COGNITIVE DEVELOPMENT OF SUBSTANCE-EXPOSED CHILDREN INVOLVED WITH AN EARLY INTERVENTION PROGRAM

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ABSTRACT

Although there is a vast literature on the developmental challenges among children with prenatal substance exposure, the evidence is limited in terms of understanding their developments in the context of an intervention. The current study aimed to examine the cognitive development of substance-exposed infants and young children in the context of an innovative early intervention and to explore the associations between the quality of the mother-child relationship, children's temperament characteristics and their links to an aspect of cognitive development – intellectual functioning. The results indicated that children's reactivity to physical environments as rated by their mothers was a significant predictor of verbal domain of intellectual functioning while children's persistence on a goal was a significant predictor of non-verbal domain. These associations were also linked to the observational scores of children's behaviors during dyadic interactions with their mothers. The importance of these findings as well as their implications and limitations were discussed.

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Early intervention is critical for healthy development of infants and young children living in high-risk, adverse environments with their substance-using mothers (Hser, Evans, Li, Metchik-Gaddis, & Messina, 2013). Prenatal alcohol and substance exposure, combined with the negative effects of high-risk postnatal environments, are often linked to an elevated risk for poor cognitive development – including language delays, difficulties with attention, memory and learning problems – and a broad range of social-emotional and behavioral challenges of these children (Bandstra, Morrow, Mansoor, & Accornero, 2010; Brown, Olson, & Croninger, 2010; Streissguth et al., 1996; Cornelius & Day, 2009; Davis, Desrocher, & Moore, 2011; Dixon, Thal, Potrykus, Dickson, & Jacoby, 1997; Fried & Smith, 2001). Although there is a vast literature on the developmental challenges among substance-exposed children, the evidence is limited in terms of understanding the impacts of prenatal substance exposure on infants' and young children's cognitive development in the context of early intervention. If vulnerable children are raised in a supportive environment through intervention, then the impact of prenatal vulnerabilities may be mitigated so the children have an opportunity to develop optimally. The purpose of this study is to examine the cognitive development of substance-exposed infants and young children in the context of an innovative early intervention and to explore the associations among the quality of the home environment, the quality of the mother-child relationship, and the parent perception of the child temperament characteristics and their links to the children's cognitive development.

Theoretical Framework: Transactional model of Development and Attachment Theory

The transactional model of development (Sameroff & Chandler, 1975) highlights children's development as "*a product of the continuous dynamic interactions of the child and the experience provided by his or her social settings*" (Sameroff, pp.16, 2010). Combining the

bidirectional effects of 'nature' and 'nurture', Sameroff emphasizes their transactional interdependency. This view of the nature-nurture interdependency highlights the need to consider both biological and environmental systems in research on the processes of development for substance-exposed infants and young children living in high-risk environments. As such, transactional theory directs the focus not only to children's individual biological characteristics in relation to their cognitive development, but also to the home environments provided by their caregivers. Therefore, the key constructs of interest for this study were the individual biological characteristics of substance-exposed children manifested in their temperament and the quality of their home environments.

In addition, attachment theory highlights the importance of the caregiver-child relationship as a critical context for development. According to attachment theory, children are biologically wired to develop close relationships with primary caregivers for safety and comfort (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1973; Bretherton, 1992). In the context of day-to-day interactions with primary caregivers, children construct internal representations of the environment and of their own actions within it (Fitton, 2012; Waters, Hamilton, & Weinfield, 2000). These early experiences with the primary caregiver influence the children's organization of self, promote age-appropriate acquisition of autonomy and self-regulation capacities, and provide the foundation for healthy development through complex and transactional developmental processes (Bowlby, 1980; Collins & Laursen, 1999; Hyson, Copple, & Jones, 2006; Kochanska, Woodward, Kim, Koenig, Yoon, & Barry, 2010; Pepler, Moore, Motz, & Leslie, 2002). As such, children's interpersonal experiences with their caregivers are critically important for their learning and cognitive development. The goal of the intervention for substance-using mothers in the present study is to enable mothers to break from their substance

dependencies and become the primary caregivers for their young children. Therefore, another key construct of interest for this study was the quality of the mother-child relationship as it relates to the cognitive functioning of substance-exposed children.

Prenatal Substance Exposure and Cognitive Development

There has been strong evidence indicating that prenatal alcohol and substance exposure is linked to impaired cognitive development in children. For instance, in a longitudinal study of developmental trajectories of substance-exposed children, children with prenatal cocaine exposure had less optimal motor development at age three compared to impoverished, but non-substance-exposed children (Mayes, Cicchetti, Acharyya, & Zhang, 2003). Impaired verbal reasoning ability was also linked to prenatal cocaine exposure among preschool-age children, placing them at risk for learning difficulties as they enter the early education system (Griffith, Azuma, & Chasnoff, 1994; Morrow, Culbertson, Accornero, Xue, Anthony, & Banstra, 2006). Researchers examining the effects of prenatal alcohol exposure on children's cognitive development have found impaired reflexes, difficulties with information-processing, and less than optimal intellectual and executive functioning of these children (Connor, Sampson, Bookstein, Barr, & Streissguth, 2000; Jacobson & Jacobson, 1994; Kable & Coles, 2004; Mattson & Riley, 1998). In addition, non-verbal reasoning ability (e.g., visual-spatial ability) and short-term memory were found to be linked to prenatal marijuana exposure (Goldschmidt, Richardson, Willford, & Day, 2008; Smith, Fried, Hogan, & Cameron, 2006). As such, there is substantial evidence that prenatal substance exposure is linked to a variety of problems in both verbal and nonverbal domains of cognitive development.

Although there is a vast literature on the effects of prenatal substance exposure on children's cognitive development, some researchers have recently shifted their focus from

domain-specific developmental difficulties to more encompassing, core biological vulnerabilities resulting from prenatal alcohol and substance exposure (Schuetze, Molnar, & Eiden, 2012b; Wang et al., 2013). This shift in the focus of research seems to reflect the growing evidence that impaired regulatory capacities are the most fundamental problems linked to developmental difficulties of prenatally cocaine-exposed children (Ackerman, Riggins, & Black, 2010; Mayes, Bornstein, Chawarska, Haynes, & Granger, 1996; Mayes & Truman, 2002; Moe, 2002). Specifically, substance-exposed children tend to display early biologically-based regulatory problems that are manifested physically during infancy in irregular patterns of crying (LaGasse, Neal, & Lester, 2005; Schuetze, Eiden, Colder, Gray, & Huestis, 2012a). In addition, dysregulated reactivity to stressful situations is linked to prenatal substance exposure and adverse early life experiences (Fisher, Kim, Bruce, & Pears, 2012; Lester & Lagasse, 2010). As a consequence, substance-exposed infants and toddlers are often perceived by caregivers as more irritable and less cuddly than non-substance-exposed children living in similar high-risk environments (Schuler, Black & Starr, 1995). In other words, not only are substance-exposed children challenged by biologically-based regulatory problems that may interfere with their development, but they are also at risk for negative interactions with their caregivers who *perceive* them as having difficult temperaments. These biological vulnerabilities reflected in substance-exposed children's temperament have to be taken into consideration in research on the cognitive development of substance-exposed children.

Temperament and Cognitive Development

Child temperament has been linked to cognitive development – particularly language acquisition and learning – in both typically developing and substance-exposed children (Dinehart, Kaiser, & Hughes, 2009; Dixon & Shore, 1997). Specifically, soothability, positive mood, and

persistence/longer duration of orientation on task are all positively linked to language development in typically developing children (Dixon & Smith, 2000). Similarly, for children with prenatal substance exposure, perseverance in completing a goal-directed activity has been linked to their intellectual development (Azuma & Chasnoff, 1993; Dennis, Bendersky, Ramsay, & Lewis, 2006). Another related temperamental characteristic – children's reactivity to sensory and environmental stimulation – is also linked to cognitive development. Highly reactive children are more likely to have reduced tolerance for environmental stimulation and require more sophisticated regulatory capacities to remain engaged at the optimal level of arousal for learning and development (Eiden, Schuetze, & Coles, 2009; Lester et al., 2009a; Lester, & Padbury, 2009b;Mayes, & Truman, 2002; Schuetze et al., 2012a). Without the development of regulatory capacities, these children will become frustrated and easily disengage from tasks in order to avoid overstimulation. As such, children who have low tolerance for stimulation place increasing demands on caregivers, who themselves need to be regulated and reflective to modulate the intensity of their interactions with their children. Not only that, substance-exposed children need intensified efforts from their caregivers to help them develop capacities to regulate their emotions and behaviours (Bandtra, Morrow, Mansoor, & Accornero, 2010; Eiden, Schuetze, & Coles, 2011). Therefore, in this study, the biological vulnerabilities reflected in substance-exposed children's temperament characteristics – specifically their persistence on a goal-directed activity and their reactivity to environmental stimuli - were considered in examining the associations between temperament characteristics and cognitive development of substance-exposed children.

The Context of Development: Mother-Child Relationship and the Home Environment

In addition, the quality of the mother-child relationship and the quality of the home environment have to be considered as the primary contexts for substance-exposed children's developmental experiences. First, children's interpersonal experiences with their caregivers in the home are critically important for their learning and cognitive development. Mothers with substance-use problems living in high-risk environments and caring for their young children generally struggle with the complex tasks of parenting; they exhibit dysfunctional parenting behaviors that are often perceived as ineffective (Hans, 2002; Harmer, Sanderson, & Mertin, 1999; Hien & Honeyman, 2000; Lieb, Isensee, Höfler, Pfister, & Wittchen, 2002; Mayes, 1995). Moreover, maternal substance-use problems often coexist with histories of severe trauma for these women whereby their capacities for building healthy, positive relationships with others – including their own children – are often compromised (Hien, Cohen, Caldeira, Flom, & Wasserman, 2010; Hien & Miele, 2003; Pepler et al., 2002). Substance-using mothers are generally low on emotional availability – namely their sensitivity and optimal structuring for their children's needs while lacking hostility and instructiveness towards the children – than demographically matched, non-substance-using mothers (Goldman Fraser, Harris-Britt, Thakkallapalli, Kurtz-Costes, & Martin, 2010; Salo, Kivistö, Korja, Biringen, Tupola, Kahila, & Kivitie-Kallio, 2009; Salo et al., 2010). Although limited, evidence suggests a link between problematic mother-child relationships and a broad range of social-emotional and adaptive functioning difficulties in substance-exposed children (Motz, Espinet, Jeong, Zimmerman, Chamberlin, & Pepler, 2013). At this point, more research is needed to understand the significant role of the mother-child relationship on substance-exposed children's development.

The links between impoverished, high-risk environments and poor developmental outcomes of young children are already well-known (Engle & Black, 2008; Owens & Shaw,

2003). High rates of maternal unemployment, poverty, transience, exposure to interpersonal violence, limited father involvement, and maternal histories of trauma and mental health problems are known risk-factors for substance-exposed children, profoundly compromising their development and general well-being (Mayes & Truman, 2002; Motz, Leslie, Pepler, Moore, & Freeman, 2006; Pepler et al., 2002). Living in impoverished, high-risk environments, however, is linked to similarly poor developmental outcomes for children with and without prenatal substance exposure (Hurt, Malmud, Betancourt, Brodsky, & Giannetta, 2001). More research is needed to understand the independent and combined effects of adverse, high-risk environments and poor parenting skills. Therefore, in this study, the environmental vulnerabilities reflected in substance-exposed children's quality of the mother-child relationship and of the home environment were both considered in understanding the cognitive development of substance-exposed children.

Interventions for Substance-Using Mothers and their Young Children

The extant research indicates that young children with prenatal substance exposure who live in high-risk environments experience a range of developmental challenges – both biological and environmental. Although there is strong evidence of the developmental challenges among substance-exposed children, the potential mitigating effects of early intervention on children's development are still understudied. For substance-exposed children with difficult temperament characteristics, the developmental problems that arise from poor parenting skills and less than adequate home environments can be exacerbated if their mothers are unable to parent effectively and buffer the impact of the children's biological vulnerabilities (Greenfield et al., 2007; Harmer et al., 1999). However, if vulnerable children are raised in a supportive environment through timely intervention, then the impact of prenatal vulnerabilities may be mitigated so the children

do not lag behind developmentally (Anderson, Shinn, Fullilove, Scrimshaw, Fielding, Normand, & Carande-Kulis, 2003). One such intervention is Breaking the Cycle, one of Canada's first community-based, early intervention programs for substance-using mothers, which has been operating since 1995 in downtown Toronto.

Breaking the Cycle (BTC) is a program developed by Mothercraft to provide direct support and services that are integrated for both the mothers and their children exposed to maternal substance abuse (Motz et al., 2006; Pepler et al., 2002). Integrated interventions – targeting both the challenges faced by mothers and their children due to maternal substance use problems – reduce the barriers to receiving treatment (e.g., child care access, parenting responsibilities, stigma associated with maternal substance abuse) and have been found effective with promising results in recent years (Hines, 2013; Kumpfer & Fowler, 2007; Suchman, DeCoste, McMahon, Rounsaville, & Mayes, 2011; Suchman, Pajulo, DeCoste, & Mayes, 2006). While the children at BTC receive psychological assessments and therapeutic programming (both at the centre and in their homes) for their developmental needs, clinicians at BTC concurrently address substance-using mothers' addiction problems and their capacities for supportive and nurturing relationships with their young children. As the developmental needs of the children are identified and addressed by clinicians in the intervention context, substance-using mothers are constantly reminded of their children's well-being in light of their recovery from addiction (Greenfield & Pirard, 2009; Grella, 2009). BTC's relationship-focused approach is embodied in the intervention whereby the goal is to improve the relational capacities of substance-using mothers – i.e., the extent to which mothers are able to sustain healthy, positive relationships with others – and the quality of the mother-child relationship. In a non-judgmental, supportive, nurturing environment of relationship-focused, integrated intervention, the emphasis

on children's well-being not only addresses their developmental needs, but can also act as a catalyst for their mothers to strive for improvement – both for their own well-being as well as for their young children's. To our knowledge, this study is among the first to examine the cognitive development of high-risk, substance-exposed children in the context of an integrated intervention with a focus on relationships.

Hypotheses

The purpose of this study was to examine the cognitive development of substance-exposed children in the context of an innovative, relationship-focused early intervention. It focused on the complex associations between children's biologically-based temperament characteristics, and the quality of parenting and the quality of their home environments in relation to the children's cognitive development. First, I was interested in the potential mitigating effects of *early* intervention on cognitive development of substance-exposed infants and young children, and proposed the following hypothesis:

Hypothesis 1.1: The length of time in the integrated intervention with a focus on relationships is positively associated with verbal and non-verbal cognitive development.

I was also interested in biological vulnerabilities as reflected in substance-exposed children's temperament in relation to their cognitive development with the following hypotheses:

Hypothesis 2.1: The temperament characteristic of child persistence is positively associated with verbal and non-verbal cognitive development.

Hypothesis 2.2: The temperament characteristic of child reactivity to environmental stimuli is negatively associated with verbal and non-verbal cognitive development.

I was also interested in how children's developmental experiences – the quality of the mother-child relationship and the quality of the home environment are related to their cognitive development, and proposed the following hypotheses:

> **Hypothesis 3.1**: The quality of the mother-child relationship (as measured by observations of the mother's behaviour, the child's behavior, and the quality of dyadic interaction) is positively associated with children's verbal and non-verbal cognitive development.
>
> **Hypothesis 3.2**: The quality of the home environment, as rated by parent-infant therapists during their home visits, is positively associated with children's verbal and non-verbal cognitive development.

This study was conducted in the context of an intervention; therefore, I controlled for the length of time in the program when I tested the hypotheses related to the links between biological and environmental vulnerabilities and children's cognitive development.

METHOD

Participants

Participants were recruited from Breaking the Cycle (BTC), one of Canada's first community-based, relationship-focused intervention programs for substance-using mothers and their young children between ages of 0 to 6 (Pepler et al., 2002). Engagement in clinical services at BTC includes the completion of intake process, individual addiction/mental health counseling and relapse prevention groups, parent psycho-educational groups, mother-child intervention through home visiting and centre-based programs, instrumental support (e.g., clothing, food), and regular developmental assessment of children. The overall focus of intervention is on mothers' and their children's current relationships and relationship capacities to overcome the effects of maternal substance use (see Motz *et al.*, 2006, for more detailed information on the programs). As an outpatient program, service is provided for both the mothers and their children until the treatment goals of the families have been met (e.g., recovery from addiction, a sustained stability in parenting and home environments), or when there is a shift in needs of the family and alternative supports are required (e.g., if the child protection agency determines a continued instability in parenting and the home environment, and child is to be removed from the mother's care).

This study is part of a larger longitudinal study examining changes through treatment in BTC, funded by the Canadian Institutes for Health Research. Given the high-risk, transient nature of the sample, many women were excluded from this study because they were no longer parenting their children when this study was conducted or they could not be reached after consent for the research assessment. Of 143 mothers who were part of the larger evaluation study and consented for research, 61 (43%) of them met the inclusion criteria and were included in this

study (see Figure B1). Inclusion criteria for the present study are that: 1) the mothers have consented to research for themselves and their young children; 2) the research assessment on children's temperament and home environment was completed during the intake phase of the intervention; 3) the mothers and their children actively participated in the intervention; 4) the cognitive development assessment of the child occurred during the course of the intervention, and 5) the child was living with his/her biological mother at the time of the assessment. For mothers with more than one child receiving services at BTC (N=25), I chose the child with the most complete data for the study; when the children had similarly complete data, I randomly chose one child to maintain independence in the data.

Procedure

For this study, ethics approval was obtained as part of the larger program evaluation research grant. Ethics approval was obtained through Office of Research Ethics at York University. Upon referral to BTC, mothers were asked to consent for research and given full information about the larger study, funded by the Canadian Institutes for Health Research. Mothers were informed that their refusal to participate in research would not jeopardize their access to intervention programs at BTC, and that participating in research was strictly voluntary and confidential. As part of routine clinical intake practices at BTC, mothers are asked to complete demographic information on the mothers and their children and a battery of questionnaires described in the measures section below. Mothers were compensated for their research participation with approximately $10 in food vouchers per participation hour. As standard clinical practice, the Parent-Infant-Therapists (PIP) at BTC visited the mothers and children at home during the intake phase to assess the quality of their home environments with respect to child rearing. In addition, developmental assessments of the children occurred as part

of the clinical services at BTC during the course of intervention. These developmental assessments, conducted by trained clinicians with advanced psychology degrees (e.g., Clinical psychologists, Psychological Associates, Psychology trainees in the Ph.D. programs) focused on the cognitive, social, and psychological profiles of the children.

Measures

The key constructs of interest for this study are child temperaments, the quality of the mother-child relationship and of the home environment, and the cognitive functioning of the child. The measures used to assess these constructs are the Carey Temperament Scale (CTS), the Emotional Availability Scales (EAS), the Home Observation for Measurement of the Environment (HOME), the Wechsler Preschool and Primary Scale of Intelligence (WPPSI), and Bayley Scales of Infant and Toddler Development (Bayley).

The Carey Temperament Scales (CTS; Carey & McDevitt, 1978; Fullard, McDevitt, & Carey, 1984; McDevitt & Carey, 1978). The CTS is used to assess a mother's perception of her child's temperament characteristics based on 9 domains: 1) Activity Level, 2) Regularity, 3) Approach-withdrawal, 4) Adaptability, 5) Intensity, 6) Mood, 7) Persistence, 8) Distractibility, and 9) Sensory threshold. Mothers are asked to indicate how often their children engage in each stated behavior on a scale of 1 to 6 ranging from "almost never" to "almost always". Raw scores are calculated by summing the individual scores and dividing by the number of items rated. Nine domain-specific scaled scores are assessed against normative cut-off scores provided by the original scale developers. A higher domain-specific score indicates more negative temperament characteristics (e.g., negative mood, non-persistence, distractibility, high activity level). Adequate reliability (α = .66 to.86) and validity have been reported for the CTS (Bogat, DeJonghe, Levendosky, Davidson, & von Eye, 2006; Carey & McDevitt, 1978).

The Emotional Availability Scales – Fourth Edition (EAS; Biringen, 2008). In the Infancy/Early Childhood version of the EAS, parents' and children's contributions to the dyadic interactions are simultaneously assessed. Four parent domains are sensitivity (e.g., affect is genuine, balanced), structuring (e.g., remains firm while connected to the child), non-intrusiveness (e.g., let the child lead and follow that lead), and non-hostility (e.g., does not use threats). Two child domains are responsiveness to the parent (e.g., affect is genuine and positive, child appropriately relies on mother to regulate emotions) and involvement in the interaction (e.g., goes to parent for emotional exchange, not just instrumental reasons). These domains are globally measured on a seven-point scale, and higher scores on all dimensions represent more positive behaviors. Then, EA composite scores are created for each domain based on the sum of the ratings. The EAS has been found to have good reliability and validity (Biringen et al., 2005; Bornstein, Gini, Putnick, Haynes, Painter, & Suwalsky, 2006; Carter, Garrity-Rokous, Chazan-Cohen, Little, & Briggs-Gowan, 2001). In this study, EA ratings were based on videotaped free-play observation sessions conducted at BTC. Raters received intensive training from the scale developer and subsequently attained reliability with their lab. To avoid rater bias, a primary coder reviewed and gave ratings to all dyads while a second coder rated 25% of randomly selected videotapes. Inter-rater reliability was achieved (for the global ratings of each domain: ICC = .79 to .95; total ratings: ICC = .81 to .95), and all final ratings were based on consensus agreement.

The Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984; Totsika & Sylva, 2004). The HOME is used to systematically assess the caring environment parents provide for their children, on both relational and physical elements of the home environment, such as "Emotional and verbal responsiveness to adults of the primary

caregiver" or "Organization of the physical and temporal environment". The Infant Toddler IT-HOME (45 items) and the Early Childhood EC-HOME (55 items) are rated by clinicians during and after an extensive observation of the home environment. Clinicians score each specified statement with either yes (score of 1) or no (score of 0) based on whether the child-rearing environment meets the specific description. Higher total HOME scores indicate a more enriched home environment. The HOME is one of the most widely used instruments for evaluating the home environment and has a relatively good internal consistency (α = .44-.88 for IT-HOME; α = .53-.83 for EC-HOME) and good validity (Bradley, & Caldwell, 1984; Fuligni, Han, & Brooks-Gunn, 2004; Pierce, Alfonson, & Garrison, 1998; Totsika & Sylva, 2004).

The Wechsler Preschool and Primary Scale of Intelligence – Third Edition (WPPSI-III; Wechsler, 2002). The WPPSI is a standardized, norm-referenced scale widely used to assess the cognitive functioning/aptitude of young children from age 2 years and 6 months to 7 years 3 months, with four composite scores: 1) Verbal IQ, 2) Performance IQ, 3) Processing Speed Quotient, and 4) General Language Composite. It consists of seven core subtests, five supplemental subtests, and two optional subtests. Trained clinicians administer the items of each subtest with standardized test protocols, and the scores on each subtest are scaled on the normative reference scores provided by the test developers. Four composite scores are scaled to the mean of 100 and the standard deviation of 15, with scores falling between 90 and 109 considered Average – meaning that the child is performing at a relatively normal cognitive functioning in reference to his or her same-age peers. The Low Average range is 80-89, and the High Average range is 110-119. The WPPSI-III is found to have a good and much improved reliability and validity than previous editions, using both special populations (e.g., children with developmental delays, language disorders, ADHD) and the normative sample (Wechsler, 2002).

Bayley Scales of Infant and Toddler Development –Third Edition (Bayley-III, 2006). The Bayley is a standardized, norm-referenced measure widely used to assess developmental functioning in infants and toddlers under the age of 42 months. Significant developmental delays or concerns can be identified using the Bayley. Trained clinicians administer the items of each subtest with standardized test protocols, and the scores on each subtest are scaled on the normative reference scores provided by the test developers. The major domains that are assessed using the Bayley are: 1) Cognitive development, 2) Receptive and Expressive Communication, 3) Fine and Gross Motor skills, 4) Social-Emotional Development, and 5) Adaptive skills. For the purpose of the study, the first two domains of the Bayley will be assessed. Similar to WPPSI, the domain composite scores are scaled to the mean of 100 and the standard deviation of 15, with scores falling between 90 and 109 considered Average. Using both the normative sample and special populations (e.g., children with developmental delay, language impairment, prenatal alcohol exposure), the Bayley is found to be a reliable and valid measure (Bayley, 2006).

Intervention Effect. As an outpatient program, service is provided at BTC for both the mothers and their children until the treatment goals of the families have been met, or when there is a shift in needs of the family and alternative supports other than BTC are required. Given that all families receive similar types and intensity of services (e.g., weekly addiction/mental health counseling services, weekly home visiting for mother-child relationship), the amount of intervention was conceptualized as the duration of service engagement, in months, from intake to termination of services.

RESULTS

This study is one of the first to examine the cognitive development of substance-exposed infants and young children as it is linked to the quality of the mother-child relationship and of the home environment in the context of an integrated intervention. Because of the exploratory nature of the study and the small sample size from this understudied, but highly vulnerable group of children, I decided to interpret findings with a less conservative *p* value of .10. All statistical analyses were conducted using SPSS versions 20.0 and 21.0. Before the analyses of the hypotheses were conducted, independent samples t-tests and chi-squared tests were run to confirm that the 61 participants selected for this study did not differ demographically from the overall sample of 143 participants in the larger longitudinal study that this sample came from. There were no significant group differences in terms of the demographic variables (e.g., participant's age, level of education, monthly income, current living arrangement, past legal involvement, referral sources); all p>.05), with an exception of their past treatment participation; the participants in the current study were 1.9 times more likely to have had a previous treatment before coming to BTC, compared to the overall sample ($\chi^2(1) = 3.85$, p=.05). In addition, regression diagnostics were run, where necessary, and met all the assumptions including normality of the residuals, linearity of coefficients, and heteroscedacity.

In presenting the results for this study, I start with a demographic profile of the mothers and children from BTC who participated in this research. This is followed by a summary of psychometric analyses of the measures and correlations among the measures. Then, the analyses associated with each of the four hypotheses are described.

Demographic Profiles

Demographic and relevant background information for the mothers and children were taken from the intake forms completed as part of the clinical services at BTC. The demographic data on mothers, presented in Table A1, indicate that these mothers had experienced a constellation of challenges. On average, they were 30 years old and had two children; almost half of the mothers did not complete high school, and only one in 10 mothers were employed at the time of intake for intervention. The mothers reported a broad range of mental health problems: over half of them reported symptoms in the clinical range for depression and about one sixth of the mothers reported clinically severe levels of anxiety-related symptoms. Substance use was a common problem, which was expected given the population being sampled: two-thirds of the mothers were poly substance users, with almost all of them reporting use of crack/cocaine. Almost all (93%) of the mothers who answered the questions about their past history of abuse reported some form of maltreatment: almost 90% reported emotional abuse, 85% reported physical abuse, and 60% reported sexual abuse.

The demographic data on the children (all under six years of age) in the study are presented in Table A2. Their average age at intake was 14 months; five of the mothers were still pregnant at intake. As Breaking the Cycle is a program for substance-using women, prenatal substance exposure was a risk factor for all of the children: 75% of the children were exposed to substances in all three trimesters; 90% of the children were exposed to more than one substance prenatally. One in seven children was born with low birth weight (<2500 g), and one in ten children was born prematurely.

Analyses of the Three Constructs

Preliminary analyses were conducted to examine the means, standard deviations, and inter-scale correlations for the three constructs of interest in this study: temperament, quality of

the mother-child relationship, and cognitive development (see Tables A3, A4, and A5, respectively).

Child Temperament. This study focused on two domains of child temperament: Persistence and Reactivity to Environment. The BTC mothers rated their children as moderately persistent (i.e., stays with a task or activity). They also reported that their children were somewhat reactive to environmental stimuli, such as sound, taste, light, etc.

Mother-Child Relationship. On the global ratings of the quality of the mother-child relationship (see Table A4), the mean scores for the mothers on maternal sensitivity, maternal structuring, and maternal non-hostility were all below five, indicating that on average, the quality of the relationship between mothers and children is somewhat compromised. On the measures of maternal non-intrusiveness and child responsiveness and involvement, the mean scores were below four, indicating more serious concerns with these aspects of the mother-child relationship. These same patterns were evident in the total (summative) ratings of the quality of the mother-child relationship (see Table A5).

Cognitive Development. On the cognitive development measure - specifically their intellectual functioning on verbal and nonverbal domains, the children's mean score was average and comparable to the average IQ score for the normative sample of children their ages (see Table A6). The majority of the children fell in the Average range (IQ score between 90 and 109) in terms of both verbal and nonverbal domains of their intellectual functioning (60.3% for verbal; 66.1% for non-verbal). The children's average verbal IQ score was slightly higher than their average non-verbal score, and these two cognitive domains were significantly correlated. The standard deviation for the scores of the children in this study was very similar to that in the general population, indicating that there was limited variance, with the majority of children's

scores falling under the normative range (i.e., below and above one standard deviation from the mean).

Quality of the Home Environment. The final scale that we examined was the HOME. According to clinicians' ratings, 83% of the scale questions were answered positively. In other words, the clinicians reported that the mothers were being effective in providing their children with a positive home environment. Contrary to expectations, at the beginning of mothers' active participation in BTC, there was little variability in clinicians' ratings of the extent to which these substance-using mothers provided their children with an enriched home environment. Due to this lack of variability and the ceiling effect on the scale, the HOME measure could not be used for further analyses.

Preliminary Analyses for the Regressions

Correlation analyses were conducted as a precursor to the regression analyses for each hypothesis in order to identify the significant mother-child interaction and home environment variables. In this way, I was able to create the most parsimonious models for this relatively small sample of high-risk mothers and their young children (see Table A7). In this sample, intervention effect was not correlated with any of the predictor or outcome variables, whereas child age was significantly correlated; therefore, child age was controlled for in the regression models.

Higher verbal intelligence scores were significantly and positively correlated with maternal ratings of child's reactivity to the environment and the quality of the relationship scores – particularly the global and total scores on child's responsiveness to adults and the global score on child's involvement of adults – in the observations of mother-child interactions. The non-verbal intelligence scores were not correlated with any of the temperament; however, it was positively correlated with the quality of mother-child relationship scales – particularly the global

scores on child's responsiveness to adults and child's involvement of adults in interactions. In addition, there was one significant correlation between the constructs of interest and control variables: girls scored higher on verbal intelligence score than boys. Based on these correlations, I identified one temperament variable (i.e., child's reactivity to environmental stimuli) and two mother-child interaction variable (child's responsiveness to adults and child's involvement of adults in interactions) to be included in the regression analyses.

Analyses of Hypotheses.

Hypothesis 1. The first hypothesis was that children who had been in the BTC intervention for a longer period of time would have higher verbal and non-verbal intelligence. As indicated in Table A7, there was not a significant correlation between the length of children's involvement in BTC and either verbal or non-verbal IQ scores.

Hypothesis 2. I was interested in biological vulnerabilities as reflected in substance-exposed children's temperament in relation to their cognitive development. I expected that children with stronger persistence would have higher verbal and non-verbal IQ. Conversely, I expected that children with lower reactivity to their environments (i.e., less affected by the environmental stimuli) would have higher verbal and non-verbal IQ. As shown in the correlations (Table A7), temperamental reactivity to the environment was positively related to verbal IQ, a finding contrary to our expectations. In other words, children who were rated by their mothers as being very sensitive to the noises, lights, smells in their environment were those who had a higher verbal IQ. There was no significant correlation between persistence and verbal and non-verbal IQ.

Hypothesis 3. I was interested in how the quality of the mother-child relationship is related to their children's cognitive development. I expected that the quality of the mother-child

relationship is positively associated with children's verbal and non-verbal cognitive development. The correlations (in Table A7) indicate that there were no ratings of mothers' behaviours that were significantly correlated with children's verbal or nonverbal IQs; however, children's responsiveness to and involvement of adults (e.g., their mothers) during the interactions was positively related to verbal IQ and non-verbal IQ.

Overall Model. A regression was used to test the overall model that links the cognitive development of substance-exposed children to their temperament and the quality of the mother-child relationship in the context of an integrated intervention. For this model, depicted in Figure B2 in the Appendix, child age at intake was the control variable given that child's age was significantly correlated with the quality of the mother-child relationship.

Controlling for age, the first regression model (see Table A8) was focused on child's reactivity to the environment as a predictor of verbal intellectual functioning; it was found that this temperament characteristic was a significant predictor ($p = .055$). A further step in the regression analyses was to add child responsiveness to adults to the regression model predicting verbal IQ. When this measure of the quality of mother-child interaction was added to the regression analysis, again controlling for age, child responsiveness to adults was a significant predictor of verbal IQ ($p = .09$). In the full model with both child temperament and child's responsiveness to adults in mother-child interaction, only the latter was significant in predicting child's verbal IQ.

Controlling for age, the second regression model (see Table A9) was focused on child's persistence as a predictor of non-verbal intellectual functioning; it was found that this temperament characteristic was a significant predictor ($p = .079$). A further step in the regression analyses was to add child's involvement of adults in interactions to the regression model

predicting non-verbal IQ. When this measure of the quality of mother-child interaction was added to the regression analysis, again controlling for age, child's involvement of adults in interactions was a significant predictor of verbal IQ ($p = .054$). In the full model with both child temperament and child's involvement of adults in mother-child interaction, only the latter was significant in predicting child's non-verbal IQ.

DISCUSSION

The goal of this study was to examine the cognitive development of substance-exposed children in the context of an innovative, integrated, and relationship-focused early intervention. More specifically, it focused on the complex associations between the mothers' perceptions of their children's biologically based temperament characteristics, the quality of the mother-child relationship, and their home environment in relation to the children's verbal and nonverbal domains of cognitive development. It should be reiterated that the results of this study are considered preliminary, given the exploratory nature of the study and the small sample size from this understudied, but highly vulnerable group of children.

Child Temperament

In this study, we were interested in substance-exposed children's temperament characteristics – which were assessed using the maternal perceptions of their children. Although there was a great degree of variation, on average, the temperaments of these children were rated by their mothers as relatively positive in terms of their persistence in completing an activity. This characteristic implies that the children tend to remain engaged in an activity for a relatively moderate period of time, but not necessarily for an extensively long period of time. The children were also rated by their mothers as somewhat reactive to their environments, with a large degree of variation. This characteristic implies that on average, the children are somewhat sensitive to disruptions in their physical environments (e.g., loud noises, bright lights, smells), with some children more or less reactive than others. These findings are consistent with previous research, for which prenatal substance exposure has been recognized as an important factor for the neurodevelopment of young children, with its long-term effects on children's level of arousal and reactivity, and their capacities for sustained and selective attention during an activity (Bandstra,

Morrow, Anthony, Accornero, & Fried, 2001; Dennis et al., 2006; Noland et al., 2005). Given the wide variations among the children in this sample, these findings suggest that the temperamental characteristics of some substance-exposed children (i.e., those at the extremes on the temperament ratings) may present as risk factors for their developmental and learning challenges. In other words, some children's impaired abilities to initiate and maintain attention, combined with less optimal levels of arousal and their heightened environmental sensitivity, can create a level of distraction and interference with learning that may accumulate into missed opportunities for learning and healthy development. Although it was beyond the scope of the current study, more research is warranted to explore other dimensions of temperamental characteristics among substance-exposed children (e.g., approach and withdrawal, negative and positive mood) and their associations with children's development and possibly their learning difficulties.

Quality of the Mother-Child Relationship

In this study, we were also interested in the quality of the relationship between substance-using mothers and their children. Evidence suggests that the quality of the mother-child relationship (e.g., attachment security, autonomy support, sensitivity and scaffolding) and their interactions comprise a critical context for developmental experiences of all young children, including children with prenatal substance exposure (Matte-Gagné, Bernier, & Gagné, 2013; McConnell, Rush, McEvoy, Carta, Atwater, & Williams, 2002; Whipple, Bernier, & Mageau, 2011). For the present study, mothers were asked to play with their children at BTC with the instruction that they should interact as if they were in their homes. The videotapes of these interactions were coded for the quality of the mother's behaviour, the child's behaviour, and the mother-child interaction. In this sample of children with prenatal substance exposure and their

mothers, the mother-child interactions were rated as moderately compromised on many of the emotional availability domains; less optimal behaviors were observed in both the children's and mothers' behaviors during their interactions.

Mothers' sensitivity and structuring of interactions for their children's needs were rated as compromised. The mothers' behaviours during the interactions were weakest on their intrusiveness. In other words, these mothers were rated as quite intrusive during their play interactions with their children. These ratings are typically given when parents frequently direct the play and dominate the interactions, rather than waiting to follow the lead and interests of the children. This finding is supported by past research on the emotional availability of substance-using mothers, in which their behaviors are often described as less sensitive to their children's needs as well as intrusive while lacking an interactive flow between communicating partners (Goldman Fraser et al., 2010; Pajulo, Suchman, Kalland, & Mayes, 2006; Truman & Mayes, 2002). Ratings of the children's behaviours indicated that they were generally low on responsiveness and low on involvement of their mothers during the interaction. In other words, it was observed that these children did not reliably reciprocate when their mothers initiated an interaction. Additionally, they generally did not initiate interactions to engage their mothers in the play activities. Therefore, although the mothers' behaviors were low on non-intrusiveness (i.e., quite intrusive), the difficulties in the mother-child interaction arose from a combination of mothers' weaknesses in being attuned to their children's needs and their children being unresponsive and lacking initiative in the interactions to engage their mothers.

This finding first highlights that children's responsiveness and involvement of adults in dyadic interactions are so closely tied to the sensitivity and reflective awareness of the adults; children are more likely to respond to and initiate interactions with responsive adults, and

similarly, adults are also more likely to continue their interactions if the children are responsive to them. Furthermore, this finding also adds to the evidence that substance-using mothers and their children are often "difficult partners for each other" in their interactions (Pajulo et al., 2011; Suchman et al., 2006). As discussed above, the children's temperamental characteristics of impaired attention and heightened environmental sensitivity may place them at risk for a range of social difficulties, including their interpersonal interactions. With these vulnerable children, there are increased demands for caregivers to have skillful interpersonal and parenting styles that will promote a positive, interactive flow between communicating partners. These demands, however, are often not met by mothers with substance use problems, given their limited capacities for healthy relationships hindering their abilities to effectively parent their young children. These impaired capacities are often associated with the women's past experiences of chronic cycles of interpersonal victimization, with unresolved traumas and comorbid psychopathology (Greenfield et al., 2007; Grella, 1996; Harmer et al., 1999).

In some ways, the mothers and children in this study may have adapted to one another's vulnerabilities. The findings of this research suggest that there is a negative, yet complementary interactive flow between substance-exposed children and their mothers, which may compensate for their interactive difficulties. When mothers dominate the interactions, there is less need for children to initiate and respond to maintain the flow of the interaction with their mothers. Taken together, mothers' intrusiveness and children's low responsiveness and low involvement of adults appear to be compensatory and complementary in their interactions. With this imbalance between mothers' and children's initiatives in the interactions, there may be a lower likelihood for conflicts or difficulties in interactions given their complementary characteristics; however, mothers' intrusiveness and children's lack of involvements can limit the opportunities and the

potential for promoting the children's social competence and relational capacities. These findings are consistent with the clinicians' anecdotal descriptions of the mothers at BTC, whom they perceive as being well-intended, but not skilled or aware enough of their children's needs and the subtle dynamics in mother-child interactions to recognize that their children are disengaged and not participating fully in the play interactions. As such, providing an early intervention for this population is critical in helping the mothers to *see* their children as young individuals with their own needs and to support these children's development of healthy attachment and relational capacities (Huth-Bocks, Theran, Levendosky, & Bogat, 2011; Salo & Flykt, 2013).

Child Temperament and Quality of the Mother-Child Relationship

When we consider these interaction patterns in terms of the findings of substance-exposed children's temperamental characteristics, a clearer picture begins to develop. Children's reactivity and vigilance to the physical environment found in this study may also extend to their social environments. In the case of their interactions with their mothers, these children may experience stress and be highly reactive to their mothers' intrusive and/or perhaps dysregulated behaviours (Mayes & Truman, 2002; Siqveland, Olafsen, & Moe, 2013). Depending on individual differences in temperamental reactivity and persistence, some children may remain engaged while others will tune out in response to their highly intrusive mothers in order to manage the level of arousal and cope in these interpersonal situations. When the children are disengaged from the interactions with their mothers, they may miss out on critical learning opportunities, particularly verbal or language learning opportunities and social exploration. When we consider these interaction patterns in a supportive, early intervention, a different picture begins to develop. Although temperamental characteristics of substance-exposed children can be thought of as risk factors, they can also act as protective factors in the context of early

intervention and healthy learning environments. For instance, children's reactivity to their physical environments may elicit more opportunities for positive interactions with sensitive adults, such as the early childhood educators at BTC. Through extended exposure to positive interactions with caring adults (e.g., parents, guardians, clinicians), these children may practice and develop more appropriate ways to attend to and regulate their level of arousal during an activity (Kochanska, Murray, & Harlan, 2000). In other words, children's temperament characteristics can act as moderators in the association between the quality of the caregiving environments and the development of substance-exposed children. Although it was beyond the scope of the current research to test this hypothesis, more research is warranted to explore the interaction effects between the temperamental characteristics of substance-exposed children and the quality of their caregiving environment.

Cognitive Development

In this study, we focused on the cognitive development of these young children. Evidence from past research indicates that cognitive or intellectual development of substance-exposed children seems to be malleable and, to a great extent, affected by their postnatal environment (Pulsifer, Radonovich, Belcher, & Butz, 2004). The goal of the present study was to examine the cognitive development of substance-exposed infants and young children as it is associated with the quality of the mother-child relationship and the quality of the home environment in the context of an integrated intervention. In this study, the majority of the children scored in the average range in terms of their verbal and non-verbal IQ scores, while a few children fell in the extreme ends of the range. Contrary to expectations (Davis, Gagnier, Moore, & Todorow, 2013), the intellectual development of these children of substance-using mothers was generally not compromised – at least not at this young age. The children in this sample had a mean score of

104 on the verbal scale and 100 on the nonverbal scale of the standardized intelligence tests. The standard deviations for the scores in this sample were 11 for both verbal and nonverbal domains of cognitive development. In other words, the range of scores from lowest to highest also resembled the pattern of typically-developing children in terms of their intellectual development. This positive result was unexpected, given that these children had been exposed prenatally to substances and their mothers were struggling in many ways, as indicated by the descriptions of the demographic data.

This unexpected pattern may have arisen because the majority of children in this sample were tested for their intellectual development during their first or second year of life and prior to entering the school system. The intellectual development of these children may closely resemble that of typically developing children when they are at this young age. Children with prenatal substance exposure will most likely begin to experience a marked developmental lag as they get older and enter into the school system where there are more sophisticated developmental expectations. It is also important to note that all of the families in the present study were in the process of initiating and/or already beginning to receive some early intervention services. As such, the expected developmental lag may have been mitigated by the intensive and extensive supports that both the mothers and their children were beginning to receive during the research time.

Predicting Cognitive Development

Given the earlier findings of the link between temperamental characteristics of these children and the quality of their relationships with their mothers, I was interested in testing those two variables as predictors of children's intellectual development. For instance, if children are highly reactive, they may be vigilant to their social settings as they are to their physical

environments. In this case, in a supportive environment children may also be more vigilant and responsive toward their mothers' behaviours and perhaps more attuned to her verbalizations, which in turn may promote positive development in the verbal domain of cognition. Similarly, if children are highly persistent on a goal in a supportive environment, they may stay with an activity for a longer period of time and elicit more attuned involvement from their mothers. Based on this logic, in the regression model, we expected that child's temperament and the quality of mother-child interaction would serve as predictors of children's cognitive development with verbal and non-verbal domains as separate outcome variables.

Controlling for age, I found that children's reactivity to their environments was a significant predictor of verbal intelligence. Children whose mothers rated them as sensitive to their physical environments were those children who had higher verbal IQs. When child responsiveness to adults coded during play interactions was added to the regression model, this measure of children's engagement with their mothers was also a significant predictor of verbal IQ. When age was controlled (but not significant), these two variables accounted for 23% in children's verbal IQ. Therefore, the children in this sample who were highest on verbal intelligence were those whose mothers rated them as quite reactive to their environments and who were observed to be responsive to their mothers during play interactions. In other words, the combined effects of highly reactive temperamental characteristics of these substance-exposed children and their appropriate responses to their mothers seem to promote verbal and/or language development of these children. As discussed previously, highly reactive children may be more vigilant toward their environment including their mothers' behaviours. As such, they may be more attuned to their mothers' verbalizations and initiation of play, which in turn may provide

more opportunities for continuous, reciprocal interactions and, therefore, promote positive cognitive development in the verbal domain.

Controlling for age, I found that children's persistence as rated by their mothers was a significant predictor of non-verbal intelligence. The children who were rated higher on the ability to stick with a task or an activity were those who also scored higher on the measure of non-verbal intelligence. When the observational scores of children's attempts to involve their mothers in the play interactions were added to the regression model, this measure of the quality of mother-child interaction was a significant predictor of non-verbal IQ. When age was controlled (but not significant), these two variables accounted for 23% in children's non-verbal IQ. Therefore, the children in this sample who were highest on non-verbal intelligence were those whose mothers rated them as persistent in a task or activity and who were observed to be active in seeking their mothers' involvement in the play interactions. In other words, the combined effects of highly persistent temperamental characteristics of these substance-exposed children and their appropriate initiation of involving their mothers seem to promote non-verbal and/or visual-spatial development of these children. Highly persistent children may be more able to stay with an activity for a longer period of time and maintain interactions with their mothers. In this case, they have more exposure to visualization and manipulation of different objects during play, which in turn provides more positive continuous, reciprocal interactions and promotes cognitive development in the non-verbal domain.

LIMITATIONS AND FUTURE DIRECTIONS

There were several limitations in the measurements for the current study. First, children's temperament characteristics were measured using maternal self-report, which may not be accurate if mothers are not well-informed of young children's development and age-appropriate behaviors related to temperaments. In addition, the quality of the mother-child relationship was assessed using the videotaped free-play observation sessions conducted at the research site – which may not capture all of the dyad's relational qualities and in a wide range of situations (e.g., when in conflict; if given a task to complete) . Substance-using mothers in this study may also be trying to represent themselves and their children in a positive light, given that they are in the context of treatment and a part of the research study. Therefore, the findings of this study should be considered preliminary, and in future research, a multimethod approach to measurement (e.g., an observation-based approach to measuring children's temperaments) will add to the objectivity and validity of the constructs. Secondly, data on the quality of the family's home environment was gathered during a home visit for a one-time assessment conducted by the parent-infant therapists at BTC. The clinicians rated the home environments very positively with little variability in their ratings of the extent to which these substance-using mothers provided their children with an enriched home environment. Due to the ceiling effect and lack of variability on the scale, the HOME measure could not be used for further analyses. Thirdly, the amount of intervention in this study was conceptualized as the duration of service engagement, in months, from intake to termination of services. Neither frequency nor intensity of service engagement was examined. In addition, the duration of service engagement was not significantly correlated with any of the variables of interest. Future research should be conducted to replicate the current study with more rigorous measures of service engagement for both substance-using

mothers and their children. Fourthly, data on the variables of interest were collected in the context of a highly supportive early intervention program for treatment-seeking mothers with substance use problems and their young children. As such, the findings of this study may not be generalizable to the larger population of substance-using mothers and their young children with prenatal substance exposure. Similarly, all mothers in the current study have reported chronic histories of poly-substance use and experiences of severe trauma in their relationships – indicating a rather homogeneous sample of substance-using mothers. As such, the degrees of prenatal substance exposure for their children are assumed to be comparable across the sample and were not included as variables of interest for the study. Future research should explore this methodological issue and utilize a more objective and systematic approach to measuring prenatal substance exposure than the retrospective maternal reports used in the present study. It is important to note, however, that there is a vast literature on the difficulties in developing a measure that accurately and reliably reveals variability in these significant prenatal risk factors for the children (Koren, Chan, Klein, & Karaskov, 2002). Lastly, given the difficult-to-engage nature of the sample, the sample size of the current study (N =61) was not sufficient to conduct a person-oriented approach to data analyses, such as the Latent Class Analysis (LCA), which can meaningfully categorize and identify developmental profiles of substance-exposed children. More focused efforts in recruiting and maintaining a larger number of research participants are required to explore this important area of research in the future.

IMPLICATIONS AND CONCLUSION

The findings of the current study highlight the need for more research on this important topic. The link between a biologically based child characteristic variable (temperament) and an interpersonally focused child characteristic variable (child's responsiveness and involvement of their mothers during interactions) was highlighted in relation to verbal and non-verbal cognitive development of children with prenatal substance exposure. The combined effects of different temperamental characteristics of these substance-exposed children and their appropriate interactional styles with their mothers were associated with unique areas of cognitive development. These findings will inform evidence-based interventions to: 1) provide more individualized interventions for these children and their mothers, which can be tailored to the mothers' emotional availabilities and their children's needs in specific domains of development, and 2) meet the needs of these young children who are at risk for significantly delayed development as a function of their biological vulnerabilities and inadequate relationship and physical home environments. The findings of this study may provide direction to refine clinical practices to promote optimal development for some of the most vulnerable children living in high-risk environments. There are significant implications associated with treatment outcomes of substance-using mothers and their young children – not only for themselves, but also for the society as a whole with respect to the costs involved in supporting families of substance-exposed children. Providing individualized, client-centered, and relationship based early intervention can be an important step to improve these families' quality of the life and reduce the social and economic costs for society.

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Appendix A

Table A1

Mothers' Characteristics

	Value
Mother Age, in years	
Mean (*SD*)	30.75 (6.16)
Median (Range)	30 (19-50)
Mother's Level of Education, %	
Did not complete high school	47.5%
Mother's Employment, %	
Currently unemployed	91.0%
No Information	29.5%
Mother's Monthly income, in Canadian dollars	
Mean (*SD*)	$1,156.90 (815.56)
Median (Range)	$1000.00 ($0-$4,167)
Parity (No. of children)	
Mean (*SD*)	2.02 (1.27)
Median (Range)	2.00 (1-5)
Mother's Psychiatric Symptoms*	
CES-D score	
Mean (*SD*)	19.89 (13.09)
Median (Range)	19.00 (0-47)
In Clinical Range (score ≥16), %	56.1%
No information	6.5%
BAI score	
Mean (*SD*)	13.09 (10.20)
Median (Range)	11.00 (0-38)
In Severe Range (score ≥26), %	15.8%
No information	6.5%
Mother's Primary Addiction to Substance, %	
Crack/Cocaine	46.0%
Alcohol	24.6%
Opiates (e.g., Heroin, Oxycodone)	16.4%
Poly-Substance Use	65.6%
Mother's Histories of Abuse experienced, %	
Emotional Abuse	88.1%
Physical Abuse	84.7%
Sexual Abuse	61.0%
No Information	3.3%

Note. $N = 61$; CES-D indicates the Centre for Epidemiologic Studies Depression Scale (CES-D; Weismann, Sholomkas, Pottenger, Prusoff, & Locke, 1977); BAI indicates Beck Anxiety Inventory (BAI; Beck & Steer, 1993).

Table A2

Children's Characteristics

	Value
ı Child Age at Intake, in months	
Mean (*SD*)	14.08 (16.99)
Median (Range)	6.00 (0-69)
Gender, %	
Female	52.5%
Gestational age, wk	
Mean (*SD*)	38.26 (1.83)
Median (Range)	40.00 (34-42)
Prematurity (<37-wk), %	10.5%
No Information	6.5%
Birth weight, g	
Mean (*SD*)	3,232.10 (700.87)
Median (Range)	3,288 (1,474-4,706)
Low birth weight (<2500-g), %	13.6%
No Information	6.5%
Substance exposure in all trimesters, %	75.9%
Multiple substance exposure, %	91.4%
Amount of prenatal substance exposure, per use	
Crack/Cocaine, g/use	
Mean (*SD*)	1.76 (2.21)
Median (Range)	1.00 (0-9.17)
No. of children exposed, first trimester*, %	53.4%
No. of children exposed, second trimester≠, %	16.1%
No. of children exposed, third trimester#, %	16.4%
Alcohol, drinks/use	
Mean (*SD*)	1.95 (1.72)
Median (Range)	1.50 (0-7)
No. of children exposed, first trimester*, %	55.2%
No. of children exposed, second trimester≠, %	16.1%
No. of children exposed, third trimester#, %	18.2%
Methadone, mg/day	
Mean (*SD*)	50.90 (30.66)
Median (Range)	46.30 (0-110)
No. of children exposed, first trimester*, %	10.3%
No. of children exposed, second trimester≠, %	17.9%
No. of children exposed, third trimester#, %	21.8%
Marijuana, cigarettes/day	
Mean (*SD*)	1.75 (1.38)
Median (Range)	1.5 (0-6.5)
No. of children exposed, first trimester*, %	17.2%
No. of children exposed, second trimester≠, %	33.9%

No. of children exposed, third trimester[#], %	21.8%
Oxycodone, mg/day	
Mean (*SD*)	97.80 (75.42)
Median (Range)	53.30 (0-250)
No. of children exposed, first trimester*, %	17.2%
No. of children exposed, second trimester[≠], %	5.4%
No. of children exposed, third trimester[#], %	5.4%
Nicotine, cigarettes/day	
Mean (*SD*)	11.53 (8.84)
Median (Range)	10.00 (0-40)
No. of children exposed, first trimester*, %	79.3%
No. of children exposed, second trimester[≠], %	60.7%
No. of children exposed, third trimester[#], %	67.3%

Note. *$N = 58$, $^{≠}N = 56$, $^{\#}N = 55$.

Table A3

Child Temperament: Preliminary Correlation Analyses, Means and Standard Deviations

Variables	**1**	**2**	**3**	**4**	***M***	***SD***
1. Temperament: Persistence – General Impression [a]	–	-.02	.51**	-.30*	2.42	.85
2. Temperament: Reactivity to Environment – General Impression [a]	-.02	–	-.17	.40**	3.84	.96
3. Temperament: Persistence – Scaled Score	.51**	-.17	–	-.30*	.47	.96
4. Temperament: Reactivity to Environment – Scaled Score	-.30*	.40**	-.30*	–	.21	.97
M	2.42	3.84	.47	.21		
SD	.85	.96	.96	.97		
n	52	49	51	51		

Note. [a] Non-parametric correlation analyses were used with these variables.
*$p < .05$, two-tailed; **$p < .01$, two-tailed

Table A4

Global Ratings of the Quality of Relationship: Preliminary Correlation Analyses, Means and Standard Deviations

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**M**	**SD**
1. Quality of Relationship: Maternal Sensitivity [a]	–	.73**	.58**	.67**	.67**	.66**	4.04	.79
2. Quality of Relationship: Maternal Structuring [a]	.73**	–	.47**	.63**	.68**	.56**	4.13	.81
3. Quality of Relationship: Maternal Non-Instrusiveness [a]	.58**	.47**	–	.56**	.54**	.49**	3.93	1.01
4. Quality of Relationship: Maternal Non-Hostility [a]	.67**	.63**	.56**	–	.46**	.36**	4.41	.96
5. Quality of Relationship: Child Responsiveness to adults [a]	.67**	.68**	.54**	.46**	–	.78**	3.76	1.04
6. Quality of Relationship: Child Involvement [a]	.66**	.56**	.49**	.36**	.78**	–	3.54	.91
M	4.04	4.13	3.93	4.41	3.76	3.54		
SD	.79	.81	1.04	.96	1.04	.91		
n	46	46	46	46	46	46		

Note. [a] Non-parametric correlation analyses were used with these variables.
*$p < .05$, two-tailed; **$p < .01$, two-tailed.

Table A5

Total Ratings of the Quality of Relationship: Preliminary Correlation Analyses, Means and Standard Deviations

Variables	1	2	3	4	5	6	M	SD
1. Quality of Relationship: Maternal Sensitivity [a]	–	.90**	.65**	.74**	.73**	.72**	18.49	3.69
2. Quality of Relationship: Maternal Structuring [a]	.90**	–	.62**	.67**	.78**	.76**	18.81	3.44
3. Quality of Relationship: Maternal Non-Instrusiveness [a]	.65**	.62**	–	.65**	.66**	.67**	17.76	3.88
4. Quality of Relationship: Maternal Non-Hostility [a]	.74**	.67**	.65**	–	.59**	.52**	20.46	3.95
5. Quality of Relationship: Child Responsiveness to adults [a]	.73**	.78**	.66**	.59**	–	.92**	17.50	3.93
6. Quality of Relationship: Child Involvement [a]	.72**	.76**	.66**	.52**	.92**	–	16.43	3.83
M	18.49	18.81	17.76	20.46	17.50	16.43		
SD	3.69	3.44	3.88	3.95	3.93	3.83		
n	43	43	42	46	42	46		

*$p < .05$, two-tailed; **$p < .01$, two-tailed.

Table A6

Cognitive Development: Preliminary Correlation Analyses, Means and Standard Deviations

Variables	**1**	**2**	***M***	***SD***
1. Cognitive Development: Verbal Domain	–	.34*	103.66	11.41
2. Cognitive Development: Nonverbal Domain	.34*	–	99.50	11.05
M	103.66	99.50		
SD	11.41	11.05		
n	58	59		

*$p < .05$, two-tailed; **$p < .01$, two-tailed.

Table A7

Preliminary Correlation Analyses with Variables of Interest

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Temperament: Persistence – General Impression [a]	–															
2. Temperament: Reactivity to Environment – General Impression [a]	n/a	–														
3. Temperament: Persistence – Scaled Score	n/a	n/a	–													
4. Temperament: Reactivity to Environment – Scaled Score	n/a	n/a	n/a	–												
5. Quality of Relationship: Maternal Sensitivity	-.03	.29 +	-.09	.17	–											
6. Quality of Relationship: Maternal Structuring	-.07	.28	-.11	.20	n/a	–										
7. Quality of Relationship: Maternal Non-Instrusiveness	-.09	.14	.09	.13	n/a	n/a	–									
8. Quality of Relationship: Maternal Non-Hostility	-.05	.11	.17	.04	n/a	n/a	n/a	–								
9. Quality of Relationship: Child Responsiveness to adults	-.16	.23	-.16	-.04	n/a	n/a	n/a	n/a	–							
10. Quality of Relationship: Child Involvement	-.13	.29 +	-.09	.02	n/a	n/a	n/a	n/a	n/a	–						
11. Cognitive Development: Verbal Domain	-.09	.41 **	-.09	.07	.17	.21	.02	-.08	.34 *	n/a	–					
12. Cognitive Development: Nonverbal Domain	-.01	-.01	-.19	.06	.04	.18	.04	-.12	.23	.23	n/a	–				
13. Quality of the **Home Environment**	-.15	.13	.11	.28 +	.13	.21	.42 *	.24	.13	.18	.13	.20	–			
14. Child Age at Intake	.28 *	.04	.28 +	-.16	.36 *	.38*	.55 *	.30 *	.35 *	.46 *	-.07	-.13	-.31 *	–		
15. Child Gender	.00	.26 +	-.13	.10	.18	.16	.05	.06	.19	.08	.28*	.18	-.18	-.12	–	
16. Intervention effect	.07	-.04	-.10	-.16	-.07	-.14	-.21	-.12	-.04	-.05	.14	.06	.09	-.35 **	-.10	–

*$p < .05$, two-tailed; **$p < .01$, two-tailed; +$p < .10$, two-tailed.

Table A8

Summary of Regression Analysis of Child Temperament and Quality of Mother-Child Relationship Predicting Verbal Domain of Cognitive (Intellectual) Development

Predictor	**ΔR^2**	***β***
Step 1:	.00	
Control Variable[a]		
Step 2:	.14	
Temperament: Reactivity to Environment, Impression		3.94^{+}
Step 3:	$.09^{+}$	
Child Responsiveness to Adults, Global Score		3.68^{+}
Total R^2	.23*	
n	34	

Note. [a] Control variable included child's age at intake.
*$p < .05$, two-tailed; $^{**}p < .01$, two-tailed, $^{+}p < .10$, two-tailed.

Table A9

Summary of Regression Analysis of Child Temperament and Quality of Mother-Child Relationship Predicting Non-Verbal Domain of Cognitive (Intellectual) Development

Predictor	**ΔR^2**	***β***
Step 1:	.02	
Control Variable[a]		
Step 2:	.09^{+}	
Temperament: Persistence, Standardized Score		-2.64
Step 3:	.19*	
Child Involvement of Adults, Total Score		6.70*
Total R^2	.23*	
n	37	

Note. [a] Control variable included child's age at intake.
*$p < .05$, two-tailed; $^{**}p < .01$, two-tailed, $^{+}p < .10$, two-tailed.

Appendix B

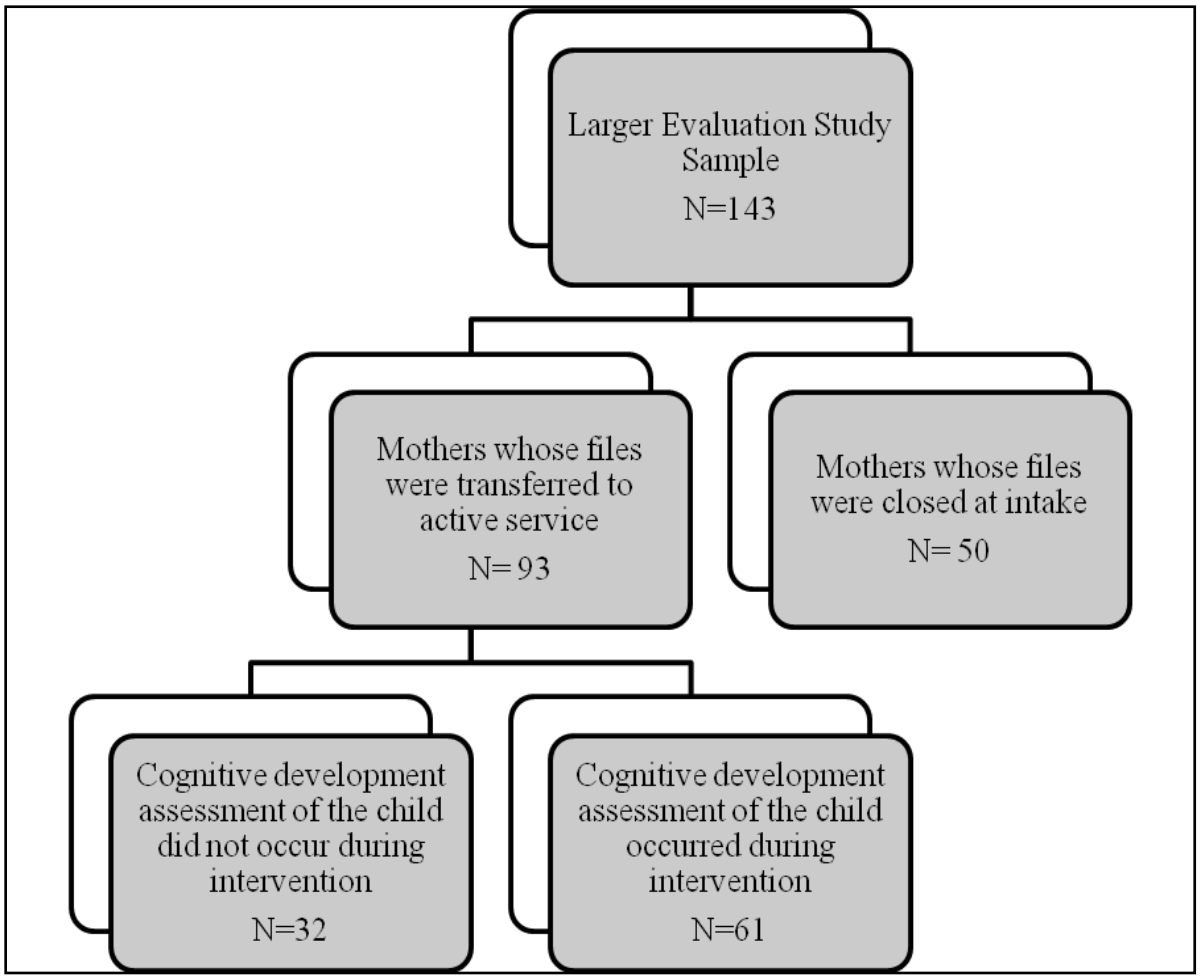

Figure B1. Participant flow chart.

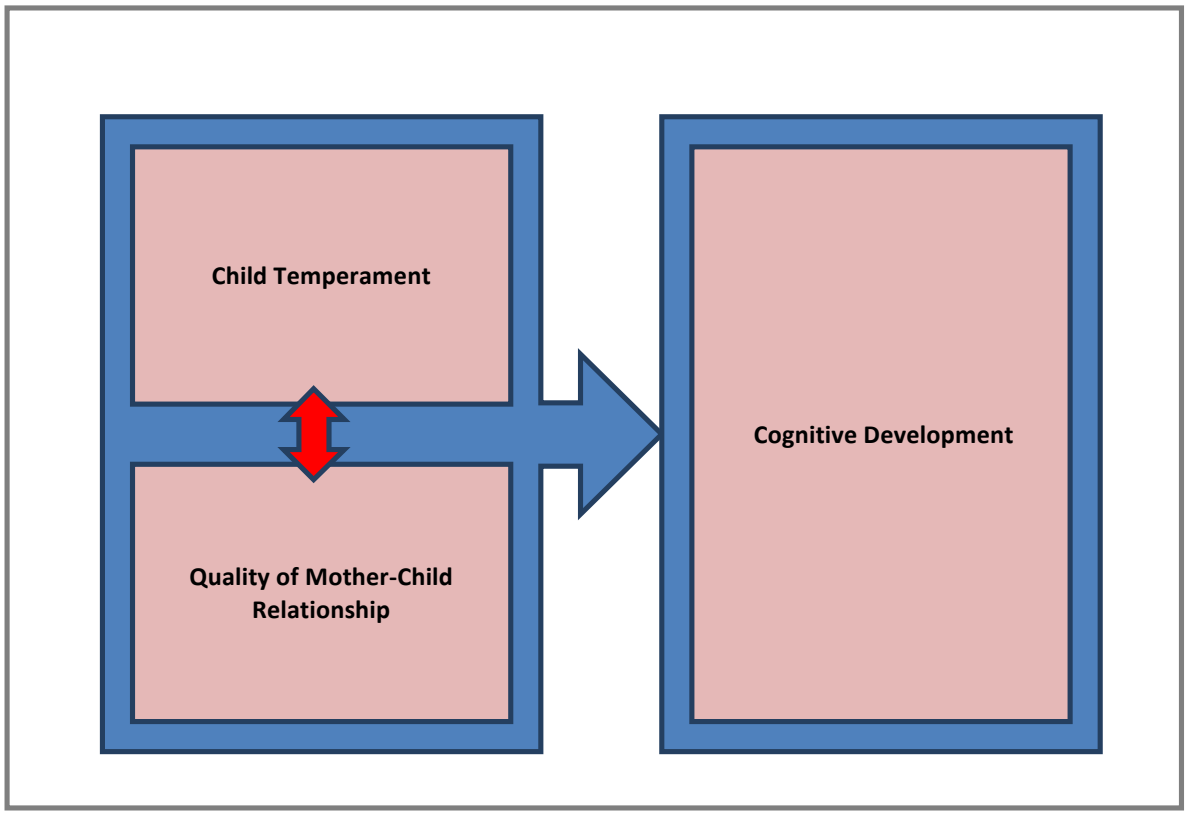

Figure B2. Overall Regression Model with Child Temperament and the Quality of Mother-Child Relationship as Predictors of Cognitive (Intellectual) Development