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Developmental Outcomes of Infants Adopted from Foster Care: Predictive Associations from Perinatal and Preplacement Risk Factors

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Abstract

Infants adopted domestically from foster care often present with prenatal substance exposure and risky birth outcomes such as prematurity and low birth weight. Because few longitudinal studies of foster-adoptive infants exist, it is unclear how these preplacement risk factors influence development over time. The present study examined associations between perinatal risk factors and developmental outcomes among an ethnically/racially-diverse sample of 97 infants in foster-care (56% boys) placed into adoptive homes at ages 0-19 months. Relative to population-norms, foster-adoptive infants showed comparable cognitive but lower language and motor functioning at baseline and one-year follow-up. Age-adjusted language scores significantly improved one year following placement, consistent with a developmental “catch-up” effect. Low birth weight uniquely predicted lower language scores at baseline, but this association was no longer significant at follow-up. Prenatal substance exposure was associated with lower baseline cognitive scores, but only for infants placed after six months of age. In contrast, infants with low birth weight and *later* placement age (>12 months) showed the most accelerated motor development. Sex differences emerged at follow-up when predicting motor and language outcomes, suggesting potential sex-specific pathways of risk. Overall, results support adoption as an early intervention that may buffer vulnerability to perinatal risk on development.

Keywords

adoption; foster care; infants; perinatal risk; prenatal substance exposure

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Infants adopted domestically from foster care often present with a number of risk factors, including prenatal exposure to substances and associated birth outcomes such as prematurity and low birth weight. Many prospective parents are reluctant to adopt infants with these early risk factors due to concerns regarding long-term outcomes (Lyons & Rittner, 1998), expressing preference for non-special needs children (Brooks, James, & Barth, 2002). While definitions vary by state, “special needs” typically refers to the presence of physical, developmental, or emotional disabilities as well as factors that may make adoptive placement more challenging, such as older age, being part of a sibling group, or being from certain ethnic/racial backgrounds (USDHHS, 2018). The preference for non-special needs children impacts the 118,000 children in the United States awaiting adoption each year (USDHHS et al., 2017), 80% of which are identified as special needs (USDHHS et al., 2015). Fearfulness and uncertainty regarding early risk factors among infants is partially a lingering effect of sensational media reports of early research on prenatally-exposed children (Bandstra, Morrow, Mansoor, & Accornero, 2010; Lyons & Rittner, 1998). Indeed, children with prenatal substance exposure are over-represented in the foster care system (National Center on Substance Abuse and Child Welfare, 2016). Both exposure itself and the perinatal outcomes commonly related to substance exposure in utero, primarily prematurity and low birth weight, have been linked with early developmental outcomes, including cognitive (Hutchinson et al., 2013), language (Foster-Cohen, Friesen, Champion, & Woodward, 2010), and motor delays (de Kieviet, Piek, Aarnoudse-Moens, & Oosterlaan, 2009). However, many infants with these perinatal risk factors demonstrate positive outcomes (Ackerman, Riggins, & Black, 2010; van IJzendoorn & Juffer, 2006; van IJzendoorn, Juffer, & Klein, 2005; Waterman et al., 2013), highlighting the need to better understand how changes in the postnatal caregiving environment, including early adoption, influence developmental patterns of resilience.

Perinatal Risk Factors

A large body of work has reported an association between perinatal risk factors, including in-utero substance exposure, prematurity, and low birth weight, and negative health outcomes across multiple stages of development (McCormick, Litt, Smith, & Zupancic, 2011; Min et al., 2014). These studies are consistent with the fetal origins theory (or “Barker’s hypothesis”), which posits that exposure to environmental insults (e.g., maternal substance use, stress) during the period of gestation has significant impacts on a broad range of later health problems (Barker, 2004; Glover, 2011). For example, a large body of evidence has linked prenatal substance exposure to poorer cognitive abilities (e.g., executive functioning; Richardson, Goldschmidt, Larkby, & Day, 2015) and delays in language and visual-motor skills (Singer, Minnes, Min, Lewis, & Short, 2015). Similarly, prematurity and low birth weight, which commonly co-occur and are linked to prenatal substance exposure (Bada et al., 2005), are associated with language delays (Barre, Morgan, Doyle, & Anderson, 2011) and lower cognitive functioning (Hutchinson et al., 2013). Naturalistic longitudinal studies demonstrate that by later childhood and adolescence, youth with perinatal risk factors have significantly greater impairments in school functioning (Hutchinson et al., 2013) compared to youth without these risk factors.

Importantly, because most studies of perinatal risk are based on cross-sectional or naturalistic longitudinal designs, perinatal effects on developmental outcomes may be overestimated due to being confounded by the quality of the postnatal environment (Frank, Augustyn, Knight, Pell, & Zuckerman, 2001). Indeed, infants with previous exposure to perinatal stress (e.g., substance exposure) are also significantly more likely to experience stress postnatally (e.g., parent psychopathology and substance use problems, maltreatment; Goodman & Wolff, 2013; Wells, 2009), factors that predict the same developmental outcomes assessed by perinatal risk studies. In fact, a study of 278 infants that assessed both prenatal *and* postnatal environmental risk reported that postnatal environmental risk (e.g., poverty, family stress) accounted for more variance in developmental outcomes at age four years than cumulative prenatal substance exposure (Carta et al., 2001). Although longitudinal studies of foster-adoptive children are rare, one study of children aged 6 to 17 years found that prenatal substance exposure predicted significantly worse pre-adoptive functioning (e.g., behavior problems), but not their post-adoption functioning (Goldman & Ryan, 2011). By separating the prenatal and postnatal environment through an adoption design, studies gain specificity of postnatal environmental effects while disentangling shared genetic variance between the parenting environment and child outcome. Together, these findings highlight the need to untangle the perinatal and postnatal environment in order to clarify the magnitude to which perinatal risk factors impact early developmental outcomes for children adopted from foster care.

Early Adoptive Placement

A growing body of research suggests that environmental factors mitigate the relation between early risk factors and developmental outcomes of children in foster care (Ackerman et al., 2010), although findings are inconsistent regarding the extent of “catch up” to majority population peers and largely come from studies of school-aged children rather than infants. Studies assessing cognitive and academic outcomes in preschool through young adulthood consistently show that children adopted from foster care outperform peers who remain in foster care or institutionalized care, and they also outperform their nonadopted birth siblings who remained with or were restored to their biological parents (van IJzendoorn et al., 2005; Vinnerljung & Hjern, 2011). Although some evidence suggests that adopted children continue to lag behind majority population peers in terms of cognitive abilities, studies generally report improved cognitive development for foster children following adoption (Lloyd & Barth, 2011; van IJzendoorn et al., 2005). Furthermore, a meta-analysis conducted by van IJzendoorn and Juffer (2006) found that specifically among children adopted before 12 months of age, academic delays assessed in later childhood were not more prevalent than majority population peers, highlighting age of adoption as a potential key factor in predicting cognitive outcomes. However, because few studies have assessed these developmental outcomes in infancy across multiple time points, it is unclear how early the protective effects of adoption may emerge.

“The earlier the better” perspective regarding age of adoption is supported by research on children adopted from Romanian institutions (Zeanah, Gunnar, McCall, Kreppner, & Fox, 2011). A longitudinal follow-up of young children adopted in the U.K. from Romanian orphanages before two years of age, for instance, reported age of placement to be the

strongest predictor of cognitive outcomes, with particularly notable developmental catch-up for infants adopted before six months of age (Beckett et al., 2006; Kreppner et al., 2007; Rutter, 1998). In a similar study, children adopted in Canada from Romania before four months of age showed higher IQs and better school readiness than children who spent at least eight months in Romanian orphanages prior to adoption into Canadian families (Ames, 1997; Morison & Ellwood, 2000). Together, these studies suggest that adoption – particularly *early* adoption – may buffer the negative effects of perinatal risk factors on cognitive and academic outcomes among former foster children and represents an important early intervention among this high-risk group.

Among children adopted after infancy, older age at adoptive placement is a known risk factor for a wide range of negative cognitive (Rutter, 1998), academic (van IJzendoorn & Juffer, 2006), and behavioral outcomes (Crea, Barth, Guo, & Brooks, 2008), whereas earlier placement may attenuate this risk, highlighting the value of early placement into a stable, nurturing home. However, infants in foster care can also vary widely in placement age, with some infants placed at birth compared to others placed after a few months or even a year after birth, the latter of which may be associated with longer exposure to an unstable or neglectful home environment. The first year of life is characterized by rapid neurological development and represents a critical period for attachment formation (Dozier & Bernard, 2017). Infants exposed for longer periods to a neglectful or unstable home environment may experience fewer stimulating interactions with caregivers needed to support their early language and cognitive development (Strathearn, Gray, O’Callaghan, & Wood, 2001). In contrast, increases in exposure to sensitive and stimulating caregiving during infancy is associated with cognitive resilience for at-risk infants (Jaffee, 2007). Furthermore, meta-analytic evidence has linked maltreatment during infancy to the formation of insecure attachment style (Baer & Martinez, 2006). Given the critical role of the caregiver-infant interaction to building early developmental skills, these differences in attachment style resulting from longer duration in an unstable or neglectful home environment during the first years of life may influence the developmental catch-up process. Importantly, almost no longitudinal studies of foster-adoptive infants have assessed cognitive, language, and motor outcomes *during* infancy and examined how age of placement may influence outcomes across time. Thus, it is unclear the extent to which placement age may buffer vulnerability to perinatal risk on later developmental outcomes for infants adopted from foster care.

Finally, biological sex differences may further influence vulnerability to perinatal risk factors (DiPietro & Voegtline, 2017). In general, male fetuses are more neurologically immature than females, and boys are more likely to experience mortality and adverse neurologic outcomes related to prematurity and low birth weight (Kent, Wright, Abdel-Latif, & Group, 2012). Although the developmental mechanisms underlying this sex-based vulnerability are poorly understood, some evidence from rodent studies suggests that these differences may reflect sexual-dimorphic effects of prenatal stress and teratogen exposure on hypothalamic-pituitary-adrenal (HPA) axis development (Weinberg, Sliwowska, Lan, & Helleman, 2008). Indeed, some evidence from humans studies suggests that boys are more sensitive to prenatal substance exposure (Jansson, DiPietro, Elko, & Velez, 2010), contributing to higher risk for negative birth outcomes. For example, a large study of premature infants found that perinatal risk factors were significantly more common in boys;

boys were also more likely than girls to develop neurodevelopmental impairment (e.g., problems in mental or psychomotor development), although sex differences in perinatal risk effects varied based on type of risk factor and outcome (Beeghly et al., 2006). Despite evidence that boys show higher rates of perinatal risk factors and demonstrate elevated levels of neurodevelopmental problems in infancy as compared to girls, most studies of perinatal risk treat biological sex as a control variable, rather than directly exploring sex-based vulnerability to perinatal risk factors (DiPietro & Voegtline, 2017).

Present Study

Few studies have examined the predictive associations between perinatal risk factors and postnatal developmental outcomes among infants in foster care. As discussed above, meta-analytic evidence indicates that adopted children can display significant flexibility in their cognitive outcomes and “catch up” to the general population (Rutter, 1998; van IJzendoorn & Juffer, 2006). However, due to limited longitudinal studies of infants transitioning from foster care to adoption, it is unclear how placement in a stable adoptive home may influence these outcomes over time. In other words, how much do early perinatal risk factors and birth outcomes predict later developmental functioning if the infant is removed from their previous environment? These developmental trajectories of risk and resilience may be further influenced by the infant’s age of adoptive placement and biological sex, which are infrequently examined as moderators of perinatal risk.

Among a racially-diverse, high-risk sample of infants detained from their biological parents and transitioning into adoption by their foster parents, the present study’s aims are to: (1) characterize the cognitive, language, and motor skills of infants in foster care, comparing them to population norms and examining patterns of developmental change across the first year of adoptive placement, (2) examine predictive associations of three common perinatal risk factors (i.e., prenatal substance exposure, prematurity, low birth weight) with developmental outcomes at baseline and one-year following adoptive placement, and (3) explore whether vulnerability to perinatal risk is moderated by age of adoptive placement and biological sex. Based on past research among older adopted children (e.g., Lloyd & Barth, 2011; van IJzendoorn & Juffer, 2006; van IJzendoorn, Juffer, & Poelhuis, 2005; Waterman et al., 2013), we hypothesized that all perinatal risk factors would predict lower cognitive, language, and motor skills at baseline, but also expected infant’s cognitive, language, and motor skills to improve between baseline and follow-up. Given that boys may have higher sensitivity to perinatal stress (DiPietro & Voegtline, 2017) and earlier adoption may help to buffer negative developmental outcomes (e.g., van IJzendoorn & Juffer, 2006), we expected both biological sex and placement age to moderate these associations, such that perinatal risk would have a stronger effect for boys and infants placed after one year of age.

Method

Participants

Families of 97 infants were recruited to participate in the present study through the UCLA TIES for Families program, which aims to facilitate successful adoption of high-risk children transitioning from foster care to adoptive placement. Based on requirements from

the Department of Child and Family Services (DCFS), prospective adoptive parents (PAPs) attended a series of educational seminars prior to being matched with a child. Approximately 85% of these seminars included announcements about the TIES for Families program, which offered three additional educational meetings about foster children's risk and resilience. PAPs who attended the three additional education meetings learned about TIES for Families program services including pre-placement consultation, parent and child therapy services, as well as medical, educational, occupational, speech-language, and psychiatric consultation. Families who subsequently had infants placed in their home and requested services from TIES for Families were invited to participate in the present research study during their initial intake. Children were eligible for the study if they had been placed for less than two months and were younger than two years of age at initial placement.

Prior to any assessment or data collection, written informed consent was obtained from the adoptive parents for each child. Eligible participants completed an assessment at baseline as well as a follow-up assessment one year following placement. Demographic characteristics of the children and their adoptive parents appear in Table 1. Children ranged from being removed at birth (N=54; 62%) up to 13.9 months old at time of removal from birth parents; approximately 60% of infants (N=42) were immediately placed into their prospective adoptive home, whereas the rest had between 1-3 foster placements before transitioning into their adoptive home. At initial adoptive placement, children were zero to 19.53 months of age (mean = 4.48 months old), with approximately half of the sample placed into prospective adoptive homes within the first month of life and about 14% (N=14) placed after one year of age. The sample was ethnically and racially diverse: most children were Latino/a, African-American, or multiracial whereas about half of the adoptive parents were Caucasian. Approximately 75% (N=66) of the adoptive homes included two caregivers, and none of the adoptive placements were kinship placements.

Some attrition (21%; N=21) was observed across time, including children not participating in the follow-up assessment due to reunification with their birth families as part of a county-wide 'concurrent planning' process, in which infants are involved in dual goals of working towards reunification with birth parents while simultaneously taking steps towards an alternative permanency goal (i.e., adoption; Child Welfare Information Gateway, 2018). Close to 80% of the original sample (N=76) participated in the one-year follow-up. There were no demographic differences between participants lost to attrition and participants who completed the follow-up assessment (p 's > .05), and attrition was unrelated to all perinatal risk factors and baseline developmental outcomes (p 's > .05).

Procedure

After determining eligibility, we obtained PAP consent and invited families for an in-person baseline (T1) assessment, including developmental testing of cognitive, language, and motor functioning. T1 assessments occurred at 6 months of age for children placed under 4 months and 2 months post-placement for children 4 months or older at placement. In addition, DCFS granted permission to review the children's records, which yielded additional data regarding the child's pre-placement history (e.g., prenatal substance exposure, birth weight, gestational age). After the T1 assessment, families returned for a parallel follow-up

assessment one year after initial adoptive placement (T2). All research procedures in this study were conducted in accordance with the ethical standards of the American Psychological Association and reviewed and approved by the UCLA Institutional Review Board.

Measures

Developmental outcomes.—At T1 and T2, children were administered the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III; Bayley, 2006), a widely-used, individually-administered instrument designed to assess developmental outcomes for infants and toddlers between the ages of one to 42 months. The Bayley-III includes measurement of cognitive, language (i.e., receptive and expressive communication), motor (i.e., fine and gross motor), social-emotional, and adaptive behavior development. Standardized composite scores (adjusted by age with a mean of 100 and SD of 15) for cognitive, motor, and language functioning at T1 and T2 were included for analyses in the present study. Nationally representative normative data based on 1,700 infants and toddlers in the United States have been established for the Bayley-III, and the measure has demonstrated adequate reliability as well as concurrent validity with other developmental diagnostic tests for infants and toddlers (Albers & Grieve, 2007; Bayley, 2006; Yu et al., 2013). The Bayley-III was administered to participants by graduate and postgraduate clinical psychology trainees under live supervision of a licensed clinical psychologist with expertise in infant development.

Perinatal risk factors.—The child's history of perinatal risk factors, including prenatal exposure to substances, birth weight, and prematurity status, were gathered from the child's records, including court and medical records as well as written reports by DCFS social workers. The record coding protocol was developed by the PI of the study (J.M.W.) and included a checklist for reviewing available records and coding the target study variables, including birth weight (ounces), gestational age (weeks), time in hospital (weeks), toxicology screen (positive or negative), toxicology details (list types of substances, if available), and any other documentation of prenatal exposure to alcohol or illicit substances based on court records or written reports from social workers (present or absent). Thus, prenatal substance exposure included all illicit substances detected in toxicology reports (including but not limited to methamphetamine, heroin, crack/cocaine, marijuana), as well as alcohol abuse during pregnancy disclosed by the mother or a relative that was documented in medical records, court records, or social worker notes. Nicotine and prescription medications were not included in prenatal substance exposure codes due to minimal opportunities for them to be systematically documented in records. An advanced undergraduate research assistant (RA) was trained to code cases until reaching 90% agreement with the PI's codes on practice cases. During the coding process, the RA received weekly supervision from the PI to resolve any potential discrepancies, including regular spot-checks for reliability. According to toxicology screens at birth, court records, and social worker reports, 80.5% of infants (N=70) with available medical records had documented prenatal substance exposure. Because these infants varied widely in the specificity of information available (e.g., many infants had missing data regarding substance types) and the high frequency of polysubstance abuse, a global 'any documented prenatal substance use' variable was used for analyses. In

addition, 26.9% (N=21) of infants had low birth weight by ICD-10-CM standards (i.e., < 88 ounces/5.5 lbs), and 54.7% (N=41) were born prematurely (i.e., < 37 weeks).

Data Analytic Plan

All analyses were conducted using Stata 13. First, to characterize T1 developmental functioning, one-sample *t*-tests compared baseline cognitive, language, and motor scores with population-based norms on the Bayley-III (i.e., $M=100$, $SD=15$). Next, paired-sample *t*-tests assessed for patterns of change/stability in these developmental outcomes across the first year of adoptive placement. To examine the effect of perinatal risk factors on developmental outcomes, prenatal substance exposure, prematurity status, and low birth weight were first fit simultaneously in a multiple linear regression to examine their independent associations with each T1 outcome, controlling for age of placement, biological sex, number of prior foster placements, hospital stay length after birth, and time since adoptive placement as covariates. In the next step, we explored the potential moderating role of age of placement by adding its interactive terms with each perinatal risk factor (e.g., age of placement x prenatal substance exposure); a parallel model was reproduced with sex interactions (e.g., sex x prenatal substance exposure). This full set of regressions was reproduced to predict cognitive, language, and motor outcomes at T2 to evaluate whether their predictive associations were maintained one year after initial placement. Finally, to examine perinatal effects on *change* in outcomes across time, this model was repeated with change scores (T2-T1) as the dependent variable, controlling for T1 scores as a covariate (Dalecki & Willits, 1991).

Following standard guidelines for interpreting interactions (Aiken & West, 1991), simple slopes conditional on values of the moderator (Z) were examined by interpreting the effect of the independent variable (X) on outcome (Y) when Z was centered at specified values. Specifically, for significant perinatal risk x sex interactions (dichotomously coded as 0=girl, 1=boy), we centered the moderator at 0 and 1, respectively, generated interaction terms based on these centered variables, and then interpreted the lower-order coefficients (“main effects”) of X on Y, which represents the simple slope of X on Y when infant sex is centered at 0=girl or 1=boy, respectively (Aiken & West, 1991). To probe interactions that included the continuous moderator of placement age, we first recoded placement age into three groups: 0 = ‘1 month old’, 1 = ‘1-12 months old’, and 2 = ‘>12 months old.’ Then, we examined the simple slopes of X on Y conditional on Z=0, Z=1, and Z=2, respectively. In addition, we conducted regions of significance (RoS) analyses to identify the specific threshold of placement age in which the association between the perinatal risk factor and developmental outcome became significant (Preacher, Curran, & Bauer, 2006). To address missing data and increase power, we employed full information maximum likelihood (FIML) estimation with robust standard errors in all linear regressions. FIML produces significantly less biased parameter and standard error estimates and decreases Type 1 error compared to other methods of handling missing data (e.g., listwise or pairwise deletion, mean imputation; Collins, Schafer, & Kam, 2001).

Results

Preliminary statistics

Descriptive statistics and correlations among demographic and study variables are presented in Tables 1 and 2, respectively. Low birth weight was positively correlated with premature birth and length of hospital stay, whereas prenatal substance exposure was not correlated with these risk factors. Neither sex nor age of placement was correlated with any perinatal risk variables. Low birth weight and hospital stay length were correlated with lower T1 cognitive (but not language or motor) outcomes, whereas prematurity and prenatal substance exposure were not bivariately correlated with any of the outcomes.

Developmental outcomes at baseline and follow-up

Comparisons to population norms.—The means and SDs of the developmental outcomes at T1 and T2 are shown in Table 3. One-sample *t*-tests revealed that compared to population-normed scores for the Bayley-III ($M = 100$, $SD = 15$), infants in this foster-adoptive sample showed comparable cognitive functioning at both T1 and T2 ($t = -.62$, $p = .54$ and $t = -.80$, $p = .43$, respectively). However, they demonstrated significantly lower scores in language ($t = -7.66$, $p < .01$) and motor skills ($t = -6.03$, $p < .01$) at T1. These differences remained significant at T2 (language: $t = -3.41$, $p < .01$, motor: $t = -6.10$, $p < .01$).

Change across first year post-placement.—Pairwise *t*-tests (Table 3) comparing mean scores from T1 to T2 revealed that cognitive and motor scores did not show significant change across time, whereas language scores significantly improved from T1 to T2.

Predictions from perinatal risk

Cognitive.—Results from the linear regression appear in Table 3, in which prenatal substance exposure, low birth weight, and premature status were simultaneously examined as independent predictors of the developmental outcomes at T1, T2, and the change in scores from T2-T1. Controlling for sex, placement age, number of previous placements, and length of hospital stay, prenatal substance exposure interacted with age at adoptive placement to predict T1 cognitive scores (Figure 1). *Post hoc* tests revealed that prenatal substance exposure predicted significantly lower cognitive scores for infants placed into adoptive homes after 12 months of age ($B = -18.24$, $SE = 5.92$, $p < .01$) and (to a lesser degree) for infants between 1-12 months of age ($B = -6.81$, $SE = 2.88$, $p = .02$); in contrast, prenatal substance exposure was unrelated to T1 cognitive scores for infants placed into adoptive homes before one month of age ($B = 4.61$, $SE = 4.08$, $p = .26$). RoS analyses further revealed that the association between prenatal substance exposure and cognitive scores was significant specifically for infants placed into their adoptive homes after 6.9 months (26.67 weeks) of age. At the T2 assessment, this interaction was no longer significant. Instead, both placement age and prenatal substance exposure had main effects on T2 cognitive outcomes: age of placement was negatively associated with T2 cognitive scores and predicted a decrease in scores from T1 to T2, whereas prenatal substance exposure was positively associated with T2 cognitive scores and predicted an increase in scores across time. No sex differences in perinatal effects were observed for cognitive scores at either time point.

Language.—Controlling for all covariates and other perinatal risk factors, low birth weight predicted significantly lower T1 language skills, but this association was no longer significant at T2. Prenatal substance exposure and prematurity did not have main effects on T1 language scores. However, sex differences began emerging at T2, such that the effects of prematurity on language skills one-year postplacement and change in scores (T2-T1) were moderated by sex. *Post hoc* analyses indicated that premature birth (<37 weeks gestational age) was associated with significantly less improvement in language scores for girls ($B = -11.14$, $SE = 4.30$, $p = .01$), but not for boys ($B = 1.65$, $SE = 3.58$, $p = .64$) (Figure 2).

Motor.—At T1, none of the perinatal risk factors had significant main effects on motor functioning; however, placement age significantly moderated the association between low birth weight and motor scores. Specifically, low birth weight predicted higher T1 motor scores for infants placed into adoptive homes after one year of age ($B = 17.34$, $SE = 6.66$, $p = .01$), whereas this association was not significant for younger infants (<1 month old: $B = -6.67$, $SE = 4.44$, $p = .13$; aged 1-12 months: $B = 5.33$, $SE = 3.83$, $p = .16$). RoS analyses further specified that this association was significant for infants placed into adoptive homes after 13.5 months (54.30 weeks) of age. A significant interaction also emerged between prenatal substance exposure and placement age. *Post hoc* analyses indicated that the association between prenatal substance exposure and T1 motor outcomes was non-significant for all three age groups after accounting for other perinatal risk factors and covariates (<1 month: $B = -0.11$, $SE = 3.76$, $p = .98$; 1-12 months: $B = -4.47$, $SE = 4.05$, $p = .27$; >12 months: $B = -8.83$, $SE = 7.81$, $p = .26$), although RoS analyses did detect a significant association between prenatal substance exposure and lower motor functioning for infants placed into adoptive homes prior to 6 days of age. When predicting T2 motor functioning, none of the perinatal risk factors had a significant main effect, regardless of age of placement. However, sex differences emerged; prenatal substance exposure predicted marginally lower T2 motor scores for boys ($B = -6.12$, $SE = 3.35$, $p = .07$), whereas it predicted marginally higher motor functioning for girls ($B = 9.92$, $SE = 5.77$, $p = .09$).

Discussion

Findings provide a unique view of a notably high-risk and high-needs group: infants removed from their biological parents and adopted domestically through foster care in the United States. Within this longitudinal sample of foster-adoptive infants, several key findings emerged: First, relative to population-norms, foster-adoptive infants showed comparable cognitive but lower language and motor functioning at both baseline and one-year follow-up (although mean scores remained in the ‘Average’ range even at baseline). Age-adjusted language scores significantly improved one year following placement, in line with a developmental “catch-up” effect. Second, low birth weight was the only perinatal risk factor with direct main effects on outcomes, uniquely associated with lower language scores at baseline, although this association was no longer significant at follow-up. In contrast, the associations between perinatal risk factors and cognitive and motor scores was moderated by age of placement. Finally, although no sex differences were observed at baseline, differences emerged at follow-up when predicting motor and language outcomes, supporting the growing literature suggesting that boys may exhibit greater vulnerability to perinatal risk

factors than girls with respect to motor and language outcomes. Below, we discuss each of these findings in more detail and offer potential implications for future research and intervention.

Developmental Outcomes of Foster-Adoptive Infants

Despite a range of perinatal and preplacement risk factors, infants' cognitive outcomes at initial adoptive placement were comparable to population norms, highlighting the resiliency of these young children. Language and motor scores were lower in this sample compared to population norms, although remaining within a standard deviation of norms, even at baseline. Overall, these results were somewhat surprising, as previous research with older children in foster care has reported significant delays across multiple developmental domains in comparison to peers without a history of maltreatment (Vinnerljung & Hjern, 2011; Waterman et al., 2013). Importantly, few studies have focused specifically on foster children adopted during infancy. Our findings from this sample of foster-adoptive infants suggest that when examining cognitive, language, and motor scores specifically during infancy, resilience may be the norm rather than the exception. In general, more studies are needed that assess developmental outcomes of foster-adoptive infants to examine how these early scores in infancy relate to later developmental (e.g., academic, social-emotional) outcomes. Paired with a stable adoptive home environment, early resilient outcomes during infancy may play a protective role in predicting later developmental outcomes, thus supporting the benefits of early adoption during infancy. However, it is also possible that delays in functioning may emerge in later developmental stages (Fisher et al., 2011; Konijnenberg, 2015), which will require longer-term longitudinal studies to evaluate.

Whereas age-adjusted scores in cognitive and motor development remained relatively stable across initial adoptive placement to one-year follow-up, language skills significantly improved in the year following placement into adoptive homes. This may have been due to language stimulation provided by adoptive families that was not available with biological families impacted by low socioeconomic status (SES) due to poverty, low education, and lack of access to resources, as research has consistently shown a link between SES and language development (Bradley & Corwyn, 2002; Hackman & Farah, 2009). Improvements in language during the first year of adoption may also be due to being in a safe and stable environment, which facilitates language learning (Rodriguez & Tamis-LeMonda, 2011), whereas maltreatment is linked with language delays (Cicchetti & Valentino, 2006; Culp et al., 1991). Improvements in language development after adoptive placement, even within the short time span of one year, is consistent with previous studies demonstrating the overall positive impact of early adoption (van IJzendoorn & Juffer, 2006; Vinnerljung & Hjern, 2011; Waterman et al., 2013). Future studies are needed to examine mechanisms of change related to language improvement among infants adopted through foster care to better understand whether a safe and stable home is sufficient for enhancing language skills, or if specific types of language stimulation by adoptive caregivers are necessary for improvement over time.

Contributions of Perinatal Risk Factors

At baseline, language functioning was the only outcome directly predicted by a history of perinatal risk, such that low birth weight uniquely predicted lower language scores. These results are consistent with many studies documenting the negative effects of low birth weight on expressive and receptive language development (Barre et al., 2011; Zerbeto, Cortelo, & Filho, 2015). Importantly, the association between low birth weight and language scores was largely transient, such that birth weight was unrelated to language scores one year after adoptive placement and did not affect changes in language development from baseline to follow-up. The transient pattern of these results in the context of our foster-adoptive study design are consistent with some evidence that children with low birth weight may be particularly sensitive to “catch-up effects” in the context of an enriching postnatal caregiving environment (Madigan, Wade, Plamondon, Browne, & Jenkins, 2015).

When predicting cognitive and motor outcomes at initial adoptive placement, age of placement played an important role in moderating the effects of perinatal risk. First, prenatal substance exposure predicted lower baseline cognitive scores, but only for infants placed in adoptive homes after 6.9 months of age, with infants placed after one year of age showing the greatest vulnerability. The observation that prenatal substance exposure was unrelated to cognitive outcomes for infants adopted within 6 months of birth highlights the critical role of the postnatal environment. Specifically, prenatally substance-exposed infants who were placed later in infancy may have spent more time exposed to a stressful postnatal environment. Indeed, mothers who engage in substance use during pregnancy are significantly more likely to continue using substances postpartum, increasing risk for inconsistent caregiving, abuse, and neglect (Goodman & Wolff, 2013; Wells, 2009), factors linked to impairments in cognitive development (Mills et al., 2011). Importantly, many prospective parents are reluctant to adopt infants with histories of prenatal substance exposure due to concerns about long-term outcomes (Lyons & Rittner, 1998), which has contributed to the over-representation of children with prenatal substance exposure in the foster care system (National Center on Substance Abuse and Child Welfare, 2016). In contrast, our study found no direct main effects of prenatal substance exposure on developmental outcomes; instead, the associations between prenatal substance exposure and developmental outcomes were moderated by the age of adoptive placement, highlighting the potential for early adoption to critically interrupt this pathway of risk. More publicly-accessible psychoeducation regarding the differential impact of prenatal vs. postnatal risk factors is needed so that prospective adoptive parents are appropriately informed about the magnitude of risk uniquely associated with prenatal substance exposure, which may be overestimated by many prospective parents.

The important role of placement age was further highlighted by the main effects of age on cognitive outcomes at the follow-up time point, in which older age of adoption directly predicted lower cognitive scores one year after adoptive placement as well as a greater decrease in cognitive scores between baseline and follow-up. Interestingly, after controlling for age of placement and co-occurring birth risks, prenatal substance exposure showed a positive association with cognitive scores at follow-up as well as an increase in cognitive scores from baseline to follow-up. Given that models controlled for co-occurring birth

outcomes (low birth weight, prematurity) as well as potential birth complications leading to a longer hospital stay, it is possible that the effect of ‘prenatal substance exposure’ observed here represents the effect of this prenatal stressor on cognitive outcomes after removing the effects of more *severe* neurological problems associated with substance exposure. Indeed, not all substance exposure is linked to neurological impairments in offspring, with emerging studies documenting nonlinear associations based on frequency, severity, and type of exposure (Goldschmidt, Richardson, Stoffer, Geva, & Day, 1996; Zammit et al., 2009). The present findings may also reflect a larger “catch-up” effect for these infants, such that prenatally exposed infants who scored lower than their peers at baseline show greater cognitive improvement in the context of an enriched caregiving environment. It is also possible that these infants received more early developmental services due to their documented prenatal substance exposure than other infants. Future longitudinal studies of foster-adoptive infants that are able to disentangle different aspects of substance exposure (including severe neurological outcomes) and postnatal environmental enrichment are needed to shed light on the mechanisms underlying changes in effects across development.

Whereas age of placement demonstrated an expected negative association with cognitive outcomes, older placement age was associated with more *advanced* motor functioning at baseline, effects that further interacted with low birth weight. Specifically, low birth weight predicted higher motor functioning for infants placed into adoptive homes after 12 months of age, whereas this pattern was not observed for infants placed at younger ages. These results initially appeared inconsistent with studies documenting the deleterious effects of low birth weight on motor development broadly (de Kieviet et al., 2009). However, in interpreting these results, it is important to reflect on the unique exposures experienced by infants born with low birth weight (a proxy for global prenatal stress; Rice et al., 2010) who were also adopted at a later age (e.g., longer exposure to a potentially maltreating environment and/or more foster placements). Some emerging evidence suggests that early life stress, particularly stress that continues from the prenatal through early postnatal periods, can accelerate the timing and pattern of physical maturation as part of a ‘predictive adaptive response’ for survival (Gluckman & Hanson, 2004; Rickard, Frankenhuis, & Nettle, 2014; Sandman, Davis, & Glynn, 2012). Indeed, motor skills have a central role in fight/flight responses to environmental stress, and the order and speed at which specific motor skills develop can vary across infants depending on the environmental challenges and opportunities available to a child (Weiss, Oakland, & Aylward, 2010). Our preliminary findings suggest that infants exposed to higher levels of prenatal stress *and* postnatal stress may show these developmental adaptations through higher motor scores on the Bayley-III. Importantly, if these findings are replicated, it will be critical for future studies to examine how these changes in maturation timing influence later developmental processes.

Sex Differences

Although no biological sex differences were observed at baseline, some differences in language and motor development emerged one year later, potentially due to increased differentiation in language and motor skills in later infancy/early toddlerhood (Goyen & Lui, 2002; van Noort-van der Spek, Franken, & Weisglas-Kuperus, 2012). Overall, girls performed better than boys in motor skills and marginally better in language skills,

consistent with prior studies demonstrating faster developmental advancement in girls than boys in early childhood (Schjølberg, Eadie, Zachrisson, Øyen, & Prior, 2011). Girls and boys also showed differential sensitivity to perinatal risk factors, although patterns of sensitivity differed based on type of risk factor. First, prenatal substance exposure interacted with sex to predict motor development: whereas prenatal substance exposure predicted marginally lower motor skills for boys, it was associated with marginally higher motor skills for girls. This is partially consistent with studies reporting that boys have higher vulnerability to fetal insults (DiPietro & Voegtline, 2017) and suggests that impairments in motor development may be one particular consequence of this increased risk.

In contrast, premature birth predicted language scores at T2 as well as change in language scores from T1 to T2, and these associations were only significant for girls, not boys. Analyzing changes in scores over time enabled further clarification of how these patterns specifically changed from baseline to follow-up. As shown in Figure 3, boys in this high-risk sample showed lower language skills compared to population norms, regardless of gestational age. In contrast, for girls, being born full-term emerged as a protective factor that predicted significant *improvements* in language development from T1 to T2, resulting in scores comparable to population norms by T2. Thus, whereas previous studies investigating sex differences in birth outcomes have suggested that boys have higher risk for later developmental delays due to being more sensitive to risky birth outcomes such as prematurity, our findings suggest that in the context of high-risk infants already at risk for developmental delays, these sex differences may also be driven by boys not benefiting as much as girls from the protective effects of full-term birth.

Together, these preliminary results suggest that infant boys adopted from foster care may have higher risk for language and motor delays due to a greater vulnerability to prenatal substance exposure, in addition to *lower* sensitivity to the protective effects of normal gestational age. Early motor delays may contribute to later problems with language development (Bedford, Pickles, & Lord, 2016; Harris, 2017), and both motor and language development are early risk factors for the development of autism spectrum disorder and other developmental disabilities that evidence disproportionately higher rates in boys (Bhat, Galloway, & Landa, 2012; Heathcock, Tanner, Robson, Young, & Lane, 2015). More exploration of how prenatal substance exposure and risky birth outcomes differentially influence language and motor development for boys and girls is needed to further elucidate potential sex-specific pathways of risk.

Limitations and Conclusions

These findings should be interpreted in the context of several study limitations. First, although our study is unique as one of the only existing longitudinal studies of infants adopted domestically from foster care, the modest sample size may have limited detection of all effects, particularly interactions. Second, although we compared sample scores to normed population scores, our study did not directly assess a normative comparison group of infants nor a group of non-adopted infants who remained in foster care. This design limited our ability to distinguish between natural changes in development over time and changes specifically due to adoption; replication studies that integrate comparison groups are needed

to substantiate these findings. Relatedly, there are likely notable differences between our sample and the Bayley-III standardization sample on demographic variables (e.g., race-ethnicity), which may have contributed to differences at baseline. For example, although data on primary language spoken in the birth home were not available in our study, types of previous language exposure may have influenced language scores. Third, baseline assessments for children placed under 4 months of age were conducted at age 6 months, given that most psychometric studies for the Bayley are available for infants 6 months of age or older. Although models controlled for time since adoptive placement, these differences should be considered when interpreting interactions by placement age. Fourth, prenatal substance exposure was coded retrospectively and dichotomously (present/absent) based on the combination of available medical records, toxicology reports, and court records indicating maternal disclosure. Standardized data on the type, timing (e.g., pregnancy trimester), and frequency/severity of substance use were unavailable, factors that likely influence developmental outcomes. Thus, we consider our results to be a preliminary view of the global associations between substance exposure in utero and developmental outcomes in a high-risk group of infants. Future studies that employ complementary methods of assessing substance abuse are needed to further elucidate the unique effects of different substance types. Similarly, data on maternal stress and psychopathology during pregnancy were unavailable from birth parents, factors to consider in conjunction with the perinatal factors examined in this study. Fifth, because our study included adoptive families who agreed to take part in a specialized adoption program and research study, these families may represent a particularly motivated group of caregivers; their children may be receiving more services than other children adopted from foster care, an important consideration regarding the generalizability of our findings. Although beyond the scope of our study, an important future direction is to measure the adoptive family context (e.g., parent-child interactions) and services employed after adoption to identify specific mechanisms that facilitate patterns of resilience. Finally, although our study focused specifically on cognitive, language, and motor outcomes, we encourage future studies to test these models in the context of other outcomes associated with special needs children in foster care, including social and emotional difficulties that have been linked to preplacement risk factors that may similarly influence prospective adoptive parents' perceptions about adopting infants domestically through foster care.

In summary, despite having a range of perinatal and preplacement risk factors, infants' baseline cognitive outcomes were comparable to population norms. Although infants in this high-risk sample demonstrated lower motor and language scores compared to norms, their mean scores fell within one standard deviation of population means. Furthermore, infants showed significant age-adjusted improvements in language skills across the first year of adoptive placement, in line with previous studies observing patterns of developmental catch-up in response to early adoption (van IJzendoorn, Juffer, & Poelhuis, 2005; van IJzendoorn & Juffer, 2005; van IJzendoorn & Juffer, 2006). Sex differences observed in this study suggest that differential sensitivity to prenatal substance exposure and birth outcomes may play an important role in sex-specific pathways of language and motor development. Overall, results support adoption as a critical early intervention among high-risk infants adopted from foster care, although follow-up studies are needed to elucidate the

heterogeneity of developmental outcomes for this high-risk population. Consistent with a growing body of research, adoption may significantly buffer the impact of preplacement risk factors on developmental outcomes for high-risk infants, even within a relatively short time period of one year.

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Figure 1.

Interaction between prenatal substance exposure and age in predicting Bayley-III cognitive scores at initial adoptive placement.

Figure 2.

Interaction between premature birth x biological sex in predicting Bayley-III language scores at 1-year post-adoptive placement. The darker portions of each bar illustrate the *average improvement* in standardized language scores from baseline to follow-up based on sex and premature birth status.

Figure 3.

Interaction between low birth weight x age of placement in predicting Bayley-III motor scores at 1-year post-adoptive placement.

Figure 4. Interaction between prenatal substance exposure x sex in predicting Bayley-III motor scores at 1-year post-adoptive placement.

Table 1

Demographic characteristics of sample and descriptive statistics of risk factors

	Child	Primary Adoptive Caregiver
	<i>M (SD) or N (%)</i>	<i>M (SD) or N (%)</i>
Sex		
Female	43 (44.3%)	65 (75.6%)
Male	54 (55.7%)	21 (24.4%)
Race-Ethnicity		
Caucasian (non-Hispanic)	15 (17.9%)	42 (48.8%)
African-American (non-Hispanic)	15 (17.9%)	12 (14.0%)
Latino/a or Hispanic	24 (28.6%)	19 (22.1%)
Mixed or Other	30 (35.7%)	13 (15.2%)
Perinatal risk factors		
Prenatal substance exposure	70 (80.5%)	--
Premature birth (< 37 weeks)	41 (54.7%)	--
Low birth weight (< 5.5 lb)	21 (26.9%)	--
Length of hospital stay (weeks)	1.72 (2.37)	--
Age removed from birth home	1.16 (3.36) months	--
Removed at birth	54 (62.1%)	--
1 month old	19 (21.8%)	--
> 1 month	14 (16.1%)	--
Number of prior foster placements	0.57 (0.82)	--
0 foster placements	52 (59.8%)	--
1 foster placement	12 (26.4%)	--
2-3 foster placements	12 (13.8%)	--
Age at adoptive placement	4.48 (6.31) months	41.29 (6.33) years
1 month old	52 (53.6%)	--
1 month – 6 months old	18 (18.6%)	--
6 months – 1 year old	13 (13.4%)	--
> 1 year old	14 (14.4%)	--
Weeks in adoptive home at T1	22.29 (9.90)	--
Caregiver's education		
Less than college	--	28 (32.6%)
College degree	--	28 (32.6%)
More than college	--	30 (34.9%)
Caregiver married/domestic partner	--	66 (75.9%)

Note. *M* = mean; *SD* = standard deviation. % = out of the total number of participants with available data for the variable.

Table 2

Bivariate correlations among demographic and study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Infant's sex	--																		
2. Low birth weight (<5.5 lb)	-.05	--																	
3. Premature birth (<37 weeks)	-.02	.38**	--																
4. Prenatal substance exposure	-.09	.04	.14	--															
5. Length of hospital stay	-.17	.49**	.19	.18	--														
6. Age at removal	.14	-.02	-.04	-.18	.15	--													
7. Age at adoptive placement	.06	.03	.04	-.08	.05	.46**	--												
8. Number of placements	.01	-.08	-.04	-.16	-.05	.39**	.78**	--											
9. Caregiver age	-.15	-.11	-.16	.09	-.02	.13	.19	.16	--										
10. Caregiver gender	-.18	-.05	-.12	-.03	.06	-.14	-.03	-.07	-.05	--									
11. Caregiver education	-.10	.19	.16	-.02	-.09	.24*	.05	-.02	-.07	.20	--								
12. Caregiver partner	.03	-.01	-.06	-.03	-.03	-.13	-.10	-.13	-.16	-.13	.09	--							
13. Time in adoptive home	-.09	.27*	.14	.23*	.04	-.39**	-.69**	-.66**	-.12	-.06	.02	.17	--						
14. T1 Bayley Cognitive	.02	-.23*	-.17	-.16	-.36**	.01	.01	.06	.14	.07	-.17	.04	.04	--					
15. T1 Bayley Language	-.05	-.11	.01	.05	.03	-.04	.09	-.01	.06	.17	-.01	.02	-.03	.21*	--				
16. T1 Bayley Motor	-.04	-.18	-.17	-.13	-.20	<.01	.20	.07	.19	.09	-.09	.05	-.10	.54**	.33**	--			
17. T2 Bayley Cognitive	-.06	-.12	-.07	.13	-.26	-.22	-.16	-.13	.16	-.01	-.07	.06	-.02	.21	.38**	.32**	--		
18. T2 Bayley Language	-.20	-.13	-.15	.20	-.15	.02	.17	.22	.09	-.08	-.25*	.01	-.06	.18	.30**	.28*	.40**	--	
19. T2 Bayley Motor	-.17	-.06	<.01	-.09	-.21	.06	.24*	.35**	.10	.01	-.10	-.05	-.15	.26*	.10	.25*	.34**	.38**	--

Notes.

* $p < .05$,** $p < .01$

Table 3

Changes in mean Bayley-III outcomes from baseline to 1-year post-adoptive placement

Outcome	Baseline	Follow-up	Paired-Samples <i>t</i> -test	
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>t</i>	<i>p</i>
Cognitive	99.93 (11.53)	99.14 (9.32)	.52	.60
Language	90.20 (13.36)	94.61 (13.79)	−2.39	.02
Motor	92.92 (13.14)	91.16 (12.67)	.97	.34

Note. *M*= mean; *SD*= standard deviation; Bayley scores are normed composite scores with a mean of 100 and SD of 15 in the normed population sample.

Table 4

Multiple linear regressions predicting developmental outcomes at baseline and one-year postplacement follow-up from perinatal risk factors

		Baseline (T1)			Follow-up (T2)			T2-T1 Change		
		<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
Predicting Cognitive Scores										
1	Sex (girls=0, boys=1)	-0.83	2.33	.72	-1.16	2.20	.60	-0.67	2.18	.76
	Age at adoptive placement	0.05	0.07	.52	-0.15	0.07	.02	-0.17	0.06	.01
	Number of placements	0.69	2.29	.76	-0.48	2.25	.83	-0.23	2.18	.92
	Hospital stay length	-1.09	0.89	.22	-1.67	0.56	<.01	-1.40	0.48	<.01
	Low birth weight (<5.5 lb)	-2.96	4.25	.49	3.48	3.21	.28	4.52	3.15	.15
	Premature birth (<37 wks)	-1.85	2.32	.43	-0.76	2.18	.73	-0.64	2.20	.77
	Prenatal substance exposure	-4.41	2.73	.11	5.23	2.13	.01	5.46	2.11	.01
	T1 baseline cognitive							0.15	0.08	.07
2a	Age x Low birth weight	0.05	.10	.61	0.13	0.07	.08	0.13	0.08	.08
	Age x Premature birth	0.05	.10	.61	-0.01	0.08	.87	-0.03	0.08	.68
	Age x Substance exposure	-0.22	.11	.04	0.04	0.11	.68	0.07	0.10	.50
2b	Sex x Low birth weight	6.16	7.53	.41	7.81	5.30	.14	5.83	5.31	.27
	Sex x Premature birth	-8.80	4.84	.07	5.07	4.97	.31	6.30	5.25	.23
	Sex x Substance exposure	5.97	5.98	.32	-1.25	5.43	.82	-1.07	5.13	.84
Predicting Language Scores										
1	Sex (girls=0, boys=1)	-2.60	2.50	.30	-5.88	3.02	.05	-4.62	2.88	.11
	Age at adoptive placement	0.20	0.12	.09	0.09	0.10	.37	0.01	0.10	.95
	Number of placements	-2.91	4.03	.47	2.89	2.72	.29	4.87	2.52	.05
	Hospital stay length	0.52	1.10	.64	-0.70	0.69	.31	-0.76	0.53	.15
	Low birth weight (<5.5 lb)	-13.02	5.87	.03	-3.50	5.04	.49	0.61	5.16	.91
	Premature birth (<37 wks)	3.33	3.12	.29	-3.78	2.82	.18	-4.69	2.79	.09
	Prenatal substance exposure	-0.75	3.11	.81	7.25	3.99	.07	7.28	3.71	.05
	T1 baseline language							0.29	0.15	.05
2a	Age x Low birth weight	0.31	0.21	.13	0.15	0.11	.18	0.07	0.14	.61
	Age x Premature birth	-0.05	0.16	.77	-0.01	0.12	.96	0.01	0.13	.92
	Age x Substance exposure	0.21	0.13	.10	-0.02	0.14	.88	-0.05	0.14	.73
2b	Sex x Low birth weight	-0.74	10.32	.94	12.96	7.92	.10	12.73	7.66	.10
	Sex x Premature birth	9.99	7.34	.17	15.15	5.50	<.01	12.79	5.66	.02
	Sex x Substance exposure	-2.53	6.81	.71	-2.87	7.41	.70	-1.82	6.98	.79
Predicting Motor Scores										
1	Sex (girls=0, boys=1)	-2.87	2.63	.28	-5.13	2.26	.02	-4.45	2.36	.06
	Age at adoptive placement	0.25	0.09	.01	-0.01	0.16	.93	-0.06	0.17	.71
	Number of placements	-4.90	2.68	.07	6.17	3.69	.10	7.45	3.79	.05
	Hospital stay length	-0.77	1.17	.51	-1.33	1.01	.19	-0.90	0.83	.28
	Low birth weight (<5.5 lb)	-4.08	4.07	.32	1.47	4.70	.75	2.36	4.95	.63
	Premature birth (<37 wks)	-2.35	2.53	.35	-0.07	3.24	.98	0.59	3.08	.85

		Baseline (T1)			Follow-up (T2)			T2-T1 Change		
		<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
	Prenatal substance exposure	-5.47	3.54	.12	-1.42	2.99	.64	-0.54	3.23	.87
	T1 baseline motor							0.21	0.11	.05
2a	Age x Low birth weight	0.30	0.09	<.01	0.33	0.19	.08	0.29	0.19	.12
	Age x Premature birth	0.05	0.08	.50	-0.18	0.17	.31	-0.18	0.17	.28
	Age x Substance exposure	0.28	0.13	.03	0.03	0.16	.86	0.02	0.16	.93
2b	Sex x Low birth weight	3.73	7.69	.63	11.70	6.99	.09	9.34	7.34	.20
	Sex x Premature birth	2.54	5.45	.64	-5.80	5.66	.31	-7.26	5.82	.21
	Sex x Substance exposure	9.80	7.41	.19	-16.04	6.87	.02	-19.25	6.37	<.01

Note. Significant effects ($p < .05$) bolded for emphasis. Stepwise regressions entered as follows: Step 1 = main effects, Step 2a = main effects + age*perinatal risk interactions, Step 2b = main effects + sex*perinatal risk interactions. All models adjusted for weeks since adoptive placement as a covariate.