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Mother–Adolescent Emotion Dynamics During Conflicts: Associations With Perspective Taking

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Parent–adolescent emotion dynamics are central to psychosocial adjustment during this developmental period. Perspective taking—the ability to take another's point of view into consideration—develops significantly during adolescence and is important for successful interpersonal functioning in contexts such as conflicts between family members. We used grid-sequence analysis (Brinberg, Fosco, & Ram, 2017) to examine interdyad differences in mother–adolescent emotion dynamics during a conflict discussion, and whether interdyad differences were associated with maternal and adolescent perspective taking. Mothers and their typically developing adolescents (N = 49, M_{age} = 14.84 years) were video-recorded during a 10-min conflict discussion. We identified patterns of multistep chains of expressed emotions that unfolded during the conflict and how interdyad differences in those patterns were associated with maternal and adolescent perspective taking. Dyads differed with respect to whether they showed turn taking in validation and interest behaviors, or whether they showed patterns of reciprocated negative affect. Higher adolescent but not maternal perspective taking was associated with dyadic turn taking of validation and interest. Maternal and adolescent perspective taking were not associated with the pattern of reciprocated negative affect. Taken together, results highlight the importance of examining the complex process of emotion dynamics in parent–adolescent interactions.

Keywords: parent–adolescent conflict, emotion dynamics, adolescence, perspective taking

Relationships between primary caregivers and children transform during adolescence. Specifically, the relationship tends to become less hierarchical and more egalitarian as adolescents exercise increasing autonomy and establish close relationships outside of the family (e.g., peers, romantic partners; Smetana, Campione-Barr, & Metzger, 2006). At the same time, interactions between caregivers and adolescents tend to become more intense and conflictual (Laursen & Collins, 2009). These changing family dynamics are likely related to adolescent emotional developments such as increased emotional intensity and lability (Rosenblum & Lewis, 2003). How caregivers and adolescents navigate the dynamics of their transforming relationship sets the stage for psychosocial adjustment and well-being in the relationship (Lougheed, 2019a). However, there are considerable individual differences in how smoothly caregiver–adolescent dyads navigate these changes. Perspective taking—the ability to see things from another's point of view (Davis, 1983)—considerably improves across adolescence (Eisenberg, Cumberland, Guthrie, Murphy, & Shepard, 2005) and is related to interpersonal dynamics between caregivers and adolescents (Disla, Main, Kashi, & Boyajian, 2019). The goal of the current study is to examine mother–adolescent emotion dynamics during conflict interactions and their associations with mother and adolescent perspective taking.

Emotion dynamics have long been considered a central feature of parent–child relationships (e.g., Bowlby, 1988). Emotions are constructed and regulated in the context of interpersonal interactions (Campos, Walle, Dahl, & Main, 2011), which, through repetition over development, coalesce into stable relationship patterns (Granic, 2005). Relationships between family members can be conceptualized as temporal interpersonal emotion systems (TIES) from the dynamic systems perspective (Butler, 2011; Lougheed, 2019b). TIES are dyadic systems that emerge from the temporal coordination of two interacting individual's moment-to-moment emotions. In the context of a close relationship (e.g., parent–child dyad), interpersonal patterns of emotions may form through repetition over development and eventually become char-

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acteristic of the dyadic system. For example, some dyads may be prone to conflict and the two individuals may quickly escalate anger during interactions, which in turn may increase the likelihood of future conflict. The conceptual framework of TIES emphasizes the use of dyadic time series methods to examine how emotions unfold over time, rather than the more common approaches of aggregating observed behaviors across time into summary statistics such as frequencies and durations (Butler, 2011; Lougheed, 2019b). In the current study, we conceptualize mother–adolescent dyads as TIES by examining complex patterns of dyadic emotion states during a conflict interaction.

Emotion Dynamics in Mother–Adolescent Dyads

A small but growing body of research has examined mother–adolescent emotion dynamics as they unfold during interactions. Some of this work has focused on the interpersonal regulation of negative emotions. Negative emotions can be up-regulated (i.e., amplified) during interpersonal interactions such as when partners respond in kind to each other's negative emotion expressions. This dynamic is called negative emotion reciprocity (Butler, 2011). Adolescents may be more likely than mothers to reciprocate negative emotion expressions, whereas mothers may be more likely to respond with a positive expression to their adolescent's negative emotion expression (Van Bommel, Van der Giessen, Van der Graaff, Meeus, & Branje, 2019). Maternal tendencies to de-escalate negative emotion dynamics with their adolescents may play a role in adolescents' healthy psychosocial adjustment (Moed et al., 2015). Moreover, adolescents' tendencies to drive negative emotion dynamics may vary by age, with older adolescents being more likely than younger adolescents to initiate negative emotion expressions (Main, Paxton, & Dale, 2016). In contrast, adolescents whose mothers supportively validate them tend to have greater psychosocial adjustment (Lougheed et al., 2016). Maternal validation may serve the function of facilitating greater closeness in the mother–adolescent relationship—adolescents are more likely to disclose personal information following maternal expressions of validation and interest (Disla et al., 2019). Taken together, variations in mother–adolescent emotion dynamics (e.g., validation and support, negative reciprocity) are associated with features of the mother–adolescent relationship and psychosocial adjustment.

Studies of mother–adolescent emotion dynamics to date have largely focused on chains of behavior consisting of two steps, such as one person's observed response to the other person's expressed emotion (e.g., Lougheed et al., 2016; Main et al., 2016; Moed et al., 2015; Van Bommel et al., 2019). Such studies provide foundational knowledge regarding interpersonal contingencies and provide some insight into the process of emotion dynamics. However, interpersonal interactions typically consist of complex patterns that unfold over multiple steps, but only one study to date has examined such complex multistep chains of behavior (Lougheed, Brinberg, Ram, & Hollenstein, 2019). Thus, there is a lack of knowledge regarding how emotion dynamics unfold over the entire history of a mother–adolescent interaction. The ability to identify specific multistep chains of parent–adolescent emotions has the potential to be extremely useful in clinical settings where clinicians working with families may need to identify and help resolve problematic family patterns (e.g., Granic & Patterson, 2006; Patterson, 1982).

Emotion Dynamics and Perspective Taking

Perspective taking is defined as the ability to take another's point of view into consideration and is generally considered a dimension of empathy in affective contexts (Davis, 1983). In the context of social interactions, especially those involving emotion and conflict, perspective taking is important because it allows individuals to understand and appreciate the point of view of the social partner (Halpern, 2001; Van Lissa, Hawk, & Meeus, 2017). Conflict inherently involves discrepant viewpoints, often accompanied by negative emotion, making it more difficult to understand another's perspective (Broome, 1993; Halpern, 2007). Perspective taking is central to successful conflict resolution because it necessitates cooperative efforts to resolve such differences in viewpoints (Main, Walle, Kho, & Halpern, 2017). Indeed, appreciation of the partner's point of view is related to fewer conflict-escalating behaviors and more constructive problem-solving behaviors in social interactions (Davis, 2018).

Though few studies have examined links between parent or adolescent perspective taking and family emotion dynamics, a great deal of research has established that parents' empathy more broadly in response to their children's emotions is crucial for promoting positive child adjustment and for fostering children's own empathy. Parents who are sensitive and responsive to their children in emotional contexts send the message that others' emotional needs are important, which promotes the development of empathy in children (e.g., Dunn & Brown, 1994). Gottman, Katz, and Hooven's (1996) emotion coaching framework suggests that when parents respond supportively to their children's emotions, children learn about the causes and consequences of emotions in themselves and others. Indeed, parents' empathic responses to their children's negative emotions (i.e., with validation and support) are associated with children's better psychosocial adjustment (Lougheed et al., 2016; Lougheed, Hollenstein, Lichtwarck-Aschoff, & Granic, 2015). Furthermore, mothers and adolescents who engage in a turn-taking pattern of validating one another evident more subjective satisfaction with the outcome and process of a conflict discussion (Main et al., 2016). In the present study, we focused on the more cognitive (vs. affective) empathy construct of perspective taking because it has been found to be associated with better conflict resolution than affective empathy (Van Lissa, Hawk, Branje, Koot, & Meeus, 2016).

To our knowledge, only one study has examined adolescent perspective taking and its associations with parent–adolescent dynamics. Disla et al. (2019) found that adolescents who self-reported high levels of perspective taking tended to follow up on previous disclosures with more disclosure of personal information, but only when mothers had responded to their previous disclosures with interest. This suggests that adolescents with good perspective-taking abilities are better able to appreciate the mothers' goal of obtaining more information about the adolescent when they expressed interest. Taken together, previous research suggests that parent–adolescent emotion dynamics may be related to individual differences in perspective taking. Given the central role of perspective taking in effective conflict management (e.g., Halpern, 2007), and the increase in conflict between parents and children during adolescence (Laursen & Collins, 2009), understanding associations between emotion dynamics and perspective taking between parents and adolescents holds implications for facilitating better parent–child communication during this developmental period.

The Current Study

In the current study, we examined mother–adolescent emotion dynamics and their associations with both maternal and adolescent perspective taking. We used a new approach called grid-sequence analysis (Brinberg, Fosco, & Ram, 2017; Brinberg, Ram, Hülür, Brick, & Gerstorf, 2018) to visualize, examine, and quantify patterns of mother–adolescent emotion expressions. This approach combines data visualization from state space grid methods used in developmental psychology (Hollenstein, 2013) with sequence analysis from biology (Kruskal, 1983) to examine interdyad differences in multistep patterns of dyadic emotion expressions. In this approach, "sequence" refers to the entire series of dyadic states observed for one dyad during the entire observation period (here, during a video-recorded conflict discussion). "Subsequence" refers to any portion of a sequence, such as a multistep chain of dyadic behavior. Using this approach, we conceptualized interpersonal dynamics in terms of multistep chains of dyadic states. This approach differs from more common approaches to interpersonal dynamics such as examining the likelihood of one partner's behavior given the other partner's previous behavior, controlling for base rates in behavior (Butler, 2011). Our approach considers multistep chains of dyadic (rather than individual) behavior, and thus incorporates both partners' emotion states simultaneously and when they consider in relation to one another. We examined if and how interdyad differences in subsequences were related to maternal and adolescent perspective taking.

Our first research question regarded whether there were interdyad differences in patterns of mother–adolescent emotion expressions during the conflict discussion. We used grid-sequence analysis in a data-driven way to identify subsequences of mother–adolescent emotion expressions that characterized differences between dyads in the sample. This research question was exploratory as only one study to date has examined such multistep subsequences greater than two turns in mother–adolescent interactions (Lougheed et al., 2019), and this one study did not examine conflict interactions. However, as previous research has identified reciprocated negative emotion expressions in parent–adolescent interactions (Main et al., 2016; Moed et al., 2015), we expected that some dyads may tend to show patterns characterized by negative reciprocity more than others.

Our second research question asked if interdyad differences in emotion dynamics were associated with maternal and adolescent perspective taking. Perspective taking is associated with parent–adolescent dynamics (Disla et al., 2019). We expected that greater maternal and adolescent perspective taking would be negatively associated with emotion dynamics characterized by negative reciprocity and positively associated with emotion dynamics characterized by validation and interest.

The current study is among the first to use grid-sequence analysis with observed dyadic emotion expressions. We controlled for the entropy of dyadic sequences in our test of our second research question to examine if emotion dynamics identified by grid-sequence analysis provide information beyond what is explained by a currently used method. Entropy is a general sequence-level quantification of the "unpredictability" of mother–adolescent emotion expressions (e.g., Van der Giessen, Branje, Frijns, & Meeus, 2013). Thus, we examined if emotion dynamics were related to perspective taking above and beyond the overall variability of emotion dynamics as captured by entropy. We also controlled for adolescent age and sex, given that both characteristics have been associated with mother–adolescent dynamics (e.g., Eisenberg et al., 2008; Main et al., 2016).

Method

Participants

Participants were 50 adolescents (30 female; M_{age} = 14.84 years, SD = 1.99, range = 13–18 years) and their mothers who participated in a study on mother–adolescent conflict (see Main et al., 2016). One dyad from the younger age group was excluded from the analyses due to an error in researcher instruction, resulting in analysis of 49 dyads. The racial/ethnic composition of the sample is as follows: 62% non-Hispanic White, 16% non-Hispanic Black, 10% Asian or Pacific Islander, 4% Hispanic, and 8% other. Maternal education ranged from a high school degree to an advanced graduate degree, with the median highest degree obtained being a bachelor's degree (36.0%). Families' annual income ranged from less than $25,000 per year to more than $150,000 per year, with the average family income being $81,000–$100,000.

Procedure

The research was approved by the Institutional Review Board at the UC Berkeley Committee for Protection of Human Subjects (protocol number 2011-05-3248). Mothers and adolescents were recruited from local communities in the San Francisco, California, Bay Area through schools, teen afterschool programs, parenting groups, and parent newsletters. Mothers and adolescents participated in a 1.5-hr laboratory visit. A research assistant orally reviewed the informed consent form with the mother and adolescent both present. Mothers read and signed an informed consent form, and adolescents completed an assent form, and 18-year-old adolescents completed an informed consent form.

Mothers and adolescents independently identified two topics that they felt caused the most disagreement in their relationship using the modified version of the Issues Checklist (Prinz, Foster, Kent, & O'Leary, 1979) and subsequently discussed these topics for 10 min each without a researcher present. Mothers and adolescents sat across from one another (approximately one meter apart) at a small table. Two visible video cameras (one facing each participant) captured the participants from the top of the head to the midchest. The conversations were monitored via one-way mirror. After 10 min had elapsed, a research assistant reentered the room and signaled the end of the discussion. Mothers were given a $20 check, and adolescents were given a $20 gift card for participating.

Measures

Observed emotions. The Specific Affect Coding System (SPAFF Version 4.0; Coan & Gottman, 2007) was used to code mother and adolescent emotions observed during the conflict discussions (see Main et al., 2016). The SPAFF is divided into positive, negative, and neutral codes, with specific emotions within each broad dimension. The SPAFF considers a gestalt of verbal content, voice tone, context, facial expression, gesture, and body movement cues in determining the presence of each emotion, meaning codes could be verbal, nonverbal, or both. Trained observers coded mothers and adolescents separately with event-based coding, which means that observers indicated the onset and offset time of each emotion (see Bakeman & Quera, 2011). This process resulted in two time-synchronized streams of emotion behavior, one for mother and one for adolescents. SPAFF codes were assigned in a mutually exclusive and exhaustive manner, meaning that only one code was applied to capture behavior at any given unit of time.

SPAFF codes were recorded using Mangold INTERACT (Version 14; Mangold, 2017). The senior author trained two undergraduate research assistants to reach 75% agreement on training videos across all codes prior to the start of coding. Reliability was based on second-by-second concordance of observers' codes throughout the 10-min interaction. All interactions were coded by the senior author and the two undergraduate coders, with the former serving as the "gold standard" to which other observers' codes were compared, as recommended by Coan and Gottman (2007). Weekly calibration checks and discussions were held to minimize coder drift. Reliability was checked for each dyad, and a minimum of 75% agreement across all SPAFF codes was required in order for the data to be included in the final analyses. Cohen's kappa was used to calculate interrater reliability. The average kappa across all codes was .77 (range = .62–.88) and .75 (range = .62–.88) for mother and adolescent codes, respectively.

For the current investigation, mother and adolescent emotions were divided into the following categories: dominant negative affect (contempt, belligerence, criticism, domineering, and anger), submissive negative affect (sadness, whining, and tension), defensiveness/stonewalling, disgust, positive affect (humor, affection, and enthusiasm), validation/interest, and neutral affect. These categories were developed based on Halberstadt and Eaton's (2002) meta-analysis on emotional expressions in the context of family interactions.

Entropy. The predictability of each dyadic sequence was quantified using Shannon's (1948) entropy. Specifically,

$$h(p_1, \ldots, p_s) = -\sum_{i=1}^{s} p_i \log(p_i)$$

where s is the number of unique states and P_i is the proportion of occurrences of the ith state in a given sequence (Gabadinho, Ritschard, Müller, & Studer, 2011). If all states in a given sequence are completely predictable from the first state—that is, all states are the same or states alternate between two different ones—entropy is zero. Higher entropy values indicate less sequence predictability in terms of how much information is required to reproduce a sequence (Hollenstein, 2013). We used the *seqient* function of the *TraMineR* package in R (Gabadinho et al., 2011) to calculate sequence entropy.

Perspective taking. The Perspective Taking subscale of the Interpersonal Reactivity Index (Davis, 1980) was used to measure mother and adolescent perspective taking. The 28-item Interpersonal Reactivity Index is a commonly used measure of distinct components of empathy, including perspective taking, empathic concern (other-oriented feelings of sympathy or concern), fantasy (the tendency to imaginatively feel for others), and personal distress (self-oriented feelings of anxiety or unease in response to others' distress). Though the subscales all tap on components of empathy, they are conceptually and empirically distinct (see Davis, 1983). Mothers and adolescents rated on a scale of 1 (*does not describe me well*) to 5 (*describes me very well*) to what degree each statement described them. Sample items for the Perspective Taking subscale include, "I try to look at everybody's side of a disagreement before I make a decision" and "When I'm upset at someone, I usually try to 'put myself in his shoes' for a while." The reliability for the Perspective Taking subscale in the current study for mothers was adequate for mothers (α = .78) and adolescents (α = .75).

Data Analysis

Grid-sequence analysis consists of five steps (Brinberg et al., 2017, 2018). We created dyad-level categorical time series from the raw data in Stage I. Then, in Stage II, we examined interdyad differences in sequences to test our two research questions.

Stage I: Intrafamily analyses. In the first stage of grid-sequence analysis, dyad-level categorical time series data are created by visualizing and quantifying dyadic sequences in grids (Brinberg et al., 2017, 2018). A state space grid is created for each dyad with each member represented on one axis of the grid. Then, grid cells are labeled and these labels are used to extract the categorical dyadic time series.

Step 1: Gridding. First, we mapped the trajectory of observed mother–adolescent emotion states during the conflict discussion in a two-dimensional state space. We created state space grids for each dyad with mothers' observed emotions on the x-axis and adolescents' observed emotions on the y-axis using the *base*, *ggplot2*, and *reshape* packages in R (R Core Team, 2018; Wickham, 2007, 2009). Figure 1A shows the grids containing 49 cells that represent all possible combinations of mothers' and adolescents' SPAFF-based emotion states. Plot points indicate the duration of time spent in each cell, with longer durations being indicated by larger plot points. The trajectory of dyadic states over time is represented by the lines connecting the plot points (Hollenstein, 2013).

Step 2: Obtain sequences. Next, we used letters to label each cell of the grid (see Figure 1A). Then, for each dyad, we extracted the sequence of letters from the grids in the order that the cells were visited. Doing so resulted in a dyad-level categorical time series (see Figure 1B), which is the sequence of time-ordered dyadic emotion expressions (i.e., states, lettered grid cells) during the conflict discussion. These sequences (one per dyad, consisting of the entire series of dyadic states observed) were then represented in a wide-format data frame with one row per dyad and the number of time points (i.e., columns) equal to the number of seconds of each dyad's conflict discussion. This data frame is visually depicted in Figure 2, with each row representing one dyad's sequence and the colors (visually from left to right) indicating the order of cells visited during the discussion.

Stage II: Interdyad differences in emotion dynamics. Interdyad differences in sequences are examined in the second stage of grid-sequence analysis. Our first research question asked whether there were interdyad differences in patterns of mother–daughter emotion expressions during the conflict discussion. We

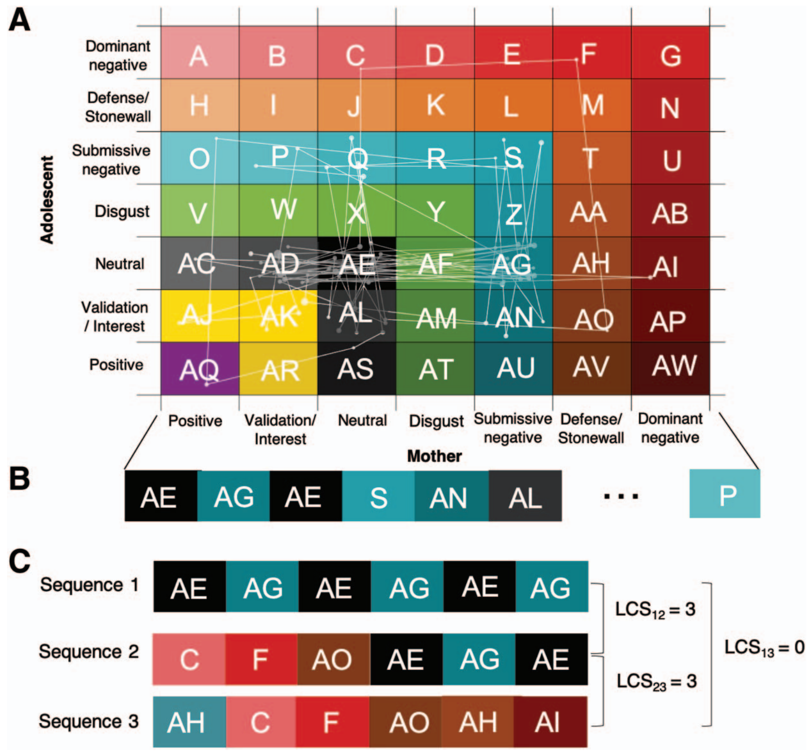

Figure 1. Steps 2 and 3 of grid-sequence analysis. (A) A state space grid for one dyad. (B) The categorical dyadic time series extracted from the state space grid for one dyad. (C) The calculation of the length of the longest common subsequence used in calculating the dissimilarity among three hypothetical dyads' sequences. See the online article for the color version of this figure.

calculated the dissimilarities among all pairs of sequences (see Step 3). Then, we used these dissimilarities to examine interdyad differences using a clustering approach. Our second research question asked if interdyad differences in emotion dynamics were associated with perspective taking. We answered this question by examining associations between interdyad differences in dyadic sequences and perspective taking using a bivariate linear regression.

Step 3: Sequence analysis. Before conducting the cluster analysis, we needed to calculate the dissimilarity (i.e., distance) between all possible pairs of sequences. We calculated the length of the longest common subsequence (LCS), which quantifies the longest subsequence among all sequence pairs (Studer & Ritschard, 2016). In other words, we compared each dyad's sequence to all other dyads' sequences and calculated the length of the LCS between all possible pairs of dyadic sequences. Longer common subsequences between sequence pairs indicate greater similarity between sequences; this value then gets converted into an index of dissimilarity to be used in further calculations. LCS captures distances between sequences primarily based on the order of states rather and thus was well-suited to our goals of identifying interdyad differences based on multistep subsequences. Figure 1 shows an example calculation for three hypothetical dyads. As can be seen in Figure 1C, Sequence 1 and Sequence 2 both contain the subsequence AE–AG–AE but in different temporal locations within the respective sequences. The length of the LCS (in number of common subsequences) between Sequence 1 and Sequence 2 is 3 (AE–AG–AE), just as the length of the LCS between Sequence 2 and Sequence 3 (C–F–AO) is 3. Therefore, the pairings of Sequence 1 and Sequence 2 (LCS = 3) and Sequence 2 and Sequence 3 (LCS = 3) are considered to be more similar to each other than Sequence 1 and Sequence 3 (LCS = 0). This process is used to compare each dyad's entire sequence with every other dyad's sequence. Thus, we obtained a 49 × 49 dissimilarity matrix for mother–adolescent sequences using the *TraMineR* and *TraMineRextras* packages in R (Gabadinho et al., 2011; Studer & Ritschard, 2016).

Step 4: Exploration of interdyad differences. We then used the dissimilarity matrix obtained in the previous step using the LCS comparisons to identify underlying subgroups of sequences. We used agglomerative hierarchical cluster analysis (single linkage method, Ward, 1963; implemented using the *cluster* package in R; Maechler, Rousseeuw, Struyf, Hubert, & Hornik, 2019). This clustering method identifies subgroups based on dissimilarity such that the dissimilarities among sequences within groups are minimized, and the dissimilarities between groups are maximized (Ward, 1963). Clusters are built hierarchically, with each observation (sequence) first forming its own cluster. Then, clusters are merged with their next most similar cluster in a hierarchical manner until one cluster containing all observations (sequences) is obtained (Maechler et al., 2019). Then, the optimal number of clusters needs to be determined. We used two methods to evaluate the optimal number of clusters. First, we used the "elbow method" to examine the decrease in within-cluster sum of squares by

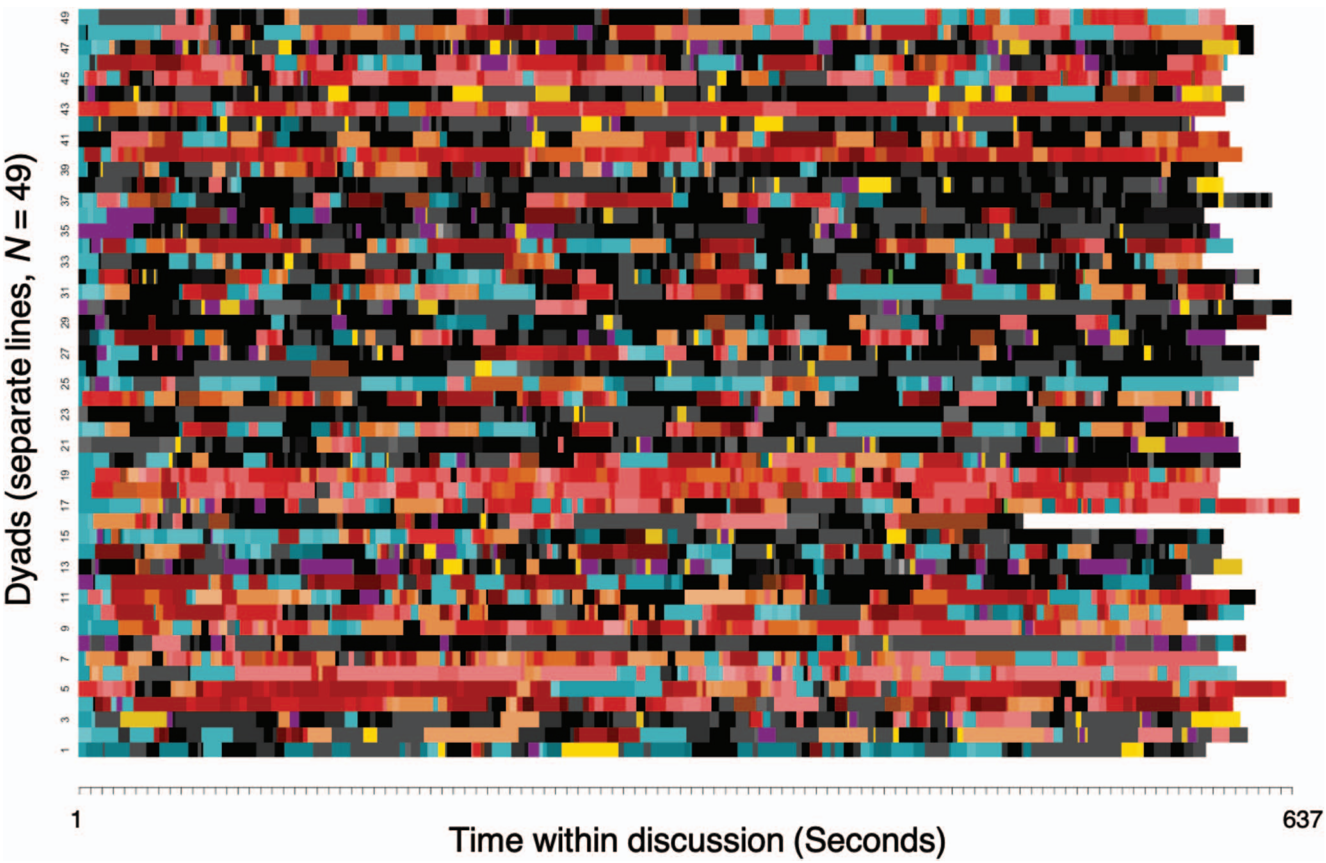

Figure 2. Time series plot depicting the 49 dyad-level sequences extracted from the state space grids. The colors of each row show one dyad's trajectory through the grid over time, with the color indicating the location of the grid cell in Figure 1. See the online article for the color version of this figure.

number of clusters, *k* (Tibshirani, Walther, & Hastie, 2001). Plotting the within-cluster sum of squares against *k* results in a plot similar to a scree plot in factor analysis, in which the identification of an elbow facilitates decision-making on the optimal number of factors (or, in the case of cluster analysis, clusters). We also represented the cluster-based dissimilarities in a dendrogram of the clustering results, which aided our determination of the number of clusters representing interdyad differences in sequences (see details in Results).

Step 5: Associations between interdyad differences and psychosocial adjustment. We used a bivariate structural equation model (SEM) to examine if and how the interdyad differences in sequences were associated with maternal and adolescent perspective taking. We conducted a bivariate SEM to simultaneously examine how each individual's (i.e., both parents' and adolescents') perspective taking was predicted by sequence clusters identified in Step 4, controlling for differences in sequence entropy, adolescent age, and adolescent sex. The bivariate SEM allowed us to explicitly model the dependence between dyad members' perspective taking (as opposed to fitting separate regressions to mothers' and adolescents' perspective taking). The bivariate SEM estimated (a) means, variances, and covariances among all predictors; (b) intercepts, residual variances, and a residual covariance across dependent variables; and (c) direct effects from all predictors to both dependent variables. This led to a fully saturated model.

Results

Research Question 1: Interdyad Differences in Patterns of Mother–Adolescent Emotion Expressions

Results from the grid-sequence analysis and identification of the clusters reflecting interdyad differences are shown in Figure 3. We used two approaches to determine the number of clusters. First, we plotted the within-cluster sum of squares against the number of clusters *k* (see Figure 3A). An elbow can be observed at the two-cluster solution, which suggests that the two-cluster solution may be the best fit to the data. We then examined the dendrogram resulting from the cluster analysis of the dissimilarities between sequences (see Figure 3B). The horizontal lines of the dendrogram indicate distances between clusters, derived from the LCS comparisons of sequences, with longer horizontal lines indicating greater dissimilarity between clusters. The number of clusters is determined by examining the lengths of these horizontal lines, which represent potential cluster divisions. We chose a two-cluster solution based on identification that dissimilarity between the

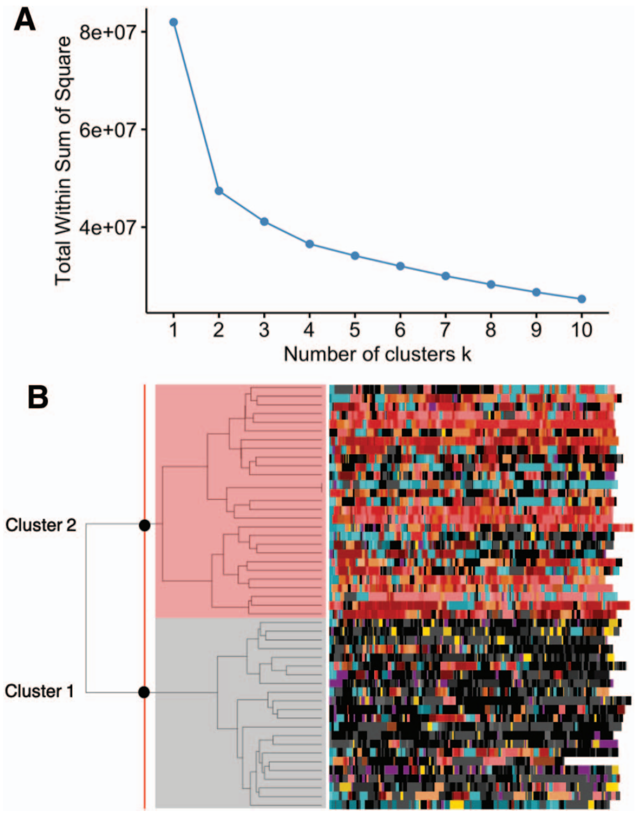

Figure 3. (A) Total within-cluster sum of squares for hierarchical cluster solutions with k = 1 to 10. (B) Dendrogram depicting the results of the hierarchical cluster analysis. The vertical red line indicates the cut point for the two-cluster solution. See the online article for the color version of this figure.

smaller clusters contained within larger clusters was greatest (longest horizontal lines) for the two-cluster solution. The similarities among sequences within clusters and the differences among sequences between clusters is visually apparent in the sequences sorted by the two-cluster solution shown in Figure 3B.

Next, we examined the differences between the clusters by quantifying the most frequent subsequences in each cluster using the *seqefsub* function of the *TraMineR* package (Gabadinho et al., 2011). This function counts all of the subsequences that occurs in a group of sequences, and counts how many sequences contained each subsequence. We did this for each cluster. Table 1 shows the five most frequent subsequences in each cluster, and the number of dyads who showed each of these most frequent subsequences. The five most frequent subsequences of Cluster 1 were primarily characterized by transitions between mutually neutral expressions (AE) and mothers' validation of and interest in their adolescent's perspective (while adolescent expressed neutral affect; AD), and adolescents' validation of and interest in their mother's perspective (while mother expressed neutral affect; AL). Thus, we labeled Cluster 1 as the neutral-validating/interest cluster. In contrast, the five most frequent subsequences of Cluster 2 were primarily characterized by transitions between mutually neutral expressions (AE) and different negative states, such as adolescent defensiveness and stonewalling while the mother expressed neutral affect (J) or dominant negative affect (N), mutually dominant negative affect (G), and adolescent dominant negative affect while the mother expressed neutral affect (C). Thus, we labeled Cluster 2 as the mutual negative regulation cluster.

Research Question 2: Associations Between Interdyad Differences and Perspective Taking

We then examined whether interdyad differences captured by the two clusters were associated with maternal and adolescent perspective taking, controlling for differences in sequence entropy, adolescent sex, and adolescent age. Results of the bivariate SEM are shown in Table 2. For adolescent perspective taking, the predictors explained 23% of the differences in adolescent perspective taking (R^2 = .227, p = .03). The mutual negative regulation cluster was associated with lower adolescent perspective taking than the neutral-validating/interest cluster ($b = -.53$, $\beta = -.42$, $p = .01$), and all other predictors were not significant. The regression for mother perspective taking was not significant (see Table 2). Figure 4 shows a conceptual diagram of the bivariate SEM. As a follow-up, we tested whether the estimated effect of cluster on perspective taking differed across adolescents and mothers. The results did not support a significant different across these two paths ($\Delta\chi^2 = 1.28$, $df = 1$, $p = .26$).

In summary, we found interdyad differences in patterns of mother–adolescent emotion dynamics. In general terms, interdyad differences related to whether dyads showed subsequences characterized primarily by neutral affect and turn taking in validating and showing interest in each other's perspectives, or by transitions

Table 1
Five Most Frequent Subsequences by Cluster

Order of frequency	Cluster 1: Neutral-validating/interest cluster			Cluster 2: Mutual negative regulation		
	Subsequence	Number of dyads	Number of dyads with female adolescents	Subsequence	Number of dyads	Number of dyads with female adolescents
1	(AE>AD)	22	13	(AD>AE)	20	12
2	(AE>AD)–(AE>AD)	22	13	(AE>J)	18	12
3	(AE>AD)–(AL>AE)	22	13	(N>J)	18	11
4	(AE>AD)–(AL>AE)–(AE>AD)–(AE>AL)	22	13	(AE>AD)	17	13
5	(AE>AL)	22	13	(G>C)	17	11
N within cluster		22	13		27	17

Note. ">" indicates a transition between two states demarked by parentheses, whereas "–" indicates remaining in the same state for some duration of time.

Table 2
Results for Bivariate Structural Equation Model Examining Relations Between Perspective Taking and Interdyad Differences in Mother–Adolescent Sequences

Regression coefficient	Adolescent perspective taking, *B* (*SE*)	Mother perspective taking, *B* (*SE*)	*M* (*SD*)
Intercept	3.64* (0.59)	4.47* (0.62)	
Entropy	−0.19 (1.09)	−0.71 (1.15)	0.56 (0.10)
Age group	0.13 (0.17)	−0.25 (0.18)	0.43 (0.49)
Adolescent sex	0.02 (0.18)	−0.18 (0.19)	0.39 (0.49)
Cluster	−0.54* (0.22)	−0.19 (0.23)	0.55 (0.50)
M (*SD*)	3.30 (0.65)	3.79 (0.62)	

Note. Neutral-validating/interest cluster = 0, mutual negative regulation cluster = 1. Adolescent sex: female = 0, male = 1.
* $p < .05$.

among various negative states. We also found evidence suggesting that these interdyad differences may be associated with adolescent perspective taking, especially in terms of adolescents and mothers taking turns in validating and showing interest in each other's perspectives rather than showing patterns of negative reciprocity.

Discussion

In line with perspectives on parent–adolescent dyads as TIES (Butler, 2011; Lougheed, 2019b), we examined complex, multi-step behavioral chains in mother–adolescent emotions during a conflict discussion. We identified interdyad differences in the patterns of emotion dynamics during the conflict using a novel application of grid-sequence analysis. Specifically, some dyads showed patterns characterized by the mutual regulation of validation and interest, whereas other dyads showed patterns characterized by the mutual regulation of negative affect. We also found that these interdyad differences were associated with adolescents', but not mothers', self-reported perspective taking. These results highlight the importance of considering parent–adolescent dyads as TIES. Process-oriented examinations of interpersonal dynamics, such as the current study, not only reflect current theoretical perspectives on parent–adolescent relationships, but also have greater potential for informing clinical prevention and intervention efforts. For example, identifying specific problematic patterns of emotion dynamics may be more helpful for clinicians to identify as areas of focus for their clients rather than general recommendations to reduce or increase certain behaviors.

In line with previous research on mother–adolescent dyads (Main et al., 2016; Moed et al., 2015; Van Bommel et al., 2019), we found that one interdyad difference in emotion dynamics was whether mothers and adolescents reciprocated each other's expressions of negative affect (e.g., defensiveness and stonewalling; dominant negative affect such as contempt, belligerence, criticism, domineering, and anger). Contrary to expectations, we did not find

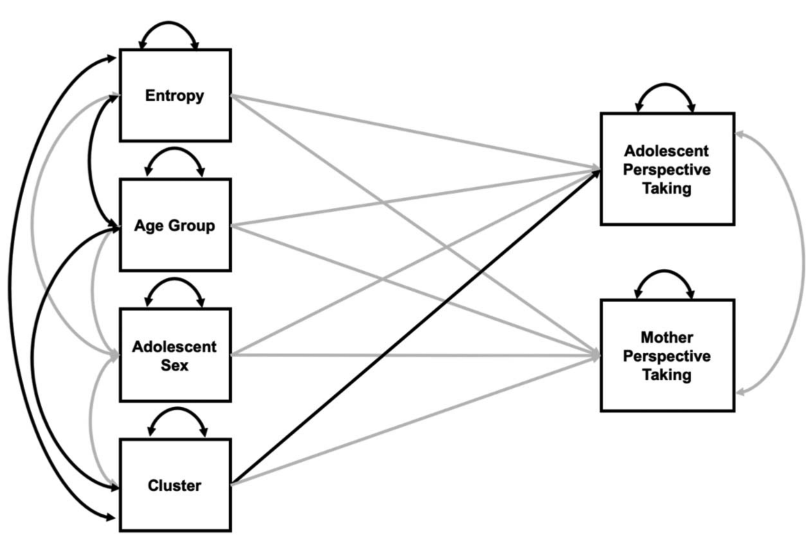

Figure 4. Bivariate path diagram used to test hypotheses associated with Research Question 2. Single headed arrows represent direct effects (i.e., regression coefficients) from predictors to dependent variables. Double-headed arrows represent variances and covariances. Black arrows indicate statistically significant effects (using standard $p < .05$ cut-off), whereas grey arrows indicate non-significant effects. Estimated means and intercepts are not depicted in the figure.

that this pattern of dynamics was related to maternal or adolescent perspective taking. Research on other dyads such as romantic partners suggests that patterns of negative reciprocity are associated with relationship difficulties (e.g., Carstensen, Gottman, & Levenson, 1995; Levenson & Gottman, 1983). It could be that this pattern is related to other individual differences such as parent–adolescent relationship difficulties or family member's internalizing or externalizing symptoms (e.g., Schwartz et al., 2012). However, these data were not available in the current study and thus could not be examined.

In line with expectations, we found that emotion dynamics characterized by mutual turn taking of validation and interest was associated with greater adolescent perspective taking. This finding is consistent with previous research showing that mothers and adolescents who engaged in mutual validation had more successful conflict resolution (Main et al., 2016). The fact that interest featured in the pattern was associated with adolescent perspective taking suggests that adolescents who maintain a curiosity about the mother's point of view may use such curiosity to gain a greater appreciation of the mother's perspective that they did not have initially (see Main et al., 2017). Surprisingly, this pattern was not associated with maternal perspective taking. This could be because in order for the dynamic of mutual validation and interest to continue to occur throughout the conversation, the adolescent needed to reciprocate the mother's validation or interest behavior. Indeed, mothers were more likely to initiate these behaviors. It is likely that unreciprocated validation and interest "short-circuited" the dyad's ability to reach mutual understanding. Thus, it was the adolescent's own willingness and ability to take the mother's perspective that predicted this mutual pattern of behavior. Because perspective taking was measured prior to the conflict discussion, it is not the case that a greater tendency to engage in mutual validation and interest predicted greater perspective taking. However, an interesting direction for future research would be to measure perspective taking before and after a conversation to see whether such patterns facilitate the development of perspective taking over time. This is particularly important in the context of adolescence, when perspective-taking and empathy skills more broadly are developing rapidly (Eisenberg et al., 2005) and parent–adolescent relationships transition from more hierarchical to more egalitarian (Collins & Laursen, 2004).

Limitations and Future Directions

There are several limitations that should be considered in interpreting the results of this study. First, the sample size was relatively small and thus this current exploratory work should be replicated in a larger sample. Second, only mothers were examined in the current study and it is crucial to understand emotion dynamics in other parent–adolescent TIES such as father–adolescent, and TIES made up of nonbiological primary caregivers such as adoptive and foster parents. It will also be important to broaden the examination to more complex TIES such as triads (two parents and one adolescent) and whole-family interactions. Third, the behavioral observations were conducted in a research laboratory and thus the semistructured lab-based conflict discussions may differ from conflicts that occur in the home environment. Future work could examine emotion dynamics using the "fly on the wall" technique (Lougheed & Hollenstein, 2018; Repetti, Reynolds, & Sears, 2015) to examine spontaneously occurring conflicts in the home, or use semistructured conflict discussions in the home environment to improve ecological validity.

It is also important to consider some limitations of grid-sequence analysis. First, the method assumes that each expression of affect is equivalent in terms of its impact on the partner. Combining behavioral codes of affective intensity and semantic content, which were not available in the current data, may provide a more in-depth understanding of the social signals in the dyadic exchange. Second, an assumption is made in grid-sequence analysis (along with other approaches to analyzing sequences such as sequential analysis) that the temporal ordering of events is meaningful—that behaviors directly preceding or following others do so in a meaningful way. However, it is possible that current affect is a response to a partner's most recent expression, but perhaps also (or instead) in reaction to something that happened earlier in the sequence. Thus, as with all such methods, it is impossible to determine what specifically affective expressions are in reaction to.

Conclusion

Emotion dynamics are complex and in line with theoretical perspectives on parent–adolescent relationships (Butler, 2011; Lougheed, 2019b), it is important to understand the process of how emotions unfold during parent–adolescent interactions. It is an exciting time for research on parent–adolescent TIES as innovations in quantitative approaches such as grid-sequence analysis (Brinberg et al., 2017, 2018) are making it possible to examine complex patterns of interpersonal dynamics. These new research directions will likely have significant impact for clinicians working with families as our field continues to incorporate such methods into the study of family processes and builds up a solid foundation of knowledge in this area.

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