Published in final edited form as:
J Dev Behav Pediatr. 2013 January ; 34(1): 31–37. doi:10.1097/DBP.0b013e318277a1c5.

The Effect of Prenatal Methamphetamine Exposure on Attention as Assessed by Continuous Performance Tests: Results from the Infant Development, Environment, and Lifestyle (IDEAL) Study

Zeina N. Kiblawi, MD[a], **Lynne M. Smith, MD**[a], **Linda L. LaGasse, PhD**[b], **Chris Derauf, MD**[c], **Elana Newman, PhD**[d], **Rizwan Shah, MD**[e], **Amelia Arria, PhD**[f], **Marilyn Huestis, PhD**[g], **Sheri DellaGrotta, MPH**[b], **Lynne M. Dansereau, MSPH**[b], **Charles Neal, MD**[c], and **Barry Lester, PhD**[b]

[a]LABiomed Institute at Harbor-UCLA Medical Center and David Geffen School of Medicine, Los Angeles, CA, USA

[b]Center for the Study of Children at Risk, Warren Alpert Medical School of Brown University, Women and Infants Hospital, Providence, RI, USA

[c]John A. Burns School of Medicine, University of Hawaii, Honolulu, HI, USA

[d]Department of Psychology, The University of Tulsa, Tulsa, OK, USA

[e]Blank Hospital Regional Child Protection Center - Iowa Health, Des Moines, IA, USA

[f]Center on Young Adult Health and Development, University of Maryland School of Public Health, College Park, MD, USA

[g]Intramural Research Program, National Institute on Drug Abuse, National Institutes of Health, Baltimore, MD, USA

Abstract

Objective—The purpose of this study is to assess for increased risk of attention deficit hyperactivity problem in young children with prenatal methamphetamine exposure from the multicenter, longitudinal Infant Development, Environment, and Lifestyle (IDEAL) study.

Methods—IDEAL enrolled 412 mother-infant pairs at four sites (Tulsa, OK; Des Moines, IA; Los Angeles, CA; and Honolulu, HI). Methamphetamine exposed subjects (n=204) were identified by self-report and/or gas chromatography/mass spectrometry confirmation of amphetamine and metabolites in infant meconium. Matched subjects (n=208) denied methamphetamine use and had a negative meconium screen. This analysis includes a subsample of 301 subjects that were administered the Conners' Kiddie Continuous Performance Test (K-CPT) at age 5.5 years (153 exposed, 148 comparison). Hierarchical linear models adjusted for covariates tested exposure effects on K-CPT measures. Using the same covariates, logistic regression was used to determine

Correspondence to: Lynne M. Smith, M.D., Los Angeles Biomedical Institute at Harbor-UCLA Medical Center, 1124 West Carson Street, Box 446, Torrance, CA 90502, Telephone (310) 222-1968, FAX: (310) 222-3887, smith@labiomed.org.

Conflicts of Interest and Source of Funding
The authors have no conflicts of interest relevant to this article to disclose.

the effect of exposure on the incidence of a positive ADHD confidence index score, defined as greater than 50%.

Results—There were no differences between the groups in omission or commission errors or reaction time for correct trials. However, methamphetamine exposure was associated with subtle differences in other outcomes predictive of ADHD, including increased slope of reaction time across blocks ($p<0.001$), increased variability in reaction time with longer interstimulus intervals ($p<0.01$), and increased likelihood of greater than 50% on the ADHD confidence index (OR 3.1, 95% CI 1.2–7.8; $p=0.02$).

Conclusion—Prenatal methamphetamine exposure was associated with subtle differences in K-CPT scores at age 5.5 years. Even at this relatively young age, these children exhibit indicators of risk for ADHD and warrant monitoring.

INTRODUCTION

Methamphetamine (MA) abuse among women continues to be a significant problem in the United States. In 2009, 0.2% of reproductive-aged women stated they had used methamphetamine in the prior month[1]. Also that year, women accounted for 46% of patients treated for MA abuse in treatment centers[2]. Further, prevalence of MA abuse during pregnancy tripled in 2006, rising to 24% of all pregnant women admitted to federally funded treatment centers[3]. Similarly, this burden is shared globally, with international data from 2004 revealing amphetamine abuse by 23% of substance-abusing mothers[4].

MA is associated with neurochemical and structural alterations in areas of the brain known to affect attention and behavior. Positron emission tomography (PET) studies have shown a decrease in dopamine transporter and receptor density in the striatum in MA using adults[5]. Proton magnetic resonance spectroscopy has documented frontal white matter neurochemical abnormalities among MA exposed children ages 3–4 years[6] and volumetric magnetic resonance imaging assessments in exposed children have shown smaller subcortical volumes in areas that impact attention and memory, including the putamen, globus pallidus, and hippocampus[7]. Further, recent neuroimaging reports have demonstrated that MA exposure is associated with reductions in striatal and caudate volume[8].

Little is known regarding the neurobehavioral effects of prenatal MA exposure in school aged children. A longitudinal study of prenatal amphetamine exposure in Sweden found slightly lower general IQ in exposed preschoolers[9], as well as increased aggressive behavior and problems with peers in exposed 8-year-olds[10]. However, this study lacked a control group, utilized a small sample size, and did not control for additional prenatal drug use. A more recent report linked *in utero* MA exposure with deficits in executive function and spatial performance during elementary school[11], as well as delays in math and language in early adolescence[12]. However, these findings were retrospective, also utilized a small sample, and did not control for the impact of attention deficit disorder medication, which enhances cognitive abilities.

The multisite Infant Development, Environment, and Lifestyle (IDEAL) study is a prospective, longitudinal study of children exposed prenatally to MA. Previous findings from the IDEAL network have described a subtle neurobehavioral profile in infancy associated with MA exposure, including increased stress, poorer quality of movement, and lower arousal[13;14], despite controlling for maternal depression[15]. Additionally, the IDEAL study has reported behavior problems in exposed children, with increased emotional reactivity and anxiety/depression at ages 3 and 5, as well as increased externalizing behavior and ADHD issues at age 5[16]. The current study reports the effect of prenatal MA exposure on attention and impulsivity in 5.5-year-old children assessed by Conners' Kiddie

Continuous Performance Test (K-CPT). The K-CPT is a useful measure of inattention and impulsivity designed to assess 4- and 5-year-old children. The objective of this study was to assess for increased risk of inattention and impulsivity among 5.5-year-old children exposed prenatally to MA utilizing the K-CPT.

METHODS

Study Design

The IDEAL study is a multi-site, longitudinal study investigating the effects of prenatal MA exposure on childhood outcome. We have previously reported recruitment methods for the IDEAL study in detail[17]. Briefly, from September 2002 – November 2004, subjects were recruited at the time of delivery from seven hospitals in four geographically diverse, collaborating centers in the following areas: Los Angeles, CA; Des Moines, IA; Tulsa, OK; and Honolulu, HI. During the recruitment period, 34,833 mother-infant pairs were screened. Of the screened population, 26,999 were available to be approached, of which 17,961 (67%) were eligible for the study. Of the eligible population, 21% (3705) mother-infant pairs were consented for participation. Meconium tests were performed on all consented infants. MA exposure was determined by self-reported use during this pregnancy and/or a positive meconium screen and gas chromatography/mass spectroscopy (GC/MS) confirmation. Comparison subjects were defined as denial of MA use during this pregnancy and a negative GC/MS for amphetamine and metabolites.

A postpartum mother was excluded if she was <18 years of age; used opiates, lysergic acid diethylamide, phencyclidine or cocaine-only during her pregnancy; was institutionalized for retardation or emotional disorders; was overtly psychotic or had a documented history of psychosis; or was non-English speaking. Exclusion criteria for the infants included: critically ill and unlikely to survive, multiple birth, major life threatening congenital anomaly, documented chromosomal abnormality associated with mental or neurological deficiency, overt clinical evidence of an intrauterine infection, and sibling previously enrolled in the IDEAL study.

The Institutional Review Boards at all participating sites approved the study and all subjects signed an informed consent. Confidentiality of information regarding the mothers' drug use was assured by obtaining a National Institute on Drug Abuse Certificate of Confidentiality, which superseded mandatory reporting of illegal substance use.

Participants

The longitudinal follow-up sample included all MA exposed infants and mothers (n=204) and comparison dyads (n=208) matched on maternal race, birth weight, type of insurance, and education. Of the 412 enrolled subjects, 301 (153 exposed, 148 comparison) remained in the study through the 5.5-year assessment and were included in this analysis.

Procedures

After consent was obtained, a medical chart review and a recruitment Lifestyle Interview[18;19] were performed to acquire information about prenatal substance use, maternal characteristics and newborn characteristics. Heavy MA use was defined as use ≥3 times/ week throughout pregnancy. Socioeconomic status (SES) was determined using Hollingshead scale, an index that ranks SES based on occupation and years of education[20]. Meconium was collected in the nursery on all infants of consented mothers. Information on the collection procedures and analysis of the meconium samples has been previously published[17].

The K-CPT assessment was administered to the subjects at 5.5 years of age by certified examiners masked to MA exposure status. The K-CPT is a computerized, visual exam that analyzes performance measures associated with ADHD, with a published 91% sensitivity and 73% specificity[21]. This assessment was derived from the Conners' Continuous Performance Test II (CPT II), which is used for children ages 6 and older, in order to allow for earlier identification of attention deficits in young children. As opposed to the CPT II, which runs for 15 minutes and utilizes letters as the stimuli, the K-CPT run time is 7.5 minutes and uses a stimulus that is familiar to young children, including a ball, horse, house, scissors and a sailboat. During the K-CPT, the child is asked to press the spacebar each time a picture appears, unless the picture is of a ball. The pictures are presented in five blocks, first in 1.5-second interstimulus intervals (ISIs) followed by 3-second ISIs within each block.

The child's performance is scored based on eleven measures: Omission, the number of pictures that the child incorrectly did not respond to; Commission, the number of times the child incorrectly responded to the picture of the ball; Hit Reaction Time, the overall response time recorded in milliseconds (ms); Hit Reaction Time Standard Error, the within-child variability of standard errors of reaction times from one block to another; Attentiveness, how well the child discriminated between the target and nontarget pictures; Perseverations, the number of times the child responded in less than 100 ms indicating impulsivity; Hit Reaction Time Block Change, the slope of change in reaction times over the five time blocks; Hit Standard Error Block Change, the slope of change in reaction time standard errors over the five time blocks; Hit Reaction Time ISI Change, the slope of change in reaction times over the two ISIs (1.5 and 3 seconds); and Hit Standard Error ISI Change, the slope of change in reaction time standard errors over the two ISIs. In general, these measures collectively detect inattention and impulsivity. For example, high omission rates indicate distractibility; in contrast, high commission error rates with a fast reaction time indicate impulsivity while high commission error rates with a slow reaction time indicate inattention. Finally, an ADHD Confidence Index score, which corresponds to the likelihood that the child displays a clinical profile consistent with ADHD, is then calculated based on the child's scores on these measures. The developers of the K-CPT suggest that a Confidence Index score greater than 50% corresponds to an ADHD clinical profile[21].

Standard Covariate Set

Covariates were selected based on conceptual reasons, published literature, and maternal and newborn characteristics that differed between groups if not highly correlated with other covariates. Previous reports have described the effect of prenatal alcohol, tobacco, and marijuana exposure on continuous performance tests in children[22–25], resulting in the inclusion of prenatal exposure to alcohol, tobacco, and marijuana as covariates. Other covariates included study site, child's age at assessment; gender; SES; caregiver IQ; caregiver change; caregiver depressive symptoms; maternal education; partner status; HOME score; and mother's current alcohol, tobacco and marijuana use. Caregiver IQ was measured by the Peabody Picture Vocabulary Test at the 5.5 years assessment. Hollingshead SES was averaged from birth to 66 months (5.5 years), caregiver change included any change in the 66 months, caregiver depressive symptoms were averaged from 1, 12 and 36 month assessments, and the HOME score was determined at the 30-month assessment. There were 48 (15.9%) missing values for the HOME. Multiple imputation was used to impute HOME scores (SAS Proc MI, version 9.1.3, SAS Institute, Cary, North Carolina) for each of the K-CPT measures separately. Ten imputed data sets were generated for each analysis. The results of each dataset were combined for the estimation of regression parameters (SAS Proc MIANALYZE). Sensitivity analyses were performed on the data with and without the imputed values and the results were similar. Reported results are from the

analyses with the imputed data to retain the full sample. Continuous covariates were grand mean centered.

Statistical Analysis

Maternal and infant characteristics were examined by prenatal MA exposure status. Significance levels for differences in MA exposure were assessed using ANOVA to compare means and chi-square tests to compare proportions for categorical variables.

Hierarchical linear models (SAS Proc Mixed) were used to test associations between exposure effects (any use; heavy use, N=28; or some use, N=120) on K-CPT measures with adjustment for covariates. Study site was included to address the nesting structure of children in study sites.

Logistic regression was used to determine the effect of exposure on the incidence of a positive ADHD confidence index score, defined as greater than 50%. In all analyses, significance was accepted at $p<0.05$.

RESULTS

Maternal and Newborn Characteristics

A comparison of the dyads included and not included at the 5.5-year evaluation is shown in Table 1. Of note, there were no significant differences in race; presence of a partner at birth; education; maternal age; any or heavy prenatal MA use; prenatal tobacco, alcohol, and marijuana use; gender; gestational age; or birth growth parameters. The only difference between the two groups was in their average Hollingshead Index of Social Position (ISP) score, with the included group having a higher score.

The maternal characteristics are presented in Table 2. There were no differences between the groups in race, maternal age, and current alcohol or marijuana use. The MA-abusing mothers had a lower Hollingshead ISP score and were less likely to have a partner at the time of delivery relative to the comparison group. Furthermore, the methamphetamine group was more likely to abuse tobacco, alcohol and marijuana prenatally, and was more likely to use tobacco at the time of the 5.5-year assessment.

The neonatal characteristics are shown in Table 3. We found no differences in gender, birth weight, or birth head circumference between the MA-exposed and comparison newborns. However, while the exposed infants were generally born at term, their gestational age was slightly shorter than the comparison infants. Lastly, the exposed neonates had a shorter birth length than their comparisons. Of note, in this sample, 11 (7.2%) of 153 in the MA exposed group were also exposed to cocaine prenatally. Prenatal cocaine exposure was tested in the models and there were no significant effects.

Outcomes on the K-CPT Assessment

After adjusting for covariates, we found differences between the MA-exposed and comparison children (Table 4) in their Hit Reaction Time Block Change ($P<0.001$) and Hit Standard Error ISI Change measures ($P=0.002$). No differences between the exposed and comparison children were found regarding errors of Omission, Commission, Hit Reaction Time or Perseverations. Moreover, while neither group averaged greater than 50%, the exposed children had higher ADHD Confidence Index scores than their comparisons ($P=0.014$). In adjusted analyses, caretaker change was associated with a decrease in Hit Reaction Time Block Change and Hit Standard Error ISI Change ($P<0.05$ for all). Gender was associated with an increase in Hit Standard Error ISI Change and a higher ADHD

Confidence Index score (P<0.05 for all). Partner status was associated with a higher ADHD Confidence Index score (P=0.003, P=0.024). These findings persisted even when we evaluated the children exposed to heavy use and some use separately (Table 4). Additionally, the incidence of scoring greater than 50% on the ADHD confidence index was higher in MA exposed children than their comparisons (41 (26.8%); 22 (14.9%); P=0.011). After adjusting for covariates, MA exposure was associated with an increased likelihood of greater than 50% on the ADHD confidence index (OR 3.1, 95% CI 1.2–7.8; p=0.02).

DISCUSSION

This is the first prospective investigation reporting the effects of prenatal MA exposure on the incidence of inattention and impulsivity. We found MA-specific differences in the Hit Reaction Time Block Change and Hit Standard Error ISI Change, measures of vigilance and attention, respectively, as defined by the K-CPT. This suggests that the MA-exposed subjects were more likely to exhibit slowing, as well as less consistent reaction times, as the test progressed. Additionally, the exposed children had a higher ADHD Confidence Index Score, suggesting a greater risk of developing ADHD. These K-CPT findings remained significant despite analyzing the heavily exposed children separately, suggesting that these discrepancies were associated with any amount of MA exposure.

Our results compliment previous findings of alterations in neurobehavior associated with prenatal MA exposure, including aggressive behavior, problems with peers, and deficits in executive function and spatial performance[23;25]. Interestingly, the work of Piper's group did not find any differences in CPT performance between methamphetamine exposed and unexposed 7- to 9-year-old children; however, they did report a four-fold higher frequency of ADHD in the exposed children, with the majority having received drug therapies prior to behavioral testing in their investigation. Moreover, our results parallel the previously reported IDEAL findings of behavioral problems in exposed 3- and 5-year old children. At both ages the methamphetamine exposed children were described as having increased emotional reactivity and anxious/depressed symptoms, with externalizing and attention-deficit/hyperactivity issues by age 5 years[16].

Our findings of increased risk for inattention are consistent with other prenatal drug exposures. Continuous performance tests have been employed in studies of *in utero* exposure to tobacco, alcohol, and marijuana, correlating prenatal marijuana and alcohol exposure with increased errors of commission, as well as prenatal tobacco exposure with increased errors of omission[22;23;25]. Conners' K-CPT, specifically, has been used to demonstrate adverse attention-related outcomes among 5-year-old children exposed prenatally to organophosphate pesticides[26]. In addition, Conners' Continuous Performance Tests have shown attention deficits at 3-, 5- and 7-year old children in reports of intrauterine cocaine exposure, with increased errors of omission[22;25;27;28]. However, as opposed to our findings, studies have also linked intrauterine cocaine exposure with impulsivity, reporting errors of commission as well[22].

The strengths of this study include that it is a longitudinal, multisite, NIH funded investigation and is the first of its kind to evaluate the K-CPT with a MA exposed population. However, our results should be interpreted with caution, as there are limitations to our study. This report employs Conners' K-CPT to assess for ADHD. While Conners' CPT-II has been a reliable instrument used in numerous studies of drug exposed older children[27;28], the K-CPT has not been utilized as consistently in these high risk populations. In fact, despite a growing number of preschoolers presenting to clinicians for assessment of attention problems, the majority of tools developed to measure attention in this age group is described only in experimental literature[29]. Therefore, the validity and dependability of this

test may not be as strong as the CPT-II. While we inquired about parental medication use, we did not include parental ADHD as a covariate. Another limitation of our study was the exclusion of subjects in the enrollment process who were critically ill or had other major medical impairments. Therefore, our sample is biased toward healthier children and, as a result, our outcome measures may have been underestimated.

In conclusion, we found persistent neurobehavioral effects to prenatal MA exposure, with patterns of abnormal attention processing at 5.5 years of age. These findings were not dose-dependent and imply a modestly increased risk for developing ADHD associated with MA exposure. Longitudinal studies will determine if these findings amplify as these preschoolers approach school age. In order to minimize the neurological sequelae of MA exposure, these increased issues with attention suggest methamphetamine exposed children require close follow-up and behavioral screening.

Acknowledgments

This study was supported by NIDA Grant# 1RO1DA014948 and in part by the National Center on Research Resources Grant# 1UL1-TR000124 and 5P20 RR11091.

Reference List

1. Substance Abuse and Mental Health Services Administration. Office of Applied Studies; 2010. 2010. Results from the 2009 National Survey on Drug Use and Health: Volume I. Summary of National Findings. NSDUH Series H-38A, HHS Publication No. SMA 10-4856Findings. 2010.
2. Substance Abuse and Mental Health Services Administration. Treatment Episode Data Set (TEDS). Rockville, MD: Substance Abuse and Mental Health Services Administration; 2011. 1999–2009. National Admissions to Substance Abuse Treatment Services, DASIS Series: S-56, HHS Pubication No. (SMA) 11-46460.
3. Terplan M, Smith EJ, Kozloski MJ, et al. Methamphetamine use among pregnant women. Obstet Gynecol. 2009; 113:1285–1291. [PubMed: 19461424]
4. Oei J, Abdel-Latif ME, Clark R, et al. Short-term outcomes of mothers and infants exposed to antenatal amphetamines. Arch Dis Child Fetal Neonatal Ed. 2010; 95:F36–F41. [PubMed: 19679891]
5. Volkow ND, Wang GJ, Kollins SH, et al. Evaluating dopamine reward pathway in ADHD: clinical implications. JAMA. 2009; 302:1084–1091. [PubMed: 19738093]
6. Chang L, Cloak C, Jiang CS, et al. Altered neurometabolites and motor integration in children exposed to methamphetamine in utero. Neuroimage. 2009; 48:391–397. [PubMed: 19576287]
7. Chang L, Smith LM, LoPresti C, et al. Smaller subcortical volumes and cognitive deficits in children with prenatal methamphetamine exposure. Psychiatry Res. 2004; 132:95–106. [PubMed: 15598544]
8. Sowell ER, Leow AD, Bookheimer SY, et al. Differentiating prenatal exposure to methamphetamine and alcohol versus alcohol and not methamphetamine using tensor-based brain morphometry and discriminant analysis. J Neurosci. 2010; 30:3876–3885. [PubMed: 20237258]
9. Billing L, Eriksson M, Steneroth G, et al. Pre-school children of amphetamine-addicted mothers. I. Somatic and psychomotor development. Acta Paediatr Scand. 1985; 74:179–184. [PubMed: 3993362]
10. Billing L, Eriksson M, Jonsson B, et al. The influence of environmental factors on behavioural problems in 8-year-old children exposed to amphetamine during fetal life. Child Abuse Negl. 1994; 18:3–9. [PubMed: 7510211]
11. Piper BJ, Acevedo SF, Kolchugina GK, et al. Abnormalities in parentally rated executive function in methamphetamine/polysubstance exposed children. Pharmacol Biochem Behav. 2011; 98:432–439. [PubMed: 21334365]

12. Cernerud L, Eriksson M, Jonsson B, et al. Amphetamine addiction during pregnancy: 14-year follow-up of growth and school performance. Acta Paediatr. 1996; 85:204–208. [PubMed: 8640051]
13. LaGasse LL, Wouldes T, Newman E, et al. Prenatal methamphetamine exposure and neonatal neurobehavioral outcome in the USA and New Zealand. Neurotoxicol Teratol. 2011; 33:166–175. [PubMed: 20615464]
14. Smith LM, LaGasse LL, Derauf C, et al. Prenatal methamphetamine use and neonatal neurobehavioral outcome. Neurotoxicol Teratol. 2008; 30:20–28. [PubMed: 18031987]
15. Paz MS, Smith LM, LaGasse LL, et al. Maternal depression and neurobehavior in newborns prenatally exposed to methamphetamine. Neurotoxicol Teratol. 2009; 31:177–182. [PubMed: 19059478]
16. LaGasse LL, Derauf C, Smith LM, et al. Prenatal Methamphetamine Exposure and Childhood Behavior Problems at 3 and 5 Years of Age. Pediatrics. 2012; 129:681–688. [PubMed: 22430455]
17. Smith LM, LaGasse LL, Derauf C, et al. The infant development, environment, and lifestyle study: effects of prenatal methamphetamine exposure, polydrug exposure, and poverty on intrauterine growth. Pediatrics. 2006; 118:1149–1156. [PubMed: 16951010]
18. Lester BM, Tronick EZ, LaGasse L, et al. The maternal lifestyle study: effects of substance exposure during pregnancy on neurodevelopmental outcome in 1-month-old infants. Pediatrics. 2002; 110:1182–1192. [PubMed: 12456917]
19. Bauer CR, Shankaran S, Bada HS, et al. The Maternal Lifestyle Study: drug exposure during pregnancy and short-term maternal outcomes. Am J Obstet Gynecol. 2002; 186:487–495. [PubMed: 11904612]
20. Hollingshead, AB. Four factor index of social status. New Haven, CT: Department of Sociology, Yale University; 1975.
21. Conners, CK. Conners' Kiddie Continuous Performance Test. Toronto: Multi-Health Systems; 2001.
22. Noland JS, Singer LT, Short EJ, et al. Prenatal drug exposure and selective attention in preschoolers. Neurotoxicol Teratol. 2005; 27:429–438. [PubMed: 15939203]
23. Streissguth AP, Barr HM, Sampson PD, et al. Attention, Distraction and Reaction Time at Age 7 Years and Prenatal Alcohol Exposure. Neurobehav Toxicol Teratol. 1986; 8:717–725. [PubMed: 3808187]
24. Dolan GP, Stone DH, Briggs AH. A Systematic Review of Continuous Performance Task Research in Children Prenatally Exposed to Alcohol. Alcohol & Alcoholism. 2010; 45:30–38. [PubMed: 19995853]
25. Leech SL, Richardson GA, Goldschmidt L, et al. Prenatal Substance Exposure: Effects on Attention and Impulsivity of 6-Year-Olds. Neurotoxicol Teratol. 1999; 21:109–118. [PubMed: 10192271]
26. Marks AR, Harley K, Bradman A, et al. Organophosphate Pesticide Exposure and Attention in Young Mexican-American Children: The CHAMACOS Study. Environ Health Perspect. 2010; 118:1768–1774. [PubMed: 21126939]
27. Bandstra ES, Morrow CE, Anthony JC, et al. Longitudinal investigation of task persistence and sustained attention in children with prenatal cocaine exposure. Neurotoxicol Teratol. 2001; 23:545–559. [PubMed: 11792524]
28. Accornero VH, Amado AJ, Morrow CE, et al. Impact of Prenatal Cocaine Exposure on Attention and Response Inhibition as Assessed by Continuous Performance Tests. J Dev Behav Pediatr. 2007; 28:195–205. [PubMed: 17565286]
29. Mahone EM. Measurement of Attention and Related Functions in the Preschool Child. Mental Retardation and Developmental Disabilities Research Reviews. 2005; 11:216–225. [PubMed: 16161088]

Table 1

Comparison of dyads included and not included at 5.5 year evaluation.

	Number (Percent)/ Mean (SD)		
	Included (n = 301)	**Not Included (n= 111)**	**P-Value**
Race			0.907
White	116 (38.5%)	44 (39.6%)	
Hispanic	64 (21.3%)	28 (25.2%)	
Pacific Islander	55 (18.3%)	16 (14.4%)	
Asian	42 (14.0%)	15 (13.5%)	
Black	16 (5.3%)	6 (5.4%)	
American Indian	8 (2.7%)	2 (1.8%)	
Average SES (Average Hollingshead ISP)	32.4 (9.0)	27.4 (8.3)	<0.001
Partner at birth	167 (55.5%)	60 (54.1%)	0.796
Education <12 years	126 (42.0%)	46 (41.8%)	0.974
Maternal Age	25.0 (5.6)	25.7 (5.7)	0.279
Prenatal MA use	153 (50.8%)	51 (45.9%)	0.379
Heavy prenatal MA use (>=3 days/week)	28 (9.5%)	7 (6.5%)	0.493
Prenatal tobacco use	165 (54.8%)	53 (47.7%)	0.202
Prenatal alcohol use	71 (23.6%)	35 (31.5%)	0.102
Prenatal marijuana use	55 (18.3%)	21 (18.9%)	0.881
Gender (boy)	155 (51.5%)	65 (58.6%)	0.202
Gestational age	38.6 (2.1)	38.7 (2.0)	0.755
Birth weight	3235.8 (598.3)	3279.1 (602.5)	0.516
Birth length	50.4 (3.4)	50.4 (3.1)	0.913
Birth head circumference	33.8 (1.8)	34.1 (1.8)	0.105

Table 2

Maternal characteristics by MA exposure

	Number (Percent)/ Mean (SD)		
	Exposed (n = 153)	**Comparison (n= 148)**	**P-Value**
Race			0.933
White	56 (36.6%)	60 (40.5%)	
Hispanic	34 (22.2%)	30 (20.3%)	
Pacific Islander	29 (19.0%)	26 (17.6%)	
Asian	22 (14.4%)	20 (13.5%)	
Black	7 (4.6%)	9 (6.1%)	
American Indian	5 (3.3%)	3 (2.0%)	
Average SES (Hollingshead ISP)	30.4 (8.7)	34.4 (8.9)	<0.001
Partner at birth	66 (43.1%)	101 (68.2%)	<0.001
Education <12 years	73 (47.7%)	53 (36.1%)	0.041
Maternal age	25.3 (5.6)	24.7 (5.7)	0.416
Prenatal tobacco use	125 (81.7%)	40 (27.0%)	<0.001
Prenatal alcohol use	52 (34.0%)	19 (12.8%)	<0.001
Prenatal marijuana use	48 (31.4%)	7 (4.7%)	<0.001
Current tobacco use	70 (45.8%)	49 (34.3%)	0.044
Current alcohol use	73 (47.7%)	78 (54.5%)	0.240
Current marijuana use	10(6.6%)	6 (4.2%)	0.374

Table 3

Neonatal characteristics by MA exposure

	Number (Percent)/ Mean (SD)		
	Exposed (n= 153)	**Comparison (n= 148)**	**P-Value**
Gender (boy)	80 (52.3%)	75 (50.7%)	0.780
Birth weight (g)	3184.5 (619.2)	3289.9 (573.2)	0.130
Birth length (cm)	49.9 (3.6)	51.0 (3.1)	0.004
Birth head circumference (cm)	33.6 (1.8)	34.0 (1.8)	0.096
Gestational Age (weeks)	38.3 (2.3)	39.0 (1.8)	0.001

Table 4

Selected coefficients from mixed models[a].

Outcome	Parameter	Any Use			Heavy vs. No Use			Some vs. No Use		
		Estimate	SE	*p*	Estimate	SE	*P*	Estimate	SE	*P*
Hit Reaction Time Block Change	Prenatal MA	17.73	4.49	<0.001	17.74	7.15	0.013	17.29	4.26	<0.001
	Caretaker Change	−8.85	4.20	0.035	−9.32	4.17	0.025			
Hit Standard Error ISI Change	Prenatal MA	7.94	2.50	0.002	8.36	4.00	0.037	7.38	2.36	0.002
	Caretaker Change	−5.34	2.33	0.022	−4.96	2.33	0.033			
	Gender	4.03	1.82	0.027	4.19	1.84	0.023			
ADHD_Confidence_Index	Prenatal MA	9.90	4.01	0.014	13.62	6.34	0.031	10.2	3.80	0.007
	Gender	8.67	2.94	0.003	8.62	2.97	0.004			
	Partner	6.85	3.03	0.024	6.89	3.11	0.027			

[a]All analyses adjusted for any prenatal exposure to alcohol, tobacco, marijuana, child's age at assessment, gender, SES (avg. birth to 66 months), caregiver IQ, caretaker change (any change through 66 months), caregiver depressive symptoms (average 1, 12, and 36 months), maternal education, partner status, HOME score (30 month assessment) mother's current alcohol, tobacco, and marijuana use, and study site.