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Understanding the Parent-Child Coregulation Patterns Shaping Child Self-Regulation

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Abstract

Parent-child coregulation, thought to support children's burgeoning regulatory capacities, is the process by which parents and their children regulate one another through their goal-oriented behavior and expressed affect. Two particular coregulation patterns—dyadic contingency and dyadic flexibility—appear beneficial in early childhood, but their role in the typical development of self-regulation is not yet clear. The present study examined whether dynamic parent-child patterns of dyadic contingency and dyadic flexibility in both affect and goal-oriented behavior (e.g., discipline, compliance) predicted multiple components of preschoolers' self-regulation. Mother-child dyads ($N = 100$) completed structured and unstructured dyadic tasks in the laboratory at age 3, and mothers completed child self-regulation measures at age 4. Findings showed that more flexible and contingent affective parent-child processes, as long as the affective content was primarily positive or neutral, predicted higher levels of self-regulation in early childhood. However, when dyads engaged in more negative affective and behavioral content, higher levels of affective and behavioral contingency and behavioral flexibility predicted lower levels of child self-regulation. Findings suggest parent-child coregulation processes play a meaningful role in children's typical regulatory development and that parent-child coregulation patterns can be potentially adaptive or maladaptive for child outcomes depending on the content of the interaction.

Keywords

parent-child coregulation; flexibility; contingency; synchrony; self-regulation

In early childhood, preschoolers are asked to manage their emotions and behaviors appropriately in accordance with the bids of caregivers and teachers. Self-regulation reflects such self-management in response to situational demands (Kopp, 1982). Various components of self-regulation emerge in early childhood, such as temperament-based effortful control (Eisenberg, Smith, Sadovsky, & Spinrad, 2004) and inhibitory control (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996), emotion regulation (Calkins, 1994), and behavioral regulation (e.g., compliance; Kopp, 1982). These self-regulation components are positively associated with other major markers of successful development

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such as school readiness (Raver et al., 2011), and better self-regulation promotes improved socioemotional functioning across the life span (Diamond & Aspinwall, 2003).

Given that self-regulation underlies individual differences in key competencies for young children, the study of antecedent processes that promote preschoolers' self-regulation is necessary to inform etiology and intervention. *Parent-child coregulation* is a strong candidate as a process that supports self-regulation in early childhood because it reflects the moment-to-moment coordination of goal-oriented behaviors and expressed affect between parent and child (Calkins, 2011; Lunkenheimer, Kemp, Lucas-Thompson, Cole, & Albrecht, 2017). Starting in infancy, parents establish behavioral and affective patterns with their children that provide external regulation for children who cannot fully regulate themselves (Feldman, 2007). Better-coordinated exchanges are thought to directly support young children's emotional, behavioral, and physiological regulation (Feldman, 2007). As children age, coregulation processes introduce them to increasingly complex experiences, offer them opportunities to practice self-regulation in a relational context, and model patterns that are eventually internalized as regulatory skills (Lunkenheimer et al., 2017). However, the field lacks systematic empirical study of how these parent-child coregulation processes contribute to typical self-regulatory development in early childhood. The present study explored two types of affective and behavioral coregulation—dyadic contingency and dyadic flexibility—to better understand the processes by which preschoolers' regulatory skills are socialized in the parent-child relationship.

Dyadic Contingency in Parent-Child Interactions

Dynamic systems (DS) theory suggests the parent-child relationship can be considered a dynamic system that self-organizes into predictable behavioral, emotional, and physiological patterns that serve a function for the system (Lunkenheimer, Olson, Hollenstein, Sameroff, & Winter, 2011). Arguably, when patterns are more predictable, they foster the homeostatic rhythms upon which self-regulation processes are built (Feldman, 2007). This predictability is often operationalized as *contingency* in interpersonal interactions, or the predictable and consistent pairing via a temporally dependent sequence (i.e., lead-lag relations) of parent and child expressed affect and behavior during the course of face-to-face interactions (Harrist & Waugh, 2002). For example, a toddler may be happily playing until she encounters a box she cannot open containing a toy. In response to her frustration, her parent might help her, attempting to offer a solution or soothe her negative affect. Consistent parental responsiveness to her emotional cues may teach the child that she can reliably trust her parent to provide support, building her sense of autonomy in the relationship as well as her emotion regulation skills (Harrist & Waugh, 2002; Sameroff, 2010).

The study of contingency in early parent-child interactions is closely related to the study of synchrony between parent and infant. Feldman (2007) referred to *synchrony* as a process of sensory, hormonal, physiological, and social coordination between parent and infant (e.g., temporal coordination of gaze, attention, vocalization, touch, and affect) that provides external regulation for salient needs such as hunger, arousal, and attachment in the infant. Synchrony involves close temporal coordination or simultaneous occurrence of parent and child behavior (Feldman, 2007). Beyond infancy, children serve as more active agents in the coregulation process. The term "positive synchrony" has been used to describe parent-child interactions in early childhood that are harmonious, reciprocal, and mutually responsive, whereas "negative synchrony" has been used to reflect mutual orientations around negative emotions or behaviors (Harrist & Waugh, 2002). Higher parent-child positive synchrony tends to be associated with better child self-regulation (Kochanska, Aksan, Prisco, & Adams, 2008), whereas negative synchrony has been linked to children's dysregulated behavior (Harrist, Pettit, Dodge, & Bates, 1994). Though the synchrony literature is informative, it often does not address which *specific* behavioral contingencies are salient for child development or whether the parent or child is driving the exchange.

Contingency analyses can elucidate which lead-lag relations and behavioral sequences are particularly salient for development. They also address the predictability of parents' and children's behaviors toward one another. In terms of self-regulation, consistent child responsiveness to parental socialization is thought to reflect the child's willingness to attend to situational demands and the degree to which predictable parent-child interactions induce stability in the child's developing regulatory skills (Kochanska, Forman, Aksan, & Dunbar, 2005; Kopp, 1982). Maternal autonomy support that involves guiding children through a task (Eisenberg et al., 2010) and proactively structuring their engagement (Landry, Smith, Swank, & Miller-Loncar, 2000) is thought to encourage children's contingent compliant and autonomous behavior. For example, stronger contingencies between maternal autonomy support and child compliance or persistence are positively related to behavioral regulation (Lunkenheimer, Kemp, & Albrecht, 2013; Lunkenheimer, Ram, Skowron, & Yin, 2017). In contrast, contingencies between coercive parenting and child non-compliance are positively associated with children's behavioral dysregulation (Dumas, Lemay, & Dauwalder, 2001). This evidence suggests that parent-child behavioral contingencies are formative in early childhood, particularly for behavioral regulation, but more research is needed to understand their role in normative self-regulatory development.

Contingencies are often examined with regard to goal-directed behavior (e.g., discipline and compliance), but parents and children may also respond contingently to each other's affective expressions (Cole, Teti, & Zahn-Waxler, 2003). Related work suggests that synchrony around positive affect is positively associated with children's self-regulation and other socioemotional outcomes (Lindsey, Cremeens, Colwell, & Caldera, 2009). Conversely, when parent-child dyads engage in more contingent negative affect, it is associated with poorer self-regulation (Cole et al., 2003). This work suggests that dyadic affective contingency could be important for socioemotional development and self-regulation in early childhood, but further research is needed.

Dyadic Flexibility in Parent-Child Interactions

Dyadic flexibility reflects the degree of variability in affective or behavioral states during parent-child interactions and is often operationalized as the number of transitions made among defined dyadic affective or behavioral states or the overall repertoire of such states used by the dyad (Granic, Meusel, Lamm, Woltering, & Lewis, 2012). The ability of the dyad to flexibly transition across a range of states is indicative of how well they adjust to changing interpersonal demands, as well as the range of behaviors or strategies they can draw upon during interpersonal interaction (Granic et al., 2012). Greater dyadic flexibility may allow preschoolers to enter more affective or behavioral states and make use of them as opportunities to learn or practice affective or behavioral regulation in response to real-time demands, particularly with appropriate parental scaffolding (Lunkenheimer et al., 2011).

Prior research largely emphasizes the influence of dyadic *affective* flexibility on children's outcomes. In particular, lower parent-child affective flexibility, often called dyadic rigidity, is related to children's higher levels of externalizing behaviors (Hollenstein, Granic, Stoolmiller, & Snyder, 2004) and the persistence of externalizing problems even after clinical treatment (Granic, O'Hara, Pepler, & Lewis, 2007). This dyadic rigidity reflects a smaller dyadic affective repertoire, fewer transitions across affective states, and/or the tendency to get stuck in particular states—often negative affective states (Hollenstein et al., 2004). Dyadic rigidity may limit parents' and children's opportunities for effectively regulating transitions between affective states and could signify that the dyad is stuck in negative affective states thought to be detrimental or dysregulating for the child.

In terms of *goal-directed behavior*, the parenting literature emphasizes the importance of parents flexibly responding to children's needs. Grusec, Goodnow, and Kuczynski (2000) have argued that effective parenting constitutes having knowledge of the child's characteristics and responses to situational demands and then flexibly choosing a response accordingly. Parental responsiveness to the child's cues is an important predictor of children's self-regulation (Kochanska et al., 2008); however, it should also be noted that inconsistent limit setting and discipline are maladaptive for children (Lengua, 2008). This research suggests that variability in parents' responses to children may reflect either effortful flexibility or inconsistency, depending on the behavioral content of the interaction. At the dyadic level, Lunkenheimer, Hollenstein, Wang, and Shields (2012) found that greater flexibility in emotion-socialization behaviors and discrete emotional states was associated with better emotion regulation in children, particularly during challenging conversation topics. Thus, dyadic behavioral flexibility occurring in the service of adaptively socializing the child may also support children's typical regulatory development.

The Importance of Interaction Content

Despite research suggesting that dyadic contingency and dyadic flexibility may support children's self-regulation, gaps remain in the literature regarding how interaction content may shape the effects of coregulatory processes. For example, if the parent and child have a generally poor relationship, or when interactions are characterized by predominantly negative words or actions, the predictable nature of dyadic contingency may confer harm instead of benefits (Harrist & Waugh, 2002). For example, parent-child coercion, characterized by negative contingencies, is positively associated with children's behavioral dysregulation (Dumas et al., 2001; Smith et al., 2014). Researchers have also argued there may be an optimal level of dyadic flexibility and that too much variability could be maladaptive for child outcomes: For example, in a clinical population, dyadic affective flexibility was positively associated with preschoolers' hyperactive/impulsive behavior through its negative effects on inhibitory control (Busuito & Moore, 2017; van Dijk et al., 2017). Additionally, greater dyadic affective flexibility paired with higher levels of dyadic positive affect has been shown to be beneficial for children's behavioral regulation, as compared to flexibility alone (Lunkenheimer et al., 2011). Accordingly, it is important to investigate how interaction content (i.e., positive or negative) interacts with dynamic patterns of dyadic contingency or dyadic flexibility to shape children's self-regulation.

The Present Study

The aim of this study was to understand how the observed coregulation of affect and goal-directed behavior between mother and child influenced self-regulation in early childhood. Primary research questions were to (a) investigate the effects of mother–child dyadic contingency (affective and behavioral) and dyadic flexibility (affective and behavioral) at age 3 years on multiple indicators of children's self-regulation at age 4 years (i.e., task persistence, social persistence, emotional lability/negativity, and inhibitory control); (b) across these four models (affective contingency, behavioral contingency, affective flexibility, and behavioral flexibility), consider whether the effects of affective versus behavioral coregulation and contingent versus flexible coregulation were similar or different in how they impacted children's self-regulation; and (c) examine these processes taking interaction content into account—that is, (a) evaluating whether the degree of positive versus negative interaction content moderated the effects of dyadic contingency and flexibility within the model and (b) including covariates of observed, cross-domain individual maternal behaviors that could shape the content or tone of the interaction (i.e., accounting for maternal affect in dyadic behavioral models and accounting for maternal goal-directed behavior in dyadic affective models). Utilizing DS methodology, dynamic, real-time measures of mother and child affect and behavior were calculated to reflect indicators of dyadic contingency and dyadic flexibility in mother-child interactions.

Method

Participants

Participants were 100 children (54% female) and their mothers recruited for a study on parent-child coregulation. The children were 3 years old at Time 1 (T1; *M* = 41 months, *SD* = 3 months) and 4 years old at Time 2 (T2; *M* = 45 months, *SD* = 3 months). Parents reported that 86% of the children were Caucasian, 8% Biracial, 3% Asian, and 3% unknown or "Other." Ten percent of the participants identified as Hispanic or Latinx. Of parents, 79% were married, 7% were cohabiting, 7% were single parents, 5% were separated or divorced, and 1% were remarried. Median annual family income was $65,000, and on average, parents were college graduates. Participants were recruited through agencies serving families with young children and flyers posted in preschools, day care centers, and other businesses. Families were excluded if parents could not read or speak in English, if the child was diagnosed with a developmental disorder, or if mother or child had a heart condition that could interfere with physiological data collection.

Procedure

At T1, mother-child dyads completed a 2-hr laboratory visit. While mothers filled out questionnaires about their child's behaviors, children performed cognitive and behavioral assessments with an experimenter. Mother-child dyads also participated in multiple dyadic tasks (described next). Families were compensated $50. At T2, mothers filled out online surveys on children's regulatory behaviors and were compensated with a $20 gift card to a local store. All study materials and protocols were approved by the institutional review board at The Pennsylvania State University for the study "Parent-Child Coregulation of Behavior, Emotion, and Physiology in Early Childhood," Protocol STUDY00009844.

Measures

Videotaped parent-child interaction tasks.—At the T1 lab visit, mother-child dyads completed three tasks: a free play task, a clean-up task, and the Parent-Child Challenge Task (PCCT; Lunkenheimer et al., 2017). During the 7-minute free play, dyads played with a variety of toys. Next, mothers were asked to guide their children to clean up the toys without physically helping during the 4-minute clean-up task. Finally, the dyad completed the 7-minute PCCT, during which mothers helped their children physically recreate three 3D wooden puzzles that escalated in difficulty, using designs from a guidebook. The task demands were above the cognitive abilities of preschoolers and required parental guidance for task completion. Please see Lunkenheimer et al. (2017) for more details on the PCCT design and procedures.

We used data from all three dyadic tasks to account for interaction dynamics across both unstructured and structured tasks with varying levels of challenge. Using a validated dyadic parent-child interaction coding system (Lunkenheimer, 2009), we coded parent and child affect and behavior continuously in real time with Noldus Observer 8.0 XT. Tasks were time limited, and affect and goal-directed behavior were coded in separate streams with mutually exclusive codes. Graduate and undergraduate student coders were trained by the coding system developer, and reliability was computed on 20% of the data using a standard 3-s window for convergence. Drift reliability was also calculated to ensure consistency of coding over time.

Affect coding.—Affect was coded based on observable vocal tone, facial expressions, and body movements. There were four mutually exclusive codes for parent and child verbal and nonverbal affect based on valence and intensity of expression: medium-high positive, low positive, neutral, and negative. Positive affect was characterized by positive fluctuations in vocal tone, smiles, laughing, a sing-song tone, warm eye contact, and body movements indicating warmth, affection, or happiness (e.g., hugs). Negative affect referred to narrowed or rolled eyes, frowns, sounds of exasperation or irritation, mocking, or nervous, repetitive movements reflective of distress or anxiety. Though codes for parent and child were the same, their intensity was coded based on developmentally appropriate behaviors (e.g., medium-high positive affect might involve excited shouting for children, whereas it might involve a higher-pitched, sing-song tone for parents). Three coders were tested for reliability on 20% of the data set in comparison to coding by the coding system developer and a trained graduate student. Average interrater agreement ranged from 90–94% for parent affect and from 87–94% for child affect, based on a standard 3-s window in Noldus Observer 8.0. For more details on all the codes, see Appendix, Lunkenheimer (2009), and Lunkenheimer et al. (2017). All codes were utilized to extract the measure of dyadic affective flexibility.

However, due to the low base rate at the extremes for affect, the codes for medium-high and low positive affect were combined to create overall scores for maternal positive affect (91% interrater agreement) and child positive affect (89% interrater agreement) for the measure of affective contingency. In addition to the dyadic affective patterns that were the main focus of the study, affect coding was also used to generate individual frequencies of maternal overall positive and negative affect (92% interrater agreement), used as covariates in the behavioral models.

Goal-directed behavior coding.—To represent goal-directed behavior, nine mutually exclusive parent behaviors (directives, teaching, proactive structure, positive reinforcement, emotional support, engagement, disengagement, intrusion, and negative discipline) and seven mutually exclusive child behaviors (compliance, persistence, noncompliance, disengagement, behavioral dys-regulation, social conversation, and solitary/parallel play) were coded. Average interrater agreement ranged from 80–93% for parent behavior codes and from 76–94% for child behavior codes, based on a standard 3-s window in Noldus Observer 8.0. For more details, please see Appendix, Lunkenheimer (2009), and Lunkenheimer et al. (2017).

All behavioral codes were utilized to extract the measure of dyadic behavioral flexibility (i.e., flexibility across the entire range of behaviors observed). However, only maternal teaching, proactive structure, and child compliance were used for the purposes of calculating dyadic behavioral contingency (i.e., contingencies between specific behaviors of interest). Maternal teaching and proactive structure were aggregated to create a *maternal autonomy support* code. Teaching statements involved parent explanation, instruction, or questions that encouraged the child to be involved in the task or learn for himself. Proactive structure involved child-centered parenting behaviors that encouraged the child's independent efforts, such as offering the child two options to choose from. *Child compliance* reflected instances when a child responded appropriately to a parent's bids or engaged in on-task behavior. Finally, as with affect coding, behavioral coding was also used to generate individual frequencies of maternal autonomy support and directives that were used as covariates in the affective models. *Maternal directives* were clear commands for specific behavioral changes from the child. Average interrater agreement was 82% for maternal autonomy support, 86% for maternal directives, and 85% for children's compliance.

Dyadic contingencies.—We used state lag sequential analyses to assess contingency as the likelihood that a criterion behavior (e.g., maternal positive affect) was directly followed by a target behavior (e.g., child positive affect) over the course of parent-child interaction. All contingencies of interest in this study were sequences of a maternal socialization behavior followed by the child's response. We allowed the interval between the onset of the mother's behavior and the onset of the child's target behavior to vary to accommodate differences in the speed of children's responses. We computed transitional probabilities for our affective (maternal positive affect→child positive affect) and behavioral (maternal autonomy support→child compliance) dyadic contingencies in Noldus Observer XT 13.0 and averaged them across all dyadic tasks. Higher probabilities indicated a stronger contingency between the respective behaviors of interest.

Dyadic flexibility.—State space grids (SSGs; Lewis, Lamey, & Douglas, 1999) were utilized to plot the time series of parent and child behavior and affect for each task. We created a 4 × 4 SSG for affect (i.e., medium-high positive, low positive, neutral, and negative affect for parent and child) and a 9 × 7 SSG for behavior (i.e., the nine parent behavior codes and seven child behavior codes described above). Each cell represented a particular combination of a parent and child affective or behavioral state, respectively. Trajectories of dyadic states were plotted using GridWare Version 1.15 (Lamey, Hollenstein, Lewis, & Granic, 2004). *Flexibility* was operationalized as the rate of transitions per minute, calculated by dividing the total number of transitions made from cell to cell across all dyadic tasks by the length of the total interaction in minutes. Higher flexibility was exhibited by a higher rate of transitions.

Positive and neutral (PN) interaction content.—We extracted and standardized the duration that each dyad spent in combined PN affective states from our affect SSGs as a measure of PN affective content. Additionally, we extracted and standardized the duration each dyad spent in combined PN behavioral states from our behavior SSGs as a measure of PN behavioral content. Since task times were fixed and affect and behavior codes were mutually exclusive, lower PN content was the equivalent of higher negative content.

Children's self-regulation.—Effortful control is considered a measure of children's temperament-based regulation (Eisenberg et al., 2004); observed effortful control was used to control for children's baseline self-regulation skills at T1. Self-regulation outcomes at T2 included mothers' reports of their children's task persistence, social persistence, emotional lability/negativity, and inhibitory control. We describe these respective measures next.

Effortful control.: We used two tasks from Kochanska and colleagues' (1996) effortful control battery. In the tower task, children took turns with the experimenter to build a tower using 20 blocks. The proportion of blocks placed by the experimenter was the index of effortful control. In the lab gift task, the child was asked to refrain from peeking while the experimenter wrapped a gift and refrain from touching the gift while the experimenter was out of the room; we coded peeking and touch behaviors (e.g., touches, lifts, fully opens the gift). Scores from both tasks were standardized and averaged for an overall effortful control score (Cronbach's alpha = .81).

Task and social persistence.: We used the Dimensions of Mastery Questionnaire (Morgan, Busch-Rossnagel, Barrett, & Wang, 2009) to assess maternal perception of children's persistence during problem-solving tasks and social interactions. Mothers responded on a scale from 1 (*not at all typical*) to 5 (*very typical*), with higher scores reflecting greater persistence. The nine-item task persistence subscale (α = .92) included items such as "Tries to complete tasks, even if it takes a long time to finish." The six-item social persistence with adults subscale (α = .85) included items such as "Enjoys talking with adults and tries to keep them interested." Item responses were averaged to calculate mean task and social persistence scores, respectively.

Emotional lability/negativity.: The Emotion Regulation Checklist (Shields & Cicchetti, 1997) assesses children's abilities to manage their emotions. The 15-item lability/negativity subscale (α = .77) captured the child's dysregulated negative affect and mood lability (e.g., "Exhibits wide mood swings") on a scale from 1 (*never*) to 4 (*always*). Responses were summed such that scores ranged from 15 to 60, with lower scores reflecting better emotion regulation.

Inhibitory control.: The 13-item inhibitory control subscale (α = .79) of the Child Behavior Questionnaire (Rothbart, Ahadi, & Hershey, 1994) includes items such as "Can easily stop an activity when s/he is told no." Mothers responded to the items on a scale from 1 (*extremely untrue*) to 7 (*extremely true*). Item responses were averaged to calculate a mean inhibitory control score, with higher scores reflecting higher inhibitory control.

Cognitive abilities.—Block design subtest scores from the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 2002) were utilized as a measure of children's cognitive ability and controlled for in all analyses. This subtest examined spatial reasoning: children assembled multicolored blocks to replicate increasingly complex patterns given to them by the experimenter. Scores were calculated according to national norms based on the number of block designs correctly reproduced by the child.

Analytic Plan

For primary analyses, we used RStudio Version 1.1.383 (RStudio Team, 2009–2019) to run four structural equation models—affective contingency, behavioral contingency, affective flexibility, and behavioral flexibility models. Within these models, we also investigated whether PN interaction content moderated the association between contingency/flexibility at T1 and children's self-regulation at T2 by including a corresponding interaction term. In all models, child sex, child cognitive abilities, and effortful control at T1 were included as covariates. Additionally, we controlled for the frequency of maternal directives and autonomy support in the affect models and the frequency of maternal positive and negative affect in the behavior models to account for the influence of individual maternal affect and behavior during the interaction.

Of our sample of 100 families, 91 had complete dyadic data, 87 had complete survey data, and 79 had complete dyadic and survey data. Data was missing completely at random according to Little's (1988) test, $\chi^2(127) = 135.73$, $p = .28$. To handle missing data, a full information maximum likelihood approach was used on the full sample to estimate each parameter using all available data for that parameter. Robust maximum likelihood was used as the estimator to account for the skew of any manifest variables. Model fit was evaluated using chi square, the comparative fit index (CFI), and the Tucker-Lewis index (TLI), where a CFI and TLI of .95 and above indicates good model fit (Hu & Bentler, 1999), and the root-mean-square error of approximation (RMSEA) and the standardized root-mean-square residual (SRMR), for which acceptable values fall below .06 and .08, respectively (Hu & Bentler, 1999).

Results

Preliminary Analyses

Table 1 displays descriptive statistics for the study variables. Assumptions of normality were met for all predictors except for maternal negative affect and dyadic affective contingency, to which log transformations were applied to correct for their positive skew, and children's cognitive abilities, which was only slightly negatively skewed and left untransformed. Exploration of sociodemographic factors revealed that income and race were unrelated to coregulation patterns or child self-regulation. Child age was modestly negatively associated with behavioral flexibility, $r(89) = -.25$, $p = .02$, but was unrelated to other variables and, thus, was excluded from analyses. Child sex was included as a covariate due to differences in self-regulation by child sex in the literature (Matthews, Ponitz, & Morrison, 2009). In this sample, the contingency between maternal autonomy support and child compliance was weaker with boys than with girls, $t(96) = -.27$, $p = .01$.

Table 2 shows bivariate correlations among coregulation predictors, covariates, and self-regulation outcomes. Unlike affective and behavioral contingencies, dyadic affective and behavioral flexibility were significantly correlated with maternal behavior and affect; since two of the three tasks utilized involved parental scaffolding for successful completion, shifts in dyadic states during these tasks may have been disproportionately shaped by maternal as compared to child behaviors. Dyadic coregulation patterns were unrelated to children's self-regulation in bivariate correlations. PN affective interaction content was negatively related to child emotional lability/negativity, and PN behavioral interaction content was positively associated with children's inhibitory control.

Dyadic Affective Contingency Model

The affective contingency model (see Figure 1) fit the data well, $\chi^2(28) = 28.58$, $p = .43$, CFI = 1.00, TLI = 0.99, RMSEA = 0.02, SRMR = 0.07, explaining significant variance in children's emotional lability/negativity (34%), inhibitory control (30%), and social persistence (12%). The interaction between dyadic affective contingency and PN affective content predicted children's social persistence, $\beta = 0.28$, $SE = 0.12$, $p = .02$, and emotional lability/negativity, $\beta = -0.24$, $SE = 0.08$, $p = .003$. The interaction term was also marginally associated with inhibitory control, $\beta = 0.15$, $SE = 0.08$, $p = .05$. Additionally, PN affective content marginally positively predicted inhibitory control, $\beta = 0.18$, $SE = 0.10$, $p = .05$, and negatively predicted emotional lability/negativity, $\beta = -0.30$, $SE = 0.08$, $p < .001$. Post hoc simple slopes testing to explore the significant interaction effects revealed that when dyads engaged in lower PN/higher negative affective content (1.5 standard deviations below the mean), stronger affective contingency was related to lower social persistence, $\beta = -0.49$, $SE = 0.21$, $p = .02$, and marginally to higher emotional lability/negativity, $\beta = 0.36$, $SE = 0.18$, $p = .05$ (Figures 5a and 5b, respectively). Conversely, when dyads exhibited higher PN affective content (1.5 standard deviations above the mean), stronger affective contingency was related to lower emotional lability/negativity, $\beta = -0.36$, $SE = 0.14$, $p = .01$, and marginally to higher inhibitory control, $\beta = 0.29$, $SE = 0.16$, $p = .06$ (Figures 5b and 5c, respectively).

Dyadic Behavioral Contingency Model

The behavioral contingency model (see Figure 2) fit well, $\chi^2(27) = 28.88$, $p = .37$, CFI = 0.98, TLI = 0.95, RMSEA = 0.03, SRMR = 0.07, explaining significant variance in inhibitory control (25%) and emotional lability/negativity (21%). The interaction between dyadic behavioral contingency and PN behavioral content marginally predicted emotional lability/negativity, $\beta = -0.21$, $SE = 0.11$, $p = .05$. PN behavioral content also positively predicted inhibitory control, $\beta = 0.19$, $SE = 0.09$, $p = .04$. Post hoc simple slopes testing to explore the interaction effect revealed that when dyads engaged in lower PN/higher negative behavioral content, stronger dyadic behavioral contingency predicted higher emotional lability/negativity, $\beta = 0.44$, $SE = 0.19$, $p = .02$ (Figure 5d).

Dyadic Affective Flexibility Model

The affective flexibility model fit well (see Figure 3), $\chi^2(25) = 25.37$, $p = .44$, CFI = 1.00, TLI = 0.99, RMSEA = 0.01, SRMR = 0.07. This model explained significant variance in children's inhibitory control (32%), emotional lability/negativity (29%), and social persistence (13%). The interaction between dyadic affective flexibility and PN affective content predicted social persistence, $\beta = 0.31$, $SE = 0.12$, $p = .01$. Additionally, PN affective content was negatively related to emotional lability/negativity, $\beta = -0.28$, $SE = 0.09$, $p = .001$. Post hoc simple slopes testing revealed that when dyads exhibited higher PN affective content, greater affective flexibility was associated with higher social persistence, $\beta = 0.52$, $SE = 0.24$, $p = .03$, and when they engaged in lower PN/higher negative content, greater affective flexibility was marginally related to lower social persistence, $\beta = -0.40$, $SE = 0.20$, $p = .05$ (Figure 5e).

Dyadic Behavioral Flexibility Model

This model fit the data well (see Figure 4), $\chi^2(27) = 29.35$, $p = .34$, CFI = 0.98, TLI = 0.94, RMSEA = 0.03, SRMR = 0.07. It explained significant variance in children's inhibitory control (25%), emotional lability/negativity (21%), and social persistence (14%). Dyadic behavioral flexibility and PN behavioral content interacted to predict social persistence, $\beta = 0.21$, $SE = 0.10$, $p = .03$. By itself, dyadic behavioral flexibility negatively predicted social persistence, $\beta = -0.29$, $SE = 0.11$, $p = .01$. PN behavioral content also positively predicted inhibitory control, $\beta = 0.17$, $SE = 0.08$, $p = .04$. Post hoc simple slopes testing to explore the interaction effect revealed that when parents and children exhibited lower PN/higher negative behavioral content, greater behavioral flexibility was related to lower social persistence, $\beta = -0.61$, $SE = 0.20$, $p = .002$ (Figure 5f).

Discussion

The purpose of this study was to examine how affective and behavioral coregulation patterns, accounting for interaction content, were associated with self-regulation development in early childhood. Covariates were included in the models to examine whether dyadic processes were associated with children's self-regulation over and above the effects of individual characteristics and behaviors. Dyadic affective contingency and flexibility paired with *higher* positive and neutral interaction content supported children's emotion regulation and social persistence, respectively. Additionally, dyadic affective contingency showed marginal support of children's inhibitory control when paired with higher positive and neutral content. However, when paired with *lower* positive and neutral content, three coregulation processes under study—dyadic affective *and* behavioral contingency and dyadic behavioral flexibility—were associated with children's poorer emotion regulation or lower social persistence. These findings highlight that parent-child coregulation plays a meaningful role in typical regulatory development in early childhood. They suggest that both predictable contingencies and flexibility in face-to-face interactions are important for supporting children's self-regulation skills, particularly those related to socioemotional aspects of self-regulation. These findings also extend the extant literature by utilizing integrative models and dynamic systems methods to reveal that parent-child interaction structure and content interact in complex ways to shape children's self-regulation. Specifically, it appears that the effects of coregulation patterns on child outcomes can depend on the interaction content (positive vs. negative) and the domain of interest (affect vs. goal-directed behavior); thus, these factors should be considered when examining coregulation as an antecedent of regulatory development.

The Coregulation of Positive Affect Supports Children's Regulatory Development

We found that parent-child affective coregulation was important for the development of socioemotional self-regulation in early childhood. Specifically, when paired with higher positive and neutral affective content, stronger dyadic affective contingencies predicted lower emotional lability/negativity, and greater dyadic affective flexibility predicted higher social persistence. These findings align with prior work demonstrating that predictable dyadic positive affect (Lindsey et al., 2009) and more positive, flexible parent-child exchanges (Lunkenheimer et al., 2011) are associated with children's better self-regulation. Such relations may be supported by children's higher enjoyment of parent-child interactions (Kochanska et al., 2005) and the higher levels of child compliance and internalized conduct (Kochanska et al., 2008; Lindsey et al., 2009) that tend to be linked to positive interactions. In other words, predictable positive affect may increase and reinforce children's enjoyment of parent-child interactions and their motivation to engage with caregivers or comply with socialization efforts, laying the foundation for further self-regulatory development.

Findings specific to parent-child affective flexibility support prior research demonstrating that affective flexibility, as long as the interaction content is predominantly positive, is adaptive for behavioral outcomes in early childhood (Lunkenheimer et al., 2011). Positive, flexible interactions could support children's social persistence via the easier repair of mismatched affective states as opposed to the dyad becoming stuck in negative states; one study found that interactive repair co-occurred with greater affective flexibility and more dyadic positive affect in families with children whose behavior problems improved over time (Granic et al., 2007). Additionally, a greater ability to transition into positive affective states could reflect the child's greater flexibility to adapt to interpersonal demands and perseverance to accomplish goals (Liu & Wang, 2014), which could support children's social persistence with adults.

Compared to *affective* coregulation processes, we did not find evidence for relations between positive *behavioral* contingencies or flexibility and the particular aspects of self-regulation of interest, even after accounting for both parent and child characteristics and behaviors. We might expect that positive dyadic behavioral contingencies would support children's better behavior regulation in early childhood from prior research (e.g., Lunkenheimer et al., 2013). However, mothers whose children's adaptive behaviors are tightly contingent to their own autonomy support could potentially rate their children as either being better regulated or perhaps more poorly regulated and in need of a lot of guidance. Another explanation could be that higher autonomy support may not be developmentally appropriate for all children; for example, research on individual differences in child temperament reveals that positive control rather than autonomy support is associated with better internalization of self-regulation skills in more inhibited children (Kochanska, 1995). In such cases, stronger dyadic behavioral contingencies may promote better situational compliance but may not support self-regulation development if such behaviors do not match children's temperament. Further research will be needed to investigate both parenting by temperament interactions and nuances in parent and child goal-directed behavior that may be important for more typical or adaptive self-regulatory development.

Interaction Content Matters: Coregulation Patterns Can Be Maladaptive

Another important finding from this study was that stronger coregulation patterns—in this case dyadic contingency and flexibility—can be harmful for child outcomes if they characterize patterns of predominantly negative content. It is important to note that since task times were fixed and affect and behavior codes were mutually exclusive, lower positive and neutral content was the equivalent of higher negative content. Thus, when paired with less positive/more negative content, stronger dyadic contingencies and greater dyadic flexibility were related to lower levels of child self-regulation—and these patterns were somewhat similar across domains of affect and goal-directed behavior. This supports prior work suggesting that parent-child coregulation patterns can be adaptive or maladaptive depending on the content, task, or risk level of study (Guo, Leu, Barnard, Thompson, & Spieker, 2015; Suveg, Shaffer, & Davis, 2016).

In the affective domain, when paired with less positive/more negative content, stronger contingencies were related to children's lower social persistence. This supports prior research showing that parent-child contingency around negative affect is associated with children's greater behavior problems (Cole et al., 2003). It is possible that negative contingencies "weigh more" such that even if overall negative affective content is not high (such as in a laboratory study of a community sample), or even if a dyad shows more contingent behaviors on average, the negative contingencies outweigh the positive. Findings also support prior work showing that parent-child rigidity around negative affective states is positively related to children's behavior problems (Granic et al., 2007; Hollenstein et al., 2004). The present study extends this prior work to show that these affective coregulation processes are related not just to children's higher behavior problems but also to reductions in their self-regulatory skills such as social persistence.

In the behavioral domain, when paired with less positive/more negative content, stronger contingencies were associated with children's higher emotional lability/negativity. The findings echo prior work on coercion showing that negative disciplinary contingencies between parent and child lead to greater emotional and behavioral dysregulation (Patterson, 1982). Further, higher negative content could also have reflected more disengagement by parent or child, wherein greater contingency could reflect mutual avoidance. In the literature, maternal disengagement is positively related to child behavior problems (Boutwell, Beaver, Barnes, & Vaske, 2012) and anxiety (Beato, Pereira, Barros, & Muris, 2016).

Additionally, greater behavioral flexibility around negative content was related to children's lower social persistence. This may reflect that disorganized negative interactions with parents are harmful to the child; greater flexibility within mostly negative content may reflect that multiple transitions among negative states tax the child's regulatory abilities, particularly for handling social situations. It may also indicate that the negative behaviors themselves (e.g., parent harsh discipline, child non-compliance) prompt greater variability—for example, when children's behavioral dysregulation prevents the dyad from achieving repair or when parents use ineffective discipline and, thus, must change strategies quickly (Dumas et al., 2001; Lengua, 2008). Such patterns may prevent children from learning how to coordinate behavioral bids in social interaction. More research will be needed to determine which specific negative parent or child behaviors could be driving such relations.

The Importance of Coregulation for Socioemotional Aspects of Self-Regulation

It is important to note that dyadic contingency and flexibility were more salient for social persistence and emotional lability/negativity than for the other dimensions of self-regulation (inhibitory control, task persistence). Children's socioemotional self-regulation is associated with parental responsiveness (Fung & Chung, 2019) and mediates the relation between attachment security and children's social engagement in the classroom (Drake, Belsky, & Fearon, 2014). Thus, perhaps during early childhood, parent-child coregulation that reflects the moment-to-moment interactions on which attachment processes are built may be particularly salient for more social regulatory skills like social persistence (Lunkenheimer & Wang, 2017). With regard to emotion regulation, prior studies suggest that parent-child coregulation of affect is a form of emotion socialization that scaffolds children's expression of affective states (Lunkenheimer et al., 2012). The presence or absence of this scaffolding may have special relevance for children's emotional lability/negativity. Notably, higher positive and neutral affective and behavioral content did show main effects on children's better inhibitory control, which reflects that adaptive emotional and behavioral aspects of the parent-child relationship support children's temperament-based behavioral self-regulation (Kochanska et al., 2005; Lindsey et al., 2009; Lunkenheimer et al., 2011; Spinrad et al., 2012). It is not clear why there were no significant relations with task persistence; there is some work to suggest that when examined conjointly, parent-child coregulatory processes may be more important for burgeoning socioemotional capacities, whereas individual child factors may be particularly salient for behavioral regulation (Lunkenheimer & Wang, 2017).

Limitations and Future Directions

This study utilized parent-report measures of self-regulation outcomes, so outcomes should be interpreted as mothers' perceptions of children's regulatory skills; multimethod assessment would yield a more unbiased assessment of child self-regulation. The community sample was characteristic of the local area and consisted largely of dual-headed Caucasian families with moderate to high income, which limits generalizability of the study findings. Recent studies with more ethnically diverse samples have found that parent-child coregulation involving adaptive responding between parent and child is positively associated with children's regulatory outcomes (Bardack, Herbers, & Obradović, 2017; Herbers, Cutuli, Supkoff, Narayan, & Masten, 2014), suggesting more research is needed to examine these processes in populations with diverse sociodemographic characteristics.

Additionally, more research is needed on children with specific challenges to regulatory skills (e.g., clinical samples, maltreated children, children living in adverse environments), particularly given that the strength of behavioral coregulation may vary depending upon the degree of risk present within the dyad (Suveg et al., 2016). Furthermore, prior work has suggested that environmental context changes the dynamics of parent-child interactions (Suveg et al., 2016). Therefore, research is needed to explore how context may shape the associations between coregulatory process by content interactions and children's regulatory development. As is common with laboratory studies, the ability to observe a full range of positive and negative behaviors may have been limited due to social desirability; we did not observe much variability in average to high levels of dyadic positive behavior, which may have reduced our power to detect the effects of coregulation of goal-directed behavior specifically. Examining change across a short time period, particularly from age 3 to age 4, is informative given how quickly self-regulation skills emerge during this window; however, a design with more assessments and a longer phase of development would offer important information about whether coregulation truly shows robust or stable effects over time. Finally, though coregulation variables were dynamic, path models were linear in nature; future research should consider whether there may be a curvilinear relation between parent-child coregulation and children's regulatory skills such that there is an optimal level of dyadic contingency or flexibility for child outcomes (Busuito & Moore, 2017).

Overall, this study emphasizes the importance of considering parent-child interactions as dynamic systems to provide a more valid understanding of how the parent-child relationship is associated with adaptive and maladaptive outcomes in early childhood. Theoretically, we expect parents to be flexible and tailor their responses to children's needs, as well as to be predictable enough to forge the dyadic rhythms upon which children can internalize regulatory skills; enacting such a balance in real-world day-to-day parenting is quite challenging. If we wish to foster children's self-regulation, or aid parents via family intervention to better support their children's early development, more research is needed on identifying and describing the adaptive real-time, dynamic coregulation processes between parent and child that should be targeted for promotion in intervention.

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Appendix

Dyadic Interaction Coding System (Lunkenheimer, 2009)

Affect codes		
Affect	**Description**	
Negative affect	Expressions of irritation, annoyance, distress, anger, disgust, sadness, discomfort, fear, nervousness, or anxiety.	
Neutral Affect	Affect that is flat with few fluctuations or lilts.	
Low positive affect	Slightly positive lilts or warm tones in the parent's voice, smiles that are small and closed-mouthed, or warm eye contact that reflects interest or engagement with the child.	
Medium/high positive affect	Regular positive fluctuations in the parent's or child's voice, open-mouthed smiles, laughing or giggling, and/or warm eye contact indicating joy or surprise.	
Goal-directed behavior codes		
Parent adaptive	**Description**	**Example**
Proactive structure	Parent encourages, guides, or prompts child to behave in a positive manner.	"Let's pretend that the box is a house and help all the dolls find their way back home."
Teaching	Parent explains how something works or asks child a task-related question and allows child the opportunity to respond verbally or behaviorally.	"I think the blue coin might go in the blue slot."
Positive reinforcement	Parent provides verbal support or praise.	"Great job!" Giving a thumbs-up.
Emotional support	Parent empathizes with child, helps child label emotions, or physically comforts child.	"Are you feeling kind of nervous?"
Directive	Parent uses commands that bid child to respond in a specific way.	"Don't throw that block." "Can you put it here?"
Engagement	Parent is engaged with child through eye contact or non-task-related conversation.	"What should we have for lunch today?"
Parent maladaptive	**Description**	**Example**
Disengagement	Parent is not engaging with child, is ignoring child, or seems spaced out during the interaction.	Parent ignoring child's request to play a game.
Intrusion	Parent physically takes over the task or object, and/ or physically completes some of the task for the child.	When child has difficulty with a puzzle, parent takes piece away and completes it herself.
Negative discipline	Parent (a) provides a harsh directive with a negative consequence, (b) criticizes child, or (c) physically punishes child.	"Get back here or I'll spank you."
Child adaptive	**Description**	**Example**
Persistence	Child persists at completing a task without preceding prompts by parent.	Child continues to work on puzzle on his or her own.
Compliance	Child clearly responds to parent's bid for a behavioral change.	Child places a piece of puzzle as requested by parent.
Social conversation	Child is engaged with parent in play-related or non-task-related conversation.	"Is Daddy going to come play later?" "Oink, oink!"
Solitary or parallel play	Child is playing on his or her own without engaging with parent.	Parent and child building two separate towers near each other.
Child maladaptive	**Description**	**Example**
Noncompliance	Child does not comply with parent's bid for behavioral change, by ignoring, disagreeing with, or refusing request.	Child picking up red block after the parent asked child to leave blocks alone.
Disengagement	Child is not engaged with parent or task, seems spaced out, or loses focus or has no particular direction.	Child looks away from task and stares at floor. Child wanders around room.

Behavioral dysregulation	Child has dysregulated emotional episodes (positive or negative) with a clear physical or behavioral component.	Child throws tantrum, withdraws by curling into a ball, runs in circles around room giggling.

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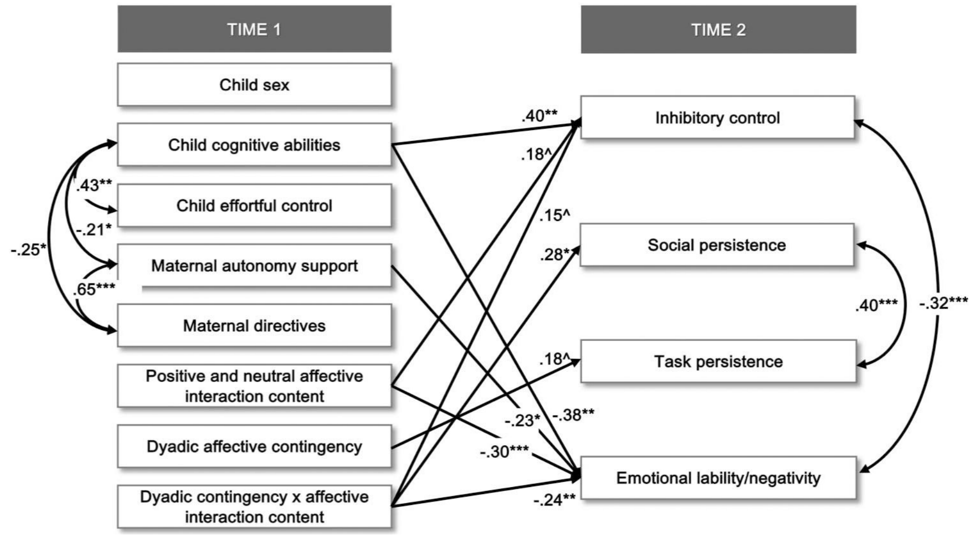

Figure 1.

Dyadic affective contingency model. Only standardized regression coefficients for significant or marginally significant relations are reported in the model. ˆ $p = .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

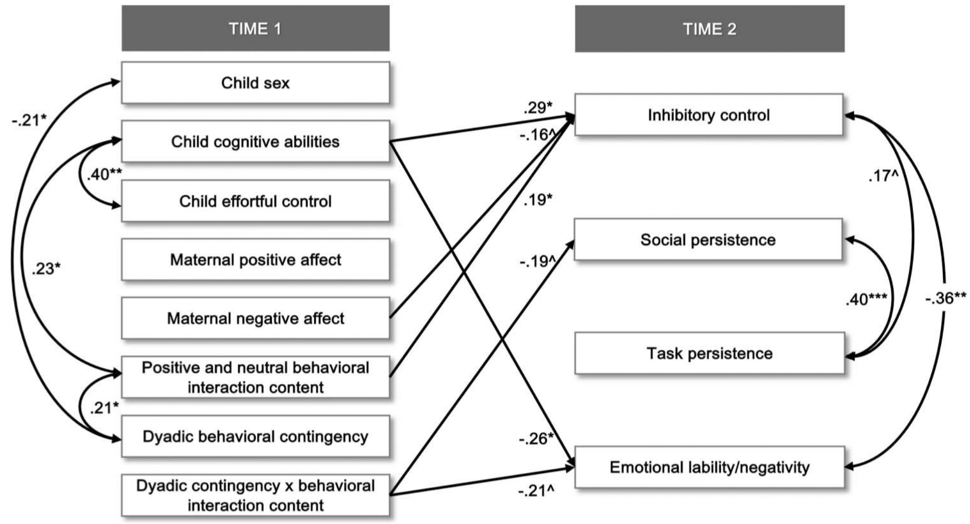

Figure 2.

Dyadic behavioral contingency model. Only standardized regression coefficients for significant or marginally significant relations are reported in the model. ^ $p = .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

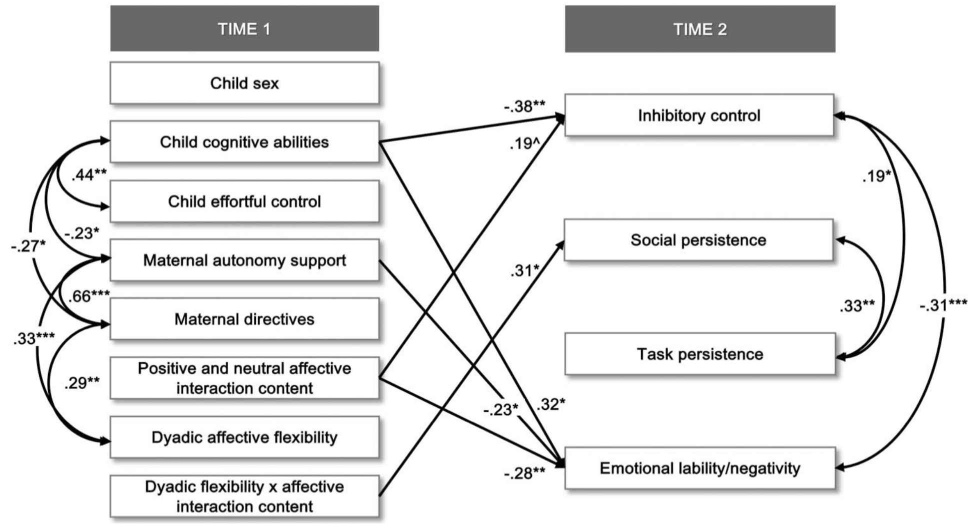

Figure 3.

Dyadic affective flexibility model. Only standardized regression coefficients for significant or marginally significant relations are reported in the model. ˆ $p = .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

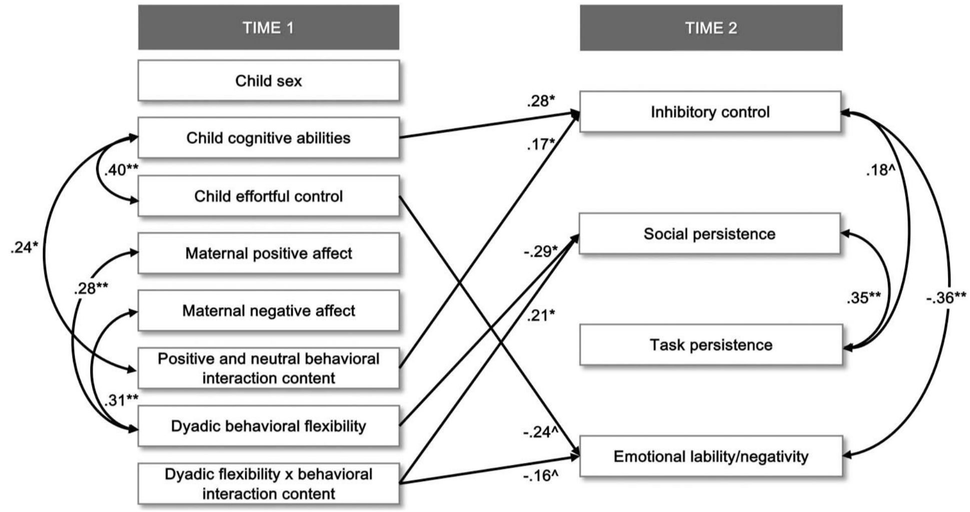

Figure 4.

Dyadic behavioral flexibility model. Only standardized regression coefficients for significant or marginally significant relations are reported in the model. ^ $p = .10$. * $p < .05$. ** $p < .01$.

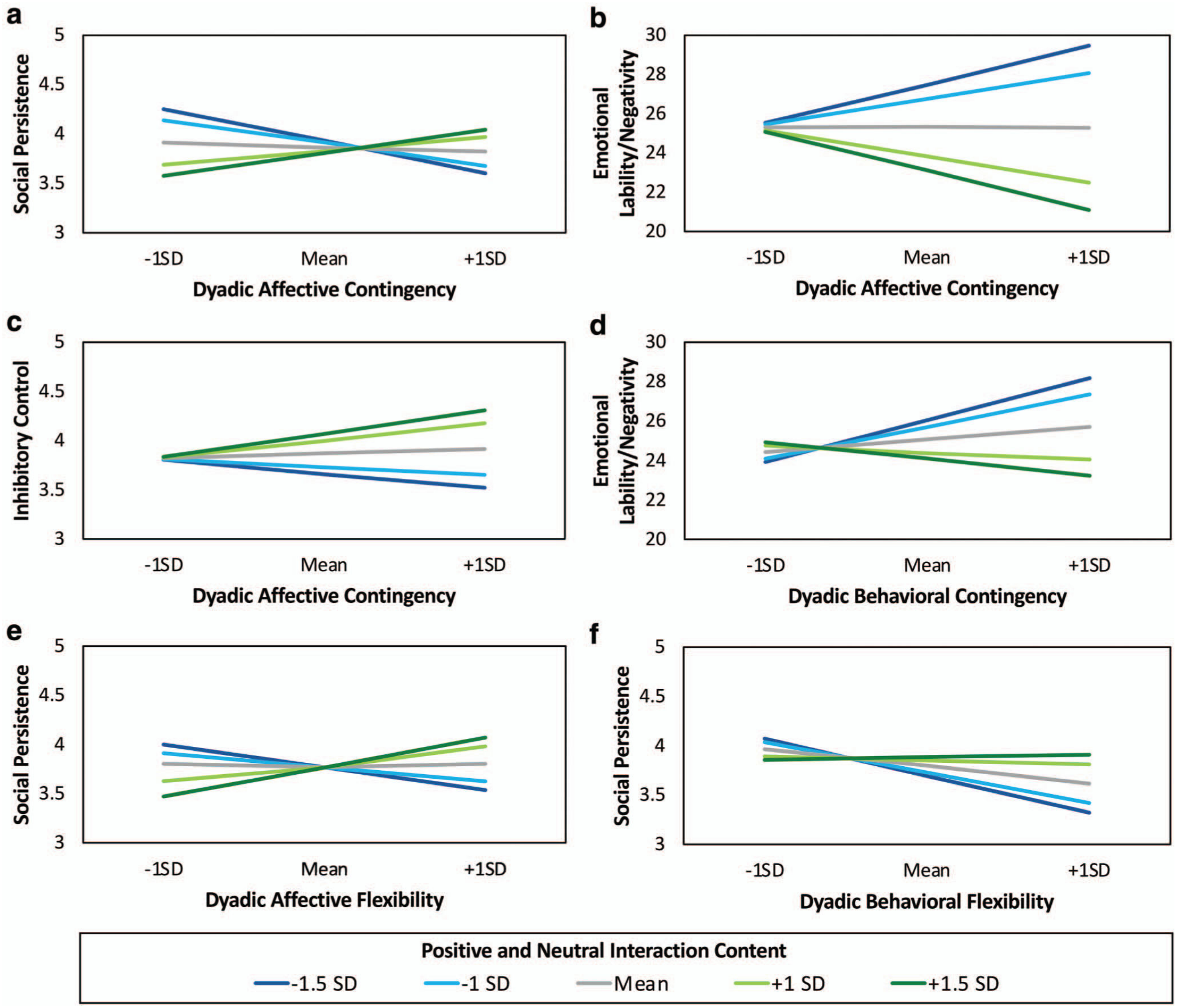

Figure 5.

Interaction effects between coregulation patterns and positive and neutral interaction content (at 1 standard deviation and 1.5 standard deviations above and below the mean) in relation to child self-regulation. Please note that interaction effects for (c) and (d) were marginally significant in primary analyses at $p = .05$.

Table 1

Descriptive Satistics for Study Variables

Variable	*N*	*M*	*SD*	Range
Child cognitive abilities	97	17.72	4.92	0.00–30.00
Child effortful control	97	−0.01	0.68	−1.97–1.32
Maternal autonomy support	98	30.92	9.49	13.00–51.00
Maternal directives	98	34.01	12.58	13.00–67.00
Maternal positive affect	98	10.94	6.51	0.00–34.00
Maternal negative affect	98	1.36	2.16	0.00–11.00
Positive and neutral affective interaction content	91	1018.73	64.44	858.46–1141.50
Dyadic affective flexibility	91	2.08	1.03	0.33–4.88
Dyadic affective contingency	98	0.15	0.15	0.00–0.56
Positive and neutral behavioral interaction content	91	851.75	111.28	568.77–1021.86
Dyadic behavioral flexibility	91	10.60	2.91	5.20–17.85
Dyadic behavioral contingency	98	0.27	0.10	0.07–0.56
Child emotional lability/negativity	87	25.21	4.92	15.00–38.00
Child task persistence	88	3.41	0.73	1.83–4.83
Child social persistence	88	3.77	0.60	2.29–5.00
Child inhibitory control	90	3.87	0.74	1.38–5.15

Table 2

Correlations Among Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Child cognitive abilities	1														
2. Child effortful control	.422***	1													
3. Maternal autonomy support	−.144	.113	1												
4. Maternal directives	−.257*	−.047	.643***	1											
5. Maternal positive affect	.099	−.020	.340***	.259*	1										
6. Maternal negative affect	−.230*	−.052	.355***	.360***	.148	1									
7. Positive and neutral affective interaction content	−.156	−.103	.161	.156	.084	−.036	1								
8. Dyadic affective flexibility	.033	−.063	.317**	.281**	.831***	.463***	−.078	1							
9. Dyadic affective contingency	.084	.036	.089	.114	.165	.128	−.109	.419***	1						
10. Positive and neutral behavioral interaction content	.298**	.151	−.027	.007	.060	−.106	.293**	−.028	.143	1					
11. Dyadic behavioral flexibility	−.154	.109	.809***	.809***	.318**	.349***	.033	.369***	.180†	−.113	1				
12. Dyadic behavioral contingency	.074	.063	.030	−.086	−.075	.055	−.033	.038	.144	.238*	.078	1			
13. Child emotional lability/negativity	−.361***	−.178	−.048	.112	−.112	.003	−.228*	−.038	.034	−.196†	.144	.061	1		
14. Child task persistence	.146	.013	−.168	−.082	.046	−.095	−.135	.056	.168	.048	−.128	.033	−.271*	1	
15. Child social persistence	.031	.015	−.150	−.093	−.018	.010	−.095	−.025	−.100	.138	−.195†	.047	−.222*	.446***	1
16. Child inhibitory control	.442***	.273*	−.043	−.155	.016	−.220*	.087	−.074	.027	.304**	−.160	.004	−.586***	.348***	172

Note. $N = 100$.

† $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.