique effects on parenting capacities that in turn affect such domains as language development.

ATTENTION AND HABITUATION

When an infant is presented with a novel stimulus, the infant will orient and attend. If that stimulus is presented repeatedly or continuously, theinfant's attention will wane and the point of decrement is called habituation. If a second novel stimulus is presented, the infant will reorient and attend again. Conversely, such an increase in attention or visual fixation will not occur with subsequent presentation of the first,

familiar stimulus (Bornstein 1985, 1989). The habituation task provides information about the organization of looking behavior and attention in the first 1 to 2 years, and the habituation process represents an early form of some type of information processing and encoding by the infant and child (Bornstein 1985; Cohen et al. 1979; Colombo and Mitchell 1990). The habituation procedure has been used to study a host of questions about early memory, concept formation, and infants, and young chil-dren's capacities to detect, categorize, and discriminate incoming information.

Habituation in infancy measured quantitatively or qualitatively shows adequate test-retest reliability and, for certain measures such as accumu-lated looking time at the stimulus, is moderately stable month to month (Bornstein and Mayes 1992). Additionally, as would be hypothesized for afunction related to information processing, habituation measures show improved efficiency with maturation (Bornstein et al. 1988; Mayes and Kessen 1989). Habituation measured between 3 and 6months of age pre-dicts Bayley performance, language production and comprehension, and full-scale intelligence quotient (IQ) test performance up to 12 years (Bornstein 1989; Bornstein and Mayes 1992). The median of predictive correlations in these studies reaches the 0.50 region (Bornstein and Sigman 1986). Additionally, the habituation response has been used in a number of studies of infants at risk for impairments in attention or early information processing, such as very preterm infants or those preterm infants with intra-ventricular hemorrhage, and has been shown to discriminate among such groups (Landry et al. 1985; McDonough and Cohen 1982; Millar et al. 1991).

Links between the dopaminergic system and attentional mechanisms that are likely to involve the habituation process (Coles and Robbins 1989) make it plausible to hypothesize that prenatal cocaine exposure could affect subsequent habituation performance. To support this hypothesis, evidence from animal studies reveals a relation between prenatal cocaine exposure and impaired postnatal associative learning (Dow-Edwards 1988, 1989; Spear et al. 1989). Two studies have examined the habituation response or similar measures in cocaine-exposed children. Struthers and Hansen (1992) reported on recognition memory in a group of 36 cocaine- and/or amphetamine-exposed infants and 26 nondrug-exposed infants who were evaluated between 27 and 52 weeks of age. The drug-exposed infants showed significantly lower scores on serial measures of visual recognition memory. Tests of recognition memory, which are moderately predictive of later cognitive performance (Fagan and Montie 1988;

Fagan et al. 1986), rely on the infant's capacity to habituate to familiar stimuli and to orient preferentially to novel information; thus, though procedurally different from standard habituation paradigms, recognition memory relies on habituation processes.

A recent series from the author's own laboratories (Mayes et al. 1995) examined 108 infants—61 cocaine-exposed and 47 controls—at 3 months of age in an infant-control habituation and novelty responsiveness proce-dure. Habituation studies were performed by investigators blind to drug exposure status. In the standard habituation paradigm, a visual stimulus appears on the screen when the infant looks directly ahead and is removed from the screen when the infant looks away. The habituation stimulus is presented repeatedly until the looking times decline to the so-called habituation criterion, which is defined as a percentage of a baseline that is the mean of the duration of the first two looks at the stimulus. Following the habituation phase, a novel stimulus is presented to measure recovery of attention to novel information. Changes in the child's level of arousal and state of alertness are monitored and coded throughout the session.

The basic unit of measurement in the habituation sequence is the duration of a look. From the duration of looks, the following measures describe habituation performance: the duration of the first and second look, dura-tion of the longest look or peak looking time, duration of the criterion look,number of looks to criterion, and the cumulative looking time before criterion is reached. Recovery of visual attention to novel stimuli is calcu-lated as a proportion of the duration of the look to the novel stimulus compared with the last look at the habituation stimulus. Accumulated looking, peak look, and recovery to novelty are predictive of later informa-tion-processing capacities measured by full-scale IQ with the median in the0.50 range (see also above; Bornstein and Mayes 1992; Bornstein and Sigman 1986).

In this series, 37 of the 108 infants fussed or cried on the presentation of the habituation stimulus and were unable to begin the habituation phase. A greater proportion of these infants were from the cocaine-exposed group (N = 27 of 61, or 44 percent) than from the nondrug-exposed group (N = 10 of 47, or 21 percent), chi square = 6.23, p = 0.01. Also, atthe beginning of the novel stimulus presentation, an additional seven infants became sufficiently irritable that they could not complete the novel stimulus test phase. Four of these infants had been cocaine exposed. Thus, in the overall habituation procedure, 44

infants became fussy and irritable, and a greater proportion of these were from the cocaine-exposed group, c2 = 5.89, p = 0.02. Infants who were unable to begin the habitua-tion phase were not significantly different in terms of gestational age, birthweight, length, and head circumference or maternal alcohol, tobacco, and marijuana use, age, and education.

For the 71 infants (34 cocaine-exposed and 37 noncocaine-exposed) who completed the habituation phase and reached criterion, variables describing habituation performance are shown in table 1. Because time data are often positively skewed, log transformations of looking times were performed, and relations between drug exposure status and habituation performance were examined. Table 1 shows no differences between the two groups in habituation performance. With the criterion for significance set to 0.05, the sample size of infants reaching habituation criterion was sufficient to detect moderate group differences (equal to 0.25 population SD) more than half the time (power = 0.56) and large group differences (equal to 0.4 popula-tion SD) more than 90percent of the time (power = 0.92). Also, because lower birthweight has been related to differences in measures of visual attention (Gotlieb et al. 1988) and measures of habituation change signifi-cantly with age (Bornstein et al. 1988; Mayes and Kessen 1989), compari-sons of habituation variables were covaried for birthweight and age in days. There were no significant differences for drug exposure status on habitua-tion performance. These means on measures of habituation and recovery to novel information are comparable to those obtained in the author's labora-tory from a large group of nondrug-exposed children from families of middle to upper SES (Mayes and Kessen 1989).

Thus, cocaine-exposed infants appeared more labile and reactive to novel stimuli, but if the infant was able to attend there was no difference in measures of habituation performance. That is, if the infant was able to maintain an alert, oriented state, measures of early information processing were no different between drug-exposed and nondrug-exposed groups. Before expanding on the possible implications of differences in reactivity to novelty, it is important to underscore that other aspects of the study sample may have contributed to the difference in reactivity between the cocaine- and noncocaine-exposed groups. As others have found (Zuckerman et al. 1989), cocaine-exposed infants were at increased perinatal risk as indicated by differences in prenatal care, number of obstetric complications, and indices of fetal growth. They were more often from families in which mothers had more limited education and

TABLE 1. Habituation performance and cocaine exposure.

Habituation Measures	MEAN (SD)	
	Cocaine Exposed N = 34	Noncocaine Exposed N = 37
First look (sec)	5.8 (3.5)	8.5 (8.1)
Baseline looking (sec)	5.2 (2.4)	7.6 (7.6)
Peak look (sec)	11.9 (10.2)	16.5 (25.2)
Criterion look (sec)	1.5 (0.8)	1.8 (1.8)
Looks to criterion	9.2 (6.7)	7.9 (4.6)
Cumulative looking (sec)	39.7 (35.2)	34.3 (22.7)
Recovery to novelty	N = 30 0.64 (0.18)	N = 34 0.62 (0.17)

were more likely to use alcohol, marijuana, and tobacco. Thus, for a number of reasons in addition to prenatal cocaine exposure, the cocaine-exposed group was at potentially increased risk for neurodevelopmental impairments. Rather than being an effect specific to cocaine or cocaine plus other drugs, it may be that the infants' overall irritability reflected their more general compromised and complicated perinatal course related to a state of relative fetal hypoxia due to cocaine's effect on placental blood flow and measured by reduced birthweight. Small for gestational age and low birthweight infants have been described well into the first and second years as more irritable and less adaptable to novelty on measures of sleep-wake patterns, temperament, and reactivity (Watt 1987; Watt and Strongman 1985). In addition, low-birthweight infants may show compromised attention to visual discrimination tasks, with more attention difficulties apparent among these infants with compromised medical courses (Gotlieb et al. 1988; Landry et al. 1985; Sigman et al. 1977).

With this caveat about overall perinatal compromise in mind, these findings regarding habituation suggest that reaction to novelty and the capacity to regulate attentional states may be important lines of investiga-tion to follow with children prenatally exposed to cocaine. For one, closer examination of the patterns of reactivity in those infants who fail to enter the habituation process (including level of motor activity, gaze aversion, change in facial affect, and heart rate patterns prior to their actual change toan irritable, crying state) will

provide information on the latency to changes in arousal following the presentation of a novel stimulus. Second,examining items commonly used in developmental assessments that employ novel materials or tasks provides similar opportunities to study reactivity to novelty or to the demand to focus and attend. For example, during the administration of the Bayley Scales, the child is faced with a number of novel and increasingly difficult tasks that place demands on arousal-regulating systems. Systematic study of shifts in states of arousal and attentiveness during standardly administered developmental assess-ments may provide additional information about the question of reactivity. Suggestive data support this possibility (Hawley and Disney 1992); cocaine-exposed 24-month-olds had more difficulty attending to several objects at the same time and in structuring an approach to an unfamiliar task on their own in the context of the developmental assessment.

It will also be important to continue to use tasks through the preschool years that rely upon habituation and novel discrimination processes and provide assessments of reactivity, frustration tolerance, and task persis-tence. Tasks such as those used by Ruff (1986), in which the child is sequentially presented with several novel toys to explore for a fixed period of time, assess not only the capacity to sustain exploration but also how the child reacts to multiple shifts in tasks or toys. Impairments in these types of domains have important implications for later school performance, where there are many more novel situations in any given day and increasing demands on a capacity to focus and move smoothly between tasks and new information.

The other domains for which some results are available from studies of preschool cocaine-exposed children are language, play, and parenting and attachment. In these areas, the available literature becomes far more scant and methodologically problematic. The few available studies to date have used small samples with mixed prenatal as well as postnatal drug exposure and combinations of preterm infants as well as SES-matched comparison groups. The measures of the particular domains have been quite variable and not conceptually linked to earlier hypotheses about how cocaine might affect functions such as reactivity and attentional regulation that in turn underlie capacities for language, play, and sustained social interaction. Additionally, only the most general measures of parent-ing, home environment, and parent-child interaction have been used. However, there are conceptually salient reasons for concern about the domains

of language, play, and parent-child interaction among cocaine-exposed children and their families.

LANGUAGE AND SYMBOLIC PLAY

Language development and the capacity for symbolic play are closely related since both involve maturing capacities for representation and for communication. Whereas play in the first year of life is largely exploratory or nonsymbolic, play in the second and third years involves the capacity for substituting function (e.g., using a cup to stand for something other than a cup) and for pretending. The capacity for verbal language emerges in parallel and likely facilitates increasingly sophisticated symbolic, pretend play. The progression from nonsymbolic to symbolic play is not only gradual, with its own rate of maturation; there are also marked individual differences in the amount of symbolic play shown by children in their second year of life. At 13 months, some toddlers never exhibit symbolic play, whereas for others as much as half of their play is symbolic (Tamis-LeMonda and Bornstein 1990, 1991). Further, capacity for symbolic play at 13 months predicts development at 20 months and thereafter; again, there is a close predictive and correlative tie between language and play sophistication.

There are many sources of such individual variation in the development of capacities for language and play, including differences in overall cognitive competency, but at least two relate to areas of concern for children prenatally exposed to cocaine. First, language development is partially dependent upon a capacity for sustained attention and exploration. Basic problems in the regulation of arousal and alert states will indirectly affect the emergence of language. Second, maternal stimulation increases children's use of language and level of play, both nonsymbolic and sym-bolic (Tamis-LeMonda and Bornstein 1990, 1991; Vibbert and Bornstein 1989). A combination of maternal social (e.g.,physical, affectionate contact) and attention directing (or didactic) activities best explains the level of sophistication of the toddler's play. As addressed below, cocaine-abusing mothers may be more likely to have difficulty with the kinds of interactive tasks that support both language and play development.

To date very few published studies have specifically addressed the language development of cocaine-exposed children. In one study, 30-pre-school children from The Netherlands who were prenatally exposed to cocaine in addition to methadone and heroin (van Baar

1990) were found, at age 30 months, to perform less well on the Bayley Mental Index than comparison children. However, when all Bayley items involving lan-guage (receptive or expressive) were removed and a nonverbal develop-ment index created, there were no differences between the drug-exposed and nondrug-exposed groups.

While it may be problematic to examine group differences in individual items from standardized tests, such an approach is useful for generating hypotheses. However, findings of specific receptive or expressive delays do not directly address language or communicative functions but only suggest that tasks involving verbal demands or requiring verbal response may be more difficult for drug-exposed children. No study has yet examined communicative functions such as joint attention (Bruner 1975) or other early communicative strategies that underlie verbal language and communication and which, given concerns about attention and reactivity in cocaine-exposed infants, may be impaired.

Further studies of language development in cocaine-exposed preschool children will need to rely not only on specific measures of communication and receptive/expressive language, but will also need to examine commu-nication precursors such as joint attention. Additionally, it will be essential for studies of language to have parallel studies of mother-child interaction.

The two available studies of the symbolic play capacities of drug-exposed toddlers, like the examination of language, provide only the most pre-liminary outlines for further investigation but do suggest areas of concern. In a study of symbolic play at 13 months of age, 18 children prenatally exposed to cocaine, phencyclidine (PCP), heroin, and/or methadone were compared with 41 SES-matched preterm children. The drug-exposed children were significantly less likely to engage in representational play or nonrepresentational exploration, but rather exhibited disorganized, poorly modulated play such as scattering and throwing toys (Rodning et al. 1989). These findings were replicated in a second cohort of 31 children and the differences were not statistically related to differences in home environment (Beckwith et al. 1994).

In addition to progression to different levels of symbolic activity, subsequent studies of play also need to focus on such measures as how long the child is able to sustain play with a given object and how often and under what types of conditions play is disrupted. Similarly, following on the earlier discussion of reactivity and lability, measures

of the child's approach, and use of novel toys or situations are conceptually analogous to the simpler novel stimulus tasks of infancy and tap the same potentially problematic domains as assessed by the habituation tasks.

PARENT-CHILD INTERACTION AND ATTACHMENT

Perhaps the most methodologically problematic area in the study of prenatal cocaine exposure in the preschool child has been the evaluation of the parenting environment (Mayes, in press). The domains of attention, reactivity, language, and play are each influenced by parental interaction and structuring activities (Tamis-LeMonda and Bernstein 1989). While attention and reactivity more directly reflect neuropsychological functions that are biologically based, over time these functions appear quite sensitive to the effects of environmental disorganization and neglect. The degree of sensitivity is individually variable for any given infant, but models of cumulative risks are particularly relevant for drug-exposed infants and children living in drug-using households.

Parents who are actively abusing cocaine and other substances have problems caring for their children, as indicated in part by the increased incidence of physical abuse and neglect in such families and by the proportionately higher numbers of children from substance-abusing families who are in foster care or other types of placements (Lawton 1992). Additionally, evidence is accumulating from substance abuse treatment programs that a high proportion of children and their mothers are witnesses to and victims of physical and verbal violence on a nearly daily basis (Lawton 1992). How such environmental events influence both a parent's ability to care for and protect a child and the child's ability to modulate aggression and develop basic capacities for empathy and relatedness are areas essentially unstudied in substance-abusing families; both are pressing issues in understanding the specific nature of parent-child interactions in these families.

Indirect though conceptually related measures of parenting include studies of attachment. Rodning and colleagues (1989, 1991), studying the same cohort described earlier, showed that drug-exposed toddlers are more likely to be insecurely attached to their mothers, while most of the comparison group of nondrug-exposed premature infants were securely attached. In addition, the drug-exposed children showed higher rates of disorganized attachment behaviors (group D;

Main and Solomon 1986). The first study from Rodning's group (1989) suggested that the high rate of insecure attachment was related more to postnatal environmental conditions than to prenatal drug exposure, since drug-exposed children reared in foster care or by a relative were less likely to be insecurely attached than those living with their biological mothers. However, similar differences in the frequency of insecure attachments among biological, relative, or foster care parents were not found in a second study of 39 infants (Rodning et al. 1991).

In addition to the difficulties already cited of mixed drug exposure and small sample sizes, the attachment studies raise two methodological concerns. First, attachment is a broad construct and the method tradition-ally used to assess attachment behaviors, the Strange Situation Paradigm (Ainsworth et al. 1978), can be particularly stressful for a child left alone with a stranger, usually in a strange place. How the child responds to the mother on her return is, in part, a measure of their relationship and the child's experience with seeking her comfort. However, the situation may impose an additional level of stress on children who have potential prob-lems with reactivity, lability, and state control in novel or strange situations. Such additional stress may add to the appearance of particularly impaired attachment behaviors in the drug-exposed group.

The second methodological concern involves the question of whether or not these differences in insecure or disordered attachment are unique to prenatal drug exposure or more reflective of the overall increased dis-organization, stress, abuse, and exposure to violence among drug-using families. An increased incidence of disordered attachment behaviors has been described for severely dysfunctional families in a number of studies (Carlson et al. 1989; O'Connor et al. 1987). Moreover, failure to find a difference between prenatally exposed infants in foster care and those in thecare of their biological mothers may not reflect a direct relationship between prenatal cocaine exposure and overall attachment, since children in foster care have usually been in their biological parents' care for months to years and have experienced more than one foster placement. Their caregiving situation at the time of the attachment assessment does not necessarily reflect the situation even a month earlier. Careful study of this issue will require far larger sample sizes and efforts to quantify the amount of exposure to the various caregiving situations.

An additional problem with measures of parenting as well as attachment rests with the issue of characterizing the actual caregiving

situation. Most of the studies of parenting among substance-abusing families have relied on parent report on instruments such as the Parental Attitudes Research Instrument (Wellisch and Steinberg 1980) that describe factors such as the degree of parental control, use of supports, or reliance on authori-tarian techniques. On measures such as these, substance-abusing mothers exhibit a range of parenting difficulties, including reliance on a more disciplinarian, threatening style of parenting and negative reinforcement (Bauman and Dougherty 1983).

In addition to the often cited problems of using self-report instruments withactively substance-abusing adults, reliance on such measures for descriptions of parenting styles does not address the questions of whether and how active cocaine abuse limits or distorts a mother's actions with her children. Infant attention, exploration, and use of language are influenced by maternal behaviors such as directing the infant's attention to a new toy, naming and pointing, or elaborating on the child's play. Because of the acute and chronic effects of cocaine on an adult's responsiveness, in addition to the more general effects of chronic stress and poverty, it is likely that cocaine-abusing mothers are able to do fewer of the types of activities most central to influencing the infant's attentional regulatory capacities, use of language, exploration, and play. Additionally, cocaine use is associated with a higher incidence of depressive symptomatology that may be both a premorbid state as well as a result of chronic cocaine use (Woods et al. 1991). In either case, such symptoms also impair an adult's ability to adequately care for a child.

There are very few direct observational studies of the interactive behaviors of cocaine-using women with their children. In one study of five polydrug-using mothers without a comparison group, drug-using mothers showed a reduction in reciprocal behaviors with their infant and infrequently structured and mediated the environment (Burns et al. 1991). These findings suggest problems with attention directing and structuring activity, but far more work is needed in this area.

METHODOLOGIC DILEMMAS

Throughout this chapter, several points have been made about method-ological problems inherent in the available studies to date. In summary, these are, first, the fact that samples are characterized by mixed drug exposure. No study has dealt with cocaine exposure

alone, including the most recent ones dealing with habituation and recognition memory in which maternal cocaine use during pregnancy was more carefully defined. At the very least, any findings that appear specific to the cocaine-exposed group reflect cocaine/alcohol exposure. It will take time to accumulate comparison groups exposed to alcohol only. The important develop-mental question may not be "What are the effects of cocaine exposure alone?" but, "Are there effects apparently related to a combination of cocaine/alcohol exposure?" In any case, the caution about attributing any findings in the present literature solely to cocaine use needs repeated highlighting. Additionally, all outcome studies in cocaine-exposed children are plagued by uncertain data about the timing, amount, and duration of the exposure to cocaine as well as other drugs.

The second problem is the considerable attrition in study samples and the likelihood that those families who remain in a longitudinal cohort do so for a variety of reasons including their own wish for help or concerns about the child. The most frequently voiced concern is that families who remain in treatment and in study cohorts are the most motivated and concerned, not the most impaired or dysfunctional. Thus, findings of only mild or no differences on various child assessments may reflect a sample biased toward children at lesser risk and thus are not generalizable to the larger population of prenatally exposed children. This concern has important policy implications, and underscores the need for some types of assess-ments of families who drop out of studies. Although such assessments cannot be as detailed as those already described, which provide a global measure of risk and need, the data are necessary to inform future research.

As has been stated by many reviewers, blinded assessments of the children are critical. Besides instituting a number of techniques such as coding from videotapes and using different examiners to see families, the author has begun asking examiners at the end of their session to indicate whether or not they feel they know the infant or child's exposure status and if so, why. The ability to guess correctly has been only slightly greater than chance, and the reasons given for choices indicate a number of deep-seated biases about the relation between drug abuse, parenting, and level of general disorganization.

The third methodological issue involves the point implicit throughout this chapter: how prenatal exposure interacts with the postnatal environment to affect those behavioral/developmental outcomes of most concern. Even basic neuropsychological functions such as

reactivity and attention are, as cited, quite sensitive to environmental effects. The three levels of most active effects are as follows.

(1) Overall increased perinatal risks due to the effects of cocaine on maternal health during pregnancy and the general effects of cocaine on fetal growth (apart from the specific effects on fetal brain development) contribute to an increased risk status for the infant and potentially result in an infant who is more difficult to care for.

(2) Continued maternal crack use after delivery puts the infant and child atrisk for passive exposure. No studies of early development and behavior in prenatally cocaine-exposed infants have considered the possibility of acute effects of cocaine due to recent postnatal exposure and the effects of chronic passive exposure on postnatal brain development, particularly during the period of synaptogenesis and synaptic remodeling occurring in the first postnatal months (Goldman-Rakic 1987).

(3) As noted above, continued postnatal use potentially affects the child's caregiving environment at three levels. Adults who are under the influence of cocaine are less able to respond adequately to their children at any given time. The effects of cocaine on an adult's attentiveness, as well as the effects of alcohol or other drugs, impair (at least during acute intoxication) the adult's ability to care for the child. More generally, because of the lifestyle associated with cocaine use (e.g., prostitution, crime, exposure to violence, and the over-whelming power of the addiction), the overall environment for these children is often chaotic, violent, and neglectful. The psychological/ personality factors that lead an adult to substance abuse (e.g., chronic affective disorder) (Rounsaville et al. 1982) may impinge on the adult's capacity to care adequately for the child. Additionally, some psychiatric disorders may also be associated with genetic risks for similar disorders in the child.

Importantly, none of these levels of prenatal or postnatal cocaine effects is more operative than another. If there is a specific effect of cocaine on fetal brain development, the exposed child may be more vulnerable to theeffects of postnatal exposure and environmental discord and chaos. These types of interactive models emphasize why it is important to examine multiple aspects of the cocaine-exposed child's functioning and environment and to think in terms of cumulative effects. Some outcomes in part related to the prenatal exposure may only become behaviorally apparent months to years after birth as a result of cumulative effects of multiple environmental failures and stressors.

CONCLUSION

In summary, the following areas are either potentially fruitful or much needed lines of investigation as part of ongoing studies of prenatally cocaine-exposed preschool children:

(1) studies of reactivity, persistence, attentional regulation, and the stability of such capacities from infancy into the second and third year of life;

(2) studies of language and communication with attention to early communicative precursors;

(3) direct observations of parent-child interaction with emphasis on parental attention-directing and structuring activities; and

(4) studies of the effects of chronic exposure to violence on such functions as a capacity for empathy or for mediating aggression.

Closer studies of basic functions that mature over time but nevertheless underlie broader developmental competencies and the interaction of such functions with the parental environment will provide a more adequate profile of potential specific and nonspecific problem areas of cocaine-exposed children as they reach school age.

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Click here to go to page 230