Published in final edited form as:

Infant Child Dev. 2020 ; 29(1): . doi:10.1002/icd.2147.

Does Maternal Warmth Moderate Longitudinal Associations Between Infant Attention Control and Children's Inhibitory Control?

Camille C. Cioffi^a, Leslie D. Leve^a, Misaki N. Natsuaki^b, Daniel S. Shaw^c, David Reiss^d, Jenae M. Neiderhiser^e

^aUniversity of Oregon

^bUniversity of California Riverside

^cUniversity of Pittsburgh

^dYale School of Medicine

^eThe Pennsylvania State University

Abstract

Attention control (AC) is thought to play an important role in the development of inhibitory control (IC) in children, yet there are few longitudinal studies of this association. This study used a prospective parent-child adoption design ($N = 361$ children) to examine whether maternal warmth at child age 27 months moderated the link between AC during infancy and IC during childhood. Tobit regression analyses indicated that low levels of infant AC at 9 months predicted low levels of IC at 6 years, controlling for birth parent IC, prenatal risk, infant distress to limitations, child sex, and openness of adoption. Adoptive mother warmth at 27 months moderated this association. In the context of higher levels of maternal warmth, the longitudinal association between low AC and low IC was attenuated. Thus, high levels of early maternal warmth may help diminish the effects of extant risk for IC deficits.

Keywords

Maternal warmth; attention control; inhibitory control; adoption design; longitudinal

Inhibitory control (IC) has been defined as the voluntary capacity to regulate automatic attentional or behavioral responses and shift attention to relevant stimuli in the presence of irrelevant stimuli (Diamond, 2013; Diamond, Barnett, Thomas, & Munro, 2007). IC is thought to diverge as a distinguishable component of executive function during the elementary school years (Bartolucci & Solis-Trapala, 2010; Huizinga, Dolan, & van der Molen, 2006; Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003; Wang, Eisenberg, & Spinrad, 2018) and has been suggested as a core cognitive skill in childhood upon which subsequent

Conflicts of Interest: The authors have no conflicts of interest to declare.

Data sharing: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

executive functions depend (Barkley, 1997, 2012). Low levels of IC have been associated with a variety of cognitive challenges and psychopathological outcomes, including low mathematic achievement (Cragg, Keeble, Richardson, Roome, & Gilmore, 2017) and externalizing disorders (Toupin, Dery, Pauze, Mercier, & Fortin, 2000); thus, understanding its precursors is important.

The development of IC is shaped by genetic influences (Engelhart, Briley, Mann, Harden, & Tucker-Drob, 2015; Gagne & Saudino, 2016), early attention control (AC; Cuevas & Bell, 2014; Swingler, Perry, Calkins, & Bell, 2014), and early parenting (Bernier, Carlson, & Whipple, 2010). Specifically, warm parenting is hypothesized to shape early development by facilitating healthy cognitive and regulatory development (Cabrera, Fagan, Wight, & Schadler, 2011; Mills-Koonce et al., 2015) and may thus serve as a protective factor for children at risk for low IC. The extent to which associations between early AC and later IC can be modified by warm mothering is unknown, yet if moderation is present, it could have important implications for the development and timing of preventive interventions to promote IC in early childhood. Our study integrated and extended prior work by using a prospective adoption design to understand the contributions of AC and maternal warmth to children's IC at age 6 years. The adoption design allows for a separate assessment of heritable and postnatal factors related to IC, because children share genes and a prenatal environment with their biological parents but not with their adoptive parents. This feature of the parent-child adoption design helps provide evidence that any effects of parental warmth on child IC are not associated with shared parent-child genes that might simultaneously influence both parental warmth and child IC.

Association Between Early Attention and Inhibitory Control

Throughout the first year of life, infants develop the foundation upon which later volitional self-regulation is built (Garon, Bryson, & Smith, 2008; Posner & Rothbart, 2007). AC, the ability to shift attention away from sources of distress and toward useful stimuli, has been considered a rudimentary form of such regulation, whereby infants as young as age 3 months begin to show both preference for and adjustment to stimuli in their immediate environment (Harman, Rothbart, & Posner, 1997). On the basis of their limited functional abilities, infants use their attention as a means of early regulation. AC allows infants to behaviorally engage in desirable stimuli while avoiding inputs that may be undesirable, such as frustrating events. Cognitively, the attention orienting network is the earliest activated attention network that establishes connectivity with the later developing executive attention network understood to underlie IC (Posner & Rothbart, 2007). This executive attention system emerges at the end of the first year of life and is more volitional in nature than is early orienting (Colombo, Kapa, & Curtindale, 2010). As infants develop more control over attentional processes across the first year of life, they are more capable of appropriately deploying their attention; conversely, infants who are unable to disengage from a frustrating stimulus display both biological and behavioral markers of dysregulation, such as EEG asymmetry and negative affect (Swingler et al., 2014) and susceptibility to distress (Rothbart, Ziaie, & O'Boyle, 1992). In the long term, the inability to disengage in periods of frustration during infancy (i.e., express AC) has been associated with later developmental

concerns (e.g., developmental disabilities, externalizing behavior; Elsabbagh et al., 2012; Leve et al., 2010).

After AC is developed, children hierarchically move to more internally driven forms of regulatory control, including the deployment of IC (i.e., inhibiting involuntary responses to focus on and achieve a certain goal or task; Johansson, Marciszko, Gredebäck, Nyström, & Bohlin, 2015; Reck & Hund, 2011). By the end of kindergarten, there are identifiable differences between children in the extent to which they have developed the ability to express IC (Huizinga et al., 2006; Lehto et al., 2003). In the absence of intervention and supportive environments, those children who demonstrate low levels of IC are at risk for low school achievement and behavioral problems (Allan, Hume, Allan, Farrington, & Lonigan, 2014). While the focus of this study was on AC in infancy as a foundation for later IC, it should be noted that the executive functioning system in childhood is multifaceted and complex: It includes multiple brain regions, such as the anterior cingulate and dorsolateral prefrontal cortex (Garon et al., 2008), and encompasses a variety of separate but related components, including AC during childhood (a more volitional process than AC in infancy) and IC (Garon et al., 2008). As such, AC and IC processes are distinct but related components of executive functioning that diverge in childhood (e.g., Henry & Bettenay, 2010).

Despite the aforementioned evidence supporting a pathway from early AC to later IC, some studies have found no evidence for this pathway, and instead have suggested that IC is detectable and stable as early as at age 6 months. For example, Holmboe and colleagues (2018) found that level of IC at 6 months rather than basic attention at 4 months predicted levels of IC at age 9 months. However, the Holmboe et al. study conceptualized infant IC with tasks that capitalize on an infant's ability to volitionally deploy attention, which may blur the relation between AC and IC. One goal of our study was to test the longitudinal association between AC and IC using a parent-child adoption design that would allow us to estimate the AC-IC association independent of shared genetic contributions from the rearing parent. By doing so, we could isolate variance explained by genetic contributions (i.e., birth parent IC) from the longitudinal prediction of AC to IC that is free from shared genetic influences in the rearing environment (i.e., from birth parent IC).

Role of Maternal Warmth in Development of Inhibitory Control

Prior research has established that emerging regulatory control, such as AC, is largely dependent on the infant's primary caregiver (Kopp & Neufeld, 2003). Parenting behaviors such as sensitivity and cognitive stimulation shape early development by facilitating healthy cognitive and regulatory development (Cabrera et al., 2011; Mills-Koonce et al., 2010). Moreover, research has demonstrated support for the association between high-quality maternal-child interactions and child executive functions, such as IC (Bernier et al., 2010), especially parental sensitivity in the toddler years (Amicarelli, Kotelnikova, Smith, Kryski, & Hayden, 2018; Kochanska, Murray, & Harlan, 2000).

A growing body of evidence also suggests that IC is heritable (Gagne & Saudino, 2016). Thus, genetically sensitive study designs are needed that can separately estimate heritable

and environmental contributions to the development of IC. Previous studies that used genetically sensitive designs (e.g., twin studies, adoption studies) have revealed an association between maternal warmth (or lack thereof) and child self-regulation (e.g., Lipscomb et al., 2013; Reuben et al., 2016). Adoption studies have established that a child's capacity to self-regulate is amenable to environmental influences, in that the effects of the rearing environment are not confounded by parent and child shared genes. Moreover, an adoption design clarifies whether parental influence is compensating for extant child risk (in the form of low AC) through the provision of warm caregiving environments that may facilitate improved cognitive outcomes (e.g., higher IC; Reiss, Leve, & Neiderhiser, 2013; Shanahan & Hofer, 2005). In environments that do not compensate for an infant's early challenges, cognitive deficits may persist across the lifespan. Using a genetically sensitive design, we examined whether maternal warmth is associated with higher levels of later IC, disrupting the path from low AC to low IC, while also examining whether variation in IC is predicted by heritable contributions of biological parent IC. Although we are not the first to use an adoption design to examine maternal warmth as a modifier of extant risk (e.g., Lipscomb et al., 2013; Reuben et al., 2016), we are unaware of any research that has examined whether the association between AC during infancy and school-age IC is moderated by maternal warmth during the toddler period. Given the importance of parental support in promoting IC, the lack of research on its moderating role in the association between early AC and later IC is a surprising and significant gap in the literature.

Study Hypotheses

The aims of our study were to build on existing literature to (a) examine the longitudinal association between infant AC and school-age IC, and (b) examine whether maternal warmth moderates the association between infant AC and later IC. We hypothesized that (1) lower levels of infant AC observed while the infant is engaging with a frustrating stimulus would predict lower child IC at child age 6 years, and (2) that high levels of warm parenting during toddlerhood would moderate the association between infant AC and child IC, such that higher levels of warm parenting would attenuate associations between low infant AC and low childhood IC.

Methods

Participants

The sample consisted of participants in the first cohort ($N = 361$) of the Early Growth and Development Study (EGDS), which is an ongoing, multisite, longitudinal sample of children adopted at birth, their adoptive parents, and their birth parents recruited in two cohorts (Leve et al., 2013). Cohort I participants were enrolled between 2003 and 2006 using a rolling recruitment procedure through U.S. domestic adoption agencies in three regions of the United States: mid-Atlantic, West/Southwest, and Pacific Northwest ($N = 33$ agencies in 10 states). Infants were placed within 3 months of birth with a nonrelative adoptive family ($M = 3$ days, $SD = 5$ days). For additional eligibility and sample information, refer to Leve et al. (2013).

The participants in our study included male (57%) and female (43%) children with a range of racial backgrounds (57.1% White, 11.4% Black/African American, 9.4% Latinx, 21.3% multiracial, 0.3% American Indian/Alaskan Native, 0.3% Asian, 0.3% not reported). Adoptive parents were predominantly White (more than 90% of adoptive mothers/fathers), college educated, and middle to upper class (median annual family income \$100,000 to \$125,000). Birth parents were predominately White (72%); the remaining participants represented 10% African American, 8% Latinx, 5% two or more races, 1% Asian, 2% American Indian/Alaskan Native. This group had an average household income of less than \$25,000 per year; 65% had achieved a graduation equivalent diploma, high school degree, or lower; 25% had a trade school or degree from 2-year college; and 10% had a 4-year college degree.

Measures

Infant attention control.—AC in infancy was coded at child age 9 months through the use of the LABTAB toy removal task, which is intended to illicit infant frustration (Goldsmith & Rothbart, 1996). After 30 seconds of infant free play in a high chair with an attractive toy, the toy was placed behind a clear “barricade” for 30 seconds (frustration phase). This free play barricade sequence was repeated two times, for a total of six 30-second intervals of toy interaction. Infant attention was coded with a continuous second-by-second coding system containing a series of mutually exclusive categories, such as “external stimuli,” when infants were looking at an artifact in the room (e.g., a noise caught their attention, a person external to the task entered the room); “gaze toward the experimenter,” when infants made attempts to engage the experimenter; “look away,” when infants lacked focused attention on the desired object but were not looking at others in the room or focusing their gaze on other objects in the room. The number of seconds of “look away” eye gaze during the three frustration intervals was used to index AC, with longer eye gaze away from the distressing object considered to be more advantageous (e.g., higher AC). The percent time spent in “look away” during each of the three frustration trials was summed and averaged. Thus, repeated measures of infant gaze behaviors were coded across approximately 90 seconds per infant to measure AC (Cioffi & Leve, 2017); $ICC_{(1,3)} = .88$, 95% CIs [.78–.93], indicating good to excellent reliability.

Adoptive mother warmth.—At child age 27 months, spouses/partners used the Iowa Family Interaction Rating Scale (Melby & Conger, 2001) to report about the mother’s warmth toward her child. The measure included 4 items, $\alpha = .89$. Each item on the 7-point scale ranged from *never* to *always*, with higher scores indicating greater warmth. Potential scores ranged from 4 to 28. A square root transformation was applied to maternal warmth to reduce negative skew. In 12 families, the child had been adopted by a same-sex male couple, and in these cases, adoptive father warmth reported by his partner was used in analyses.

Child inhibitory control.—To measure child IC, children completed the day/night Stroop task when they were 6 years old, and percent correct was coded (Gerstadt, Hong, & Diamond, 1994), $ICC = .98$, 95% CIs [.95–.98], $\kappa = .98$, indicating excellent reliability. In this task, children were presented with cards with a sun and cards with a moon and stars. Children were instructed that they are to say “night” whenever they saw a sun card and

“day” whenever they saw a moon card. Children received one point for each correct answer, and the scores ranged from 0 to 16 out of 16. The day/night Stroop has been shown in other studies of children in this age range to demonstrate good reliability and validity (Montgomery & Koeltzow, 2010) and to provide a useful indicator of the development of IC between ages 5 and 7 years (Macdonald, Beauchamp, Crgan, & Anderson, 2014).

Covariates.—Birth parent IC was measured using the computerized color Stroop task. In this task, color words “RED,” “BLUE,” “GREEN,” and “YELLOW” were shown on the computer screen in color. In the word condition, the word and color were either congruent, in which each word was shown in the color identified by the word, or noncongruent, in which each word was shown in a color different from that identified by the word. The percent correct from incongruent trials was scored for analysis (MacLeod, 1991; Stroop, 1935) in order to be consistent with the scoring system used for the child’s day/night Stroop task.

Infant distress to limitations was measured when infants were 9 months old, with adoptive mother report on the Infant Behavior Questionnaire (IBQ; Rothbart, 1981). The Distress to Limitations subscale (20 items) was used to control for shared variance for general distress that infants may experience when confined in a high chair and having a toy removed, $\alpha = .85$. By accounting for general distress to limitations, we can be more certain that associations between infant AC during the barricade task and later IC are related to the hierarchical development of IC rather than a general aspect of the child’s level of distress. This is especially important to account for, given associations between IC and dimensions of temperament in preschool-age children that later predict kindergarten adjustment (Dollar, Stifter, & Buss, 2017). Several studies have validated this scale (Gartstein & Rothbart, 2003; Putnam, Helbig, Gartstein, Rothbart, & Leerkes, 2014; Rothbart, 1981).

The degree of openness in adoption was assessed using perception of openness by the birth mother, adoptive mother, and adoptive father to control for similarities that may result from contact between birth and adoptive families. This composite score included each participant’s rating of the degree and nature of contact/communication with their counterpart. The scale ranged from 1 (*very closed*) to 7 (*very open*); $\alpha s = .62-.75$. For additional information, see Ge et al. (2008). Prenatal risks were controlled for because of their role in the development of low IC (Baron, Kerns, Müller, Ahronovich, & Litman, 2012; Fryer et al., 2007; Huijbregts, Warren, de Sonnevle, & Swaab-Barneveld, 2008). Birth mother report of pregnancy risks/complications via a calendar history recall method was used to assess prenatal risk (Caspi et al., 1996). Responses to each item were scored from 1 (*not harmful or relevant*) to 6 (*very great harm to or deviation in offspring*). Consistent with McNeil-Sjöström scoring protocols (McNeil & Sjöström, 1995), a risk severity score was created by summing items scored 3 or greater. For detailed information, see Marceau, De Araujo-Greecher, Miller, and Massey (2016).

Analysis Approach

There were missing data on each variable (ranging from 1% to 20%), and thus we conducted Little’s test of missing at random (1988) to examine patterns of missingness. All variables

were determined to be missing completely at random ($\chi^2 = 85, p = .20$), and listwise deletion was applied for the remaining analyses.

When we inspected the dependent variable, school-age IC, we found that approximately 45% of children received a 100% correct score on the Stroop task. Tobit regression models were therefore used, because tobit regression adjusts for censoring from above, as was present in the IC data (Greene, 1997). To estimate the linear relation between infant AC and school-age IC and the interaction between infant AC and maternal warmth, two separate tobit regressions (main effects model, $n = 235$, and interaction model, $n = 210$) were conducted in the statistical program R v3.4.3 using the packages AER (Kleibers & Zeileis, 2008) and CensReg (Henningsen, 2011). We report the marginal effects from the tobit regression because the standardized coefficients are not synonymous to beta coefficients for a linear regression, and thus are often misinterpreted (Greene, 1997).

Results

Descriptive Statistics

Descriptive statistics and bivariate correlations are presented in Table 1. Consistent with Hypothesis 1, lower levels in AC at 9 months were associated with lower IC scores at age 6 years ($r = .19, p < .01$). Consistent with Hypothesis 2, higher levels of adoptive mother warmth at 27 months were associated with higher child IC at age 6 years ($r = .19, p < .01$). Adoptive mother warmth and infant AC were not significantly correlated, suggesting that maternal warmth was not reactive to infant AC. Female sex was related to higher infant AC and higher child IC, and openness of the adoption was negatively associated with infant AC.

Attentional Control and Later Inhibitory Control

A multiple tobit regression was used to test whether level of AC at age 9 months predicted level of IC at age 6 years. Consistent with univariate results, controlling for openness of adoption, infant distress to limitations, birth parent IC, and child sex, infant AC continued to be associated with child IC, accounting for 19% of the incremental change in age 6 IC ($ME = .19, SE = .08, t = 2.42, p = .016$). Child sex also predicted age 6 IC (females had better IC). No other covariates were statistically associated with age 6 IC ($p > .05$). The model explained 24% more of the variance in IC compared with that of the intercept-only model (pseudo $R^2 = .24$). Results are presented in Table 2.

Warm Parenting and Moderation of Attentional Control

A multiple tobit regression was used to test whether adoptive mother warm parenting moderated the association between infant AC and IC at age 6 years. All continuous variables were mean centered prior to the creation of interaction terms. Consistent with Hypothesis 2, a significant interaction (see Table 3) emerged between infant AC at 9 months and warmer parenting at 27 months, which predicted level of school-age IC at 6 years and accounted for 57% of incremental change in child IC ($ME = -.57, SE = .22, z = -2.57, p = .01$). To probe the interaction, we examined the interaction between ± 1 SD above and below the mean and at the mean for adoptive mother warmth and infant AC using PROCESS v3 (Hayes, 2017). Results are presented in Figure 1. The interaction model accounted for an additional

34% of the variance compared with that of the intercept-only model and 13% over the main effects model (pseudo $R^2 = .34; .13$). The Johnson-Neyman technique (Hayes & Montoya, 2017) was used to ascertain the values of the moderator when the point of linearity of the association is no longer statistically significant. For at or below mean levels of warmth specifically ($< 26/28$ in this sample), a linear relationship between warmth and AC existed for IC such that for each increase in warmth (increase of 1), there was a .1 decrease in the association between AC and IC (i.e., at higher than mean levels of warmth, the association between AC and IC was not present).

Discussion

We used a longitudinal adoption design to understand the association between infant AC and child IC and the moderating role of maternal warmth while controlling for birth parent IC and prenatal risks. We found that lower AC in infancy predicted lower school-age IC, and the interaction between mother warmth and infant AC predicted level of school-age IC. Specifically, infants with lower AC and lower levels of maternal warmth had lower school-age IC, whereas higher levels of maternal warmth protected against the effects of low infant AC.

Our findings provide evidence to suggest that infant AC is foundational for the development of IC (Garon et al., 2008; Johansson et al., 2015) above and beyond heritable contributions of low birth parent IC that are known to predict individual differences in IC (Cragg et al., 2017; Gagne & Saudino, 2016; Gagne, Saudino, & Asherson, 2011; Sinzig, Morsch, Bruning, Schmidt, & Lehmkuhl, 2008; Toupin et al., 2000). The infants in our study were in the latter half of their first year of life, which is marked by the emergence of the early executive attention system (Colombo et al., 2010) that enables infants to purposefully disengage with frustrating stimuli (Harman et al., 1997). Our study builds on previous research identifying links between low early AC and executive functioning deficits, which until now have been observed only up to the preschool age (Brooker et al., 2014; Cuevas & Bell, 2014; Johansson et al., 2015).

Environmental Support and Diminished Risk

Previous adoption studies have found that lower levels of parental warmth are directly associated with regulatory dysfunction (Reuben et al., 2016). However, no studies to our knowledge have examined maternal warmth as a moderator of infant AC in the context of a genetically sensitive design. These findings corroborate what we know about maternal warmth, that it facilitates healthy cognitive and regulatory development (Cabrera et al., 2011; Kopp & Neufeld, 2003; Mills-Koonce et al., 2015). However, our study adds to previous work because we found that with below-average (for the sample) levels of maternal warmth, continuity between low AC during infancy and low IC at age 6 years remained moderately high. However, in the presence of higher levels of warmth, the stability in child regulatory function was improved and reached levels of IC indistinguishable from those of infants who earlier had demonstrated more-advanced AC. These results suggest that very high levels of maternal warmth can modify extant hierarchical risk for IC associated with lower infant AC. This finding is in line with models of social compensation, which refer to a

positive environment preventing the unfolding of a predisposed risk (Shanahan & Hofer, 2005). Specifically, a highly warm caregiving environment may override extant risk when mothers maintain a consistent level of warmth despite child attributes that may elicit less warmth (Reiss et al., 2013). Similarly, warm mothering may provide extra opportunities for children to practice regulatory behavior and compensate for early expressions of less-regulated behavior (McDonnell & Valentino, 2017). It has been suggested that interventions for children with low executive functioning should include practices that specifically target executive functioning skills along with those that enhance emotional and social development (Diamond & Lee, 2011). Our work suggests that improving maternal warmth may be an alternative strategy for improving child executive functioning deficits. Several evidence-based interventions have shown positive effects of increasing maternal warmth during early childhood (Kim & Mahoney, 2004; Landry, Smith, & Swank, 2006; Landry, Smith, Swank, & Guttentag, 2008).

Limitations

This study has limitations. First, maternal warmth was measured using partner-report warmth, and the mean levels of maternal warmth in this study were quite high. Partner-reported warmth may be confounded by other perceptions of the partner, such as relationship quality. However, partner reports of maternal warmth demonstrated higher internal consistency and greater variability compared with maternal self-reported warmth, within our sample, and could be considered more objective than self-report ratings. It is unlikely that partners were compelled to rate mothers as high simply because they are adoptive parents, given prior research indicating that parents tend to rate their feelings and behaviors similarly toward adoptive and nonadoptive children (Glover, Mullineaux, Deater-Deckard, & Petrill, 2010). However, it is possible that adoptive parents exhibit higher levels of warmth than do nonadoptive parents, although no research to our knowledge has evaluated this possibility. Moreover, we are aware of one study comparing reports of partner behavior during conflict and self-report behavior during conflict that found that partner reports were indistinguishable from observer reports, whereas self-report demonstrated only good validity (Sanford, 2010). Thus, we believe that partner report may provide a more realistic and objective representation of warmth, especially because mothers tended to self-report higher levels of warmth than did their partners in our sample.

Second, this study used only single tasks to assess both AC and IC. Although the Stroop task has demonstrated strong validity and is often used to assess IC, future work should consider using multiple measures of IC and additional indices of executive functions to capture a wider breadth of the potential consequences of poor infant AC. In regard to AC, although we included repeated observations of AC during a frustration task and thus used a similar amount of time as have previous studies (e.g., Cuevas & Bell, 2014), it may be useful to obtain additional measurements of AC, perhaps at multiple time points (e.g., 7 months, 8 months, 9 months). Furthermore, future work should seek to understand the antecedents of low infant AC, especially for those infants with mothers who are less able to provide a highly warm caregiving environment. This should perhaps include a multifaceted, hierarchical approach to studying IC that examines not only levels of early attention as a predecessor to child IC, but also examines intermediary paths from infant AC to toddler and

preschool executive functions and child IC and beyond, to child academic and behavioral outcomes. This approach could include multiple indices of maternal warmth at multiple points across early childhood. By both including multiple measures of IC and looking at earlier indicators of child regulatory risk, especially within the context of a longitudinal design, we may be better able to identify infants who may benefit from additional support. We also may identify how much stability is observed over time and whether early warmth can truly buffer long-term risk beyond the early elementary years.

Third, multiple variables were transformed. We adjusted IC by using a tobit regression to correct for censoring from above, and we adjusted maternal warmth by using a square root transformation to reduce skewedness. Although we completed analyses without these corrections and both approaches yielded similar results, other researchers may consider identifying more-sensitive variables to allow for a wider range of variance and to detect more-advanced IC and instances of lower maternal warmth. It should be noted, however, that we were primarily interested in IC deficits, which were well captured by the measure used.

Fourth, recent work has raised concerns that other measures (i.e., the Child Behavior Questionnaire and the Temperament in Middle Childhood Questionnaire) from Rothbart and colleagues (developers of the IBQ) recently demonstrated poor construct validity (Kotelnikova, Olino, Klein, Kryski, & Hayden, 2016; Kotelnikova, Olino, Klein, Mackrell, & Hayden, 2017). Therefore, the IBQ may not be the optimal measure of distress to limitations. However, in support of the validity of this measure in infancy, we identified several studies that have validated the Distress to Limitations scale (Gartstein & Rothbart, 2003; Putnam et al., 2014; Rothbart, 1981).

Finally, although our use of an adoption design eliminates influences resulting from shared genes between the mother and child, our sample of families who had adopted a child also had higher than average economic resources and stability, circumstances that are typically associated with higher levels of warmth and higher executive functioning (Hendry, Jones, & Charman, 2016; Vernon-Feagans, Willoughby, & Garrett-Peters, 2016). This may limit the generalizability of our findings. However, we suggest that when parents do not rate their partner as “always warm” (i.e., not displaying consistent warmth), it may open an avenue for intervention. Thus, even in a sample with greater resources and high levels of warmth, there are still opportunities for growth and intervention, especially when the children they are parenting may have experienced greater than average prenatal risks and a higher genetic risk.

Future Directions

This study highlights opportunities for future research. We found that high levels of maternal warmth compensated for children’s AC deficits; conversely, infants with AC deficits who had mothers with lower levels of warmth remained at risk for IC deficits. Although one explanation is that infants at risk remain so in the absence of intervention, an alternative explanation is that infants with AC deficits also possess a greater liability for exaggerated temperament, which may evoke less warm reactions from caregivers. Previous work has indeed found that child temperamental frustration and fearfulness elicit negative parenting, which is associated with later increases in child impulsivity (Kiff, Lengua, & Zalewski, 2011). Future studies should consider examining these bidirectional processes and include

additional measures of temperament and personality, especially for children with AC deficits who have mothers who exhibit less warmth. Future research should also test how IC may mediate the relation between AC and later behavioral and academic challenges into middle childhood to better understand both the hierarchical nature of development from AC to IC to psychosocial difficulties and the role of parental warmth throughout childhood. Testing these associations would benefit from using genetically sensitive designs, especially because the heritability of executive functions is more fully expressed during middle childhood (Engelhardt et al., 2015). Other aspects of AC, such as an infant's attention to their mother, should also be incorporated into future research, to understand unique contributions of different AC deployment strategies. Moreover, our study considered warmth only during the toddler period. This is an important period, given that executive functions are rapidly developing (Garon et al., 2008). However, some research has suggested that parenting must be adapted to accommodate the needs of the developing child, especially for IC (Spruijt, Dekker, Ziermans, & Swaab, 2018). Therefore, multiple aspects of parenting across early development should be considered in future studies.

In summary, this study provides new evidence to support the theoretical link between early AC and later IC. We did so prospectively with an impressive stretch of time from infancy to school entry and by using a design that eliminated passive gene–environment correlation between maternal warmth and child AC and IC. This study is the first to highlight that maternal warmth is a protective factor between lower levels of infant AC and lower levels of IC at age 6 years. This finding underscores the importance of early caregiving that fosters consistent warmth and support, especially for children with extant risk for IC deficits.

Acknowledgments:

This project was supported by grant R01 HD042608 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development and the National Institute on Drug Abuse, NIH, U.S. PHS (PI Years 1–5: David Reiss, MD; PI Years 6–10: Leslie Leve, PhD), by UH3 OD023389 (PIs: Leslie Leve, Jenae Neiderhiser, Jody Ganiban) from the Office of the Director, NIH, U.S. PHS, and by grant R01 DA020585 from the National Institute on Drug Abuse, the National Institute of Mental Health and OBSSR, NIH, U.S. PHS (PI: Jenae Neiderhiser, PhD). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Child Health and Human Development or the National Institutes of Health.

References

- Allan NP, Hume LE, Allan DM, Farrington AL, & Lonigan CJ (2014). Relations between inhibitory control and the development of academic skills in preschool and kindergarten: A meta-analysis. *Developmental Psychology*, 50, 2368–2379. doi: 10.1037/a0037493 [PubMed: 25069051]
- Amicarella AR, Kotelnikova Y, Smith HJ, Kryski KR, & Hayden EP (2018). Parenting differentially influences the development of boys' and girls' inhibitory control. *British Journal of Developmental Psychology*, 36, 371–383. doi: 10.1111/bjdp.12220 [PubMed: 29314168]
- Barkley RA (1997). Behavioural inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, 121, 65–94. doi: 10.1037/0033-2909.121.1.65 [PubMed: 9000892]
- Barkley RA (2012). *Executive functions: What they are, how they work, and why they evolved*. New York, NY: The Guilford Press.
- Baron IS, Kerns KA, Müller U, Ahronovich MD, & Litman FR (2012). Executive functions in extremely low birth weight and late-preterm preschoolers: Effects on working memory and response inhibition. *Child Neuropsychology*, 18, 586–599. doi: 10.1080/09297049.2011.631906 [PubMed: 22122351]

- Bartolucci F, & Solis-Trapala I (2010). Multidimensional latent Markov models in a developmental study of inhibitory control and attentional flexibility in early childhood. *Psychometrika*, 75(4), 725–743. doi:10.1007/s11336-010-9177-1
- Bernier A, Carlson SM, & Whipple N (2010). From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development*, 81, 326–339. doi: 10.1111/j.1467-8624.2009.01397.x [PubMed: 20331670]
- Brooker RJ, Neiderhiser JM, Ganiban JM, Leve LD, Shaw DS, & Reiss D (2014). Birth and adoptive parent anxiety symptoms moderate the link between infant attention control and internalizing problems in toddlerhood. *Developmental Psychopathology*, 26, 347–359. doi: 10.1017/S095457941300103X.Birth
- Cabrera NJ, Fagan J, Wight V, & Schadler C (2011). The influence of mother, father, and child risk on parenting and children's cognitive and social behaviors. *Child Development*, 82, 1985–2005. doi: 10.1111/j.1467-8624.2011.01667.x [PubMed: 22026516]
- Caspi A, Moffitt T, Thornton A, Freedman D, Amell JW, Harrington H, ... Silva PA (1996). The Life History Calendar: A research and clinical assessment method for collecting retrospective event-history data. *International Journal of Methods in Psychiatric Research*, 6, 101–114. doi:10.1002/(SICI)1234-988X
- Cioffi CC., & Leve LD (2017). EGDS micro gaze coding manual. Unpublished manuscript University of Oregon, Prevention Science Institute.
- Colombo J, Kapa L, & Curtindale L (2010). Varieties of attention in infancy In Oakes LM, Cashion CH, Casasola M, & Rakison DH (Eds.), *Infant perception and cognition: Recent advances, emerging theories, and future directions* (pp. 3–26). New York, NY: Oxford University Press.
- Cragg L, Keeble S, Richardson S, Roome HE, & Gilmore C (2017). Direct and indirect influences of executive functions achievement. *Cognition*, 162, 12–26. doi: 10.1016/j.cognition.2017.01.014 [PubMed: 28189034]
- Cuevas K, & Bell MA (2014). Infant attention and early childhood executive function. *Child Development*, 85, 397–404. doi: 10.1111/cdev.12126 [PubMed: 23711103]
- Diamond A (2013). Executive functions. *Annual Review of Psychology* 64, 135–168. doi: 10.1146/annurev-psych-113011-143750
- Diamond A, Barnett WS, Thomas J, & Munro S (2007). Preschool program improves cognitive control. *Science*, 318, 1387–1388. doi: 10.1126/science.1151148 [PubMed: 18048670]
- Diamond A, & Lee K (2011). Interventions shown to aid executive function development in children 4-12 years old. *Science*, 333(6045), 959–964. doi: 10.1126/science.1204529 [PubMed: 21852486]
- Dollar JM, Stifter CA, & Buss KA (2017). Exuberant and inhibited children: Person-centered profiles and links to social adjustment. *Developmental Psychology*, 53(7), 1222–1229. doi:10.1037/dev0000323 [PubMed: 28471219]
- Elsabbagh M, Divan G, Koh YJ, Kim YS, Kauchali S, Marcin C, Montiel-Nava C, ... Fombonne E (2012). Global prevalence of autism and other pervasive developmental disorders. *Autism Research*, 5, 160–179. doi: 10.1002/aur.239 [PubMed: 22495912]
- Engelhardt LE, Briley DA, Mann FD, Harden KP, & Tucker-Drob EM (2015). Genes unite executive functions in childhood. *Psychological Science*, 26, 1151–1163. doi:10.1177/0956797615577209 [PubMed: 26246520]
- Fryer SL, Tapert SF, Mattson SN, Paulus MP, Spadoni AD, & Riley EP (2007). Prenatal alcohol exposure affects frontal–striatal BOLD response during inhibitory control. *Alcoholism: Clinical and Experimental Research*, 31, 1415–1424. doi: 10.1111/j.1530-0277.2007.00443.x
- Gagne JR, & Saudino KJ (2016). The development of inhibitory control in early childhood: A twin study from 2-3 years. *Developmental Psychology*, 52, 391–399. doi: 10.1037/dev0000090. [PubMed: 26784384]
- Gagne JR, Saudino KJ, & Asherson P (2011). The genetic etiology of inhibitory control and behavior problems at 24 months of age. *Journal of Child Psychology and Psychiatry* 52, 1155–1163. doi: 10.1111/j.1469-7610.2011.02420.x [PubMed: 21627653]
- Garon N, Bryson SE, & Smith IM (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, 134, 31–60. doi: 10.1037/0033-2909.134.1.31 [PubMed: 18193994]

- Gartstein MA, & Rothbart MK (2003). Studying infant temperament via the Revised Infant Behavior Questionnaire. *Infant Behavior and Development*, 26(1), 64–86.
- Ge X, Natsuaki MN, Martin D, Leve L, Neiderhiser J, Shaw DS, ... Reiss D (2008). Bridging the divide: Openness in adoption and post-adoption psychosocial adjustment among birth and adoptive parents. *Journal of Family Psychology*, 22, 529–540. doi: 10.1037/a0012817 [PubMed: 18729667]
- Gerstadt CL, Hong Y, & Diamond A (1994). The relationship between cognition and action: Performance of children 3½–7 years old on a Stroop-like day–night test. *Cognition*, 53, 129–153. [PubMed: 7805351]
- Glover MB, Mullineaux PY, Deater-Deckard K, & Petrill SA (2010). Parents' feelings towards their adoptive and non-adoptive children. *Infant and Child Development*, 19(3), 238–251. [PubMed: 21088705]
- Goldsmith HH, & Rothbart MK (1996). *The Laboratory Temperament Assessment Battery*. Prelocomotor (Version 3.0). Unpublished manuscript.
- Greene W (1997). Marginal effects in the censored regression model. *Economics Letters*, 64, 43–49. doi: 10.1016/S0165-1765(99)00059-2
- Harman C, Rothbart MK, & Posner MI (1997). Distress and attention interactions in early infancy. *Motivation and Emotion*, 21, 27–43.
- Hayes AF (2017). Introduction to mediation, moderation, and conditional process analysis, second edition: A regression-based approach. New York, NY: Guilford Press.
- Hendry A, Jones EJH, & Charman T (2016). Executive function in the first three years of life: Precursors, predictors and patterns. *Developmental Review*, 42, 1–33. doi:10.1016/j.dr.2016.06.005
- Henningsen A (2011). censReg: Censored regression (tobit) models. R package (Version 0.5). <http://CRAN.R-project.org/package=censReg>.
- Henry LA, & Bettenay C (2010). The assessment of executive functioning in children. *Child and Adolescent Mental Health*, 15, 110–119. doi:10.1111/j.1475-3588.2010.00557.x
- Holmboe K, Bonneville-Roussy A, Csibra G, & Johnson MH (2018). Longitudinal development of attention and inhibitory control during the first year of life. *Developmental Science*. Advance online. doi:10.1111/desc.12690
- Huijbregts SCJ, Warren AJ, de Sonnevile LMJ, & Swaab-Barneveld H (2008). Hot and cool forms of inhibitory control and externalizing behavior in children of mothers who smoked during pregnancy: An exploratory study. *Journal of Abnormal Child Psychology*, 36, 323–333. doi: 10.1007/s10802-007-9180-x [PubMed: 17924184]
- Huizinga M, Dolan CV, & van der Molen MW (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, 44, 2017–2036. doi: 10.1016/j.neuropsychologia.2006.01.010 [PubMed: 16527316]
- Johansson M, Marciszko C, Gredebäck G, Nyström P, & Bohlin G (2015). Sustained attention in infancy as a longitudinal predictor of self-regulatory functions. *Infant Behavior and Development*, 41, 1–11. doi: 10.1016/j.infbeh.2015.07.001 [PubMed: 26241679]
- Kiff CJ, Lengua L, & Zalewski M (2011). Nature and nurturing: Parenting in the context of child temperament. *Clinical Child and Family Psychology Review* 14(3), 251–301. doi: 10.1007/s10567-011-0093-4 [PubMed: 21461681]
- Kim JM, & Mahoney G (2004). The effects of mother's style of interaction on children's engagement: Implications for using responsive interventions with parents. *Topics in Early Childhood Special Education* 24(1), 31–38. doi: 10.1177/02711214040240010301
- Kleiber C, & Zeileis A (2008). *Applied econometrics with R*. New York, NY: Springer-Verlag.
- Kochanska G, Murray KT, & Harlan ET (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology*, 36, 220–232. doi: 10.1037/0012-1649.36.2.220 [PubMed: 10749079]
- Kopp CB, & Neufeld SJ (2003). Emotional development during infancy In Davidson RJ, Scherer KR, & Goldsmith HH (Eds.), *Handbook of affective sciences* (pp. 347–374). New York, NY: Oxford University Press.

- Kotelnikova Y, Olino TM, Klein DN, Kryski KR, & Hayden EP (2016). Higher- and lower-order factor analyses of the Children's Behavior Questionnaire in early and middle childhood. *Psychological Assessment*, 28, 92–108. doi:10.1037/pas0000153 [PubMed: 26029946]
- Kotelnikova Y, Olino TM, Klein DN, Mackrell SVM, & Hayden EP (2017). Higher and lower order factor analyses of the temperament in middle childhood questionnaire. *Assessment*, 24, 1050–1061. doi:10.1177/1073191116639376 [PubMed: 27002124]
- Landry SH, Smith KE, & Swank PR (2006). Responsive parenting: Establishing early foundations for social, communication, and independent problem-solving skills. *Developmental Psychology*, 42(4), 627–642. doi: 10.1037/0012-1649.42.4.627 [PubMed: 16802896]
- Landry SH, Smith KE, Swank PR, & Guttentag C (2008). A responsive parenting intervention: The optimal timing across early childhood for impacting maternal behaviors and child outcomes. *Developmental Psychology*, 44(5), 1335–1353. doi:10.1037/a0013030 [PubMed: 18793067]
- Lehto JE, Juujärvi P, Kooistra L, & Pulkkinen L (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology*, 21, 59–80. doi: 10.1348/026151003321164627
- Leve LD, Kerr DC, Shaw D, Ge X, Neiderhiser JM, Scaramella LV, ... Reiss D (2010). Infant pathways to externalizing behavior: Evidence of Genotype × Environment interaction. *Child Development*, 81, 340–356. doi:10.1111/j.1467-8624.2009.01398.x [PubMed: 20331671]
- Leve LD, Neiderhiser JM, Shaw DS, Ganiban J, Natsuaki MN, & Reiss D (2013). The Early Growth and Development Study: A prospective adoption study from birth through middle childhood. *Twin Research and Human Genetics*, 16, 412–423. doi: 10.1017/thg.2012.126 [PubMed: 23218244]
- Lipscomb ST, Leve LD, Shaw DS, Neiderhiser JM, Scaramella LV, Ge X, & Reiss D (2013). Negative emotionality and externalizing problems in toddlerhood: Overreactive parenting as a moderator of genetic influences. *Development and Psychopathology*, 24, 167–179. doi: 10.1017/S0954579411000757
- Little RJA (1988). Little's test of missing completely at random. *Journal of American Statistical Association*, 83(404), 1198–1202.
- Macdonald JA, Beauchamp MH, Crigan JA, & Anderson PJ (2014) Age-related differences in inhibitory control in the early school years. *Child Neuropsychology*, 20, 509–526. doi: 10.1080/09297049.2013.822060 [PubMed: 23909718]
- MacLeod CM (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, 109(2), 163–203. doi: 10.1037/0033-2909.109.2.163 [PubMed: 2034749]
- Marceau K, De Araujo-Greecher M, Miller ES, & Massey SH (2016). The perinatal risk index: Early risks experienced by domestic adoptees in the United States, *PloS One*, 11 Advance online. doi: 10.1371/journal.pone.0150486
- McDonnell CG, & Valentino K (2017). Maternal warmth In *SAGE encyclopedia of abnormal and clinical psychology* (pp. 2057–2061). Thousand Oaks, CA: SAGE Publications. doi:10.4135/9781483365817.n826
- McNeil TF, & Sjöström K (1995). The McNeil-Sjöström scale for obstetric complications. Malmö, Sweden: Lund University, Department of Psychiatry, University Hospital.
- Melby JN, & Conger RD (2001). The Iowa family interaction rating scales: Instrument summary In Kerig JK & Lindhal JM (Eds.), *Family observational coding systems: Resources for systemic research* (pp. 33–58). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.
- Mills-Koonce WR, Willoughby MT, Zvara B, Barnett M, Gustafsson H, & Cox MJ (2015). Mothers' and fathers' sensitivity and children's cognitive development in low-income, rural families. *Journal of Applied Developmental Psychology*, 38 Advance online. doi:10.1016/j.appdev.2015.01.001
- Montgomery DE, & Koeltzow TE (2010). A review of the day–night task: The Stroop paradigm and interference control in young children. *Developmental Review*, 30(3), 308–330. doi: 10.1016/j.dr.2010.07.001
- Posner MI, & Rothbart MK (2007). Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology*, 58, 1–23. doi: 10.1146/annurev.psych.58.110405.085516

- Putnam SP, Helbig AL, Gartstein MA, Rothbart MK, & Leerkes E (2014). Development and assessment of short and very short forms of the Infant Behavior Questionnaire-Revised. *Journal of Personality Assessment*, 96, 445–458. doi: 10.1080/00223891.2013.841171 [PubMed: 24206185]
- Reck SG, & Hund AM (2011). Sustained attention and age predict inhibitory control during early childhood. *Journal of Experimental Child Psychology*, 108, 504–512. doi: 10.1016/j.jecp.2010.07.010 [PubMed: 20801457]
- Reiss D, Leve LD, & Neiderhiser JM (2013). How genes and the social environment moderate each other. *American Journal of Public Health*, 103, S111–S121. doi: 10.2105/AJPH.2013.301408 [PubMed: 23927504]
- Reuben JD, Shaw DS, Neiderhiser JM, Natsuaki MN, Reiss D, & Leve LD (2016). Warm parenting and effortful control in toddlerhood: Independent and interactive predictors of school-age externalizing behavior. *Journal of Abnormal Child Psychology*, 44, 1083–1096. doi: 10.1007/s10802-015-0096-6 [PubMed: 26496906]
- Rothbart MK (1981). Measurement of temperament in infancy. *Child Development*, 52, 569–578.
- Rothbart MK, Ziaie H, & O'Boyle C (1992). Self-regulation and emotion in infancy In Eisenberg N, & Fabes RA (Eds.), *Emotion and its regulation in early development* (pp. 7–23). San Francisco, CA: Jossey-Bass/Pfeiffer.
- Sanford K (2010). Assessing conflict communication in couples: Comparing the validity of self-report, partner-report, and observer ratings. *Journal of Family Psychology*, 24(2), 165–174. doi: 10.1037/a00179553 [PubMed: 20438192]
- Shanahan MJ, & Hofer SM (2005). Social context in gene--environment interactions: Retrospect and prospect. *Journals of Gerontology: Series B: Psychological Sciences and Social Sciences*, 60B(1, Special Issue), 65–76. doi: 10.1093/geronb/60.Special_Issue_1.65
- Sinzig J, Morsch D, Bruning N, Schmidt MH, & Lehmkuhl G (2008). Inhibition, flexibility, working memory and planning in autism spectrum disorders with and without comorbid ADHD-symptoms. *Child and Adolescent Psychiatry and Mental Health*, 2, 1–12. doi: 10.1186/1753-2000-2-4 [PubMed: 18197978]
- Spruijt AM, Dekker MC, Ziermans TB, & Swaab H (2018). Attentional control and executive functioning in school-aged children: Linking self-regulation and parenting strategies. *Journal of Experimental Child Psychology*, 166, 340–359. doi:10.1016/j.jecp.2017.09.004 [PubMed: 29024846]
- Stroop JR (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18, 643–662. doi: 10.1037/h0054651
- Swingler MM, Perry NB, Calkins SD, & Bell MA (2014). Maternal sensitivity and infant response to frustration: The moderating role of EEG asymmetry. *Infant Behavior and Development*, 37, 523–535. doi: 10.1016/j.infbeh.2014.06.010 [PubMed: 25038524]
- Toupin J, Dery M, Pauze R, Mercier H, & Fortin L (2000). Cognitive and familial contributions to conduct disorder in children. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 41, 333–344. doi: 10.1111/1469-7610.00617
- Vernon-Feagans L, Willoughby M, & Garrett-Peters P (2016). Predictors of behavioral regulation in kindergarten: Household chaos, parenting, and early executive functions. *Developmental Psychology*, 52(3), 430–441. doi: 10.1037/dev0000087 [PubMed: 26751500]
- Wang FL, Eisenberg N, & Spinrad TL (2018). Bifactor model of effortful control and impulsivity and their prospective prediction of ego resiliency. *Journal of Personality*. Advance online. doi:10.1111/jopy.12444

Highlights

- The study examined associations between infant attention control, maternal warmth, and children's inhibitory control.
- Using a parent-child adoption design, we found that maternal warmth moderated the association between infant attention control and school-age inhibitory control.
- Children with early risk for inhibitory control deficits may benefit from parental involvement in interventions that facilitate high maternal warmth during toddlerhood.

Figure 1.

MW = maternal warmth. Lower limit of chart is at approximately two standard deviations below the mean on child inhibitory control, upper limit is set at the maximum limit.

Moderation effects are modeled without censoring to provide meaningful interpretation.

Table 1

Intercorrelations Between Study Variables

Variable	M	SD	1	2	3	4	5	6	7
Outcome									
1. Child IC (6 yrs)	0.88	0.21							
Predictor									
2. Infant AC (9 mo)	0.32	0.16	.19**						
Moderator									
3. Maternal warmth (27 mo)	25.19	3.17	.19**	.02					
Covariates									
4. Birth parent IC	0.95	0.05	-.01	-.01	.07				
5. Child sex	–	–	.12*	.11*	.09	-.05			
6. Distress to limitations	3.13	0.76	.09	.02	-.07	.01	-.05		
7. Openness of adoption	0.04	0.93	.01	-.11*	-.07	.12*	-.08	.10	
8. Prenatal risk	13.98	10.57	.02	.02	-.03	-.05	.04	-.07	.03

Note. IC = inhibitory control, AC = attention control

* $p < .05$

** $p < .01$

Table 2*Multiple Tobit Regression of Infant AC at 9 Months on Child IC at Age 6 Years (n = 235)*

Source	Tobit model		Marginal effects	
	Estimate	SE	Estimate	SE
Child sex	0.12 *	0.06	0.05 *	0.02
Openness of adoption	0.01	0.03	0.01	0.01
Distress to limitations	0.06 ^	0.04	0.03 ^	0.02
Birth parent IC	-0.01	0.01	-0.01	0.01
Prenatal risk	0.01	0.01	0.01	0.01
Infant AC	0.44 *	0.18	0.19 *	0.08
Log (scale)	-1.00 *	0.08		
Log-likelihood	-124.46	6 df		
Right-censored observations	131			

Note. IC = inhibitory control, AC = attention control

^
p < .10

*
p < .05

Table 3

Multiple Tobit Regression of Interaction Between Infant AC at 9 Months by Adoptive Mother Warmth at 27 Months on Child IC at Age 6 years (n = 210)

Source	Tobit model		Marginal effects	
	Estimate	SE	Estimate	SE
Child sex	0.09	0.06	0.04	0.03
Openness of adoption	0.01	0.03	0.01	0.01
Distress to limitations	0.06	0.04	0.03	0.02
Birth parent IC	−0.01	0.01	0.00	0.00
Prenatal risk	0.01	0.01	0.01	0.01
Infant AC	0.32 [^]	0.18	0.14 [^]	0.08
Adoptive maternal warmth	0.14 [^]	0.08	0.06 [^]	0.03
Infant Attention × Maternal Warmth	−1.30 ^{**}	0.50	−0.57 [*]	0.22
Log sigma	−1.04 ^{**}	0.08		
Log-likelihood	−108.36	10 <i>df</i>		
Right-censored observations	114			

Note. IC = inhibitory control, AC = attention control

[^]
 $p < .10$

^{*}
 $p < .05$

^{**}
 $p < .001$