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Running head: DYADIC VARIABILITY

Parental Depressive Symptoms, Parent-Child Dyadic Behavioral Variability, and Child Dysregulation

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Abstract

Parental depressive symptoms are associated with greater variability and inconsistency in parenting behavior as well as children's emotional and behavioral dysregulation. The present study whether such relations extended to dyadic processes, examining whether maternal and paternal depressive symptoms at child age 3 ½ interacted with concurrent higher dyadic behavioral variability (DBV) in mother-child free play to heighten children's emotional and behavioral dysregulation at age 4 (N = 100). Child dysregulation was measured as mother-reported emotional lability/negativity and externalizing problems and DBV was measured as the number of transitions among dyadic behavioral states using State Space Grids. Parent behaviors included parent directives, positive reinforcement, and disengagement and child behaviors included child compliance, persistence, and noncompliance, among others. Analyses also accounted for the degree of positive (as compared to negative) behavioral content. Moderation analyses showed that DBV predicted greater child dysregulation only when maternal or paternal depressive symptoms were higher. Further, DBV was detrimental only when dyadic positive interaction content was low. Findings suggest dyadic behavioral variability combined with low positive content in parent-child interactions is a particular risk factor for children's regulatory development. Fostering positive, predictable interaction patterns may be an important target for family interventions with a depressed parent.

Keywords: dyadic variability; parent-child interaction; depressive symptoms; fathers; self-regulation; externalizing problems

Parental Depressive Symptoms, Parent-Child Dyadic Behavioral Variability, and Child Dysregulation

Depressive symptoms in parents remain a key risk factor for the development of depressive disorders in children (Gotlib, Joormann, & Foland-Ross, 2014; Hammen, 2009). Children are adversely affected by parents' depressive symptoms even before they reach diagnostic criteria for a mood disorder, displaying greater internalizing and externalizing symptoms in early childhood, middle childhood, and adolescence (Goodman et al., 2011; Gotlib et al., 2014). Prior research shows a strong genetic influence in the development of adult-onset depressive disorders (Goodman & Gotlib, 1999), but environmental factors such as the parent-child relationship have greater explanatory value when describing subclinical symptoms, and the mechanisms accounting for childhood-onset symptoms remain unclear (Goodman et al., 2011).

Dynamic patterns of parent-child interaction may act as mediators or moderators of risk transmission in early childhood. Parental depressive symptoms are related to greater variability and inconsistency in parenting as well as children's emotional and behavioral dysregulation (Lovejoy, Graczyk, O'Hare, & Neuman, 2000; Murray, Woolgar, Cooper, & Hipwell, 2001). Further, greater variability and negativity in dyadic parent-child interactions predicts children's emotional and behavioral dysregulation (Lobo & Lunkenheimer, 2020). We extended this work to explore whether dyadic variability in goal-directed behavior (e.g., parental guidance, child compliance) interacted with parental depressive symptoms to heighten children's emotional and behavioral dysregulation. Dyadic behavioral variability (DBV) was defined as the number of changes in dyadic behavioral states during face-to-face interaction, where each dyadic state was made up of a combination of specific parent and child behaviors (e.g., parent directive – child compliance; see Method). Given most family interventions target changes in parent and child

behaviors, we hoped a better understanding of dyadic behavioral patterns between parents and children could have the potential to inform family interventions with a depressed parent.

Depressive Symptoms and Child Regulatory Development

Symptoms of depression emerge as early as the toddlerhood and preschool years. They are often assessed as internalizing and externalizing behavior problems or emotional negativity, reported by parents and teachers (Hammen, 2009). Young children who show symptoms may be distinguished by dysfunction in emotion regulation, or the child's ability to modulate emotional states in the service of meeting social or internal goals (Calkins, 1994). Difficulties in regulating emotion serve as a precursor to psychopathology in children (Fox & Calkins, 2003). For example, sadness may be a typical reaction to an unpleasant situation, however, children at risk for depression may have more difficulty resolving this sadness, characterized by excessive and persistent negative emotion (Cole, Luby, & Sullivan, 2008). Such differences are apparent early in children of mothers with higher depressive symptoms (Murray et al., 2001).

Developmental models suggest younger children may be more vulnerable to the adverse effects of parental depressive symptoms (Goodman & Gotlib, 1999) because they have less developed internal regulatory systems and are more dependent on parental support (Fox & Calkins, 2003). Early exposure to parental depressive symptoms may hamper children's social strategies for interacting with the affected parent, which may extend to interactions with others and become internalized as poorer self-regulation (Tronick, 1989). A meta-analysis of the effects of maternal depressive symptoms revealed that maternal symptoms had a greater detrimental impact on child internalizing and externalizing symptoms, as well as negative affect and behavior, when children were first exposed to symptoms at younger ages (Goodman et al., 2011).

Dysfunctional regulatory strategies emerge in the context of the family system where

multiple factors interact, including parent psychopathology, children's difficult temperament, and family stress (Goodman & Gotlib, 1999). Preschoolers' difficult and dysregulated behavior may make disciplinary interactions particularly challenging for parents. Further, the combination of parent symptoms and difficult child behavior can contribute to dysregulated dyadic patterns, such as greater negativity and inconsistency in disciplinary interactions (Lunkenheimer, Lichtwarck-Aschoff, Hollenstein, Kemp, & Granic, 2016; Patterson, 2002). However, less research has been dedicated to examining the parent-child dyad as the unit of analysis, which includes a focus on dynamic interaction patterns between parent and child (Lovejoy et al., 2000). This is an oversight because the organization of parent-child interactions may serve a significant role in either transmitting depressive symptoms to children or protecting children from them.

Depressive Symptoms and Parenting

Research has shown that both the content (e.g., verbalizations, emotional expressions) and structure of parent-child interactions (e.g., variable vs. stable patterns of behavior) differ by parental depressive symptoms. In terms of content, mother-child interactions are more negative when mothers experience greater depressive symptoms, characterized by greater sadness, hostility, and conflict (Goodman & Gotlib, 1999; Lovejoy et al., 2000). Depressed parents also show less positive behavior in situations that are expected to be positive, such as free play (Rubin, Both, Zahn-Waxler, Wilkinson, & Cummings, 1991). Depressed parents are also less effective in scaffolding the child's environment to promote autonomy, which could contribute to detriments in child self-regulation (Cicchetti & Schneider-Rosen, 1986). Lower attention to child needs may lead depressed mothers to place unrealistic expectations on children, overwhelming their systems for managing difficult emotions (Zahn-Waxler, Iannotti, Cummings, & Denham, 1990). They may also struggle to think of alternative responses to negative behavior (e.g.,

redirection; Barrett & Fleming, 2011), resulting in a more limited behavioral repertoire.

In terms of structural differences, mothers with higher depressive symptoms may struggle to coordinate behavior with children, resulting in poorer attunement that contributes to children's emotional and behavioral dysregulation (Hoffman, Crnic, & Baker, 2006). Parental depressive symptoms have also been linked with inconsistent discipline (Lovejoy et al., 2000; Psychogiou & Parry, 2014), for example, when parents set limits but do not always uphold them, or are equally likely to initiate positive or aversive control exchanges with children. Inconsistencies in discipline may occur during stressful episodes of child misbehavior when parental self-regulation may be exhausted (Lunkenheimer et al., 2016). For example, dyadic patterns with higher-symptom mothers have been shown to be characterized by more inconsistent parenting behavior, which could stem from depressed parents' difficulties shifting behavior when required to match the needs of children (Lunkenheimer et al., 2013).

Dyadic Variability in Goal-Directed Behavior

On one hand, greater behavioral variability could reflect multiple ways of responding to challenges and enabling partners to work collaboratively and creatively to meet goals (Granic, Meusel, Lamm, Woltering, & Lewis, 2012). When applied to positive goal-directed behaviors like parental guidance and child compliance, this framework might reflect the degree to which parents and children calibrate to one another's needs. For example, if a child was unmotivated to engage, but her parent tried multiple strategies and the child responded to them, this could demonstrate greater DBV in goal-directed behavior. However, DBV may be adaptive with respect to some behaviors and not others. For example, DBV that supports sensitive responding and engagement could be adaptive, whereas DBV in limit setting and compliance could be problematic, reflecting the disciplinary inconsistency associated with parental depressive

symptoms and child behavior problems (Dumas, Lemay, & Dauwalder, 2001; Tronick, 1989).

The benefits of greater variability around positive behavior has been demonstrated in related prior work on affective or emotional patterns. For example, with respect to populations with higher clinical symptoms, greater positive affective variability (termed flexibility) between parent and child is considered an adaptive mechanism, one that breaks up the rigidity of negative coercive cycles (Granic, O'Hara, Pepler, & Lewis, 2007). For instance, when parents and children experience conflict but can repair this relatively easily with affection or humor, it can prevent them from becoming stuck in negative emotional states (Hollenstein et al., 2004). Greater affective flexibility has been shown to predict fewer behavior problems in preschoolers, particularly when affective interaction content is predominantly positive (Lunkenheimer et al., 2013; Lunkenheimer, Olson, Hollenstein, Sameroff, & Winter, 2011).

In contrast, there is little research on the benefits of DBV in positive, goal-directed behavior, as compared to affect. Rather, most work on behavioral variability or inconsistency has been on negative behavior from a developmental psychopathology lens (e.g., Dumas, Lemay, & Dauwalder, 2001). One study examined dynamic parental responses to child misbehavior and how it differed by maternal depressive symptoms and child behavior problems (Lunkenheimer et al., 2016). In lower-risk dyads, greater behavioral variability was observed overall, but parents became less variable (more rigid) when children went off-task, reflecting that they stuck to a chosen disciplinary strategy. In contrast, in higher-risk dyads, mothers responded to misbehavior with increased variability, reflecting inconsistency when discipline was required. These results could imply that for lower-risk dyads, behavioral variability reflects parents' proactive, flexible responding to children's misbehavior, whereas for higher-risk dyads, variability reflects reactive, inconsistent patterns of discipline. Given that depressed parents seem to struggle to positively

scaffold environments for children (Cicchetti & Schneider-Rosen, 1986), higher *individual* behavioral variability in these parents may reflect inconsistency rather than adaptive flexibility. It is less clear whether the same could be said for *dyadic* behavioral variability, which could be driven by parents, children, or both, though preliminary evidence suggests that greater DBV combined with negative content is related to preschoolers' lower self-regulation skills (Lobo & Lunkenheimer, 2020). Therefore, we examined whether these dyadic processes showed adaptive or maladaptive effects on child dysregulation in relation to parental depressive symptoms; we also examined the role of positive behavioral content to aid interpretation of the adaptive (higher positive) vs. maladaptive (lower positive) nature of these dyadic processes and their effects.

Maternal and Paternal Depressive Symptoms

Prior research has typically focused on how mothers' depressive symptoms influence parenting, but fathers' depressive symptoms have a similarly negative effect on parenting and child outcomes (Sweeney & MacBeth, 2016; Wilson & Durbin, 2010). Additionally, family systems perspectives suggest the practices of one parent influence the relationship between the child and the co-parent (Cox & Paley, 1997), for example when depressed mood in fathers influences mothers' behaviors with children through its effects on the mother's affective state (Erel & Burman, 1995; Ponnet et al., 2013). Also, similar levels of negative parenting (e.g., intrusion) have been observed between mothers and fathers with the same child (Barnett, Deng, Mills-Koonce, Willoughby, & Cox, 2008). As such, depressive symptoms experienced by fathers may affect the quality of the relationship between mothers and children, and vice versa (Field, Houssain, & Malphurs, 1999; Goodman, 2008). In heterosexual two-parent families, fathers' depressive symptoms can exacerbate the negative effects of maternal depression on child behavior problems (Mezulis, Hyde, & Clark, 2004). Thus, the influence of both mothers' and

fathers' depressive symptoms were examined in relation to mother-child interactions and child emotional and behavioral dysregulation in the present study.

Present Study

Given that parent-child interaction dynamics vary by parental depressive symptoms, maternal and paternal depressive symptoms were examined as a moderator of relations between mother-child DBV and children's emotional and behavioral dysregulation. Given the novelty of this question, it was unknown whether the main effects of DBV would be positive or negative. However, we hypothesized that higher depressive symptoms would be associated with higher DBV because it would reflect the inconsistency shown to be characteristic of parent-child disciplinary interactions with depressed parents and their children in prior research (Lovejoy et al., 2000). We then expected that this interaction between higher depressive symptoms and higher DBV would predict higher child emotional and behavioral dysregulation. We also tentatively hypothesized that for dyads where parental depressive symptoms were lower, higher DBV could reflect adaptive responding, and thus would predict lower child dysregulation.

These hypotheses were tested in a short-term longitudinal study of psychopathology risk and parent-child interactions in a community sample with predominantly White preschoolers. Early childhood was targeted as a period in which children's regulatory skills are still developing and are shaped by parents; further, emotional and behavioral dysregulation in this age range is a common covariate of parental depressive symptoms (Calkins, 1994; Cole et al., 2008). DBV was observed during an unstructured free play task to allow for greater variability in behavior; the effects of depressive symptoms on behavior may be more observable during unstructured tasks in which parents are responsible for creating the agenda versus tasks that are structured for them (Lovejoy et al., 2000; Psychogiou & Parry, 2014). State Space Grids (Lewis, Lamey, & Douglas,

1999) were used to assess DBV and dyadic positive content of mother-child interactions. Models accounted for the interaction between DBV and positive behavioral content due to prior research showing that DBV is adaptive for child outcomes specifically in the context of majority positive (as opposed to negative) content (Lunkenheimer et al., 2013). Positive behavioral content was also relevant given that free play contexts pull for positive behaviors and depressed parents tend to show lower positive behaviors during free play (Rubin et al., 1991). Models also accounted for baseline child externalizing problems to control for stability in child dysregulation over time.

Method

Participants

One hundred mothers, fathers, and 3 ½-year-old children (45% female) participated. Mothers were college-educated on average and median annual household income was $65,000. The majority of mothers (79%) were married; 7% were cohabitating, 7% were single, 5% were separated or divorced, and 1% were remarried. Average child age was 41 mos (*SD* = 3 mos) at the lab visit (T1) and 45 mos at follow-up (T2). Children were 86% White, 8% multiracial, 3% Asian, and 3% of unknown racial background; 10% were of Hispanic or Latinx ethnicity. Families were recruited through flyers and email LISTSERVs at daycares, preschools, and agencies for families with young children. Families were excluded due to diagnosed developmental delay or cardiac condition that would prevent physiological data collection.

Procedure

A 2-hour T1 lab visit involved dyadic tasks including an unstructured free play where mothers and children were given toys and asked to play as they normally would (7 min). Mothers filled out surveys regarding demographics, child behavior, and symptoms; fathers also reported on their own symptoms. At the T2 4-month follow-up, mothers completed questionnaires online

regarding child behavior. Families were compensated $50 at T1 and were mailed a $20 gift card for T2. All procedures were approved by the university Institutional Review Board.

Measures

Observational coding. The free play task at T1 was coded using Noldus Observer XT 8.0. Behaviors were coded in real time by two undergraduate and one graduate research assistants using an established parent-child interaction coding system (Lunkenheimer, 2009). All parent and child behaviors were coded for precisely the duration the behavior occurred and every second was represented by a behavioral code. Reliability was conducted by creating a confusion matrix of agreements and disagreements for each video and whether coders coded the same behaviors at the same time throughout the observation, for every single code in our coding system, using a standard 3-second window in Observer. Reliability involved comparison to a gold standard coder on 20% of the sample: drift reliability was also subsequently conducted to ensure consistency of coding over time. Disagreements were resolved by consensus. Interrater reliability for behavioral codes was sufficient; we reached a 75% agreement standard on the entire system and individual codes showed > 80% agreement, ranging from 83-100%.

Mothers' behavior was coded into nine mutually exclusive states. *Proactive structure* referred to mothers' attempts to guide and prompt positive, desired behavior from children (e.g., suggesting a positive activity, offering choices, or using reflection or labeling the child's experience). *Positive reinforcement* referred to mothers' verbal expressions of praise or support of children's behavior and emotions (e.g., "Good job!" or "That's right"). *Teaching* referred to offering explanation or instruction about a task or game in a helpful way (e.g., "The red block goes in the middle" or "Where do you think this goes?"). *Directive* referred to firm commands for behavior change from children (e.g., "It's time to clean up." or "Pick up the toys.").

Engagement referred to the parent's orientation and attention toward the child and included general social or play-related conversation that did not meet other criteria for other codes (e.g., "What's that?" "Yes," or "Uh huh."). *Intrusion* referred to instances when mothers took over the child's play or task-related behavior (e.g., doing something for the child, taking a toy away from the child). *Negative discipline* referred to negative behaviors including warnings, threats, unpleasant consequences, criticism, and negative physical contact (e.g., moving the child roughly, pulling the child). Emotional support and disengagement were also coded but were excluded due to low incidence; thus, seven parent codes were used in the present analysis.

Child behavior was coded into seven mutually exclusive states. *Compliance* referred to clear responding to mothers' bids for behavior change (e.g., playing along with a parent's game, following rules). *Persistence* referred to the child's sustaining work on a task without continued guidance from the mother. *Social Conversation* represented the child's play-oriented or non-task oriented social verbalizations with the mother. *Noncompliance* referred to ignoring, disagreeing, or refusing to cooperate with the mother's bids for behavior change. *Disengagement* referred to the child's off-task and otherwise undirected behavior (e.g., "spacing out" or gazing at the floor). Solitary/parallel play and behavioral dysregulation (i.e., tantrum) were also coded but were excluded due to low base rates; thus, five child codes were used in the present analysis.

Dyadic behavioral variability and dyadic positive behavior. Mother-child DBV at T1 was assessed with Gridware 1.15 (Lamey, Hollenstein, Lewis, & Granic, 2004) in line with prior work using state space grids (SSGs) to measure parent-child DBV (Cerezo, Trenado, & Pons-Salvador, 2012; Granic, Hollenstein, Dishion, & Patterson, 2003). Behaviors were mapped onto SSGs with 5 child behaviors on the x-axis and 7 parent behaviors on the y-axis, creating a grid with 35 dyadic states. Trajectories of dyadic behavior were plotted in real time (Figure 1). The

circles vary in size and reflect the duration of time in the respective state, while arrows denote the trajectory's direction. SSGs allow an examination of the dyad as a unit, reflecting the integration of parent and child behavior rather than solely the effect of one partner on the other. *DBV* was operationalized as the total number of transitions from one dyadic state to the next across the seven minutes of free play. Prior research has used the number or rate of transitions, the range of behaviors utilized, and the dispersion of behaviors across the SSG to operationalize variability (Cerezo et al., 2012; Granic et al., 2003). We chose transitions because it was highly correlated with these other indices (r = .96, .94, respectively) and is the most common index; we did not use transition rate because the free play task had a set time limit with very little variation in duration across dyads. *Dyadic positive behavior* was operationalized as the total duration of mutually positive behavior (the 15-cell region highlighted in Figure 1), for example, when the mother engaged the child in a positive activity and the child complied. Note that codes were mutually exclusive in the grid, thus lower positive content reflected higher negative content.

Parental depressive symptoms. Depressive symptoms were self-reported on the 20-item Center for Epidemiological Studies Depression Scale (CESD; Radloff, 1977) at T1. Parents noted the number of times they felt a certain way in the past week (e.g., "I felt that people disliked me") on a 4-point scale where 0=rarely or none of the time, 1=some or a little of the time, 2=occasionally or a moderate amount of time, and 3=most or all of the time; the sum represented their depressive symptoms. Cronbach's alphas for mothers' and fathers' depressive symptoms were 0.72 and 0.84, respectively. Eleven mothers and 10 fathers met criteria for clinical depression with a score equal to or above the cut-off score of 16 (Radloff, 1977).

Child externalizing problems. Behavioral dysregulation at T2 was operationalized as mother reports of externalizing via the Child Behavior Checklist (CBCL/1.5-5; Achenbach &

Rescorla, 2000); T1 levels were also controlled for in primary models. This subscale reflects poor attentional control, hyperactivity, and physically aggressive behavior. The 99 items are rated on a 3-point scale with 0 = "not true (as far as you know)", 1 = "somewhat or sometimes true" and 2 = "very true or often true" (Cronbach's alpha = 0.89 for T1 and 0.93 for T2). Eleven children had t-scores above the clinical cutoff (T = 64) for externalizing disorder.

Child emotional negativity/lability. Emotional dysregulation at T2 was measured as mother reports of child emotional negativity/lability on the 24-item Emotion Regulation Checklist (Shields & Cicchetti, 1997). This subscale (15 items) examines the affective lability, intensity, valence, and appropriateness of emotional displays, including dysregulated negative emotion (e.g., "Is prone to angry outbursts"). Mothers rated children on a 4-point Likert scale where 1 = never, 2 = sometimes, 3 = often, and 4 = almost always. Cronbach's alpha was 0.77.

Analytic Plan

Relations between mother-child DBV, positive behavioral content, and maternal and paternal depressive symptoms at T1 and child emotional and behavioral dysregulation at T2 were estimated using path analysis in Mplus 8 (Muthén & Muthén, 1998-2017). Separate models were run for maternal versus paternal depressive symptoms to maximize analytic power. Interactions between DBV and maternal and paternal depressive symptoms, respectively, and the interaction between DBV and positive behavioral content, were also included as predictors; these terms were included to assess the moderating effects of parental depressive symptoms on the relations between DBV and child outcomes, and to account for the effects of DBV in relation to the proportion of positive (vs. negative) content. Significant interaction effects were explored post-hoc by estimating simple slopes using the PROCESS 3.4 macro in SPSS 25 (Hayes, 2017). PROCESS produced simple slopes at mean and +/- 1 SD levels of depressive symptoms. Each

model included the planned covariate of children's baseline externalizing problems at T1.

Fathers' depressive symptom data was missing for 14 families and dyadic interaction data was missing for six families. In addition, child dysregulation data was missing for 13 families at T2 due to attrition. Families who participated at T2 had significantly higher maternal education, $t(100) = 2.545$, $p < .05$, higher SES, $t(100) = 2.403$, $p < .05$, lower maternal depressive symptoms, $t(100) = -2.874$, $p < .01$, and lower paternal depressive symptoms, $t(100) = -3.196$, $p < .01$. There were no differences in age, gender, ethnicity, annual household income, dyadic positive behavior, or dyadic behavioral variability. The valid N for each variable is presented in Table 1. Missing data was handled using full information maximum likelihood in Mplus.

Results

Preliminary Analyses

Table 1 displays means, standard deviations, and bivariate correlations. We explored the sociodemographic covariates of child age, sex, family income, and maternal education, which could have impacted mother-child interactions. Maternal education was negatively correlated with maternal and paternal depressive symptoms, and child age was negatively correlated with DBV, thus these two covariates were controlled for in primary analyses. Values for maternal depressive symptoms, paternal depressive symptoms, and maternal education were log transformed to adjust for skew observed in these variables (Pearson's coefficient of skew > |2|). Descriptive analyses revealed that parent and child behavioral codes were comparably related to DBV, with positive correlations across codes ranging from $r = .36$ - .78 for children and $r = .27$ - .74 for mothers, suggesting neither parent nor child was disproportionately influencing DBV.

Primary Analyses

Primary analyses centered on the relations among mother-child DBV, positive interaction

content, parental depressive symptoms, and child emotional lability/negativity and externalizing problems, accounting for the interaction of DBV and depressive symptoms, the interaction of DBV and positive content, and the child's baseline externalizing problems at T1. Two path analytic models were run, one for maternal and one for paternal symptoms.

Maternal depressive symptoms model. Model fit for the maternal model was good, χ^2 (18) = 21.34, n.s.; CFI = 0.96, RMSEA = 0.04, SRMR = 0.07 (Figure 2). The model accounted for 16% ($p < 0.05$) of the explained variance in children's emotional lability/negativity and 52% ($p < 0.001$) of the variance in externalizing problems. In terms of main effects, DBV predicted higher levels of children's externalizing problems, $b = 0.49$, SE = .16, $p < .01$, and emotional lability/negativity, $b = 0.51$, SE = .21, $p < .05$, suggesting it was detrimental for children's regulatory development. DBV was negatively related to dyadic positive behavior, confirming it was disproportionately made up of transitions among negative behavioral states. Contrary to expectations, maternal depressive symptoms were not correlated with DBV.

There were also significant interaction effects. The interaction between maternal depressive symptoms and DBV predicted children's emotional lability/negativity, $b = 0.31$, SE = .13, $p < .05$. An analysis of simple slopes, $F(77, 3) = 2.27$, $p = .05$, $R^2 = .08$, revealed that no significant relationship between mother-child DBV and child negativity/lability was observed at mean, $b = 0.06$, $t(77) = 0.55$, $p = .58$, and lower levels of depressive symptoms (1 SD below the mean), $b = -0.25$, $t(77) = -1.47$, $p = .15$. However, when maternal depressive symptoms were higher (1 SD above the mean), higher levels of mother-child DBV predicted greater child negativity/lability, $b = 0.37$, $t(77) = 2.27$, $p < .05$ (Figure 4a). Effects of DBV on the other outcome, child externalizing problems, were not moderated by maternal depressive symptoms.

The interaction between mother-child DBV and dyadic positive behavioral content also

predicted children's emotional lability/negativity, $F(90, 3) = 2.56$, $p = .05$, $R^2 = .08$. An analysis of simple slopes revealed that no significant relation between DBV and child negativity/lability was observed at mean, $b = 0.06$, $t(90) = 0.57$, $p = .57$, and higher levels of positive content (1 SD above the mean), $b = -0.20$, $t(90) = -1.47$, $p = .14$. However, when positive behavioral content was lower (1 SD below the mean), higher levels of DBV predicted greater child negativity/lability, $b = 0.32$, $t(90) = 2.21$, $p < .05$ (Figure 4b).

Paternal depressive symptoms model. Model fit for the model with paternal depressive symptoms was also good, χ^2 (18) = 24.19, n.s.; CFI = 0.95, RMSEA = 0.04, SRMR = 0.07 (Figure 3). The model accounted for 16% ($p < 0.05$) of the explained variance in children's emotional lability/negativity and 55% ($p < 0.001$) of the variance in children's externalizing problems. In terms of main effects, DBV once again directly predicted higher levels of children's externalizing problems, $b = 0.56$, SE = .16, $p < .001$, and emotional lability/negativity, $b = 0.59$, SE = .21, $p < .01$, similar to the model for mothers. DBV was also once again negatively correlated with dyadic positive behavior. Additionally, unique to the paternal model, paternal depressive symptoms were negatively correlated with mother-child dyadic positive behavioral content, and DBV was positively correlated with children's baseline externalizing problems.

With respect to interaction effects, the effects of mother-child DBV on child emotional negativity/lability were significantly moderated by paternal depressive symptoms, $b = 0.31$, SE = .12, $p < .01$, similar to the model for mothers. However, in a post-hoc analysis of simple slopes the overall effect was not significant, $F(70, 3) = 1.70$, $p = .17$, $R^2 = .06$, despite the fact that the effects at the parameter level were significant and in the same direction as the effects for mothers' depressive symptoms in comparable post-hoc analyses. Parameter effects showed that only at higher levels of paternal depressive symptoms, higher mother-child DBV predicted

greater emotional negativity/lability in children, $b = 0.37$, $t(70) = 2.08$, $p < .05$ (Figure 4c).

Additionally, the effects of mother-child DBV on child externalizing problems were significantly moderated by paternal depressive symptoms, $b = 0.21$, SE = .10, $p < .05$. An analysis of simple slopes, $F(70, 3) = 7.41$, $p < .001$, $R^2 = .24$, revealed that no significant relation between mother-child DBV and child externalizing was observed for lower depressive symptoms (1 SD below the mean), $b = 1.82$, $t(70) = 1.62$, $p = .11$, but higher levels of mother-child DBV predicted greater externalizing problems at both mean, $b = 3.23$, $t(70) = 4.41$, $p < .001$, and higher levels of paternal depressive symptoms, $b = 4.64$, $t(70) = 3.81$, $p < .001$ (Figure 4d). Also, the interaction between higher mother-child DBV and lower dyadic positive behavioral content once again predicted higher emotional lability/negativity in children, which was unsurprising given that these particular variables did not differ across models for mothers and fathers.

Discussion

Dynamic patterns of parent-child interaction vary by parental depressive symptoms and may act as mediators or moderators of risk transmission in early childhood, influencing the development of children's self-regulation (Lunkenheimer et al., 2013). This study extended this research to test whether and how dyadic variability in parent and child behavior was more or less adaptive for children's regulatory development in the context of parental depressive symptoms. We learned mother-child variability in goal-directed behavior predicted higher child emotional negativity/lability only when mothers or fathers had higher depressive symptoms, and higher externalizing problems only when fathers showed mean or high depressive symptoms. Further, dyadic behavioral variability was only maladaptive when positive interaction content was low. Contrary to expectation, we did not find the reverse to be true, that dyadic behavioral variability was adaptive when depressive symptoms were low or positive content was high. Overall, this

suggests higher behavioral variability in this analysis reflected the dyadic negative behaviors and disciplinary inconsistency associated with parental depressive symptoms and child dysregulation shown in prior research (Lovejoy et al., 2000). These findings suggest that dyadic behavioral variability combined with low positive content in parent-child interactions is a particular risk factor for children's regulatory development when parents have higher depressive symptoms.

Dyadic Inconsistency in Families at Risk

Some types of behavioral variability may be adaptive, for example, parents shifting behavior to suit child needs, or dyads attempting multiple strategies to solve a problem (Tronick, 1989). But in the context of parental depressive symptoms, we did not find these adaptive processes. Rather, dyadic variability in the presence of higher symptoms appeared to reflect less adaptive, inconsistent behavior, such as parents having difficulty maintaining limits or children struggling to comply with requests (Lunkenheimer et al., 2016). This finding aligns with prior work on depressive symptoms and inconsistency in parenting (Goodman & Gotlib, 1999; Lovejoy et al., 2000), but extends it to inconsistency in dyadic interaction patterns. It is likely that child impairments in emotion regulation resulting from parental depressive symptoms, such as persistent sadness or dysregulated fear (Cole et al., 2008), are exacerbated when parent-child interactions that children rely upon for security and socialization are unpredictable and negative. Descriptive analyses confirmed that neither parent and child contributed disproportionately to variability, thus these problematic patterns were a function of both parent and child.

Depressive symptoms are characterized by emotion regulation difficulties (Beauchaine & Thayer, 2015), which may lead parents with higher depressive symptoms to respond reactively rather than formulating responses that are attuned to the needs of the child and the situation (Psychogiou & Parry, 2014). These difficulties may be elevated in response to children's

misbehavior (Lunkenheimer et al., 2016). Heightened dyadic inconsistency may also be driven by children's temperamental dispositions towards emotional and behavioral lability. Children of depressed parents experience more behavior problems (Murray et al., 2001) and difficult child temperament may exacerbate parents' depressive symptoms and prompt dysregulation in interactions with parents due to children's self-regulation deficits (Hammen, 2009; Hoffman et al., 2006). Collectively, the interaction of these child, parent, and dyadic processes may exacerbate child dysregulation over time. Though our sample was not characterized by higher behavior problems, variability was negatively correlated with child age. Younger children may have shown more behavioral variability due to fewer internalized regulatory skills and/or parents may have had more challenges parenting younger children consistently due to these lesser skills. Future research could examine whether parent, child, or both are driving these patterns.

The Adaptive vs. Maladaptive Nature of Dynamic Interaction Patterns

Most research on dynamic patterns in the family system has arisen from a developmental psychopathology framework with the goal of understanding mechanisms by which risk is transmitted from parent to child (Granic et al., 2007; Hollenstein et al., 2004). Accordingly, the adaptive or maladaptive nature of dynamic patterns can be inferred from their relations to specific risk factors and theoretical and empirical evidence supporting those relations. However, one should also consider the age of the child, the domain of behavior in question (e.g., affect expression, disciplinary behavior, socialization), the valence of the behavior (e.g., positive vs. negative), and the nature of the assessment (e.g., unstructured tasks, structured tasks, or naturalistic observations) when inferring whether dynamic processes are adaptive vs. maladaptive. For example, dyadic *affective* variability has been shown to be *adaptive* in relation to psychopathology, which makes sense given that rigidity in negative emotion, behavior, and

cognition is a common component of mental health symptoms (e.g., depressive symptoms, anxiety, hostility; Lunkenheimer et al., 2016). However, we found that dyadic *behavioral* variability was *maladaptive* for child outcomes in the context of parental depressive symptoms. Thus, we can conclude that variability in goal-directed behavior and low positivity in the context of free play is a risk factor for children with parents with higher depressive symptoms, but these findings may not necessarily extend, for example, to other forms of behavior or all types of tasks. We should continue to be cautious in future work to note how and why particular dynamic patterns are adaptive vs. maladaptive given the behavioral content and context in question.

Accordingly, the present findings raise certain implications for methodology. First, dynamic measures of interaction may sometimes require more value-free terms such as "variability" (e.g., vs. "flexibility") to ensure we do not make incorrect a priori presumptions about the adaptive or maladaptive nature of these processes. Second, inclusion of interaction content continues to be essential in research on dynamic interaction processes given that patterns may have differential meanings in relation to positive vs. negative content. Third, relations may not always be linear, therefore analytic approaches could include the testing of curvilinear effects considering that the extremes of too much or too little of a particular pattern may be maladaptive; for example, Lougheed and Hollenstein (2016) found that mid-range levels of socioemotional flexibility in parent-adolescent interactions were associated with lower mental health symptoms, whereas low flexibility was associated with higher symptoms and high flexibility was not related. Fourth, we need more research on dynamic interaction patterns as normative socialization factors in child development, i.e., not only in relation to psychopathology risk.

Fathers' Depressive Symptoms Matter

The present findings support the need to study paternal effects on dyadic and child

processes. Maternal and paternal depressive symptoms interacted similarly with mother-child behavioral variability in increasing child *emotional* dysregulation over time. However, only fathers' depressive symptoms interacted with dyadic behavioral variability to impact child *behavioral* dysregulation. Thus, paternal symptoms had effects on both emotional and behavioral domains. Fathers may have stronger effects on child behavior due to their sometimes larger role in discipline in heterosexual two-parent families (Cox & Paley, 1997); however, given prior evidence of maternal symptom effects on externalizing (Goodman et al., 2011), it seems more likely that in our case, controlling for maternal ratings of Time 1 externalizing may have reduced the variance with which to discover effects on externalizing outcomes in the mother model.

Father effects may reflect crossover where fathers' symptom effects are transferred to maternal or child behavior, in turn influencing mother-child dynamics (Erel & Burman, 1995; Ponnet et al., 2013). Fathers' symptoms may also affect mother-child interactions through the breakdown of cooperative coparenting (Williams, 2018). Non-depressed fathers may provide more support when mothers have higher symptoms, and positive interactions with fathers are protective for children whose mothers are depressed (Nelson, O'Brien, Blankson, Calkins, & Keane, 2009; Vakrat, Apter-Levy, & Feldman, 2018). Thus, healthy relationships with fathers may compensate for the effects of negative mother-child interactions on children's regulatory difficulties. However, fathers' own symptoms may also interfere with their ability to offer compensatory behaviors such as warmth, engagement, and support (Wilson & Durbin, 2010).

Relatively little prior work on parental depressive symptoms and child outcomes has analyzed moment-to-moment parent-child behavioral exchanges as covariates or mechanisms of transmission. In this work, it is important to consider the intersection of family systems and dynamic systems processes. For example, if children are experiencing inconsistency and/or

negativity in interactions with depressed fathers, this dynamic pattern of behavior may spillover to interactions with mothers (Erel & Burman, 1995). Alternatively, if inconsistency is present in one parent-child dyad, perhaps it is in response to, or serves to trigger, an opposite pattern in the other parent-child dyad, indicating a compensatory process (Cox & Paley, 1997). More work on father-child interaction dynamics is needed to determine the extent to which the child's interactions with one depressed parent are related to interactions with the other. Additionally, more research is needed that includes same-sex parents to understand the degree to which such co-occurring patterns are characteristic of co-parents regardless of biological sex.

Implications for Practice

Depression is highly prevalent in parents of young children (Hammen, 2009). As such, understanding the modifiable mechanisms of symptom transmission from parent to child is crucial, particularly during early childhood when symptoms are first expressed and regulatory development is active. Our findings suggest that greater negativity and inconsistency in common behaviors between parents and preschoolers (e.g., guidance, discipline, compliance) contributed to more emotional and behavioral dysregulation in children. These findings may point to intervention strategies with parents with higher depressive symptoms. Intervention efforts could center on increasing consistency in everyday exchanges, such as consistency in limit-setting, responses to child bids, provision of autonomy support, or family routines. Depressive symptoms are associated with poorer cognitive flexibility, therefore parents may become overwhelmed if presented with too many new strategies to manage children's behavior (Barrett & Fleming, 2011). It may be more beneficial to teach parents with depressive symptoms one or two effective strategies that they can use in many situations, for example, a specific reward system for positive child behavior or mirroring children's behavior and speech (Dozier, Bernard, & Roben, 2002).

Greater consistency may be beneficial with young children who are prone to emotional lability (Field et al., 2007; Gotlib et al., 2014). Our results also underscore the importance of including fathers who experience symptoms of depression in family interventions. Taken together with prior research indicating that increases in affective flexibility characterize families who improve in intervention (Granic et al., 2007), these findings suggest that family interventions with a depressed parent could benefit from a focus on improving dyadic consistency around goal-directed and disciplinary behaviors, as well as increasing dyadic affective flexibility.

Strengths and Limitations

A strength of this study was the application of a dynamic systems framework and SSG methodology to model dyadic behavioral variability in real time. This approach allowed us to separate variability from behavioral content to examine each as distinct predictors of child outcomes. Other strengths included attention to fathers and a longitudinal model that allowed us to test the effects of dyadic parent-child processes on children's developing self-regulation. Additionally, certain limitations must be noted. We relied on mother reports of child outcomes, which could have been influenced by negative perceptions of child behavior among mothers with higher depressive symptoms (Goodman et al., 2011). Only 11% of mothers and 12% of fathers exhibited clinical levels of depression on the CES-D, so results may not be generalizable to parents with a diagnosed depressive disorder. The sample of families was majority White and married with higher education and income levels and thus findings will need to be replicated to extend to other sociodemographic groups. Finally, the dyadic behavioral patterns observed in this study may not be specific to depressive symptoms and may characterize other symptoms of psychopathology or general distress, as disturbances in parent behavior are associated with a variety of disorders (e.g., anxiety, personality disorders; Lovejoy et al., 2000).

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Table 1

Means, standard deviations, and bivariate correlations among study variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	*M*	*SD*	*N*
1. DBV (# transitions)	--									67.57	22.18	94
2. Paternal Depressive Symptoms	-.13	--								6.98	6.16	86
3. Maternal Depressive Symptoms	-.10	.05	--							7.53	7.27	100
4. Child Lability/Negativity T2	.05	.03	.04	--						25.21	4.92	87
5. Child Externalizing T1	.19†	.08	.08	.02	--					10.64	6.63	100
6. Child Externalizing T2	.42***	.07	.12	.11	.64***	--				7.91	7.34	91
6. Dyadic Positive Behavior (seconds)	-.22*	-.17	-.14	-.02	.01	-.12	--			355.50	60.84	94
7. Maternal Education	-.18†	-.29**	-.25*	-.13	-.25*	-.15	.06	--		6.73	1.24	100
8. Child Age (months)	-.23*	-.09	-.13	.01	-.04	-.18†	.11	.06	--	41.00	2.97	100

† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

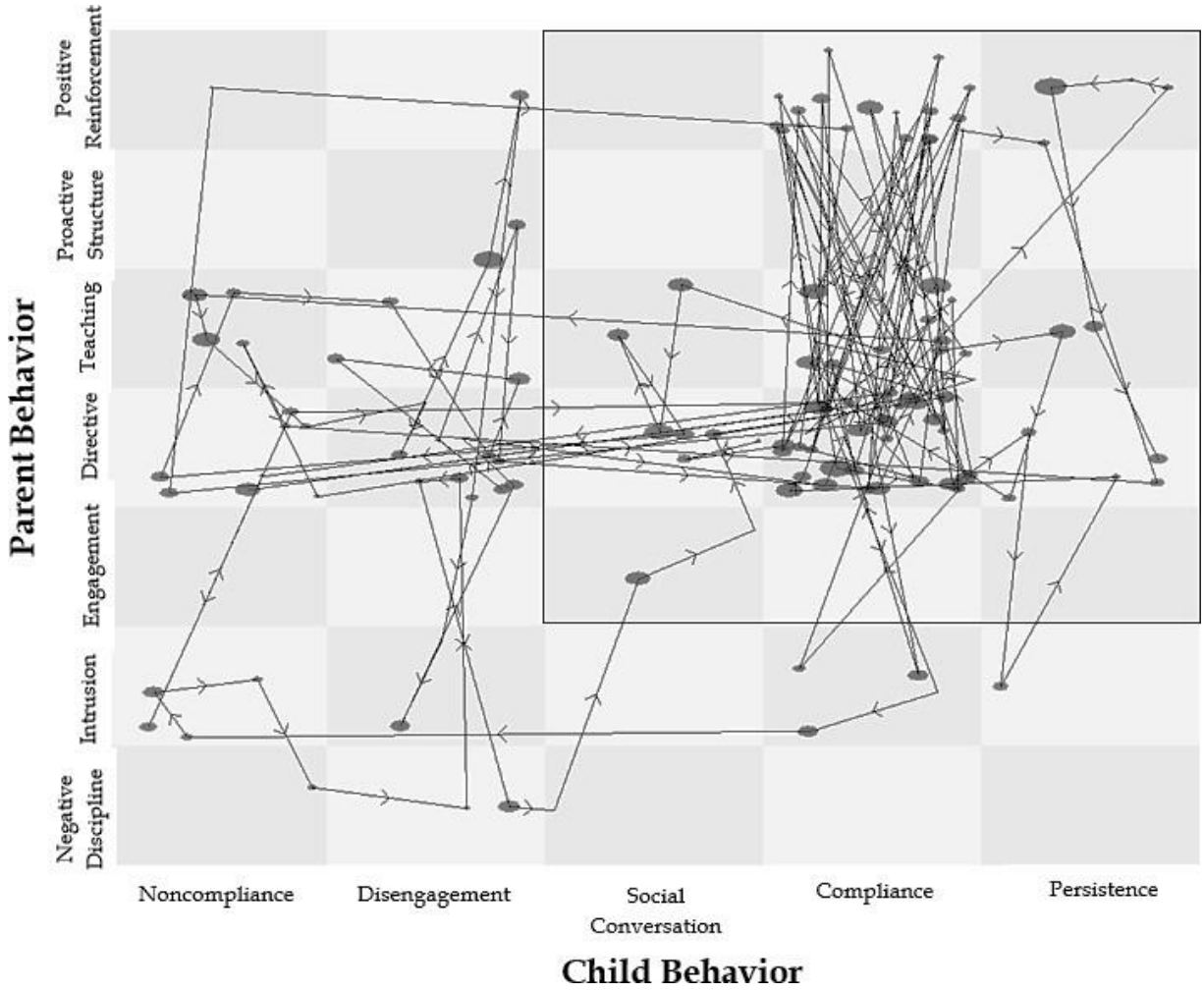

Figure 1. State Space Grid depicting a trajectory of parent-child behavior throughout the course of a free play task. Circles vary in size based on the duration of time spent in a particular behavioral state, with larger circles denoting more time. Lines indicate transitions between dyadic states and arrows show the direction of transitions; dyadic variability was measured as the total number of those transitions. The highlighted region reflects dyadic states characterized by mutual positive behavior in parent and child; dyadic positive behavior was measured as the total duration of dyadic behavior occurring within this region.

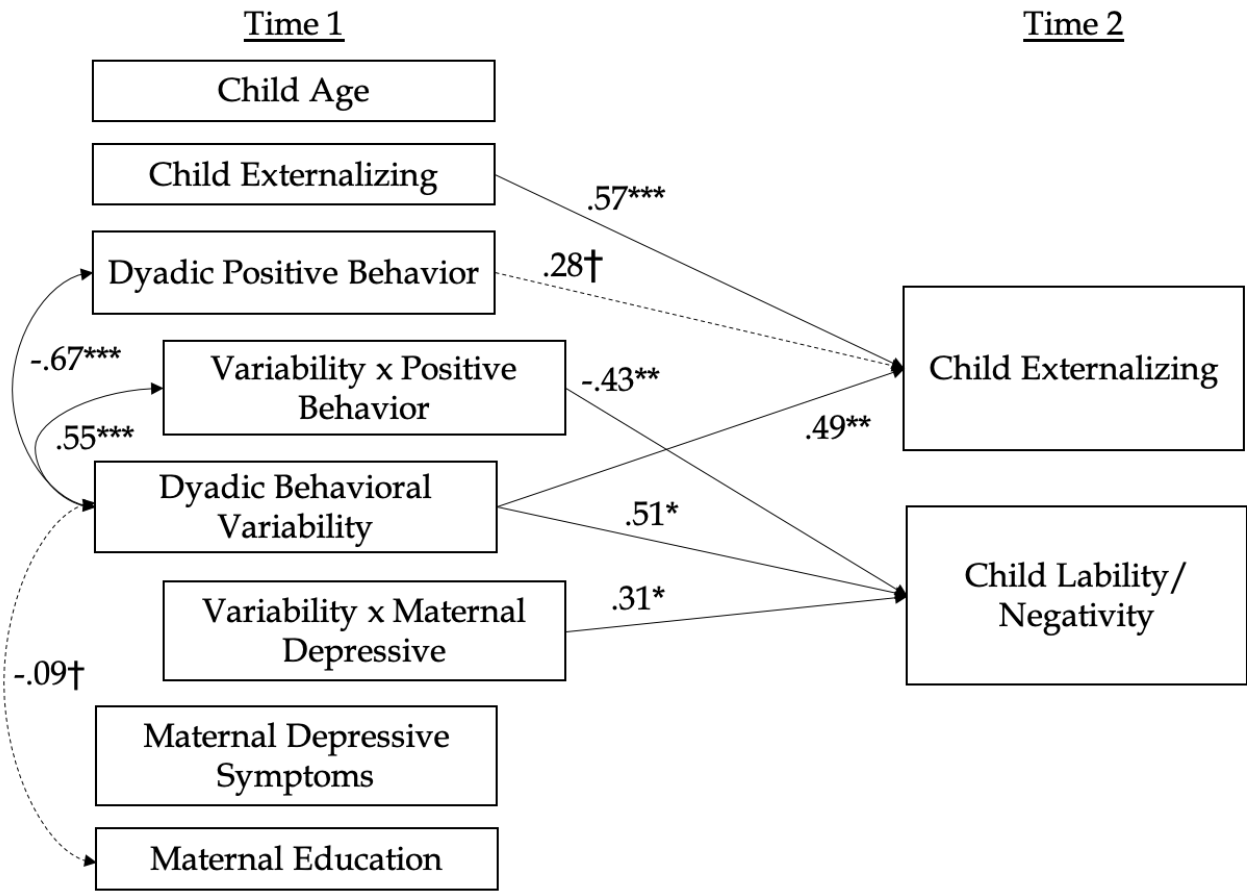

Figure 2. Path model examining the relations among maternal depressive symptoms, mother-child behavioral variability, and child externalizing problems and emotional negativity/lability. Note: † $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

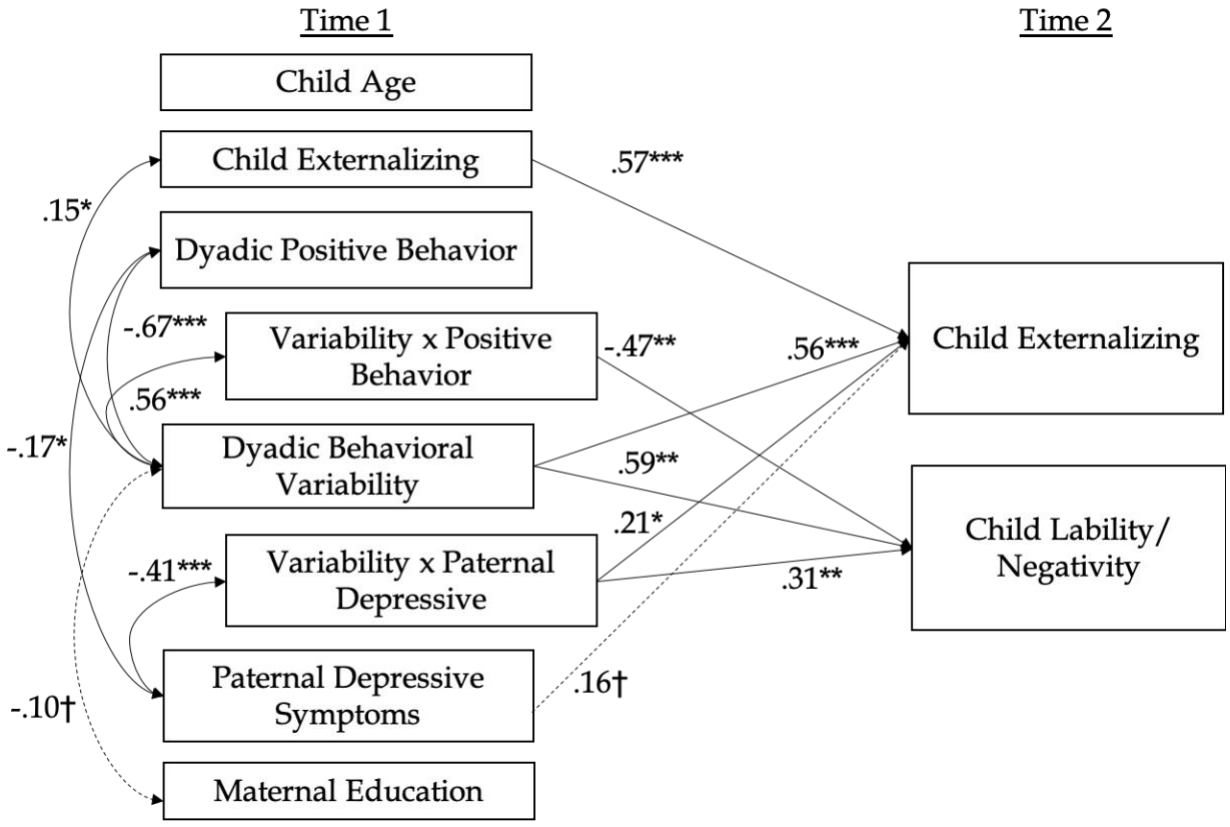

Figure 3. Path model examining the relations among paternal depressive symptoms, mother-child behavioral variability, and child externalizing problems and emotional negativity/lability. Note: † $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

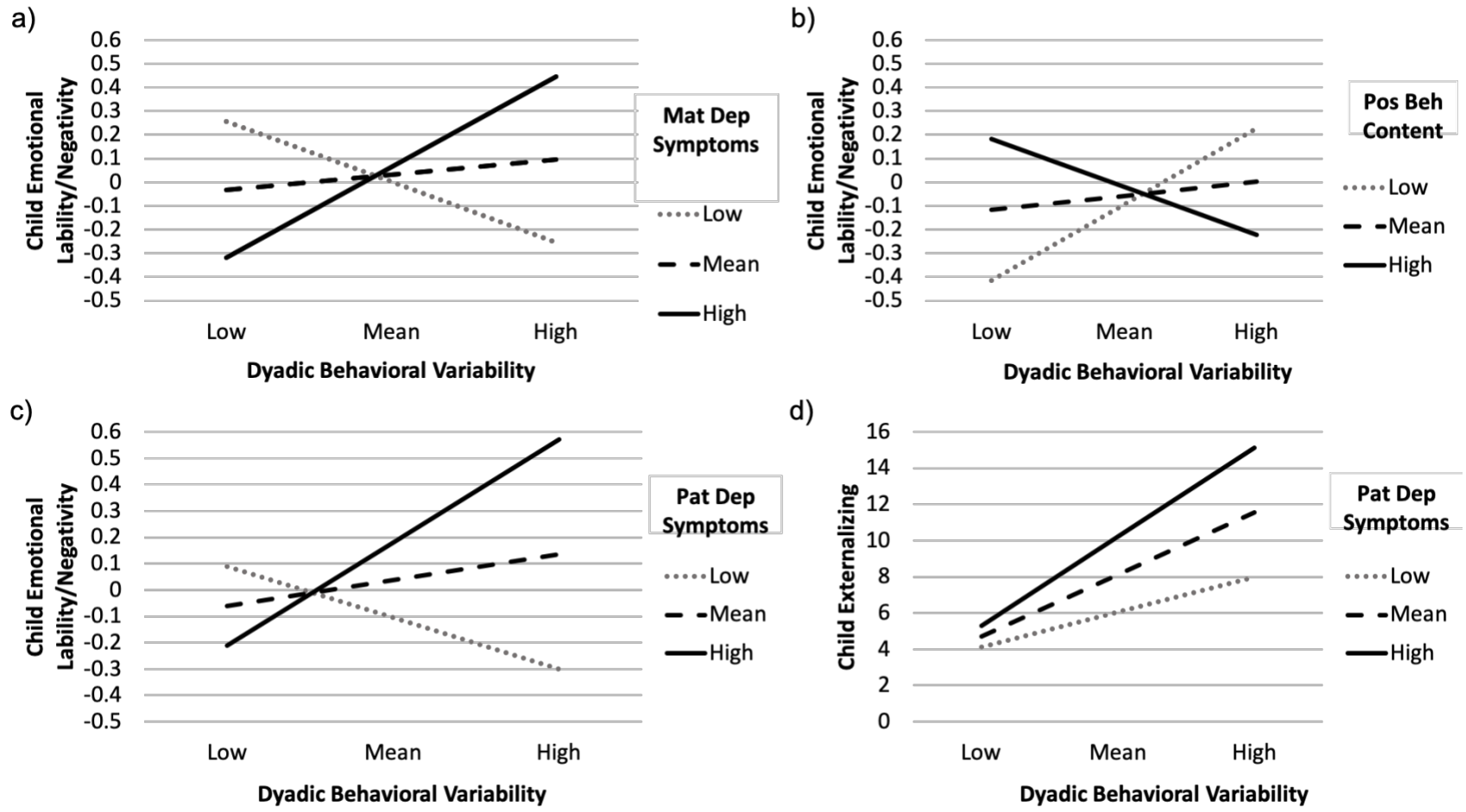

Figure 4. Graphs depicting simple slopes for the moderating effects of (a) maternal depressive symptoms, (b) dyadic positive behavioral content, and (c) paternal depressive symptoms on the relations between mother-child dyadic behavioral variability and child emotional negativity/lability; as well as the moderating effects of (d) paternal depressive symptoms on the relation between dyadic behavioral variability and child externalizing problems. Note: Low, mean, and high depressive symptoms are based on -1 SD, mean, and +1 SD levels. Mat Dep = maternal depressive symptoms; Pos Beh = positive behavioral content; Pat Dep = paternal depressive symptoms.