1995

Understanding the Impact of Polydrug Exposure on Child Development and Early School Performance

Kristine Coyle Larkin
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LOYOLA UNIVERSITY CHICAGO

UNDERSTANDING THE IMPACT OF POLYDRUG EXPOSURE ON CHILD DEVELOPMENT AND EARLY SCHOOL PERFORMANCE

A DISSERTATION SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL IN CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF CURRICULUM INSTRUCTION AND EDUCATIONAL PSYCHOLOGY

BY KRISTINE COYLE LARKIN

CHICAGO, ILLINOIS
JANUARY, 1996
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CHAPTER I
INTRODUCTION

Throughout the history of the United States, prohibitions of potentially harmful and addictive substances have been legislated by the federal government in an effort to protect both individuals and society. With the enactment of the Pure Food and Drug Act of 1903, government first attempted to protect individuals from various drugs. The degree of success of such legislative efforts, however, has been frequently debated in light of the estimated growing incidence of addicted individuals.

Addiction to substances affects all areas of a person's life - biological, psychological, and social - and has the potential to render a person, even a mother, uncaring and utterly disinterested in everyone and everything except that which is related to procuring additional drugs. It should be noted that addiction does not have a greater propensity to occur in specific ethnic groups and/or among those of particular socioeconomic levels (Chasnoff, Landress, & Barrett, 1990). In addition, addiction is not necessarily the result of a substandard set of moral values or a personality disorder. In what follows, an effort will be made to develop a strong case for the notion that an addicted individual and the effects that an addicted individual may have on those around him or her are perhaps best understood by studying a
multitude of influences, including environmental and social components.

**Incidence**

A study conducted in Florida revealed some interesting statistics and descriptive information regarding addiction and drug use by pregnant women. Common perceptions of a 'drug-abusing mother' often are restricted to a poor, unmarried minority woman typically living in a public housing project. Interestingly, it is true that these are indeed the individuals who are most likely to be reported to the authorities for illegal substance use by their doctor (Chasnoff et al., 1990). However, by no means are they the only women in society today who are abusing drugs during the course of their pregnancy. It was reported that the prevalence detected between public and private health clinics through the use of urine tests was quite similar overall, with 16.3% of the pregnant women testing positive for drug use in the public clinics and 13.1% of the pregnant women testing positive for drug use in the private clinics (Chasnoff et al., 1990).

This sample was further studied according to their ethnicity and it was found that among those women who had been identified as having used drugs, the percentage of the women from the two different ethnic backgrounds studied (African American and Caucasian) were approximately equal (Chasnoff et al., 1990). From this research it can be seen that viewing the issue of prenatal drug exposure as only an inner city
The scope of this substance abuse problem and its resulting effects on unborn children was also uncovered by use of a survey performed by the National Household Surveys on Drug Abuse (1988 and 1990). The investigators reported that approximately 350,000 to 625,000 children were exposed in utero to one or more illegal drugs each year (Gomby & Shiono, 1991). Other estimates have been reported that document that between 11% to 18% of the newborns each year have been prenatally exposed to illicit substances (Chasnoff, 1992b; Chavkin, Allen, & Oberman, 1991; DeSylvia & Klug, 1992; Elliot & Coker, 1991; Gittler & McPherson, 1990).

Drug Abuse Research

The drug that has been most commonly used by pregnant mothers is cocaine (Fejes-Mendoza, 1991). Notably, however, research has shown that drug abusing mothers who use a substance such as cocaine typically use other substances as well. That is, a person who uses an illicit drug such as cocaine will often use other substances such as marijuana, heroin, alcohol, and tobacco, to enhance the effects of
cocaine (Chasnoff, 1991a; Chasnoff, Griffith, Freier, & Murray, 1992; Streissguth, Grant, Barr, Brown, Martin, Mayock, Ramey, & Moore, 1991). This pattern of multiple drug use has been described as 'polydrug use' and is the most frequent pattern of drug use found among substance abusing women.

It appears that a significant amount of research in the field to date has not been directed at the issue of polydrug use. Most researchers have focused on the main effects from a single drug when a single drug has not been methodically verified as causing isolated outcomes (Beeghly & Tronick, 1994). These researchers have claimed to have uncovered single effects of drug use, when in fact proper control of maternal use of other substances (such as alcohol, tobacco, and marijuana) has not been achieved and verified. Given this situation, it is the author's view that the results of these single effect studies should be cautiously interpreted.

**Child Development and Polydrug Exposure**

Over the past several years there has been considerable fear proliferated by media coverage focusing on worst-case scenarios regarding the children's developmental outcomes of these polydrug using mothers. Many have claimed that those born exposed to cocaine will be "doomed to a misty, stumbling life," (Rosenthal, 1993, p. A33). The message portrayed has been that the majority of children born to these mothers who have used drugs during their pregnancy will be extreme behavioral challenges in our classrooms (Bauer, 1991;
Gregorchik, 1992; Rist, 1990) in addition to their having attentional weaknesses, language delays, and cognitive deficits (Sautter, 1992). The growing number of drug exposed children is believed to be at least partially responsible for an increase in special education referrals in large metropolitan areas, such as New York City (Cohen & Taharally, 1992). However, researchers are now beginning to demonstrate that any differences these children exhibit are not entirely unique to their drug exposure and that there are a multitude of variables to consider when attempting to describe which factors may have affected a child's overall development (Beckwith & Parmalee, 1986; Beeghly & Tronick, 1994; Brooks, Zuckerman, Bamforth, Cole, & Kaplan-Sanoff, 1994; Coles & Platzman, 1993; Delapenha, 1992; Freier, 1994; Griffith, 1992; Griffith, Azuma, & Chasnoff 1994; Lester & Tronick, 1994; Neuspiel, 1993; Parker, Greer, & Zuckerman, 1988; Richardson & Day, 1994; Wasik, Ramey, Bryant, & Sparling, 1990; Zuckerman & Frank, 1992). Another important finding is that many of these children do not appear to have severe learning disabilities (Cohen & Taharally, 1992).

The more accurate perspective of looking at the commonalities of all children, regardless of whether or not they have been prenatally drug exposed, recognizes the importance of a child's environment, both the immediate environment of his or her actual home and the more distal environment of his or her community (Bernstein, Hans, & Percansky, 1991; Brooks et al., 1994; Bronfenbrenner, 1986; Chasnoff, 1991b). The importance of a child's environment and
whether or not the child is able to master his or her environment has long been recognized by researchers such as Erikson (1950) and Bronfrenbrenner (1986) as being critical if there is potential for the child's healthy development (Miller, 1989). These researchers have addressed the detrimental impact the environment may have on development when a child's needs of attachment, security, and trust are preempted by an unstable environment and/or an unpredictable caregiver.

Investigations directed at concurrently examining the effects of prenatal polydrug exposure ('nature') and the integral role of the environment ('nurture') on the child's development make logical sense, particularly in the field of drug exposure. The nature versus nurture controversy revolves around the question as to what is more important: what individuals are endowed with genetically (nature) or the environment and circumstances under which individuals are reared (nurture) (Miller, 1989). Fortunately, most researchers and educators appreciate the significance of both nature and nurture, the interaction of nature and nurture, and that there may be critical periods of development when either nature or nurture may take on a more principal role in child development (perhaps with nature being pivotal in prenatal development and nurture being critical during early childhood).

The study to be described in what follows was designed in an effort to better understand the cumulative effects of polydrug exposure on child development and early school
performance. The early school performance of a sample of children (N=37) selected from the original cohort established seven years ago was systematically evaluated. Approximately one half of the original sample has been lost due to attrition. It should be noted that these children were afforded numerous early intervention opportunities and benefits. The children's current developmental performance (cognitive, academic, and behavioral) was studied within the context of other information obtained over the course of an ongoing longitudinal study. It is hoped that this broadened investigation of the ecological variables influencing children as they develop will enable professionals to more accurately understand and facilitate the healthy development of all children.
CHAPTER II
REVIEW OF THE LITERATURE

This chapter begins with an examination of the research that was designed to delineate single effects of some of the most commonly used drugs and their influence on early child development. In the second section of the chapter research related to polydrug usage by pregnant women and the potential biological and neurological outcomes associated with polydrug usage on infants is summarized. In the third section of the chapter, a review of the theories and research related to the psychological impact of being raised by an addicted caregiver is presented. Research related to polydrug exposed children beyond infancy is then described. The final section of the chapter consists of a critical summary of the research done in the field of polydrug exposure.

Research Predicting Single Effects of Drugs

The substances to which many are presently addicted include tobacco, alcohol, marijuana, heroin, and cocaine. The effects of each of these drugs have been researched with specific attention being paid to the effects on the child's prenatal and postnatal development. In what follows, a summary of some of the most frequently used drugs and their hypothesized effects is presented.
Tobacco

It has been estimated that nearly 25% of women continue to smoke during their pregnancy, despite potentially endangering their child. Research has shown that prenatal exposure to tobacco smoke has a relationship with preterm delivery, spontaneous abortion, and low birthweight (Floyd, Zahniser, Gunter, & Kendrick, 1991; Naeye, 1992). In fact, maternal smoking has been cited as the one source of low birthweight that could be most easily avoided. The amount the mother smokes is believed to be inversely proportional to the fetal growth of the child (Sastry, 1991) and to be correlated to a decreased flow of amino acids through the placenta. The developing child's supply of amino acids are transported through the placenta and are dependent upon the mother's own supply of amino acids. The efficient transfer of amino acids may be undermined by a mother's smoking and the subsequent presence of nicotine and carbon monoxide create a reduced oxygen supply through the placenta (Sastry, 1991).

Altered neurobehavior has been associated with maternal tobacco use. It has been cited that there is a rise in neurobehavioral anomalies for those infants who were prenatally exposed to tobacco based on the infants' performance on the Brazelton Newborn Assessment Scales (Chiraboga, 1993). This test was designed to assess a child's reaction to stimuli. It has been reported that infants whose mothers smoked tobacco had seriously influenced autonomic regulation, orientation, and habituation. They also exhibited
delays in hearing capability as well as a modified startle response (Chiraboga, 1993).

Some research has proposed that there is an inverse relationship between the amount of smoke to which a child was exposed prenatally and the child's subsequent cognitive development (Bauman, Flewelling, & LaPrelle, 1991). This study was guided by the theory that maternal smoking reduces the amount of oxygen available in utero to the child and therefore may simultaneously be adversely affecting development of the child's brain. Results of the study did suggest a relationship between the cognitive test used and maternal smoking and that the relationship may be proportional to the amount which the mother smoked (Bauman et al., 1991). The researchers additionally studied potential intervening variables that may have affected the child's cognitive ability, including the learning environment as established by the parent as well as the parent's health to determine if these factors may have contributed to differing cognitive abilities. After partialling out the effects of these variables, however, there still remained relationships between the child's cognitive ability and the parent's smoking.

Other researchers have replicated the findings of Bauman et al. (1991) and have concluded that the amount a mother smoked during pregnancy may be inversely proportional to the child's cognitive development (Sexton, Fox, & Hebel, 1990). Groups of children who were three years of age were grouped according to when their mothers had quit smoking during their pregnancy (during the 20th, 25th, or 30th week of gestation).
Similar to the previous study, these researchers attended to intervening variables, including the amount of alcohol drank by the pregnant women. It was found that the children of the mothers who had stopped smoking compared to the children of the mothers who had continued to smoke, achieved at a statistically higher level on cognitive measures, specifically those measures which were language-based. Similarly, research conducted by Fried, O'Connell, and Watkinson (1992) has supported the hypothesis that prenatal exposure to tobacco is related to decreased cognitive performance and weaker language skills after controlling for alcohol use by the mother.

Investigations targeted at the behavior of children prenatally exposed to tobacco have yielded a number of interesting results. Naeye (1992) studied children in the same family (to help reduce for the confounding effects of the environment) whose mothers had smoked during the pregnancy of one child but not during the pregnancy of a sibling. The findings indicated that there was indeed an increased incidence of hyperactivity, impulsive behavior, and decreased attention span associated with those children who had been exposed to tobacco prenatally compared to their own siblings who had not been exposed to tobacco (Naeye, 1992).

Research conducted by Fried, Watkinson, and Gray (1992) replicated the results reported by Naeye (1992) with regard to supporting the relationship between intrauterine exposure to tobacco and child hyperactivity. A negative correlation was found between the child's abilities on the behavioral measures administered and the amount of tobacco to which the child had
been exposed. The areas of behavior which were investigated included assessments of the child's impulsivity and attention. The investigators reported a noticeable relationship between a mother's smoking and her child's impulsivity.

Alcohol

Alcohol, like tobacco, is another legal drug frequently used by pregnant women. It serves as a depressant for the central nervous system and decelerates such functions as the mother's pulse, heart rate, and respiration. Of all the drugs to which a child may be prenatally exposed, it appears that exposure to alcohol may have the most harmful effects (Coles & Platzman, 1993). The impact of alcohol on the developing fetus is identified to be the principal known source of cognitive delay in children and the second most common source of birth defects.

Prenatal exposure to alcohol has been associated with such profound effects as Fetal Alcohol Syndrome (FAS). Deficits composing the pattern of FAS include: a) prenatal and/or postnatal growth retardation (with the child's weight and length being below the 10th percentile); b) central nervous system deficits, encompassing developmental delays, neurological anomalies, hyperactivity, and cognitive delays; and c) a combination of irregular facial characteristics including microcephaly (small head circumference), flattened nasal bridge, eye abnormalities (wide-set eyes, small eye openings, drooping eyelids), thin upper lip, and long philtrum
There are three times as many children who have had prenatal alcohol exposure but do not have deficits in any of the three categories described above for FAS. These children may be diagnosed as having Fetal Alcohol Effects (FAE) or Alcohol Related Birth Defects (ARBD). The distinction between FAS and FAE is not necessarily one of severity. Rather, children described as having fetal alcohol effects do not have characteristics in each of the three specific categories required for classification as FAS. Similar to children with Fetal Alcohol Syndrome, children with Fetal Alcohol Effects often are of low birthweight, have cognitive delays, and behavioral problems. Regarding older children's development, their prenatal alcohol exposure has been associated with impaired judgment, memory problems, anxiety, and depression (Scherling, 1994).

These children's performance and behavior in school may include hyperactivity, learning disabilities, attentional deficits (Scherling, 1994), and aggression (Gonzalez & Campbell, 1994). Additional areas where children who have been prenatally exposed to alcohol may exhibit weaknesses are in the areas of impulsiveness, speech and hearing difficulties (Streissguth, Sampson, & Barr, 1989; Van Dyke & Fox, 1990), and increased difficulties with problem solving (Streissguth & LaDue, 1985).

Review of alcohol abuse compared to other substance abuse by a parent suggests that those who use only alcohol are
viewed differently by the courts. Alcohol use appears to be viewed more positively than abuse of other substances (such as cocaine or marijuana). It has been estimated that of those parents who have their children removed from their custody, 90% of them are using illicit drugs while only 60% of those who use only alcohol have their children permanently removed. It should be noted that 95% of the parents who use only alcohol were repeatedly involved in the court system studied for child mistreatment. It appears that the alcohol rehabilitation procedures in place designed to help the caregiver recover and resume adequate care for the child are highly unsuccessful. Furthermore, these procedures serve to simply retain the child in what may be a very chaotic and unpredictable home environment (Murphy et al., 1991).

Marijuana

One illegal drug mistakenly believed to be harmless is marijuana – a drug made from the plant Cannabis Sativa. An estimated 14 to 27% of women have reported using marijuana at some point during pregnancy (Chiraboga, 1993). The primary component of this drug which produces the desired intoxicating effect is THC (delta9-tetrahydrocannabinol). The dried fragments of the plant are the primary ingredient in the cigarette which is smoked by the user. Correlations between low birthweight, greater risk for Sudden Infant Death Syndrome (SIDS), and increased irritability have been found for those infants whose mothers used marijuana during their pregnancy.
Animal studies have shown that the effects of maternal marijuana use on the child are greatest during the last trimester and that prenatal exposure to marijuana is highly associated with growth retardation. The means by which marijuana exercises its potency, however, are unidentified at this time. What is known is that the metabolites of marijuana are easily passed through the placenta and may linger up to thirty days before being excreted. Additionally, the carbon monoxide created by marijuana is five times the amount caused by cigarette smoking and could be intertwined with the child's oxygen supply and prenatal growth (Chiraboga, 1993).

Research on the cognitive ability, behavioral development, and language development for marijuana exposed children has indicated that there is not a relationship between exposure to marijuana and subsequent development for children one or two years of age (Fried, 1989). Fried examined the children's home environment and attempted to determine if marijuana exposure was related to the child's postnatal growth outcomes. Multiple regression was used to determine if prenatal marijuana exposure would help to predict resulting development. The children's prenatal exposure to marijuana was not found to significantly predict the domains of development being evaluated. When these same children were studied at four years of age, however, it was found that poorer memory and verbal ability were associated with their prenatal marijuana exposure (Chiraboga, 1993).

These findings were replicated in research conducted by a team from Ottawa (Fried et al., 1992) who studied the
language and cognitive development of children at age four who had been prenatally exposed to marijuana as well as the control group who had not been exposed to marijuana. Once again, a mother's use of marijuana during pregnancy was not found to be negatively correlated with global measures of cognitive or language development, whereas it was found to be related to specific subtests on the McCarthy Scales of Children's Abilities (verbal and memory subtests). This correlation continued to be significant after other variables were controlled. The researchers postulated that skills demanded of the four year olds, particularly on the cognitive measure, required a higher level of development and thus made evident some small and elusive weaknesses believed to be related to the marijuana exposure that were not evident two or three years prior (Fried et al., 1992).

Notably, a study conducted by Day, Richardson, Goldschmidt, Robles, Taylor, Stoffer, Cornelius, and Geva (1994) yielded results analogous to those of Fried et al. (1992). Their research focused on a group of three year olds exposed intrauterine to marijuana and the children's cognitive development. Similar to the aforementioned research by Fried et al. (1992), prenatal marijuana exposure was not found to be negatively correlated with overall cognitive ability at age three as estimated by the Stanford-Binet Intelligence Scale: 4th Edition. However, the marijuana exposure was found to be significantly correlated to the child's abilities as measured on the short-term memory subtests of the cognitive measure. These researchers further analyzed the children in their
program specifically according to the children's race and their performance on the cognitive measure. The ethnic groups which composed the given sample were Caucasians (50%) and African-Americans (50%). When the analysis was performed for each individual ethnic group, the adverse effects of prenatal marijuana exposure were observed on the verbal reasoning subtests and the short-term memory subtests, but only for the African-American three year olds. Finally, it was reported that for the Caucasian children in the study, that their achievement on the cognitive measure was countered by being enrolled in a pre-school or day-care program (Day et al., 1994).

In a study performed by O'Connell and Fried (1991), two groups of school-age children were compared. One group was established as the control group which had been exposed to tobacco and alcohol in utero while the comparison group of school-age children had been prenatally exposed to marijuana in addition to alcohol and tobacco. Results of this study suggested that prenatal marijuana exposure may make those children more susceptible to having behavior problems as measured on the Conners' Parent Questionnaire, specifically the Conduct Problems Scale (O'Connell & Fried, 1991).

Heroin

Heroin is an opioid, a synthetic narcotic, that originates from the opium-yielding poppy, Papaver somniferum. Examples of opiates which are derived naturally include opium,
morphine, and codeine while examples of opioids other than heroin include darvon, demerol, and methadone. Opiates are believed to have been in existence for several thousand years, dating back to early Egyptian and Mesopotamian cultures (Hoegerman & Schnoll, 1991). Much like cocaine, heroin was believed to be nonaddictive and was proclaimed to be a cure for morphine addiction. With the Pure Food and Drug Act of 1903 came the regulation of narcotics and the recognition that its use may be harmful.

Heroin is believed to be the most commonly used opioid in the United States. This drug acts as a depressant on the central nervous system, is typically used for an euphoric effect, and is frequently prescribed by a physician to abate pain. It is believed that addiction to heroin takes nearly two years from the time of initial usage and that a tolerance level may be built up such that a user would have to increase the amount taken to achieve the desired effect (Hoegerman & Schnoll, 1991). It is postulated that infants may be born addicted to opiates and exhibit withdrawal symptoms. Neonatal withdrawal frequently develops among those newborns who have been exposed prenatally to opiates and is considered to be an extremely dangerous threat to their lives (Dow-Edwards, 1991).

Research findings related to the effects of prenatal opiate exposure have not yielded conclusive results, perhaps because of the many confounding variables involved including polydrug use, inaccuracy of self-report data, differential effects of the environment, and the inability to control the dosage of a substance to study the level of substance
exposure. Hoegerman and Schnoll (1991) said that the research regarding the impact of heroin exposure on long-term child development is "scarce, often contradictory, and inconclusive," (Hoegerman & Schnoll, 1991, p. 53). These researchers readily admitted that any delays in development or difficulties in learning could not be specifically cited as being directly caused by the narcotic exposure when the same children were reared in a seemingly precarious environment.

Studying the effects of maternal methadone use are more easily regulated than the effects of heroin, as long as the mother does not supplement the methadone with another narcotic. Mothers who use methadone instead of heroin are believed to give birth to children with fewer medical complications upon delivery and improved neonatal outcomes (Hoegerman & Schnoll, 1991). Women addicted to heroin, on the other hand, have been found to have an increased amount of premature deliveries and placental abruption (Finnegan, Hagan, & Kaltenbach, 1991; Little, Snell, Klein, Gilstrap, Knoll, & Breckenridge, 1990).

The rationale for supplanting methadone for heroin may appear to be contradictory as both are controlled substances. The critical difference is that methadone is a considerably safer drug for both the mother and her unborn child. Methadone, unlike heroin, is an opioid that is sustained in a person's system for a relatively long period of time and can be taken orally. Thus, the risk of being exposed to contaminated needles is controlled and the nature of the methadone remaining in the human system for a longer period of
time serves to stabilize the woman's cravings for a greater amount of time (Zweben & Payte, 1990). Another concern regarding persons advocating the use of methadone for pregnant addicts is that they are supporting a woman's desire to be high. This, however, should not be the case if the physician prescribing the amount of methadone to be taken monitors the effects on the individual and any symptoms (or lack of) that may be exhibited. It has been argued that if "the proper dose of methadone is administered...then no euphoria and no narcotic effect...can be perceived by the patient or observed or measured by the physician...and withdrawal symptoms will not appear for twenty-four or more hours," (Zweben & Payte, 1990, p. 591).

Deliveries of infants whose mothers had been treated using a methadone maintenance program of intervention were found to be routine. The sooner in the pregnancy the woman makes the transfer from heroin to methadone, the better the effects for her and her child. Women who switched to methadone were found to have extended pregnancies and babies with a greater birthweight in comparison to those women who continued heroin use throughout pregnancy (Zweben & Payte, 1990). These children who were methadone exposed were again studied when they were six months of age and were not found to have any unusual developmental difficulties.

Early child development for those who have been heroin exposed may involve behavioral problems, difficulty getting along with one's peers, or mild developmental delays (Gonzalez & Campbell, 1994; Little et al., 1990) with no specific
syndrome, in contrast to those children who have been prenatally exposed to alcohol. It should be noted that the children followed by these researchers were of a significantly lower birthweight and length, yet their head circumference was not found to be significantly reduced.

Research conducted by Hans (1989) suggested that heroin may indeed have a direct impact on small head circumference, more weakly developed motor coordination, greater body tension, and lagging development of motor milestones. Regarding cognitive development, however, there were not found to be any direct effects for the group of children born exposed prenatally to heroin. When the groups were looked at individually according to their environment, however, it was found that those who were reared in 'extremely poor environmental circumstances' exhibited significantly delayed cognitive growth (Hans, 1989).

Coles and Platzman (1993) compared groups of school-aged children who had been prenatally exposed to heroin, methadone, or were nonexposed. There were not found to be any significant differences among the three groups of children. However, the group that had been exposed to heroin had a greater frequency of children with severe cognitive delays (Coles & Platzman, 1993).

Cocaine

Research demonstrates that perhaps the most prevalent of these addictive substances is cocaine. Cocaine has been
present in a variety of forms in the United States for well over a hundred years and prior to knowledge of its negative side effects and its highly addictive nature, it was a widely recommended remedy for a variety of afflictions including hay fever, alcoholism, and morphine addiction. The illusions related to the use of cocaine have been that it is innocuous, not addictive, and an aphrodisiac (Cregler & Mark, 1986). Amazingly, cocaine was even named the official remedy of the United States Hay Fever Association in 1886 (Musto, 1992).

It was not until the early 1900's that the effects of cocaine became better understood. It was subsequently regulated by law with the Harrison Act of 1914 (the first federal law outlawing cocaine) which required that it be prescribed only by a medical doctor. After the legal ban, the use of cocaine dropped markedly over the next several decades to the point that cocaine abuse was reported to be no longer a serious concern (Musto, 1992).

The popular reemergence of cocaine (along with heroin, marijuana and LSD) occurred in the late 1960's in combination with a more tolerant view towards the experimentation of drugs. Cocaine was considered to be a 'safe drug' as its use did not require an injection and it was commonly believed to be nonaddictive. This drug has been described as a short-acting stimulant for the central nervous system obtained from the South American coca bush. In the United States it is customary for it to be sold as a pure white powder combined with additives so that it is more profitable for the seller. Cocaine in this form is snorted thorough the nose, injected,
or modified into a smokable form and is then in 'freebase' form (Harpring, 1990). Its prevalence in the United States did not escalate notably until 1985 or 1986 when a new form of cocaine ("crack") was created that was more affordable.

It is important to note the impact that the more affordable cost of crack is believed to have had on the incidence of drug use. Previously cocaine was quite costly and was referred to as "the champagne of drugs," and its high price (estimated to be $1000 or more per ounce) hindered extensive use of it (Cregler & Mark, 1986; Hutchings, 1993). As of late, however, cocaine has become more affordable through its use in the form of crack and its accessibility has escalated. Inventive drug dealers modified the standard powder form of cocaine to restore it back to a free base and marketed it in individual use quantities. The prevalence of cocaine use prior to crack was estimated to lie near 21.6 million users in 1982 and shortly thereafter jumped to an estimated 35 to 40 million users in 1987 (Kandall, 1991). Because of this new form of cocaine and its highly addictive nature, the percentage of cocaine users virtually exploded in the inner cities, specifically among the impoverished and depressed neighborhoods, where drug use has been more prevalent (Elliot & Coker, 1991). In New York City, cocaine has been documented to be the primary substance abused by pregnant women (Kaye, Elkind, Goldberg & Tytun, 1989). Today, it is believed that as many as 30% to 40% of the cocaine addicts are women who are of childbearing age (Kandall, 1991).

Many researchers rely on the urine analysis results of
newborns to obtain a reliable estimate of the number of cocaine exposed children. Unfortunately, this commonly used method may not identify maternal cocaine use in 60% of the truly exposed children (Sumner, Mandoki, & Matthews-Ferrari, 1993). The problem with using the immunoassay of urine to uncover cocaine is the brief half-life of cocaine and its metabolites. Those urine analyses which have tested positive at a child's birth point to only those women who have used cocaine within the past one to five days. In order for this sampling technique to provide a more accurate estimate of incidence, it is believed that the technique would have to be employed frequently throughout a woman's pregnancy to insure that one is obtaining a reliable calculation of actual usage. A more reliable and more recently created technique is that of studying a child's meconium. Meconium samples of a newborn provide a much broader window as to whether or not a child has been drug exposed as analysis may uncover exposure from as early as the first trimester (Dow-Edwards, 1991; Singer et al., 1993).

Crack is believed to be the most commonly used form of cocaine today. It is made by combining cocaine in its powder or crystal form with water and baking soda. This compound is then boiled until all the water has been removed and what remains are chunks or pellets which are to be smoked (Smart, 1991). As it is smoked, the drug is imbibed swiftly through the lung and creates an abrupt high for a total of five to fifteen minutes within ten to fifteen seconds after use. Persons have reported that immediately after smoking crack,
that they feel omnipotent and sexually excited. Because the desired effect occurs so promptly after use, its addictive nature is believed to be further increased. Additionally, effects of crack are thought to be considerably more robust than cocaine in a powdered form (Cregler & Mark, 1986; Dixon, Bresnahan, & Zuckerman, 1990).

Cocaine acts as a stimulant on the central nervous system and its immediate influences include constriction of blood vessels and dilation of the pupils. Use of cocaine may end with brain seizures, strokes, hypertension, and the respiratory failure of otherwise healthy persons (DeSylvia & Klug, 1992; Hutchings, 1993; Hutchinson, 1991). Initial feelings of euphoria and reduced fatigue are succeeded by a nervous, agitated, anxious and depressed temper (Bauer, 1991; DeSylvia & Klug, 1992). The continued use of cocaine and its repeated stimulation of the brain's neurotransmitters may have the effect of establishing a tolerance level such that additional amounts of cocaine would have to be used in the future if a person wants to continue getting the same high. There is disagreement among those in the field regarding how long it would take to become addicted. Some say it can occur within just a few uses of the drug while others believe that addiction would require at least one or two months of continued usage (Rist, 1990).

Researchers studying the single effects of crack usage on a developing child have found that crack passes through the placenta and easily travels to the child's brain. The precise effect which this exposure will have on the child is believed
to be dependent upon how old the child was at the time of exposure and how much crack was consumed.

One factor which is commonly agreed upon regarding the growing child and the effects of the cocaine exposure is that an unborn child is less equipped to process and excrete the drug than is the child's mother. Therefore, the extended length of time it is believed to take the immature liver and renal system to pass the drug may very well make the child susceptible to more extensive neurobehavioral harm in the long run (DeSylvia & Klug, 1992). It is not believed, however, that these exposed infants are "addicted" to cocaine as many of their mothers are addicted to cocaine. Rather, the neonates who have been exposed to cocaine typically score within the standard range on measures which are designed to assess the magnitude of withdrawal symptoms (Dow-Edwards, 1991).

Crack serves to arouse the nucleus accumbens, which is located between the limbic system and the motor cortex. The nucleus accumbens may be described as the "attraction center" of the brain as it is this structure which is believed to draw persons in the direction of pleasurable endeavors (Hutchinson, 1991). Injury to brain cells in the limbic system as well as in the nucleus accumbens have been hypothesized to be damaging in relation to a variety of reactions and feelings of these exposed children. Furthermore, the damaging impact of the exposure may even be related to the maladaptive relationships that some cocaine exposed children have connecting with those in their environment (Hutchinson, 1991).
Other specific areas of the brain proposed to be affected by prenatal cocaine exposure are the motor cortex and speech center. As some of these children do exhibit delays in the motor activities of crawling and walking, motor cortex involvement does seem feasible. Similarly, speech and language delays are often evident in children known to have been exposed to cocaine and the speech center of these children frequently being injured has been indicated (Hutchinson, 1991).

Potential Perinatal Effects Associated with Cocaine and Polydrug Use

Biological Effects

Recognizing the incidence of prenatal drug exposure, knowledge of the potential biological effects of this polydrug exposure on the child is critical for understanding the child's development. The maternal effects of polydrug use have been reported to place the pregnancy at high risk due to a variety of complications that coincide with the mother's drug use (Eisen, Field, Bandstra, Roberts, Morrow, Larson, & Steele, 1991; Horgan, Rosenbach, Ostby, & Butrica, 1991; Little, Snell, Gilstrap, & Johnston, 1990), including placing the child at a greater risk for HIV if the mother uses drugs intravenously (Little et al., 1990). Researchers have found that even when information such as socioeconomic variables are controlled for when looking at the birth outcomes of these
substance exposed infants, the relationship between a mother's drug use and poor birth outcome of her child remained (Kaye et al., 1989).

Adverse perinatal effects on the child associated with maternal polydrug use encompass higher risks of medical and neurological problems including: spontaneous abortion; abruptio placentae; preterm labor; low birthweight; congenital malformations; Sudden Infant Death Syndrome (SIDS); and neurobehavioral deficiencies (Chasnoff, 1992b; Dow-Edwards, 1991; Kandall, 1991; Streissguth et al., 1991). Many of these complications appear to be more closely linked with maternal use of cocaine. However, given the finding that most women who use cocaine are polydrug users, the complications are related with polydrug use and not solely cocaine use.

Spontaneous abortion can be precipitated by use of cocaine in the early months of pregnancy and is believed to be related to cocaine inducing vasoconstriction of the placenta and a subsequent loss of oxygen for the child (Gregorchik, 1992). Prematurity rates have been found to be significantly increased with maternal cocaine use (Chasnoff, 1991a; Kandall, 1991). Abruptio placentae is a condition that can be fatal to both the mother and her unborn child. It occurs when the placenta pulls away from the wall of the uterus before labor, causing extensive bleeding, and results in a loss of oxygen to the developing child. Depending upon the amount of time the child is deprived of oxygen, the effects for the child may include brain damage or the child being stillborn. These three medical complications are all believed to be related
primarily to maternal cocaine use.

Low birthweight of a child is the one common indicator associated with the single use of alcohol, heroin, tobacco, marijuana, or cocaine (Chasnoff, 1992b). It is believed that the poor maternal nutrition and infrequent prenatal care of the drug using population are highly related to a child's low birthweight. Cocaine, however, does seem to have a consistent influence with respect to producing intrauterine growth retardation and reduced head circumference size at birth for these children. Use of cocaine has been estimated to account for 10% of the children born of low birthweight (Pettiti & Coleman, 1990). This finding is important when is it recognized that head circumference at birth has commonly been believed to be a powerful predictor of subsequent cognitive growth (Chasnoff et al., 1992).

Congenital malformations in children born to mothers using cocaine may include cardiac, intestinal, central nervous system, and limb-reduction irregularities. Cocaine's pharmacological effect of interfering with the intrauterine blood supply is believed to encourage the following: heavy or uncontrollable bleeding in conjunction with an acute rise in systemic and cerebral blood pressure; and a deficiency of oxygen resulting from uterine, placental, embryonic, or fetal vasoconstriction (Chasnoff, 1992b). The physical anomalies that may be evident in a cocaine exposed child are believed to be caused by this interruption of the child's blood supply during a critical period of in utero development.

Sudden Infant Death Syndrome (SIDS) has been found to
occur with greater incidence in children exposed to drugs. In the United States the occurrence of SIDS in the population at large is 0.5%. Estimates include that 5% of the children of narcotic addicted mothers have died of SIDS compared to 8% to 15% of the children of cocaine addicted mothers having died of SIDS (Schutter & Brinker, 1992). It is believed that the reason there is such an escalated danger of the Sudden Infant Death Syndrome for the children of substance using mothers is related to the infants as well as their mothers having "abnormal sleeping respiratory problems, characterized by an increased frequency of apnea episodes," (Schutter & Brinker, 1992, p. 90).

The potential biological effects of polydrug use shortly after birth may include evidence of withdrawal for the children. Some of the symptoms of withdrawal may not become apparent for a few days or until nearly two weeks after birth. Indicators that the child may be going through withdrawal are a high-pitched cry, seizures, frequent startles, and irritability (Schutter & Brinker, 1992).

Neurological Effects

In an effort to better understand temporal effects of drug exposure on a developing child, research has been performed with varying the levels of drug exposure at different stages of development on unborn laboratory rats. It has been found that even relatively small amounts of cocaine exposure during a critical time of growth may have an
unalterable effect on brain capacity. It seems that the effects of cocaine may cause lasting changes on the capabilities of the cerebral routes and passages. Research led by Dow-Edwards (1988) determined:

Exposure to cocaine during a critical period of development has been shown to produce lasting changes in the function of the brain...The animals are hyperactive as adults. Hyperactivity in humans is well known to interfere with performance in school. Therefore, although low to moderate exposure to cocaine during pregnancy does not appear to induce obvious structural abnormalities in the offspring, it is possible that the drug may place exposed children at risk for neurobehavioral abnormalities that may last into adulthood (Dow-Edwards, 1988, p. 301).

These findings of children prenatally exposed to cocaine having a greater potential for hyperactivity were confirmed by Mirochnick et al. (1991). They studied blood levels of dihydroxyphenylalanine and found that the cocaine exposed infants had higher levels of this amino acid than did the nonexposed children. Thus, the cocaine exposure may modify neurodevelopmental functioning in the unborn child, thereby possibly making the child more susceptible to hyperactivity and mood changes.

Other researchers in this area have found that drug use
by the mother may produce neurobehavioral deficiencies in the neonate by affecting the developing brain (Carta, Sideris, Rinkel, Guamaraes, Greenwood, Baggett, Peterson, & Atwater, 1994; Chasnoff et al., 1989). The specific neurotransmitters affected by drug use are serotonin, norepinephrine and dopamine. These transmitters are integrally related to fundamental operations encompassing the directing of attention, reaction to sensory stimuli, and the alteration of mood states (Mayes, 1994; Mayes, Granger, Bornstein, & Zuckerman, 1992). Continued prenatal drug exposure, particularly exposure to cocaine, can change these neurotransmitters' performance of the developing child's nervous system. Some researchers, however, are quick to add that many of the neurobehavioral deficiencies described seem to be short-term and often are no longer evident at six months of age (Mayes, 1994). It should be noted that the research findings by Mayes are not consistent with the results reported by Dow-Edwards (1988).

It is considerably more challenging to be able to accurately study the temporal pattern of drug use among humans as one cannot directly manipulate the drug use of the pregnant woman. One conducted by Chasnoff et al. (1989), however, did monitor and compare women's temporal drug use patterns. A group of infants born to women who used drugs only for the first trimester were compared to a group of infants born to women who used drugs throughout the pregnancy. Results after the children were born indicated that for both groups neurobehavioral response deficiencies were found in the
following areas: orientation; motor ability; state regulation; and abnormal reflexes. Information obtained from this study appears to provide evidence that central nervous system damage has the potential to develop, particularly early in gestation. Based on the two comparison groups which were used, it is also believed that the deficiencies exhibited after birth were due to the early drug exposure and were not merely indicators of withdrawal as one group had not been exposed to any drugs for several months (Chasnoff, Griffith, MacGregor, Dirkes, & Burns, 1989).

Results have been contradictory with respect to reporting the drug exposed newborn's behavior, even when using the same assessment measure (the Brazelton Neonatal Behavioral Assessment Scale - NBAS). Chasnoff has conducted a number of studies and found that the cocaine exposed infants have "increased state lability (more shifts from alert to crying or alert to sleep), increased startles, and decreased interactive behaviors," (Chasnoff et al., 1989, p. 1743). However, in a more recent study, it was reported that there were no dissimilarities when comparing a group of cocaine exposed and nonexposed neonates within seventy-two hours after birth (Neuspiel & Hamel, 1991).

In an effort to cope with the issue of conflicting results of these children's performance, a 'neurodevelopmental battery' was created. The goal for the battery of tests was to be able to detect even the most subtle of effects due to cocaine exposure. The study was based on the premise that traditional tests of child development may be too broad in
nature to detect the individual regions of the brain affected by cocaine exposure. The study was designed to assess development in the four domains believed to be most influenced by prenatal drug exposure: attention; arousal; affect; and action (Lester & Tronick, 1994). The domain of attention involves the processing of visual and auditory information from the environment while the domain of arousal consists of the continuum of states from sleeping to wakefulness. Affect refers to the formation of a child's style of socializing and associating with others and finally the domain of action demonstrates the child's unfolding gross and fine motor skills (Lester & Tronick, 1994). It is hoped by these researchers that through focusing on these four domains, researchers will be better able to identify less prominent deficits.

All things considered, one must remember that the biological and neurological perinatal effects associated with drug use are potential effects and are not evident in every child who has been exposed prenatally to drugs. All children are affected uniquely depending on a multitude of variables. An accurate assessment of the child's development should be undertaken with the following three points in mind: a) various drugs are believed to have varying results on brain development during fetal development; b) different areas of the brain are affected uniquely; and c) a considerable amount of brain development occurs postnatally, therefore, continued passive exposure and the child's environment have the potential for further detrimental effects on brain development (Mayes, 1994).
Potential Psychological Effects

While the potential biological and neurological effects are indisputably pivotal for the infant's healthy development, the psychological effects of being reared by a drug abusing mother have the possibility of adding further challenges to a child's life. The attributes of a drug addicted mother do not typically include a consistently high level of attention to the child's needs. Rather, many of these infants leave the hospital to arrive at a home that is unstable with a mother who is preoccupied with fulfilling her cravings for her own addiction (Howard, Beckwith, Rodning, & Kropenske, 1989). Substance using mothers are not characteristically adept at providing a nurturing attachment and the comforting environment that children need to develop appropriately. Furthermore, these mothers have to meet the needs of a newborn who may be atypically irritable because of drug exposure (Freier, 1994; Resource Guide for Educators of Children Affected by Alcohol and Other Drugs, 1993; Tronick, 1989).

Not surprisingly, it has been reported that these children are at an unusually high risk for neglect or abuse (Elliot & Coker, 1991; Murphy, Jellinek, Quinn, Smith, Poitras, & Goshko, 1991; Scherling, 1994; Sumner et al., 1993; Wasserman & Leventhal, 1993; Zuckerman & Frank, 1992). A drug addicted parent will primarily focus on obtaining and using drugs, and consequently there is often neglect in meeting the needs of the developing child. Murphy et al. (1991) reported that a parent who had been proven to have a substance abuse history had a greater proclivity to all of the
following: 1) have prior allegations of child abuse; 2) to be assessed by a court investigator as demonstrating a high risk to his or her children; 3) to refuse to comply with programs mandated by the court; and 4) to subsequently have his or her children permanently taken from custody (Murphy et al., 1990).

These children also are believed to have a greater propensity for developmental and behavioral difficulties (Zuckerman & Bresnahan, 1991). A neonatologist in the field of drug exposure remarked, "Crack has replaced parenting for these mothers. It's replaced everything. They say, "While I'm on the pipe, I'm without pain. And that's the only time," (Crack Babies, 1989, p. 108). Obviously, any child born to a parent who is psychologically unavailable to the child, regardless of whether or not the child has been drug exposed, would be at great developmental risk.

What are the potential risks for a child's psychological development when being reared by a caretaker who does not consistently provide for the infant's needs? Perhaps the most critical consequence would be that of the baby's lack of a secure attachment to the caregiver. While it is believed that humans are genetically predisposed to develop attachments to their caregivers, this attachment needs to be developed and nurtured through the primary caregiver who consistently and predictably attempts to meet the needs of the infant (Bowlby, 1984; Brooks-Gunn, McCarton, & Hawley, 1994; Cohen & Taharally, 1992; Coles & Platzman, 1993; Fejes-Mendoza, 1991; Freier, 1994; Resource Guide for Educators of Children Affected by Alcohol and Other Drugs, 1993; Scherling, 1994).
If the infant's needs are attended to when the caregiver has not recently used a substance, yet are repeatedly ignored when the caregiver has used or is coming down from a substance, the infant learns that this person is unpredictable and therefore cannot be relied upon (Freier, 1994). In this situation, the child would not be likely to develop a secure attachment to the caregiver.

The importance of a child's attachment to the caregiver cannot be overemphasized. The quality of this attachment has been related to different facets of the child's functioning at the same age and later ages. For example, the quality of a child's attachment has been related to the child's willingness to explore his environment at age one, his or her problem-solving and sociability at age two, and his or her curiosity and behavior management in the preschool years (Egeland & Farber, 1984).

Attachment can be accurately described as an essential cornerstone of all future learning -- cognitive, emotional, and behavioral. Infants who are more difficult to soothe, less responsive, more irritable, and more easily overstimulated, as are many infants who have been exposed prenatally to drugs (Chasnoff, 1992a; Johnson et al., 1989), are more challenging for any caregiver and may therefore be ignored (Johnson & Cole, 1992). Obviously, there is a greater propensity for these children to develop insecure attachments. How insecure attachments are translated into overt problem behavior include the possibility that these insecure children become anxious, apprehensive, and/or unconcerned about the
welfare of others. It has also been found that for many of these children that their frequency of crying is higher, and that subsequent to crying they may be 'unresponsive' to comforting. Their anger is more readily provoked, and unfortunately once these behavioral routines are created, they are not likely to change without intervention (Bowlby, 1984).

Children who are reared by a responsive caregiver are more often the children found to be resilient. Resiliency as defined in the Webster's Dictionary is the "ability to recover or adjust easily to misfortune and change." A study of children, including both drug exposed children and nonexposed children, was performed by Johnson, Glassman, Fiks, and Rosen (1989) to ascertain if there were any early indicators in a child's life which could be used to predict positive future development (resiliency) or negative future development (vulnerability). Results of this research underscored the importance of a child having a mother who consistently and adequately responded to the child's needs. The children whose development was described as being resilient despite their being reared in adverse circumstances had mothers who:

were able at least some of the time to relate to their children as separate beings, and to differentiate the children's needs from their own. They could therefore recognize that their children needed help in order to develop to their fullest capacity. Amazingly, these women were keenly aware that many of their children's problems were to some
degree the results of under-stimulation, repeated separations, and exposure to a somewhat unpredictable environment (Johnson et al., 1989, pp. 536-37).

Not surprising to those who recognize the importance of attachment for a child's subsequent healthy development, the variables which distinguished resilient children from less resilient children were primarily related to the adequacy of a child's family and environment meeting his or her needs consistently and reliably. If there is early ecological support for a child, this strengthening may supersede early prenatal insult, including prenatal exposure to drugs, and serve to shield the child from future vulnerabilities (Cobb, 1976; Garmezy, Masten, & Tellegen, 1984; Johnson, 1993).

Research Beyond Infancy

Polydrug Exposed Children at Two Years of Age

What is the impact of this exposure on children as they grow and develop beyond infancy? The National Association for Perinatal Addiction Research and Education (NAPARE) began a longitudinal study in the mid 1980's when use of cocaine and crack by pregnant women became more prevalent. One of the initial studies the NAPARE group published was designed to address the children's development at the time they were two years of age. The groups of children were originally identified while the mother was nearly four months pregnant.
and the women were then voluntarily enrolled in a therapeutic intervention program aimed at assisting them in overcoming their addiction.

Prior to establishing the group in which a child would be placed (drug exposed or nonexposed), a drug history was taken as reported by the mother in addition to a urine analysis being completed through enzyme multiplied immunoassay technique screening.

The substance exposed children were divided into two groups: group 1 children were exposed to cocaine and other drugs, including alcohol, but not opiates; group 2 children were exposed to drugs including marijuana and/or alcohol but not cocaine or any opiates; and group 3 was the control group which consisted of children who had been not exposed to alcohol or any illicit drugs in utero. It is important to emphasize that the drug using mothers reported that while they may have used one drug predominantly, the majority of them admitted to frequently using other drugs. The mothers in the control group were matched to the other groups at the onset of the study according to the age, race, and the socioeconomic status of the mother. It was reported that the women in the study, both the women who used drugs as well as the controls, were primarily from a low socioeconomic class and that roughly 70% of the women were obtaining public aid. An important additional factor noted was that the women were all from the inner city of Chicago and that their environments were believed to be quite analogous.

It should be noted that the personnel at NAPARE who
evaluated the children did not know which group a particular child was in nor were they familiar with the drug history of the child's mother.

The results of the NAPARE studies indicated that the children born exposed to cocaine and other drugs (group 1) had significantly reduced growth indicators - weight, length, and head circumference - at birth but within one year after birth, the majority of these children had similar weight and length growth when compared to the children in the control group who had not been exposed to any drugs. The group of children who were born exposed to various drugs but were not exposed to cocaine (group 2) did have a smaller head circumference at birth than the control group, yet their weight and length development were not found to be significantly different. The single growth indicator that remained significantly less developed for both of the drug exposed groups when compared to the control group two years after birth was head circumference (Chasnoff et al., 1992). In light of the belief that head circumference may be a good predictor of cognitive development, this finding was considered to be quite important (Lifschitz, Wilson, Smith, & Desmond, 1985).

A standardized instrument which was used to compare the progression of the three groups both cognitively and motorically was the Bayley Scales of Infant Development. This measure is used to estimate cognitive development (Mental Developmental Index) in addition to psychomotor development (Psychomotor Developmental Index). Results from use of the Bayley Scales indicated that overall the obtained
developmental scores - combining both the Mental Developmental Index and the Psychomotor Developmental Index - of the drug exposed groups were not significantly different from the overall scores of the control group. However, there was a larger percentage of the children who had been drug exposed and achieved a score of greater than two standard deviations below the mean on both the MDI and the PDI when compared to the control group (Chasnoff et al., 1992).

The researchers of this study found prenatal exposure to cocaine to be the foremost predictor of head circumference. For all children in the study, there was a significant correlation between reduced head circumference and developmental scores. Given these findings, it was postulated that those children who are prenatally exposed to drugs, particularly cocaine, may be in greater danger of negative developmental consequences.

Polydrug Exposed Children at Three Years of Age

NAPARE's evaluations of these same children continued and another complete evaluation was performed when the children were three years of age. Again, the children were compared on the basis of those who had been prenatally exposed to cocaine and other substances such as marijuana, alcohol, and tobacco but not to opiates (group 1), children who had been exposed to a variety of drugs but no cocaine or opiates (group 2), and the control group of nonexposed children (group 3).

Once again, the personnel at NAPARE who evaluated the
children did not know which group a particular child was in nor were they familiar with the drug history of the child's mother.

The measures taken for the children at three years of age included their weight, length, head circumference in addition to a cognitive measure (the Stanford-Binet Intelligence Scale: 4th Edition), a behavioral measure (the Achenbach Child Behavior Checklist - Parent Report Form), a measure of sustained attention (the Summative Perseverance Scale), and finally a measure of negative environmental influences and enrichment present within the child's home environment (the Home Screening Questionnaire).

Results related to the three year NAPARE study indicated that the average weight of each of the three groups of children was comparable. However, the two groups of drug exposed children continued to have significantly smaller average head circumferences than the control group average head circumference. Although the difference in head circumference continued to exist, it was not found to be a significant direct predictor of intellectual ability, yet it was found to be a significant intervening variable in the overall predictive model used within the context of the three year data set (Azuma & Chasnoff, 1993).

Regarding the children's level of perseverance as measured on the Summative Perseverance Scale, the three groups of children performed similar to each other with average levels of perseverance. Correspondingly, the three groups achieved similar scores on both of the behavioral measures
administered. Each of the groups scored within the normal range on the Achenbach Child Behavior Checklist (CBCL). It should be noted that each of the groups was found to be in the 'at-risk' range on the home environment assessment (Azuma & Chasnoff, 1993).

While the measures of cognitive development again did not indicate that there were significant differences in the various groups' ability level (all three groups were found to be within the average range), the two groups of children who had been prenatally exposed to drugs were identified as achieving average scores which were approximately four to five points less than the average score of the nonexposed children (Azuma & Chasnoff, 1993). Further research following longitudinal patterns of cognitive development has cited that for children who are born with a low birthweight (not necessarily due to prenatal substance exposure) there appears to be a greater proportion of children who are exhibiting a weakening in their cognitive development by the time the children reach three years of age (Liaw & Brooks-Gunn, 1993).

A path analysis was performed on the data set in an effort to better understand the structural relationships among the variables. It was expected that exposure prenatally to substances would have a significant indirect effect on the cognitive performance of children at three years of age. The one measure which was not found to contribute significantly to the path analytic model was the behavioral measure (CBCL). The remaining variables, however, were found to be useful in understanding which factors influenced cognitive ability. The
influence of drug exposure was also intertwined with the child's home environment, head circumference, and perseverance. Using these variables, 48% of the total variance in the cognitive ability of prenatally exposed children at age three could be explained (Azuma & Chasnoff, 1993).

Researchers were quick to add, although, that this study needs to be interpreted with caution remembering the services to which the mothers of these children were able to avail themselves. That is, while these were drug exposed children who were being reared in an inner city, by simple virtue of their mothers having enough interest in their children to maintain involvement in the study, the children received intervention and assistance that is believed to be atypical for many of the drug exposed children in an inner city environment. Consequently, the children in the NAPARE study are openly agreed to be a 'best case' scenario for children of their background and community environment.

Similar research was conducted by Lifschitz et al. (1985). They reported that the head circumference of the children born exposed to drugs were indeed small, however when different variables were studied to determine which variable had a significant direct effect on head circumference, polydrug use did not have a significant direct effect. Rather, those components which were found to be related to the child's head size at birth were the weight of the child at birth and the nutritional condition of the mother. Regarding the intellectual potential of the children born to the
polydrug using mothers, there was indeed found to be a greater occurrence of children having low average and moderate cognitive disabilities. Upon further study of the variables which predicted cognitive ability of these children, it was found that the extent of drug use was not a significant predictor of cognitive ability after environmental and prenatal variables were utilized (Lifschitz et al., 1985).

Despite the aforementioned study by Azuma and Chasnoff (1993) on polydrug exposed toddlers in which no notable differences were found in the level of behavioral development for this population from the norm, another group of researchers reported quite different results. Rodning, Beckwith and Howard (1989) studied another sample of polydrug exposed toddlers who had been afforded similar intervention opportunities for an extensive period of time. In addition, the children involved in both research programs were of comparable socioeconomic backgrounds. In contrast to the NAPARE researchers, they reported that prenatal polydrug exposure was related to significantly lower performance on the developmental measures used and that their subjects also evidenced weaknesses in the area of behavioral development.

To assess the polydrug exposed toddlers level of development, the children were administered either the Gesell or Bayley Scales of Infant Development. The children's play was videotaped, carefully analyzed, and their attachment to the primary caregiver was assessed through the Strange Situation procedure.

The results of this study indicated that the children
involved did have significantly lower developmental scores which were within the low average range on the measures which were used. Regarding their behavior as observed during the videotaped play situations, the children were described as having "inhibit(ed) self-initiation and self-organization," as well as insecure attachments with their primary caregivers (Rodning et al., 1989, p. 286). Interestingly, these researchers' results found deficits or delays in each domain assessed in contrast to the research findings reported by Azuma and Chasnoff (1993).

Researchers who performed an extensive review focusing on the behavioral development of children prenatally exposed to drugs found that less than half of the reviewed studies demonstrated statistically significant detrimental outcomes for those exposed (Carta et al., 1994). The largest portion of adverse consequences were observed in those who were under thirty days old in the area of neurobehavior. Interestingly, it was reported that research findings that do not confirm negative results associated with drug exposure were less likely to be approved for presentation, even if the studies were more robust in their research design than those studies in which significant delays were reported (Carta et al., 1994).

These researchers noted the paucity of data on older children, particularly those of school age, and acknowledged that future research of this age group needs to include information about the environment if healthy interventions are to be planned and implemented (Carta et al., 1994).
The finding that indeed less than half of the drug exposed children are exhibiting any significant behavioral problems (Carta et al., 1994) is quite noteworthy when one realizes the extremely negative picture portrayed in the media. Unfortunately, the media has continued to support many misperceptions about the limitations of these children despite the more hopeful findings reported above.

**Critical Summary of Previous Research**

It is believed that an authentic study of child development must include the critical role the environment has upon the child and how the environment may impede or facilitate development. All persons are affected by the various ecological systems with which we come in contact, and if one is to truly understand how and why a child is functioning in a particular manner, then one needs to have an accurate picture of what has enveloped the child on a consistent basis (i.e., his or her environment).

Richardson and Day (1994), and Sameroff, Seifer, Barocas, Zax, and Greenspan (1987). The research program headed by Sameroff (1987) not only acknowledged the impact of a child's environment on his or her development, it also established a 'cumulative environmental risk index' that consisted of factors involving the child's mother, family, and culture. The results of this study underscore the importance of the environment when discussing development. The investigators found that matched amounts of risk factors yielded comparable outcomes on cognitive development. No one element by itself was found to aid or detract from a child's intellectual development. Rather, the investigators expected that it was the aggregate of numerous risk factors that elevated the likelihood of a child's development being jeopardized (Sameroff et al., 1987). These results were upheld in the research of Liaw and Brooks-Gunn (1993) as the sample of low birthweight children's development was reported to be the outcome of not simply biological components affecting them during their prenatal development, but also the result of environmental and social influences which affected the children throughout their development.

Furthermore, it is held that any study of children who have been born exposed to drugs should take into consideration the finding that drug using women typically use more than one drug. That is, the attempt to cite single causes and effects from a drug appears to be faulty given that a woman may report that heroin is the only drug she is using when in fact she also may be using alcohol, tobacco, and whatever drug is
available when she is already high on a substance. It is additionally important to recognize that adulteration of drugs sold on the streets is quite common so that even if a person thinks he or she is using only one substance, it may very well have been 'cut up' several times and enhanced with other, less expensive substances so that the dealer may get a greater profit.

It appears that current researchers are heading in the direction of acknowledging the problem issue as being polydrug in nature, that it is not simply being operated under the assumption that all exposed children will have significant deficits, and now recognizes the importance of the child's environment for subsequent development. Some researchers such as Fejes-Mendoza (1991), Chasnoff (1992b), Johnson (1993), Lifschitz and Wilson (1991), and Schutter and Brinker (1992) have successfully addressed the problem issue of polydrug use within the past few years. More recent work completed by Beeghly and Tronick (1994) and Lester and Tronick (1994) was designed to examine polydrug use and maternal polydrug use. Longitudinal research in the field is serving to educate both the public and the media with regard to the observed behavioral outcomes of these children. We are slowly gaining in awareness that we need not expect that the majority of these children will be academic failures and behavioral problems in the years to come.

The importance of the environment for the healthy development of any child is now more widely accepted and referred to when a child is having difficulties. Speaking to
the significance of the environment, Dr. Barry Zuckerman, professor and chairman of the pediatrics department at the Boston University School of Medicine and Boston City Hospital said that "it matters for premature babies, it matters for other babies, and it matters for drug-exposed babies. It's not that there's not damage, but there's also recoverability. Everything we know about the newborn brain implies optimism, particularly with a good home environment," (Leroux & Schreuder, 1994, p. 13).

Researchers who evaluate the complete picture of drug exposure -- studying not just the mother's admitted use of an illicit substance but also the quality of the home environment and possible effects of being raised by an addicted caregiver -- will provide us with a more realistic perspective related to the development of these polydrug exposed children. It is anticipated that systematic, long-term studies related to prenatal circumstances and the postnatal environment, will better enable educators to plan effective interventions and resource services for those children who are found to have significant delays in a given developmental domain.

Future Directions: Polydrug Exposed School Age Children

Understanding the effects of drug usage on a developing child in utero and foreseeing the potential long-term consequences of such exposure has been an area in which a substantial amount of research has been focused these past several years. There has been, however, considerably less
published information related to studying the development of polydrug exposed children who are of school age and their performance in the school environment. Previously it had not been possible to study a group of these children who were definitively exposed to drugs in utero and who were of school age. Given this situation, the investigation to be described in what follows was designed to carefully examine the impact of being raised by a caregiver who has been addicted to drugs and the interrelationships among variables intertwined in the lives of a sample of school age children who have been polydrug exposed.
CHAPTER III
METHODS

The methods chapter consists of five components. The first component includes the proposed hypotheses while the second component describes characteristics of the subjects who were involved in the study. Outlined in the third section are the instruments and measures which were used. The fourth section reviews the procedures followed with the fifth and final section which includes the method for data analysis of the study.

Hypotheses

The hypotheses proposed include the following:

1) The number of substances used by the mother during pregnancy will have a significant negative effect on the child's head circumference at birth;

2) The number of visits made by the mother to her doctor during pregnancy will have a significant positive effect on the child's head circumference at birth;

3) Head circumference at birth will have a significant positive effect on the child's cognitive ability;

4) Head circumference at birth will have a significant
positive effect on the child's academic achievement;

5) The level of a mother's education will have a significant positive effect on the child's cognitive ability;

6) The level of a mother's education will have a significant positive effect on the child's academic achievement;

7) Home enrichment will have a significant positive effect on the child's academic achievement;

8) Cognitive ability will have a significant positive effect on the child's academic achievement;

9) Internalizing behavioral difficulties will have a significant negative effect on the child's academic achievement;

10) Externalizing behavioral difficulties will have a significant negative effect on the child's academic achievement;

11) Impulsivity will have a significant negative effect on the child's cognitive ability;

12) Impulsivity will have a significant negative effect on the child's academic achievement;
13) The effects of a child's prenatal environment (as reflected in the number of substances used by the mother during pregnancy and the number of prenatal visits made to her doctor) will be mediated through the child's head circumference, impulsivity, mother's level of education and cognitive ability to have significant indirect effects upon achievement;

Subjects

The mothers and their children who served as subjects in this study were participants in a longitudinal study that was initiated in 1986 at Northwestern Memorial Hospital. This longitudinal study is currently being continued by the National Association for Perinatal Addiction Research and Education. The original longitudinal study was implemented with the goal of learning more about the developmental consequences of prenatal polydrug exposure related to children as they grow and develop.

The number of children involved in the longitudinal study who were of school age and were therefore potential subjects for this study came to a total of thirty-seven. This total number of subjects involved in the NAPARE study is approximately one half of the original cohort from the onset of the study seven years prior.

Thirty-seven teacher questionnaires were mailed to the classroom teachers of the children who were still involved in the study. Out of the thirty-seven questionnaires, twenty-eight were returned and the final sample of children consisted
of those twenty-eight children for whom information was available on each of the variables. The average age of the children was six years and six months at the time of the educational evaluations with all of the children being enrolled in school. Eighteen of the children were in the first grade (64%) with six children in the second grade (21%) and four in kindergarten (14%). Seventeen of the children were girls (60%) while eleven of the children were boys (40%) (Table 1). Due to the small size of the sample, however, the performance of the children was not evaluated for gender differences.

The women had been identified as having used drugs early in their pregnancy and were registered in the program by the fifteenth week of pregnancy. The average age for the children's mothers studied in this sample at the time of delivery was thirty-five. The ethnic groups represented in the sample included individuals who were Caucasian (11%), African American (72%), and Hispanic (17%). Reported drug use for the women in this sample included use of cocaine, marijuana, alcohol, and tobacco, but not use of opiates. In an effort to accurately determine which drugs the mother was using, a urine toxicological analysis was conducted through the use of an enzyme multiplied immunoassay screening technique. Those screenings which tested positive for drug use were then verified by gas chromatography/mass spectrometry. The women were given services aimed at both discontinuing their use of drugs and providing them with appropriate prenatal care.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Percentage in Sample</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethnic Group of Sample</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>72%</td>
<td>20</td>
</tr>
<tr>
<td>Hispanic</td>
<td>17%</td>
<td>5</td>
</tr>
<tr>
<td>Caucasian</td>
<td>11%</td>
<td>3</td>
</tr>
<tr>
<td><strong>Grade Placement of Children</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten</td>
<td>14%</td>
<td>4</td>
</tr>
<tr>
<td>First Grade</td>
<td>64%</td>
<td>18</td>
</tr>
<tr>
<td>Second Grade</td>
<td>21%</td>
<td>6</td>
</tr>
<tr>
<td><strong>Sex of Children</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>40%</td>
<td>11</td>
</tr>
<tr>
<td>Female</td>
<td>60%</td>
<td>17</td>
</tr>
</tbody>
</table>
It should be noted that the majority of the participants in the study were from a low socioeconomic status. Approximately 93% of the participants received public assistance. They all were residents of Chicago and were sharing roughly the same ecological climate within the inner city.

**Instruments and Measures**

The number of substances reportedly used by the mothers during pregnancy along with the number of prenatal visits they made to their doctors were obtained during a clinical interview with the mothers. An effort was made to determine if the child's prenatal environment was related to the child's head circumference at birth. A child's head circumference is believed to be indicative of his or her intrauterine brain growth and a child may be considered to be at an increased risk for developmental delays if his or her head circumference is less than thirty-three centimeters (Chasnoff, 1992a). The baby's head circumference as well as his or her weight in grams were recorded at time of birth. Given that the baby's head circumference is generally considered to be a more powerful predictor, head circumference was chosen as the primary growth variable in the current research project.

The level of education that the mother had received was hypothesized to be related to her child's cognitive ability as well as to her child's level of academic achievement.

The *Home Screening Questionnaire* (Coons, Gay, Fandal, Ker, & Frankenburg, 1981) was completed by the child's mother
when the child was three years of age to estimate the amount of educational stimulation provided within the child's home. The Home Screening Questionnaire (HSQ) is cautioned to be used only for screening purposes and should be succeeded by a thorough survey of the child's home if the score is suspect. The measure was standardized on a population of low socioeconomic individuals and is meant to be used only for that population. A total HSQ score of less than forty-one is suggestive that the child may be 'at risk' for developmental delay due to a home environment lacking in enrichment.

The Wechsler Intelligence Scale for Children - Third Edition (Wechsler, 1991) is one of the most widely used instruments today for estimating a child's overall intellectual potential. This instrument is composed of Verbal Subtests as well as Performance Subtests and a child's ability in these two categories generates three composite scores: a Verbal IQ, a Performance IQ, and a Full-Scale IQ. The Full-Scale IQ is the sum of the scaled scores on both the Verbal Subtests and the Performance Subtests and is generally considered to be an accurate reflection of a child's overall cognitive abilities. The mean score on the Wechsler Intelligence Scale for Children - Third Edition (WISC-III) is 100 with a standard deviation of 15. A Full-Scale score of 90 to 109 is considered to be within the average range, while a score of 80 to 89 is considered to be in the low average range.

The Gordon Diagnostic System (Gordon, McClure, & Post, 1986) is an instrument which was designed to evaluate a
child's level of impulsivity and sustained attention. Through a progression of behavioral tasks, the examiner obtains both quantitative and qualitative information regarding a child's proficiency to demonstrate self-control. The Gordon Diagnostic System (GDS) includes two different tasks: the Vigilance Task and the Delay Task. The Vigilance Task is described by its authors as requiring the child "to inhibit responding under conditions that make demands for sustained attention," (Gordon & Mettelman, 1987, p. 8). The specific task for the child is to touch the button of an electronic display each time that a number one is followed by a number nine. The machine registers the number of times that the child has touched the button at the correct time (Correct Responses), the number of times that the child has failed to touch the button at the correct time (Errors of Omission), and the number of times that the child touched the button without the appropriate stimulus (Errors of Commission).

The Delay Task was designed to assess a child's level of self-restraint. The child is asked to touch a button, pause, and then to touch the button again. In order for a child to score points on the Delay Task, the child has to suppress responses and not simply hit the button uncontrollably over and over again. If the child succeeds in pausing for a minimum of six seconds, a light flashes to signal to the child that he or she succeeded in the delay. The machine catalogs the child's performance according to the number of times the child hit the button (Button Presses), the number of times the child hit the button after pausing for at least six seconds.
(Correct Responses), and the child's percentage of correct responses (Efficiency Ratio).

In this study, the child's number of Errors of Commission on the Vigilance Task was considered to be most reflective of impulsivity. According to the norms for children aged six to nine years old, a total of twenty-four or more commission errors places the child's performance on the task in the abnormal range. It is believed that a child's degree of impulsivity will have an important effect on the child's estimated cognitive ability as well as academic achievement.

The Tests of Achievement on the Woodcock-Johnson Psycho-Educational Battery - Revised (Woodcock & Johnson, 1989) were used to estimate the children's academic development. For the purposes of the present study, the following achievement clusters in the standard battery were emphasized: Broad Reading, Broad Mathematics, and Skills. The Broad Reading cluster includes an estimate of the child's decoding skills as well as his or her reading comprehension abilities while the Broad Mathematics cluster focuses on the child's math reasoning skills and computation abilities. The Skills cluster incorporates decoding skills, math reasoning skills, as well as a child's knowledge of spelling, word usage, and capitalization. Achievement scores on the WJ-R of 90 to 110 are considered to be in the average range while scores 80 to 89 are in the low average range. Similar to the WISC-III, a score of 100 is the mean and 15 is one standard deviation.

The Achenbach Child Behavior Checklist (Achenbach, 1988) is a standardized measure devised to collect descriptive
information about a child's behavior from individuals who have known the child well for an extended period of time (the child's parents and teachers). This measure is composed of several problem scales and is further organized into two broad-band groupings (externalizing and internalizing syndromes). The individual problem scales that comprise the Internalization Domain include: a) somatic complaints, schizoid or anxious, depressed, uncommunicative, and obsessive-compulsive (for boys); and b) schizoid-obsessive, somatic complaints, social withdrawal, and depressed (for girls). The individual problem scales that comprise the Externalization Domain include: a) delinquent, cruel, aggressive, and hyperactive (for boys); and b) delinquent, aggressive, hyperactive and sex problems (for girls). As different problems occur with varying frequency across the age and sex of the respondents, different norms were established for boys and girls as well as for children from ages four to five, six to eleven, and twelve to sixteen. In the present sample, the norms for boys and girls from ages six to eleven were used.

**Procedures**

The data collected regarding the children's development at age six included their: 1) cognitive ability as measured by their Full-Scale Intelligence Quotient on the *Wechsler Intelligence Scale for Children - Third Edition* (Wechsler, 1991); 2) impulsivity as measured by the number of Errors of Commission committed on the Vigilance Task on the *Gordon*
Diagnostic System (Gordon et al., 1986); 3) academic achievement as measured by the Tests of Achievement on the Woodcock-Johnson Psycho-Educational Battery - Revised (Woodcock & Johnson, 1989); and 4) behavioral development as estimated by the Achenbach Child Behavior Checklist (Achenbach, 1988). This information was obtained over the course of two assessment sessions conducted at the NAPARE facility by a staff psychologist. Each assessment session was held on a different day and lasted approximately two hours per session. The sessions were divided to insure that the child had sufficient rest and motivation to perform at his or her best ability.

Informed parental consent for contact to be made with the child's teacher regarding his or her classroom behavior was procured in person at the NAPARE site (Appendix A). A teacher questionnaire (Achenbach Child Behavior Checklist - Teacher Report Form) was subsequently sent to the child's teacher at his or her respective school along with a copy of the consent form signed by the parent and a letter from the investigator asking for participation in a study regarding students' behavior (Appendix B). Every effort was taken to insure confidentiality regarding the child's participation in an ongoing drug exposure study. No reference was made to NAPARE on the consent form nor on the letter to the teachers asking for their participation. Teachers were instructed to return their completed questionnaire to the investigator, a school psychologist within the Chicago Public Schools.

In hopes of enhancing teacher participation, a ten dollar
gift certificate redeemable at Marshall Field Department Store was promised to any teacher who returned the completed questionnaire. A reminder letter was sent to each teacher who had not returned the questionnaire after three weeks encouraging his or her participation and emphasizing the researcher's goal (Appendix C). The obtained response rate for the thirty-seven teacher questionnaires mailed was 75.7% (twenty-eight of the thirty-seven were returned completed).

The data from the parent questionnaire (Achenbach Child Behavior Checklist - Parent Report Form) was obtained during a visit to the NAPARE clinic. The children's mothers were asked to complete the Achenbach Child Behavior Checklist - Parent Report Form as a part of the standard battery of information to be collected for each child.

Data Analysis

The primary procedure employed for the analysis of the data set was a path analysis. Path analysis is a regression-based approach applied when one hopes to better understand the interrelationships among the variables involved through developing a structural diagram that reveals possible "causal" mechanisms. These "causal" mechanisms are those which are speculated by the researcher and are not to be misunderstood as meaning cause and effect (Asher, 1976).

The path model is crafted by the investigator prior to undertaking one's study and is based on research findings and theory in the area under study (Pedhazur, 1982). A well designed path diagram enables one to envision one's hypotheses
and facilitates understanding the problem being studied (Asher, 1976). This procedure has been found to be helpful in the research of such fields as political science, psychology and sociology where multiple variables are presumed to have direct and indirect effects upon a given outcome (Asher, 1976).

The statistical program that was used to test the path model proposed was LISREL VII (Linear Structural Equation Systems - 7 developed by Joreskog and Sorbom, 1979). Utilization of this program yields path coefficients which delineate the direct and indirect effects among the variables. When the variables are described in standardized form, the path coefficients are similar to standardized regression coefficients (Beta weights) determined in normal regression analysis (Pedhazur, 1982). Using the path coefficients, a researcher may then discuss the relative direct and indirect effects of the variables being studied and the strength of the variables' effects within context of the overall path analytic model.

Additional information which is obtained in the LISREL-VII analysis includes how adequately the independent variables predict the dependent variable. Included in the LISREL-VII analysis are the squared multiple correlations which indicate the amount of variance accounted for by the independent variables. The chi-square statistic test may be interpreted as a test of one's proposed model and whether or not the model the researcher has hypothesized adequately reflects the data set in the correlation matrix. A relatively small chi-square
value indicates that the hypothesized model adequately fits the data set. It is added that a common problem with the chi-square statistic is that it is extremely sensitive to nonnormal distributions and to small sample sizes (Joreskog & Sorbom, 1979).

Additional information yielded by the LISREL-VII analysis package include of a goodness of fit index, adjusted goodness of fit index, and the root mean square residual. Since these values are less affected by sample size, they are considered by many to be more appropriate for determining the fit of the data set to the model than the chi-square statistic. The adjusted goodness of fit index is modified for the degrees of freedom. Both the goodness of fit index and the adjusted goodness of fit index have a value between zero to one. A one indicates a perfect fit of the data set to the model. Finally, the root mean square residual is a calculation of the average of the residuals and is particularly helpful when comparing the size of this value to the values of the path coefficients within one's model. If the model's path coefficients are notably larger than the root mean square residual, it is indicative that true effects were measured rather than simply error variance (Joreskog & Sorbom, 1979).

The a priori model established prior to the analysis of the data set (Figure 1) was based on the investigator's premise that it is vital to evaluate characteristics of the child's prenatal environment (the amount of prenatal visits made, the number of drugs used during pregnancy, and the child's resulting head circumference at birth), the maternal
Figure 1. Predictive Model for Academic Achievement

NUM = number of drugs used during pregnancy; FULL6 = Full-Scale IQ;
PRN = number of prenatal visits; EDUC = maternal level of education;
HC = head circumference at birth; VIGCOM = level of impulsivity;
TINT = internalization score; TEXT = externalization score;
HSQ = score on the Home Screening Questionnaire (age 3); ACHIEVEMENT = academic achievement on the WJ-R
characteristics (level of her education), and characteristics of the child's home environment (the level of enrichment provided in the home), as well as the behavioral characteristics of the child. Given the variables of special interest, it was hypothesized that characteristics of the child's mother, the child's prenatal and postnatal environment, and the characteristics unique to each child (including his or her behavioral development and level of impulsivity) may have direct and indirect effects on the development of the child's cognitive ability and level of academic achievement.
CHAPTER IV
RESULTS

The results chapter is composed of four segments. The first segment relates the descriptive data obtained from the present study while the second section provides a summary of the testing of the hypotheses. The third section concentrates on assessment of the predictive model and the final section is an overall summary of the results.

Descriptive Data

The descriptive data is displayed in Table 2. The average age of the women whose children were evaluated for this study was thirty-five. The mean number of drugs which were reportedly used during pregnancy was 2.8, while the average number of prenatal visits was eight. According to information obtained from the Medicaid Department, the expected amount of prenatal visits for a woman aged thirty-five is twelve to fifteen visits. Having only eight visits would reportedly place a woman's pregnancy 'at-risk.' For this sample of women, the average level of education the women had received was twelve and a half years.

An analysis of the longitudinal data indicated that the children had an average head circumference of thirty-three centimeters at birth and an average birthweight of 2967 grams.
Table 2. Descriptive Statistics for Polydrug Exposed Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>N=28</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maternal Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal Age at Conception</td>
<td></td>
<td>35.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Maternal Level of Education (ys)</td>
<td></td>
<td>12.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Number of Drugs Used</td>
<td></td>
<td>2.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Number of Prenatal Visits</td>
<td></td>
<td>8.1*</td>
<td>5.6</td>
</tr>
<tr>
<td><strong>Growth Parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Circumference at Birth (cm)</td>
<td></td>
<td>33.0*</td>
<td>1.7</td>
</tr>
<tr>
<td>Birthweight (grams)</td>
<td></td>
<td>2967.4*</td>
<td>698.3</td>
</tr>
<tr>
<td><strong>Behavior and Home Assessment Ratings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HSQ (at age three)</td>
<td></td>
<td>35.3*</td>
<td>5.7</td>
</tr>
<tr>
<td>Vigilance Commissions (GDS)</td>
<td></td>
<td>29.2*</td>
<td>32.3</td>
</tr>
<tr>
<td>CBCL Externalization Score: TRF</td>
<td></td>
<td>10.1</td>
<td>15.8</td>
</tr>
<tr>
<td>CBCL Internalization Score: TRF</td>
<td></td>
<td>6.1</td>
<td>9.4</td>
</tr>
<tr>
<td><strong>Intellectual and Achievement Measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-Scale IQ: WISC-III</td>
<td></td>
<td>87.3</td>
<td>10.8</td>
</tr>
<tr>
<td>Verbal IQ: WISC-III</td>
<td></td>
<td>88.2</td>
<td>9.7</td>
</tr>
<tr>
<td>Performance IQ: WISC-III</td>
<td></td>
<td>88.4</td>
<td>12.9</td>
</tr>
<tr>
<td>Broad Reading Cluster: WJ-R</td>
<td></td>
<td>86.5</td>
<td>11.6</td>
</tr>
<tr>
<td>Broad Mathematics Cluster: WJ-R</td>
<td></td>
<td>92.9</td>
<td>16.7</td>
</tr>
<tr>
<td>Skills Cluster: WJ-R</td>
<td></td>
<td>87.4</td>
<td>16.0</td>
</tr>
</tbody>
</table>

Note. Table continues
Table 2 continued.

* signifies the score is at least one standard deviation from the norm or is considered to be 'at risk'

These infants' average head circumference and birthweight were found to be below the 10th percentile (according to both boys and girls growth charts as established by Roche, 1977) and placed the babies at increased risk for developmental delay.

The children's home environment was found on the average to be in the at risk range; the sample of children had a home environment that would be described as being 'at-risk' according to the Home Screening Questionnaire norms.

The children's performance on the Vigilance Task of the GDS reflected that the children exhibited high levels of impulsivity. Their mean level of performance was found to be in the abnormal range. That is to say that they committed an inflated amount of commissions on the Vigilance Task ($M=29$). These results should be interpreted with caution since they are based on the size of the standard deviation ($SD=32$) compared to the obtained mean. The sample size was relatively small and the overall mean was skewed by extreme scores where two of the children committed an unusually high number of vigilance commissions. Over half of the sample, however, did exhibit levels of impulsive behavior that were at least within the borderline range.

Upon review of the data obtained from the parent questionnaire, it was found that the obtained correlations gained from the mothers' reports of their children's behavior were quite small when compared to the size of the other correlations in the matrix, particularly in comparison to the size of the correlations from the teacher report form of the same behavioral measure. Given this situation, it was
determined to rely solely on the teacher reports of behavior for predictive purposes.

The children's behavioral development according to their classroom teachers' perceptions was not problematic; the children in the sample did not exhibit a greater propensity for behavioral problems. The average scores for the children on both the Externalization Domain and the Internalization Domain of the Achenbach Child Behavior Checklist were found to be within the normal range.

In an effort to estimate the children's level of intellectual potential, they were administered the Wechsler Intelligence Scale for Children - Third Edition. The mean scores for the children's performance were quite similar across the Verbal Scale, the Performance Scale, and the Full-Scale IQ scores. It should be noted that while the average Full-Scale IQ score for the children was in the upper limits of the low average range, it was still within one standard deviation of the mean.

Regarding their academic achievement, the children performed highest on the Broad Mathematics cluster where it was estimated that their skills were developed solidly in the average range. On the Skills cluster and the Broad Reading cluster, however, their performance was similar to their performance on the WISC-III. These skills were found to be within one standard deviation of the norm, and in the upper limits of the low average range on the WJ-R.

In summary, an examination of the descriptive statistics (Table 2) obtained from this group indicates that the sample
of children performed within one standard deviation of the
norm on measures of intellectual potential, behavioral
development, and academic achievement. Despite their having
been exposed to polydrug use in utero, their having a
relatively small head circumference and a low birthweight that
placed them in the 'at-risk' category for developmental delay,
being reared in home environments described as being 'at­
risk,' and over half of the sample having impulsive behavior
that was at least in the borderline range, these children were
still able to perform adequately in critical arenas of daily
functioning.

Summary of Hypothesis Testing:
The hypotheses tested include the following:
1) The number of substances used by the mother during
pregnancy will have a significant negative effect on the
child's head circumference at birth;
The results did not support this hypothesis as the parameter
estimates from the number of substances used ('NUM') to the
child's head circumference at birth ('HC') did not reach
statistical significance (Figures 2 - 6).

2) The number of visits made by the mother to her doctor
during pregnancy will have a significant positive effect on
the child's head circumference at birth;
This hypothesis was not supported as the parameter estimates
from the number of visits made by the mother to her doctor
('PRN') to the child's head circumference at birth ('HC') did not reach statistical significance (Figures 2 - 6).

3) Head circumference at birth will have a significant positive effect on the child's cognitive ability;
This hypothesis was not supported as the parameter estimates from head circumference at birth ('HC') to the child's cognitive ability ('FULL6') were not significant (Figures 2 - 6).

4) Head circumference at birth will have a significant positive effect on the child's academic achievement;
This hypothesis was supported for the math model (Figure 4), however the hypothesis was not supported for the reading and skills models as the parameter estimates from head circumference ('HC') to reading or skills achievement did not reach statistical significance (Figures 2 and 6).

5) The level of a mother's education will have a significant positive effect on the child's cognitive ability;
This hypothesis was not supported as the parameter estimates from a mother's level of education ('EDUC') to a child's cognitive ability ('FULL6') did not reach the level of statistical significance in any of the models (Figures 2 - 6).

6) The level of a mother's education will have a significant positive effect on the child's academic achievement;
This hypothesis was not supported as the parameter estimates
from a mother's level of education ('EDUC') to the child's academic achievement did not reach the level of statistical significance (Figures 2 - 6).

7) Home enrichment will have a significant positive effect on the child's academic achievement;
This hypothesis was supported for the reading model as a child's level of home enrichment ('HSQ') had a significant positive effect on a child's reading skills (Figure 2). This hypothesis was not supported for the math and skills models as the parameter estimates from the home enrichment measure ('HSQ') to academic achievement did not reach the level of statistical significance (Figures 4 and 6).

8) Cognitive ability will have a significant positive effect on the child's academic achievement;
This hypothesis was supported for reading and math models as the parameter estimates from cognitive ability ('FULL6') to achievement ('READING' and 'MATH') were statistically significant (Figures 2 - 5). This hypothesis was not supported for the skills model as the parameter estimate from cognitive ability ('FULL6') to skills achievement ('SKILLS') was not statistically significant (Figure 6).

9) Internalizing behavioral difficulties will have a significant negative effect on the child's academic achievement;
The results supported this hypothesis for math achievement and
skills achievement as the parameter estimates from internalizing behaviors ('TINT') to math skills ('MATH') and skills achievement ('SKILLS') were negative and statistically significant (Figures 4 - 6). The results did not support the hypothesis for reading achievement as the parameter estimate from internalizing behaviors ('TINT') to reading skills ('READING') was positive and statistically significant (Figure 2).

10) Externalizing behavioral difficulties will have a significant negative effect on the child's academic achievement;

The results supported this hypothesis for reading achievement as the parameter estimate from externalizing behaviors ('TEXT') to reading skills ('READING') was negative and statistically significant (Figure 2). The results did not support the hypothesis for math achievement or skills achievement as the parameter estimates from externalizing behaviors ('TEXT') to math skills ('MATH') and skills achievement ('SKILLS') were not statistically significant (Figures 4 and 6).

11) Impulsivity will have a significant negative effect on the child's cognitive ability;

This hypothesis was not supported as the parameter estimates from impulsivity ('VIGCOM') to cognitive ability ('FULL6') did not reach the level of statistical significance (Figures 2 - 6).
12) Impulsivity will have a significant negative effect on the child's academic achievement;
The results supported this hypothesis for math achievement and skills achievement as the parameter estimates from impulsivity ('VIGCOM') to math skills ('MATH') and skills achievement ('SKILLS') were statistically significant and were negative (Figures 4 - 6). The results did not support the hypothesis for reading achievement as the parameter estimate from impulsivity ('VIGCOM') to reading skills ('READING') was positive and was statistically significant (Figure 2).

13) The effects of a child's prenatal environment (as reflected in the number of substances used by the mother during pregnancy and the number of prenatal visits made to her doctor), the child's head circumference, and the mother's level of education will be mediated through the child's cognitive ability to have significant indirect effects upon achievement.
The results did support this hypothesis for the models as the effects of these mediating variables did not reach the level of statistical significance (Figures 3 and 5).

Model Assessment

The hypothesized path analytic model for predicting academic achievement was maintained across the three different academic areas (reading skills, math skills, and skills achievement). Slightly different structural relationships
were found across the academic areas being predicted (i.e., different paths were found to have varying strengths depending upon the specific area of achievement). In the sections that follow, a review of the common effects shared by the models and a discussion of the unique effects within each of the models is presented.

Common Effects Shared by the Three Models

Across the models for reading, math, and skills achievement (Figures 2, 4, and 6) it was found that a greater number of drugs used by the mother during pregnancy ('NUM') had a negative effect on the size of the baby's head circumference at the time of birth ('HC'). Furthermore, the number of prenatal visits made by the mother during pregnancy ('PRN') had a positive effect on the baby's head circumference ('HC').

The child's head circumference ('HC') had a positive effect on the child's cognitive ability ('FULL6') at age six. While the strength of the path coefficient from head circumference to cognitive ability was not found to be statistically significant, it closely approached the level of significance. The positive effect of cognitive ability on academic achievement, however, was found to be significant for the reading and math models. In fact, the strength of this effect for the reading and math models was found to be more than twice the strength of the effect from head circumference to cognitive ability.
The child's level of impulsivity ('VIGCOM') was found to have an inverse effect on the child's level of cognitive ability ('FULL6'). That is, the more impulsive the child, the lower he or she performed on the cognitive ability measure. Another factor that was consistently found to be related to a child's intellectual potential was the mother's level of education. That is to say that a mother's level of education ('EDUC') was found to have a positive effect on her child's level of intellectual potential ('FULL6').

Broad Reading Cluster

Several significant path analytic effects were found upon analysis of the path model for reading achievement cluster (Figure 2). The child's level of home enrichment at age three ('HSQ') was found to have a significant effect on reading achievement ('READING'). The effect of home enrichment ('HSQ') on reading skills ('READING') was positive; the greater amount of enrichment in the home, the higher child's reading score ('READING').

For this model a child's level of impulsivity ('VIGCOM') was found to have a positive effect on his or her level of reading achievement, despite it having a negative effect on the child's cognitive ability ('FULL6'). While the effect of impulsivity ('VIGCOM') was found to be significant, its value was similar in strength to the root mean square residual (Table 7). It is therefore believed that this observed effect was not reflective of the true impact of impulsivity on reading skills and was skewed by error variance in the model.
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Table 3 continued.

READ6 = Woodcock-Johnson Psycho-Educational Battery - Revised Broad Reading Cluster; FULL6 = Wechsler Intelligence Scale for Children-III Full-Scale IQ; INTER = internalization score on the Achenbach Child Behavior Checklist - Parent Report Form; EXTER = externalization score on the Achenbach Child Behavior Checklist - Parent Report Form; TINT = internalization score on the Achenbach Child Behavior Checklist - Teacher Report Form; TEXT = externalization score on the Achenbach Child Behavior Checklist - Teacher Report Form; EDUC = maternal level of education in years; HSQ = score on the Home Screening Questionnaire; HC = head circumference in centimeters at birth; PRN = number of prenatal visits; NUM = number of drugs used during pregnancy; VIGCOM = number of commissions on Vigilance Task on the Gordon Diagnostic System
Figure 2. Predictive Model for Broad Reading Cluster

NUM = number of drugs used during pregnancy; FULL6 = Full-Scale IQ;
PRN = number of prenatal visits; EDUC = maternal level of education;
HC = head circumference at birth; VIGCOM = level of impulsivity;
TINT = internalization score; TEXT = externalization score;
HSQ = score on the Home Screening Questionnaire (age 3); READING = Broad Reading Achievement on the WJ-R

*indicates that the path reached significance at the .05 level
**Figure 3.** Predictive Model for Indirect Paths: Broad Reading Cluster

NUM = number of drugs used during pregnancy; FULL6 = Full-Scale IQ;
PRN = number of prenatal visits; EDUC = maternal level of education;
HC = head circumference at birth; VIGCOM = level of impulsivity;
READING = Broad Reading Achievement on the WJ-R

*indicates that the path reached significance at the .05 level
Interestingly, the higher the score the child received on the Internalization Domain for the Teacher Report Form of the Achenbach Child Behavior Checklist ('TINT'), the higher he or she performed on the reading measure ('READING'). The effect of this path was found to be significant when predicting reading achievement.

While internalizing behaviors were found to have a significant positive effect on reading achievement, externalizing behaviors ('TEXT') were found to have a significant negative effect on reading achievement. In fact, externalizing behavior was found to have the single greatest effect upon reading skills in the entire model, even greater than the direct effect of cognitive ability ('FULL6') on reading achievement. Finally, it should be noted that the effect of cognitive ability on reading achievement was also found to be significant (Figure 2).

In terms of indirect effects that were observed within the model (Figure 3), the effects of head circumference ('HC') and prenatal environment ('PRN' and 'NUM') along with the mother's level of education ('EDUC') were mediated through the child's cognitive ability ('FULL6') to have important indirect influences upon a child's subsequent reading skills. The effects of head circumference ('HC') and the effects of a mother's level of education ('EDUC') on cognitive ability ability did not reach statistical significance, however they closely approached the level of significance. The paths which were not found to have relatively strong effects mediated through cognitive ability in this model were removed (Figure
An overall examination of the model for reading skills achievement demonstrated that according to the squared multiple correlations, 88.7% of the variance in reading skills was accounted for by the independent variables while 24.2% of the variance was accounted for in cognitive ability. The weakest squared correlation was for head circumference as only 2.6% of the variance was explained by this model (Table 6).

A significant chi-square value of 48.71 with 29 degrees of freedom and a p value of .012 was found for the reading achievement model. The goodness of fit index (GFI) was .774 while the adjusted goodness of fit index (AGFI) was .572 (Table 7). The root mean square residual (RMSR) was .234 and when compared to the size of the significant paths within the model, the RMSR is suggestive that the model has an adequate fit to the data (Joreskog & Sorbom, 1979).

Broad Mathematics Cluster

Several of the variables in the math skills model were found to have a significant effect upon math achievement (Figure 4). In this model the child's head circumference at birth ('HC') had a significant effect on the child's future academic skills in arithmetic ('MATH'). It should be noted that this was the only model in which this direct effect between a child's head circumference and academic achievement at age six was found to be statistically significant.
Table 4. Correlation Matrix for Broad Mathematics Cluster

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Note. Table Continues
Table 4 continued.

MATH6 = Woodcock-Johnson Psycho-Educational Battery - Revised Broad Math Cluster; FULL6 = Wechsler Intelligence Scale for Children-III Full-Scale IQ; INTER = internalization score on the Achenbach Child Behavior Checklist - Parent Report Form; EXTER = externalization score on the Achenbach Child Behavior Checklist - Parent Report Form; TINT = internalization score on the Achenbach Child Behavior Checklist - Teacher Report Form; TEXT = externalization score on the Achenbach Child Behavior Checklist - Teacher Report Form; EDUC = maternal level of education in years; HSQ = score on the Home Screening Questionnaire; HC = head circumference in centimeters at birth; PRN = number of prenatal visits; NUM = number of drugs used during pregnancy; VIGCOM = number of commissions on Vigilance Task on the Gordon Diagnostic System
Figure 4. Predictive Model for Broad Mathematics Cluster

NUM = number of drugs used during pregnancy; FULL6 = Full-Scale IQ;
PRN = number of prenatal visits; EDUC = maternal level of education;
HC = head circumference at birth; VIGCOM = level of impulsivity;
TINT = internalization score; TEXT = externalization score;
HSQ = score on the Home Screening Questionnaire (age 3); MATH = Broad Mathematics Achievement on the WJ-R

*indicates that the path reached significance at the .05 level
Figure 5. Predictive Model for Indirect Paths: Broad Mathematics Cluster

NUM = number of drugs used during pregnancy; FULL6 = Full-Scale IQ;
PRN = number of prenatal visits; EDUC = maternal level of education;
HC = head circumference at birth; VIGCOM = level of impulsivity;
MATH = Broad Mathematics Achievement on the WJ-R

*indicates that the path reached significance at the .05 level
The child's level of impulsivity ('VIGCOM') was found to have a significant and inverse effect on his or her math skills (i.e., the more impulsive the child and the less able he or she was able to focus attention, the more poorly his or her math skills were developed).

Unique to this model was the finding that the mother's level of education ('EDUC') had a significant direct effect on the child's math achievement ('MATH'). It was found that the greater the amount of maternal education, the higher the child's arithmetic skills. While the relative strength of this effect was less than the strength of the effect from impulsivity ('VIGCOM') to achievement or the effect from cognitive ability ('FULL6') to achievement, it did exceed the strength of the direct effect of head circumference ('HC') to math achievement ('MATH').

Similar to the reading achievement model, there was found to be a significant direct effect of cognitive ability ('FULL6') on math achievement ('MATH'). Interestingly, the effect of cognitive ability on math achievement was found to be less than the direct effect of either a child's level of impulsivity ('VIGCOM') or a child's level of internalizing behaviors ('TINT') on math achievement.

The final direct effects to be discussed in this model are the effects of behavior on math achievement (Figure 4). There was a significant negative effect of internalizing behavior ('TINT') on mathematics achievement ('MATH') while in the previous model it was discussed that a positive effect was found from internalizing behavior on reading achievement.
Externalizing behavior ('TEXT') essentially was found to have a negligible effect upon math skills.

In terms of indirect effects that were observed within the model (Figure 5), the effects of prenatal environment ('PRN' and 'NUM'), head circumference ('HC'), and the mother's level of education ('EDUC') were mediated through the child's cognitive ability ('FULL6') to indirectly effect a child's math skills. Similar to the indirect effects demonstrated in the reading model, the indirect effects of these biological and environmental variables clearly had influential links to a child's math skills at age six.

Examining the overall path analytic model for math skills achievement, the squared multiple correlations established that 80.9% of the variance in math skills was accounted for while 24.2% of the variance in cognitive ability was explained by the independent variables. The independent variables which were used to predict head circumference accounted for 2.6% of its variance (Table 6).

The chi-square statistic for the math model was 47.79 with 29 degrees of freedom and a p value of .015. The goodness of fit index was .778 with the adjusted goodness of fit index being .579 (Table 7). The root mean square residual (RMSR) was .166 and when compared to the size of the significant paths within the model, the RMSR is suggestive that the model has an adequate fit to the data (Joreskog & Sorbom, 1979).
Skills Cluster

The skills achievement cluster consisted of a combination of the child's dictation skills (spelling, punctuation, word usage, and capitalization), letter-word recognition skills, and math reasoning skills. Unlike the previous two models, few significant path analytic coefficients were empirically verified. That is to say that variables that in the reading and math models which were found to have relatively strong predictive effects generally had very little effect within the skills cluster model (Figure 6).

While the child's head circumference at birth ('HC') was not found to have a significant effect on the child's skills achievement ('SKILLS') at age six, the path coefficient was relatively strong and was of nearly the same strength as the effect of head circumference on cognitive ability ('FULL6') at age six.

An additional path that was found to have a relatively strong effect within the model was the mother's level of education ('EDUC') having a positive effect both on the child's level of skills achievement ('SKILLS') and on the child's cognitive ability ('FULL6').

A child's level of internalizing behavior ('TINT') was found to have an inverse effect on his or her skills achievement. This finding was similar in strength to the effect that internalizing behavior appears to have on math achievement.

The final path to be discussed demonstrated the single greatest effect on skills achievement within the model. The
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<td>-.153</td>
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<td>-.229</td>
<td>.012</td>
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</table>

Note. Table Continues
Table 5 continued.

SKILL = Woodcock-Johnson Psycho-Educational Battery - Revised Skills Cluster; FULL6 = Wechsler Intelligence Scale for Children-III Full-Scale IQ; INTER = internalization score on the Achenbach Child Behavior Checklist - Parent Report Form; EXTER = externalization score on the Achenbach Child Behavior Checklist - Parent Report Form; TINT = internalization score on the Achenbach Child Behavior Checklist - Teacher Report Form; TEXT = externalization score on the Achenbach Child Behavior Checklist - Teacher Report Form; EDUC = maternal level of education in years; HSQ = score on the Home Screening Questionnaire; HC = head circumference in centimeters at birth; PRN = number of prenatal visits; NUM = number of drugs used during pregnancy; VIGCOM = number of commissions on Vigilance Task on the Gordon Diagnostic System
Figure 6. Predictive Model for Broad Skills Cluster

NUM = number of drugs used during pregnancy; FULL6 = Full-Scale IQ;
PRN = number of prenatal visits; EDUC = maternal level of education;
HC = head circumference at birth; VIGCOM = level of impulsivity;
TINT = internalization score; TEXT = externalization score;
HSQ = score on the Home Screening Questionnaire (age 3); SKILLS = Skills Achievement on the WJ-R

*indicates that the path reached significance at the .05 level
effect of a child's impulsivity ('VIGCOM') on his or her level of skills achievement ('SKILLS') was negative. That is to say that the more impulsive the child, the more poorly he or she performed on the skills achievement measure of the Woodcock-Johnson-Revised.

Upon review of this model, it appears that indirect effects did not play a major role in skills achievement. The indirect effects would have been mediated through a child's cognitive ability ('FULL6') and the path from cognitive ability ('FULL6') to skills achievement ('SKILLS') was among the weakest paths in the model; cognitive ability does not appear to have had a significant mediating role in this model. Rather, skills achievement was primarily affected by behavior and the effects of behavior on skills achievement were direct.

During analysis of the model for skills achievement, the squared multiple correlations established that 51.9% of the variance in skills achievement was accounted for while 24.2% of the variance in cognitive ability was accounted for in this model. Only 2.6% of the variance in head circumference was predicted by the independent variables in the model (Table 6).

The chi-square value for 29 degrees of freedom was 45.12 with a p value of .029. The goodness of fit index (GFI) was .787 and adjusted for degrees of freedom (AGFI) was .595 (Table 7). The root mean square residual (RMSR) was .161 and when compared to the size of the significant paths within the model, the RMSR is suggestive that the model has an adequate fit to the data (Joreskog & Sorbom, 1979).
Summary of Results

Depending upon the area of academic achievement being predicted, the independent variables were found to be of different strengths and occasionally unique structural effects on the specific achievement area were found. The variables which typically had the strongest effects with the three different areas of academic achievement were the child's level of impulsivity and internalizing behaviors. For each of the three models, the effects of these two variables on academic achievement generally were found to be significant. The amount of enrichment provided in a child's home, along with cognitive ability, internalizing and externalizing behaviors were significant for predicting reading achievement. When predicting math achievement, however, slight differences were noted as a mother's level of education, the baby's head circumference at birth, as well as the child's cognitive ability and internalizing behaviors aided significantly in future projections.

Regarding the strengths of the paths found in the model, it is believed that due to the longitudinal nature of the variables being studied, the measurable effects of the variables in the study may have become attenuated over a prolonged period of time. Furthermore, intervening variables which were not included in the initial study, such as effects of the children's community upon their development and the stability of their home life, may have had a considerable influence on their present day achievements.
Table 6. Squared Multiple Correlations: Broad Reading Cluster

<table>
<thead>
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<tr>
<td>Head Circumference at Birth</td>
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<tr>
<td>Full Scale IQ on <strong>WISC-III</strong></td>
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<td>Reading Cluster on the <strong>Woodcock-Johnson-R</strong></td>
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Squared Multiple Correlations: Broad Mathematics Cluster

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<td>.026</td>
</tr>
<tr>
<td>Full Scale IQ on <strong>WISC-III</strong></td>
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<td>Mathematics Cluster on the <strong>Woodcock-Johnson-R</strong></td>
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Squared Multiple Correlations: Skills Cluster

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<tbody>
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### Table 7. Lisrel Goodness of Fit Indices for Models

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<th>p</th>
<th>GFI</th>
<th>AGFI</th>
<th>RMSR</th>
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<td>.579</td>
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<td>.787</td>
<td>.595</td>
<td>.161</td>
</tr>
</tbody>
</table>

Note: GFI = Goodness of Fit Index; AGFI = Adjusted Goodness of Fit Index; RMSR = Root Mean Square Residual
The adjusted goodness of fit indices did not achieve statistically desirable levels and the chi-square statistics were indeed significant for the models (Table 7). Inspecting only these statistics, the data set appears to be an inadequate fit to the model and the model appears to require some revision.

Reviewing the size of the root mean square residuals (Table 7) and the squared multiple correlations for the models (Table 6), however, offers evidence of the accuracy of the models. The values of the root mean square residuals were typically small when compared to the values of the significant paths, thus suggesting that genuine effects were measured in the model rather than simply error variance. Furthermore, the squared multiple correlations for both the reading and math models were strong and suggestive of an adequate fit between the data and the models in light of the amount of variance which was accounted for in the dependent variables.

Rather than evaluating the models solely upon the basis of whether or not numerical values reached a level of statistical significance, it is advised that a broader, more comprehensive evaluation be taken. Considering the nature of the study and the types of variables which were involved, the statistical calculations obtained seem to pale in comparison to the interpretive information obtained. Given the effects that were found among the variables, a case can be made for the notion that specific academic interventions can be implemented and students can be helped in critical problems areas which were previously unknown or unclear. For example, the
importance of early enrichment to foster reading skills development has been highlighted along with the significance of addressing problematic behaviors if one is going to support skill development in any academic area.

The model was created in an effort to better understand the nature of polydrug exposure and how the effects of this exposure may be mediated through different variables as a child develops. These goals were achieved as the relative strengths of the variables' effects are better understood as a result of the model. In summary, the model sheds greatly needed light upon the process of child development for those who have been prenatally exposed to substances.
DISCUSSION

CHAPTER V

This chapter begins with an interpretation of the results. The second segment consists of a fine-grained analysis of the implications of the findings, how they may further our understanding of child development for those who have been exposed to substances, as well as acknowledge limitations of the present study. The third segment will be devoted to suggestions for future research in the field while the fourth and final segment will summarize the study and the importance of the findings.

Interpretation of the Results

The findings that an increased number of prenatal visits had a positive effect on a newborn's head circumference and that the greater amount of substances taken by the mother had an adverse effect on the size of a baby's head circumference appear to be congruent with current medical research evidence that provides support for the importance of good prenatal care and proper nutrition. Typically, the better a mother takes care of herself during pregnancy, the better the outcomes for her child at birth.

Head circumference at birth, an indicator of intrauterine brain growth, had a positive and relatively strong effect on
both cognitive ability and academic achievement at age six. While the strength of the effect of head circumference on cognitive ability at age six did not quite reach the level of statistical significance, it does point to the importance of good prenatal care for future development. It is believed that the effect of head circumference on cognitive ability did not reach the level of significance due to: 1) the extended period of time between these two variables being measured and also, 2) due to the plasticity of cognitive development. Up to age six, a child's cognitive ability can be greatly affected by enrichment within the environment. Thus, while quality of prenatal care (and a child's resulting head circumference) is obviously important for future potential, the child's environment also may have an important impact on cognitive ability at age six.

Only for math achievement was the effect of head circumference on achievement found to be significant. What might be suggested from this finding is that math skills may be strongly affected by the quality of one's prenatal development. If during one's prenatal growth one was provided with consistent prenatal care and had sufficient intrauterine brain growth, one may have an increased potential for math achievement. Similarly, the poorer the quality of one's intrauterine environment and the less seriously a mother followed through with prenatal care, the more a child's potential for mathematical reasoning and skills may be limited.

A mother's level of education had a relatively strong
effect on both her child's cognitive ability and academic achievement at age six. A mother's level of education is believed to be an informal measure of educational stimulation provided within the home and would be expected to have an important effect on a child's cognitive ability and academic achievement. In fact, a mother's level of education was found to have a slightly greater effect upon cognitive ability than the direct effect of head circumference on a child's cognitive ability. Both variables are indisputably important, however the amount of enrichment a mother could provide in the home was found to have a slightly greater effect on cognitive ability than the effect of prenatal care and the effect of the child's resulting head circumference on cognitive ability.

For the math model, the strength of the effect of a mother's level of education on her child's math skills was found to be significant. It is proposed that significance was found for this path because a mother's own proficiency in math would affect her ability to teach her child basic mathematical skills as well as her ability to reinforce what skills her child had learned in school. The more education the mother has received and the more developed her own academic skills, the more adept she should be at helping her child develop math skills. If the mother is unable to answer her child's questions regarding how to carry out newly learned mathematical procedures, her child may have a more difficult time mastering the subject area.

The child's level of home enrichment was found to have a significant and positive effect on reading achievement, while
insignificant effects were noted between the HSQ and math and skills achievement. Considering the nature of this instrument, however, this finding is not surprising. There are several items on the HSQ related to the amount of time an adult spends at home reading to a child, how many children's books there are in the home, and if the children's books are accessible to the child while only one question specifically asked about teaching numerical concepts to a child. It follows that this instrument would be a sound predictor of reading skills rather than math skills based on the items included in the measure. Similar to the absence of questions related to math enrichment, the only questions which addressed the types of skills assessed on the broad skills cluster were those questions specifically related to reading. The skills cluster is a composite of reading, math, spelling and word usage activities. In order to predict performance on this cluster, new questions would need to be incorporated into the HSQ. It is believed that while the HSQ may be quite effective in predicting reading skills, it may not be an adequate measure for predicting math or skills achievement. It is possible that if more items related to math and spelling were included on the HSQ, a stronger effect of home enrichment on these skills would be obtained.

A child's cognitive ability was found to have a positive effect on academic achievement in all three path analytic models. This effect was significant for the reading and math models. What was surprising, however, was the lack of a solid effect between cognitive ability and skills achievement. In
fact, one of the weakest paths in the entire skills model was the path from cognitive ability to skills achievement. This finding leads one to believe that the skills achievement cluster is greatly affected by behaviors (the only paths which were significant in the model were the paths from impulsivity and internalizing behaviors). That is to say that it may be that the child's behaviors will have the greatest power in predicting achievement in the skills cluster, not his or her cognitive ability, head circumference, nor amount of early enrichment to which he or she has been exposed.

As explained previously, the obtained correlations gained from the mothers' reports of their children's behavior were quite small when compared to the size of the correlations from the teacher report form of the same behavioral measure. It is recognized that the CBCL is a highly valid and reliable instrument for measuring behavior and that a moderate amount of interrater variance is expected for parent observations versus teacher observations. While a child's behavior is likely to vary depending upon the setting in which the child is being observed and depending upon the individuals present who are observing the child (McConaughy, 1993), the amount of variance between the two raters' observations in this study was not typical.

Differences in these behavioral reports given by the parents and teachers may have occurred because the teachers often possess a more objective view of a child's behavior; teachers are professionals who are trained in how to work with children and how to identify their needs. Consequently,
teachers may be more perceptive when observing children's behavior and be better able to describe that behavior. It is possible that a mother's perception of her child may be distorted, particularly if the mother is still using substances and is not able to critically evaluate her child's behavior for an extended period of time. It has been suggested in research that parents may be more apt to focus on the difficulties they are having with their child when asked by a clinician to answer questions describing their child's behavior (Cohen, Gotlieb, Kershner, & Wehrspann, 1985). Furthermore, a study by Conrad and Hammen (1989) cited mothers who were depressed as relating more behavior problems than the mothers who were not depressed. Considering the present sample of mothers, their addictive tendencies, and the mood swings that often occur when a person is addicted to substances, it is likely that the mothers may not have presented accurate portraits of their children and therefore weakened the obtained correlations.

Teacher reports of a child's level of internalizing and externalizing behavior were observed to have varying effects on achievement across the three models. While internalizing behavior was found to have a negative effect on math and skills achievement, it was found to have a positive effect on reading achievement. Internalizing behaviors on the CBCL include the child appearing to be depressed, socially withdrawn, schizoid, and uncommunicative. While these behaviors may not appear to be positively associated with reading achievement, this finding has been reported in other
investigations. Research by Cohen, Gotlieb and Kershner (1985) reported stronger reading skills were associated with children who scored high on the Internalizing Domain of the CBCL. Considering the nature of reading achievement, it does follow that a child who is drawn 'inward,' has less socialization contact with the environment, and is described as being 'uncommunicative' may be more apt to better develop his or her reading skills as reading involves little contact with others. Reading does not require one to interact with others and is often a preferred individual activity, particularly for individuals who may have a more difficult time coping with their environment.

The negative effect of internalizing behaviors on math achievement and skills achievement was not surprising. In order for a child to develop proficiency in a given area of academics, he or she may need to vocalize a need to have directions repeated or to have the teacher provide further explanation in order to fully understand the material. Children who are depressed, uncommunicative, or socially withdrawn may be less inclined to inform the teacher they are confused and do not grasp the information. Chances are that the teacher may assume that the child understands the material if he or she is not asking for help, seems to be following along with the class, and is not causing a disturbance. Another plausible explanation is that if a child is depressed, he or she may not be adequately attending to instruction due to emotional difficulties and may lack the drive to adequately follow the teacher's lesson or be less willing to inform the
teacher that he or she is confused.

These findings are in support of the premise that there are different requirements for success in reading, math, and skills achievement as each achievement area may be uniquely intertwined with social behavior. While being drawn inward and not seeking added extra attention from one's environment may be associated with better developed reading skills, these same behaviors would not necessarily enhance math and skills achievement. On the contrary, these internalizing behaviors would be expected to have a detrimental impact upon one's ability to succeed in complex topic areas if one is unlikely to express a need for academic support.

Externalizing behavior was noted to have a significantly negative effect on reading achievement, while insignificant effects were found on math and skills achievement. Externalizing behaviors include aggressive, delinquent, and hyperactive behaviors. Considering the nature of these behaviors, it is reasonable to believe that hyperactive and acting out behaviors which are exhibited by a student to the classroom teacher are associated with poorer achievement. If the child has a propensity to be creating disturbances in the classroom or is hyperactive, it is probable that the child has not been adequately attending to classroom instruction and subsequently may perform more poorly on measures of standardized achievement.

Given the small, but positive, relationship that was found between externalizing behavior and math achievement, a case can be made for the notion that this is an idiosyncratic
finding and is not believed to be genuinely reflective of the relationship between externalizing behaviors and math achievement. Children who are often regarded as behavioral problems and have a proclivity to be aggressive or delinquent in school are not typically the children who are performing adequate academic work in math or any other subject. Academic achievement generally suffers when a student displays conduct difficulties in school.

Impulsive behavior had a negative effect on cognitive ability at age six. This finding in and of itself is not surprising, but it is important to consider when remembering that the sample scored in the low average range of the WISC-III and that their level of impulsivity was in the abnormal range. As their abnormally high level of impulsive behavior had a negative relationship with cognitive performance, it is possible that the children performed more poorly on the WISC-III, not because they have a lower level of cognitive ability, but rather because their impulsive behavior had a detrimental effect upon their overall performance and weakened their Full-Scale IQ score. Psychologists commonly caution that results on cognitive ability tests should be considered as a minimal estimate when a child's response style was impulsive or when the child was found to be highly distractible. An estimate of cognitive ability can easily be affected by a child not taking a sufficient amount of time to think about a response prior to answering the examiner's questions. Similarly, when a child knows that a particular subtest is being timed (as many are on the WISC-III), he or she may react even more impulsively and
simply try to "race the clock," work as quickly as possible, and then fail the item because he or she did not carefully evaluate a response. Therefore, it is the author's recommendation that the findings regarding the children's Full-Scale IQ lying in the low average range be cautiously interpreted. That is to say that the results be considered as a minimal estimate in light of the respondents' impulsive response style.

Prior research has demonstrated that the greater number of risk factors to which a child is exposed, the greater the negative effect upon a child's developmental outcomes. The children whose performance deteriorated most noticeably on measures of cognitive ability in a study by Liaw and Brooks-Gunn (1993) were the children who were exposed to the greatest number of 'risk factors' in their lives. Therefore, considering the present sample and the multiplicity of risk factors to which they were exposed (i.e., prenatal drug exposure, maternal addiction, infrequent prenatal care, low birthweight, home environments being categorized as 'at risk,' and living in inner city communities), it is quite possible that the estimates of their cognitive ability lying in the low average range is not as reflective of their being prenatally exposed to substances as it may be reflective of their having been exposed to a great number of risk factors throughout their young lives. Therefore, if the polydrug exposed children's intellectual potential lies in the low average range (from previously being assessed at lying in the average range when the children were age three), it may be possible to
provide early intervention in the lives of these children and positively affect their development if risk factors are reduced; it is encouraging to recognize that if the composite of perils to which young children are exposed was diminished, it is probable that the children's subsequent cognitive and academic development could be enhanced.

A child's level of impulsivity was found to have a negative effect on his or her math achievement cluster as well as on the skills achievement cluster. Again, it is assumed that the children's mean score on the GDS and their increased level of impulsivity be carefully considered when evaluating performance on the achievement measures. Impulsive behavior would likely impede a child's performance on the achievement measures (similar to its likely effect on the cognitive ability measure), and therefore would provide a lower estimate of the child's achievement skills than may actually be the case. Children who have an impulsive response style are typically more concerned with providing a quick response, not necessarily the correct response. A weaker performance on the achievement measure would not be surprising when working with an impulsive child.

A significant positive relationship was observed between impulsive behavior and reading achievement skills. This finding is believed to be a peculiarity of the data set obtained from this sample and is assumed to not accurately reflect the true effect of impulsivity on reading skills, particularly in light of the fact that the strength of this path was comparable to the value of the root mean square
residual for the model and that it was the weakest significant path in the model. It is not probable that the less able a child is to focus his or her attention, the more adept he or she will be at reading comprehension and reading decoding tasks. Particularly in the area of reading comprehension, it is believed that impulsive behavior would result in weakened performance. In all likelihood, a highly impulsive child would not be taking adequate time to carefully read a passage, to understand the theme and main ideas of the passage, and then be able to accurately answer insightful questions over the material which was just read. In a larger sample, it is believed that a negative relationship would be documented between reading skills and impulsive behavior.

In summary, several of the variables in the reading skills path analytic model and the math skills path analytic model were found to have significant effects on the achievement areas being predicted. By examining different types of variables and their varying effects on reading, math, and skills achievement, a fuller understanding of the interplay among elements related to various academic skills was obtained.

Specifically, the reading model offers hope for early intervention as it was found that home enrichment from the child's early years may have a profound impact on the child's reading skills when he or she is school age. Those children who were provided with ample books and had persons who would read to them when they were only three years of age performed significantly better on measures of reading achievement.
Focusing on the math model, the obtained findings underlie the importance of good prenatal care to insure that the child has essential intrauterine growth. This was the only model for which head circumference was found to be a significant direct predictor of a child's academic achievement. The better the prenatal environment to which the child was exposed and the larger his or her head circumference, the better developed were his or her math skills at six years of age.

While the measure which was considered to be a tool for estimating home enrichment (HSQ) did not help significantly with respect to predicting math achievement, the mother's level of education was found to significantly aid the successful prediction of math achievement. This finding is promising as it is believed that the greater the level of education the mothers had received, the better able they were to help their children with developing their math skills. While a mother's level of education is not a measure of home enrichment per se, this variable is believed to be indicative of maternal support and early enrichment of a child's academic skills.

Analysis of the skills model indicates that it was the achievement area with the lowest squared multiple correlation (only 51.9% of the variance in skills achievement was accounted for by the independent variables included in the model). Considering the nature of the skills achievement cluster, however, this finding is not surprising. It would be expected that when predicting performance on a broader range of skills (such as on the skills achievement cluster) less of
The variance may be accounted for than when predicting a specific skill such as math achievement or reading achievement.

The only two variables in the skills model which were found to have significant effects, albeit negative ones, were impulsivity and internalizing behaviors. That is, a child's behaviors had greater effects upon achievement in this area than did the effect of cognitive ability, home enrichment, or prenatal development. In addition, impulsivity and internalizing/externalizing behaviors were found to have significant effects upon reading and math achievement. For educational interventions, this finding suggests that to further develop a child's academic achievements, it is critical to address the child's behaviors. Consequently, if one were able to regulate the child's impulsive behavior and intercede to lessen the intensity of the child's internalizing or externalizing behaviors, two of the greatest negative influences upon achievement would be weakened and better academic development could then be aggressively encouraged.

Comparing the results of this study to the previously described study by Lifschitz and Wilson (1991), the children's cognitive performance was found to be similar. The children born to polydrug using mothers in the Lifschitz and Wilson sample were found to have a greater occurrence of low average cognitive ability, and the children in the present sample also typically scored in the low average range of cognitive ability.

In the NAPARE polydrug exposed sample, head circumference
was not found to be a significant direct predictor of intellectual ability at age three while it was found to have an important indirect effect. While head circumference was not a significant direct predictor of intellectual ability at age six, it did closely approach the level of significance and continue to have important indirect effects on academic achievement. While the three year old children in the NAPARE program were acknowledged to have intellectual ability scores which were estimated to be approximately four to five points less than the average score of the nonexposed children, the present sample of six year olds had intellectual ability scores in the low average range. Furthermore, a decline in the measured cognitive ability of children born with a low birthweight and raised in challenging environments has been documented in previous research by Liaw and Brooks-Gunn (1993). The present sample of polydrug exposed children was indeed born with a low birthweight (less than the tenth percentile) and was also reared in complex environments.

Both samples of children were being reared in home environments which were described as being 'at risk' according to their scores on the Home Screening Questionnaire. At age three the NAPARE polydrug exposed sample was found to have typical behavioral development on the CBCL and similarly the present sample did not exhibit above average behavioral problems on the CBCL at age six. While the NAPARE sample of children at age three were found to have average levels of perseverance, the six year old's average score on the Vigilance Task indicated high levels of impulsivity as over
half of the sample scored in the borderline range.

It is recognized that the finding that the polydrug exposed children are not exhibiting significant behavioral problems at age six may be startling for many. Rodning et al. (1989) reported that their sample of prenatally polydrug exposed children displayed notable weaknesses in behavioral development when the children were only two to three years of age. As previously reviewed, however, the present sample of six year olds was described by their classroom teachers and, on the average, the children were not found to have excessive behavioral problems despite their high levels of impulsivity; it appears that the children's classroom teachers were able to distinguish genuine behavioral problems from purely impulsive behavior in their students.

**Implications of Findings**

The results of this longitudinal research project will be surprising and indisputably significant for anyone who has followed early research in the area of prenatal drug exposure. Researchers' predictions have overwhelmingly been negative when trying to judge how the drug exposed infants and toddlers would fare when they became school age. A common forecast was that these children would create turmoil within the regular education classroom, that they undoubtedly would overload special education classrooms, and that they would therefore place a tremendous burden on the public school system because of their special needs and developmental delays.
Despite these predictions and assumptions, the results of the present study indicate that the sample of polydrug exposed children possess reasonably well developed academic skills and near average cognitive ability despite the developmentally dangerous influences to which they were exposed early in their lives. It is carefully added, however, that prenatal drug exposure is hardly believed to be inconsequential for future development. The positive signs noted in the sample's growth and abilities are not meant to downplay the perilous nature of exposing children in utero to substances. What is implied, however, is that factors affecting a child after birth must also be evaluated when estimating why a child developed as he or she did. It cannot simply be concluded that a child's subsequent development is exclusively correlated to prenatal development.

It is particularly important for educators to know that simply because a child has been prenatally exposed to substances, it does not mean that the child's behavior will be problematic. While on the average these children did exhibit an abnormally high level of impulsivity, they were not reported by their classroom teachers as having significant behavioral problems within the school environment. Their impulsive behavior appears to be more of a detrimental factor on their academic achievement and not necessarily to be related to increased behavioral problems in the classroom. That is to say that people should not assume that a child is going to have lagging behavioral development solely as a result of prenatal exposure to substances. Unfortunately,
when one anticipates a problem with a child, a self-fulfilling prophecy may generate a problem where it otherwise might not have manifested itself (Clarke-Stewart, Friedman, & Koch, 1985).

These results are important to anyone who will be working with or parenting children. Expectations must be altered regarding polydrug exposed children's development. The present outcomes indicate that by no means should we expect significantly decreased performance on measures of cognitive ability or academic achievement; rather, we should expect these children to score within one standard deviation of the norm. Furthermore, when decreased performance is found on cognitive measures or on measures of academic achievement, a child's level of impulsivity and possible behavioral problems should be systematically evaluated to determine whether or not these factors may be adversely related to the child's performance. Attention needs to be directed at those areas in which professionals can intervene and assist the child develop. While there is little intervention for furthering the development of cognitive ability at age six, there is much that can be done regarding early educational enrichment, helping a child control his or her level of impulsivity, assisting in modifying negative behaviors, and consequently helping a child achieve academic success in school.

Perhaps the greatest limitation of the study was that the sample was a 'best case' sample and therefore the findings reported here may not be clearly generalizable to other polydrug exposed children. The very fact that the children
had mothers who were caring and committed enough to maintain involvement in the longitudinal study for at least six years implies that these substance using mothers were more reliable and dedicated than one would expect of substance using persons. The mean age of the women being thirty-five further suggests that the women were different from the average substance using mother. One could build a strong case for the notion that because of the age of the women and the possibility of their being more mature, the studied sample of children may have been further supported and strengthened in their early development by mothers who were strongly committed to helping their children and supporting the argument that nurture (one's environment) may play as a significant of a role in development as nature (one's genetic endowment).

Despite the slight advantages afforded to many of the mothers in this study (e.g., perhaps being more stable and committed), these children were hardly the products of ideal conditions for learning and development. They were born to mothers who used approximately three substances at the time of pregnancy and did not follow through with an adequate number of prenatal visits. They were born with a head circumference less than the tenth percentile and they were reared in home environments which were classified as being clearly 'at risk.' The studied sample may have been less at risk than some children who have been born polydrug exposed, however they continued to be at risk. While some substance exposed children are born to mothers who utilize quality health care coverage and come from stable home communities, this sample of
children was reared in a poor inner city environment with few social supports. Therefore, while they may have been given enhanced opportunities for success, they were by no means isolated from the difficult challenges that face many children who grow up within a home and community where substance abuse is often a tolerated way of living.

Due to the longitudinal nature of the study, the sample size was much smaller than desired. Attrition is a common problem with longitudinal studies and the present sample was no exception. The relative effects of different variables within the path analytic model occasionally were uninterpretable, presumably because the sample was relatively small and may have been affected by idiosyncrasies within the data set. Had the sample size been larger, it is believed that an enhanced understanding of the relationships among some variables, such as the relationship between impulsive behavior and reading skills as well as the relationship between home enrichment and math skills, would have been achieved. It is recognized that few generalizations may be made from the study due to its preliminary nature with a small number of subjects and a great number of variables. What is advised, however, is that the present findings be considered in conjunction with other analyses of children born prenatally exposed to substances and who were reared in complex environments. This study is believed to be one of the first among many which will document the development of polydrug exposed children.

An additional limitation of the study was the measure used to assess the amount of enrichment provided within the home.
While the other instruments were well standardized and effective at measuring the construct they were designed to measure, the Home Screening Questionnaire did not prove to be useful with respect to predicting achievement in areas other than those related to reading. Upon a follow-up review of the items on the measure, it is apparent that there were ample questions related to reading enrichment, yet questions which would be helpful in predicting other academic skills were not included. The HSQ was designed to assess a child's global level of enrichment and would need further refinement if it is to be sufficiently helpful when predicting future achievement in specific academic areas.

Directions for Future Research

It is recommended that future research on the topic of polydrug exposure continue to explore a multitude of variables, with greater attention paid to influences in the children's environment, in an effort to further our understanding of how we may effectively intervene in the lives of children. It is believed that one's environment is integrally related to one's development and that added tools are needed to better study these relationships. Continued use of multivariate procedures, such as path analysis, would facilitate understanding of the effects of the variables involved. Recognition that a child is not neurologically programmed for academic failure due to polydrug exposure may open a new window of opportunity for many of these children
and raises further questions for researchers as to how their development may best be supported.

While longitudinal studies may be the most complex to carry out, they provide invaluable information when investigating a sample of this nature. Additional longitudinal studies where further intervention is implemented would greatly contribute to the state of the field. As a mother's level of education was found to be related to academic achievement, a program where mothers could further their own education to obtain their high school diploma or enroll in courses at a community college may be found to have a significant impact on the children's educational performance. If researchers were able to demonstrate that furthering a mother's education would have a direct bearing on the child's achievement, support services for these families could be revised to have a significantly greater effect on the lives of all the family members.

Evaluation of potential gender differences with a larger sample of children should also be considered in future research. Unfortunately, this was not possible in the present study due to the small sample size. It may be found that different internalizing or externalizing behaviors surface as areas of difficulty depending upon the gender of the child. If the sample were divided by gender to allow potential differences to be exhibited, such differences may become evident.

Behavioral problems, both high levels of impulsivity and some behavioral difficulties were generally found to have a negative impact on overall academic achievement. Admittedly,
these difficulties are not easy to remediate. Perhaps, however, if the children who exhibited behavioral difficulties received counseling services, behavioral training and/or medication to help control their impulsivity, some of the behavioral problems may be curtailed. If these kinds of interventions were indeed found to improve academic achievement, it is likely that administrators would approve an increase in funding for mental health services within the schools.

Summary and Conclusions

This study was designed to enhance our understanding of a sample of polydrug exposed children and their early school performance. Variables related to the children's prenatal environment, characteristics of their mothers, and the quality of children's home enrichment were systematically measured from the children's prenatal development during the course of the investigation. The average mother had irregular prenatal checkups, used nearly three different substances during her pregnancy, and had a child born with a head circumference below the tenth percentile. The home environments of the children were described as being clearly 'at risk.'

Despite these early indicators which appeared to be rather foreboding, the children performed well on the measures of cognitive ability and academic achievement. Their cognitive ability was estimated to lie within the upper limits of the low average range and was within one standard deviation of the
norm. Similarly, their skills on the broad reading cluster and the skills cluster were found to be in the upper limits of the low average range and within one standard deviation of the norm. The children's math skills were developed solidly in the average range.

From the information acquired from the children's classroom teachers, the children did not display significant behavioral problems. In addition, on average the children's scores on both the Internalizing Domain and the Externalizing Domain of the CBCL were below the level of significance.

The one area related to behavior which did present itself as a problem for the sample was their abnormally high level of impulsivity. It was postulated that the elevation of these children's level of impulsivity may have adversely affected their performance on the cognitive measure as well as their performance on the measures of achievement, and that these scores should be considered as a minimal estimate of their ability.

Evaluating the information gained in its entirety, the resiliency of this sample of children to overcome such overwhelming obstacles is quite resounding. The children were born with a developmental disadvantage due to hazardous prenatal conditions. They were reared not only in home environments lacking in enrichment but also in communities generally regarded to be impoverished, yet they seemingly managed to overcome the weighty odds against them. The majority of the subjects appear to have an intellectual potential just below the average range and perform at grade
level despite the negative factors which were presumed to be a part of their early developmental history. Taken together, the results of this study strongly suggest that if we can educate others with respect to the tremendous potential that lies within polydrug exposed children and not unequivocally consider them a lost cause because they were exposed to substances prenatally, these children might overcome perhaps the greatest obstacle in their lives -- society's preconceived and apparently inaccurate judgments as to their abilities and potential development.
Parental Consent Form

I understand that as part of the Follow-Up Project, the doctors are studying the development of children and how well they do in school.

I give my permission for my child's classroom teacher to complete the Achenbach Teacher Report Form, a questionnaire of my child's behavior in the classroom.

I understand that my signature is voluntary consent for my child to participate in this phase of the Follow-Up Project.

I may refuse participation of my child in this study and withdraw my child's participation at any time.

I acknowledge receiving a copy of this consent form.

Child's Name:_________________________________________
Teacher Name:_______________________________________
School Name and Address:______________________________
Parent or Guardian Signature:__________________________
Date:________________________________________________
APPENDIX B

Letter to Classroom Teachers

December 1, 1993

Dear Classroom Teacher,

I am inviting you to participate in a research project in which I am currently involved. The purpose of this study is to obtain specific information regarding children's behavior in school as observed by his or her classroom teacher. I believe that you - the classroom teacher - have a wealth of information regarding children's behavior which has not been systematically compared and studied. With your help, it is believed that a more comprehensive understanding of the children in our schools today will be revealed.

Enclosed with this letter I have included:
1) one short questionnaire asking you to describe one of your student's ( ) classroom behavior;

2) a copy of the consent form I have obtained from the child's parent that authorizes your release of this information; I am anxious to hear what you have to say and sincerely hope that you will take fifteen minutes or so out of your very busy schedule to complete the enclosed teacher questionnaire.

Currently I am a school psychologist with the Chicago Public Schools and can be contacted either at work or at home. If you have any questions, I can be reached at my schools according to the schedule below and my home phone number is (312) 348-3106. Please feel free to contact me!

Mondays and Fridays Lewis School X 43065
Tuesdays and Wednesdays Stone Scholastic Academy X 42045
Thursdays Lewis School or Stone Academy

As a small token of gratitude we will send you a $10.00 gift certificate from Marshall Field Department Store upon completion of the questionnaire. Thank you in advance for your time and effort.

Sincerely,

Kristine Larkin, M. Ed.
School Psychologist
Chicago Board of Education
APPENDIX C

Reminder Letter to Classroom Teachers

January 22, 1994

Dear Classroom Teacher,

Approximately three weeks ago I mailed you a questionnaire asking you to describe the behavior of a particular child in your classroom.

I realize that you have an extremely busy schedule and would just like to remind you that I am still interested in hearing about the behavior of the given child in your classroom.

If you have misplaced the form or if you have any questions, please feel free to contact me. If needed, I can send you a new form to be completed. I can be reached at my school according to the schedule below and my home phone number is (312) 348-3106. Please feel free to contact me!

Mondays and Fridays              Lewis School            X 43065
Tuesdays and Wednesdays          Stone Scholastic Academy X 42045
Thursdays                        Lewis School or Stone Academy

Sincerely,

Kristine Larkin, M. Ed.
School Psychologist
Chicago Board of Education
REFERENCES


VITA

Kristine Coyle Larkin was born on September 6, 1966, in Morton, Illinois. Kristine graduated from Marquette High School in Michigan City, Indiana in 1984. She graduated magna cum laude with a Bachelor of Science in Psychology from Loyola University Chicago in 1988. Kristine worked as an assistant to the Dean of Loyola University's Rome Center of Liberal Arts through 1989. In 1992 she received the degree Master of Education in School Psychology from Loyola University Chicago and became a certified school psychologist in the state of Illinois.

Kristine has worked as a school psychologist for the Chicago Board of Education since 1991. As a school psychologist, Kristine's responsibilities have included counseling both individual and small groups of students in areas related to academics, personal issues, and family challenges. Furthermore, she has been responsible for the administration, scoring, and interpretation of a wide variety of diagnostic instruments including measures of cognitive functioning, adaptive behavior, sensorimotor development, personality, and academic achievements for the individual evaluation of children aged three through twenty-one in all areas of exceptionality.

Presently, Kristine is working full-time at Stone Scholastic Academy in Chicago as a school psychologist. Being
a newly appointed full-time staff member, she is afforded the opportunity to work more closely with students and staff in an effort to facilitate children's development in a supportive and educational environment.
The dissertation submitted by Kristine Coyle Larkin has been read and approved by the following committee:

Carol Harding, Ph. D., Director
Professor, Counseling Psychology
Loyola University Chicago

Scott Azuma, Ph. D.
Developmental Psychologist, Senior Research Coordinator
National Association for Perinatal Addiction Research and Education

Ronald Morgan, Ph. D.
Associate Professor, Curriculum Instruction and Educational Psychology
Loyola University Chicago

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the committee with reference to content and form.

The dissertation is, therefore, accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[Signature]
Date: 9/6/96

[Signature]
Director's Signature