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Rigidity in Parent–Child Interactions and the Development of Externalizing and Internalizing Behavior in Early Childhood

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Behavioral rigidity is a common feature of many psychopathologies, yet the association between rigidity and the development of childhood psychopathology has not been studied. State space grids (a dynamic systems [DS] method) were used to examine the relation between rigidity in parent–child interactions and childhood externalizing and internalizing problems. High-risk kindergarten children ($n = 240$) and their parents were observed for 2 hr engaging in a variety of tasks that were expected to elicit a range of affect. State space grid analysis of the observational data revealed an association between rigidity in parent–child interactions and child externalizing behavior problems in the fall and spring of kindergarten and 1st grade, and with growth in those problems over time. Rigidity was associated with concurrent levels and with chronic high-level internalizing problems. Strengths and limitations of the new DS methodology in relation to understanding child psychopathology are discussed.

KEY WORDS: dynamic systems; parent–child relations; rigidity; internalizing; externalizing.

INTRODUCTION

The content of parent–child interactions is often used to predict problem behaviors in early childhood. There is a general agreement that interactions characterized as mutually hostile, harsh, permissive, or overcontrolling contribute to a wide spectrum of child psychopathologies. This paper aims to extend this research by shifting the focus of investigation from the content to the structure of family interactions. Structure refers to the relative flexibility versus rigidity[6] of the behavioral interaction of parent–child dyads. Until recently, structural analyses of family patterns were largely inaccessible because of the dearth of methodologies appropriate for such analyses (Granic & Hollenstein, 2003; Hinshaw, 2002; Richters, 1997; Sameroff & Chandler, 1975). The present study addresses this gap by resurrecting the concept of rigidity and by employing a new dynamic systems (DS) methodology (state space grids [SSGs]) to examine the relation of the development of psychopathology to the structure of parent–child interactions.

Theories and investigations of behavioral rigidity have a long and rich history spanning all the subdisciplines and zeitgeists of psychology over the past century. Prior to 1960, these operationalizations ranged from a focus on perseveration in perceptual-motor domains (Spearman, 1927) to a focus on more dispositional limitations of habit in the face of novelty (Cattell, 1935) and cognitive flexibility (Luchins & Luchins, 1959). Werner (1946) defined *rigidity* as the lack of response variability or the lack of adaptability of behavior. Werner further made the distinction that stability is not the same as rigidity but a "flexibility of response in order to preserve the functional

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[6]In this paper we will use flexibility and rigidity interchangeably as opposing poles of the same dimension.

equilibrium of the organism in the face of mutable situations" (Werner, 1940, p. 55). By the 1950s, however, the proliferation of terms, definitions, and approaches to the study of rigidity created little insight (Chown, 1959) and little empirical research on rigidity (Schultz & Searleman, 2002). What has persisted is a conceptualization of rigidity as a personality trait (e.g., DeYoung, Peterson, & Higgins, 2002) or as a cognitive individual difference factor in tasks that require a shift from one practiced response to another (Harris, 1988; Luchins & Luchins, 1959). These approaches to rigidity have conspicuously lacked an emotional component and little attention has been paid to nonnormative samples.

In the clinical domain, researchers, practitioners, and theorists continue to observe that psychopathology represents "diminished flexibility and constrictions in the affective, cognitive, and behavioral correlates of adaptational patterns" (Overton & Horowitz, 1991, p. 3). However, this view of psychopathology as overlearned, automatized cognitive, affective, and behavioral patterns that are insensitive to environmental change and that interfere with social functioning (Cicchetti & Cohen, 1995; Mahoney, 1991) has rarely been empirically demonstrated. One notable exception is the circumplex model of adaptive family functioning (Minuchin, 1974; Olson, 2000) that assesses the state of a family system along the dimensions of flexibility and cohesion. What is interesting about this approach is that rigidity is addressed as a function of two or more individuals, and not just a property of one individual. However, like personality measures, the methods used to test this theoretical model are static, summary measures that fail to tap the inherently temporal quality of rigidity and real-time change in behavior and in response to varying environmental demands. This study explores patterns of rigidity in real-time family interactions and the association of these patterns with the development of psychopathology in early childhood.

Three common core aspects of rigidity can be identified. The first aspect is a diminished behavioral repertoire wherein there are fewer states available to the parent–child system, regardless of the environmental demands. The second is a limited capacity to switch among behaviors in response to changes in the environment. The third aspect is the tendency to perseverate in any particular behavior. This study examined the relations between problem child behavior and the relative flexibility or rigidity of family interactions in early childhood. Our general hypothesis was that rigid parent–child interactions are related to, and predict growth in, childhood externalizing and internalizing behavior.

The Development of Rigid Behavior

At the individual level, evidence suggests that rigid response patterns are associated with a wide range of problem behaviors in childhood. Temperament has been conceptualized as the confluence of reactivity and regulation (Rothbart & Derryberry, 1981) whereby emotional experiences that are well regulated "flexibly change in response to changing conditions, and rise and fall in a manner that permits a productive accommodation to changing situational demands" (Thompson, 1990, p. 373). In contrast, dysfunctional affect regulation is characterized by prolonged emotional responses and a lack of alternative reactions, possibly because of the lack of proper regulatory interactions with a caregiver (Rothbart, Ziaie, & O'Boyle, 1992; Schore, 2003; Weinberg & Tronick, 1998). This lack of regulatory flexibility, whether resulting from child temperament or unskilled caretaking, increases a child's vulnerability to environmental stressors and augments risk for negative outcomes (Rutter, 1995). Similarly, the hostile attribution bias expressed by aggressive children (Crick & Dodge, 1994; Weiss, Dodge, Bates, & Pettit, 1992) has been conceptualized as a rigid emotional appraisal of others' intentions in ambiguous situations. Anxious children have also been found to overinterpret ambiguous situations as threatening but to react with avoidant rather than aggressive solutions to threat (Barrett, Rapee, Dadds, & Ryan, 1996; Shortt, Barrett, Dadds, & Fox, 2001). Common to these disorders, regulatory dysfunctions and cognitive biases—regardless of the specific *content* of the affects, cognitions, or behaviors—is a structure of responding to environmental change that is rigid in terms of a diminished behavioral repertoire, an inability to adapt or respond effectively to changes in the environment, and a tendency to perseverate.

Beyond the individual, it is useful to understand the structure of experience and its contribution to development in a social context. From a systems perspective, developmental trajectories arise from multiple and reciprocally causal interactions (Cicchetti & Toth, 1998; Dumas & LaFreniere, 1995; Dumas, Lemay, & Dauwalder, 2001; Granic, 2000; Hinshaw, 2002; Minuchin, 1974; Sameroff & Chandler, 1975). A child's behavior prompts a response from the mother and this response then influences the child's behavior, and so on. Over time, these interactions constrain future behavior to more predictable patterns that at an extreme may translate into more specific problems for the child, such as depression or aggression. A classic example is the coercive cycle described by Patterson and colleagues (Patterson, 1982; Patterson, Reid, & Dishion, 1992). In this process, an aggressive child's coercive behavior is reinforced through repeated instances of nattering on the part of the parent, opposition from the child, and the eventual capitulation of the parent. Thus, the family system is a context wherein parents and children form patterns of interaction together, and these patterns can be identified as more or less rigid.

Family interactions related to the development of psychopathology show evidence of the three core aspects of rigidity. For example, internalizing behavior has been associated with a reduced range of (flattened) affective expression (Downey & Coyne, 1990; Field et al., 1985; Gelfand & Teti, 1990). All families experience some conflict, but the families of aggressive children engage in extended and escalating (i.e., perseverative) exchanges of coercive behavior (Patterson, 1982). It is the inability to flexibly exit those corrosive interactions that leads to psychopathology (Dumas et al., 2001; Gottman & Notarius, 2000). Thus, it is not only the content but the structure of parent–child behavior over time (i.e., rigidity) that can influence child adjustment.

Previous investigations have focused on the negative content of social interaction, but rigidity in structure may apply to interaction content that is positive as well as negative. Getting "stuck" in a dyadic state is what is problematic. That rigidity in mutual positive states is problematic may seem counterintuitive. However, parents in well-adjusted families will typically respond to extended periods of high positive arousal in children with a range of downregulatory responses, thus moving through a number of dyadic states rather than remaining perpetually positive. Flexibility in affective and behavioral states is also likely to better accommodate the variety of typical social tasks encountered by a family. Some tasks elicit both elation and frustration (e.g., game playing, homework), some are more directly confrontational and anger provoking (e.g., problem solving), and others are enjoyable and unconstrained (i.e., eating a snack). Thus, dyads that remain continuously in mutually positive states might not be adapting well to the shifting environmental demands of these tasks, and it is important for families to display, utilize, accommodate, and regulate a range of emotions evoked by these different tasks.

DS Methods

We have proposed a relationship between rigidity in parent–child interactions and subsequent child psychopathology, and three core aspects of rigidity that need to be quantified in order to test this relationship empirically. To ensure ecological validity, rigidity was measured as it manifests in affective–behavioral interactions across several task contexts. A DS approach provides the means to track rigidity in emotional expression during parent–child interaction in real time across several contexts.

Two DS concepts are particularly relevant for understanding and measuring rigidity in parent–child interactions. The first is the concept of an *attractor:* an absorbing state that "attracts" the system from other potential states. The behavior of a system can be thought of as a trajectory that is typically "pulled" toward an attractor state. For example, a state of mutual hostility can be understood as an attractor for a particular family that means that they easily get drawn toward a hostile pattern of interaction and once the conflict has begun, it is difficult to pull out of this pattern. Over developmental time, attractors represent recurrent behavioral habits or patterns that eventually stabilize and become increasingly predictable. As noted by Thelen and Smith (1994), all developmental acquisitions can be described as attractor patterns that emerge over weeks, months, or years. Importantly, attractors occur within the context of many other possible states for a particular system, and any single attractor must be understood within this broader context.

The configuration of all possible states for a particular system is termed a *state space*. A state space can be represented as a topographical landscape of peaks (improbable states) and valleys (attractors) that constrain any movement across the landscape. At any given time, the system will be in one particular state. Over time, movement from one state to another is constrained by the topography of the state space. A flexible system would be represented as a state space with several shallow or weak attractors and movement from state to state would be relatively fluid. In contrast, a rigid system would likely have one or few strong attractors and movement across the space would be relatively limited.

On the basis of these DS constructs, Lewis, Lamey, and Douglas (1999) recently developed a graphical approach that utilizes observational data to quantify two ordinal variables that define the *state space* for the system. This SSG technique has been adapted for the study of parent–child interactions (Granic, Hollenstein, Dishion, & Patterson, 2003; Granic & Lamey, 2002). With this method, the sequence of behavioral states is plotted as it proceeds in real time on a grid representing all possible behavioral combinations of the dyad. The parent's coded behavior is plotted on the *x*-axis and the child's behavior on the *y*-axis. Anytime a behavior changes, a new point is plotted and a line is drawn connecting it to the previous point. Thus, the grid represents a series that moves from one dyadic state to another over the course of an interaction. A hypothetical trajectory representing 10 s

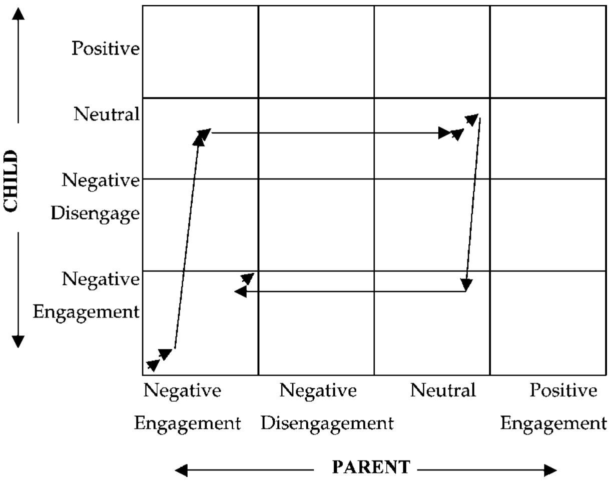

Fig. 1. Example of a state space grid with a hypothetical trajectory representing 10 s of coded behavior, one arrow head per second. Plotting begins in the lower left part of the cell and moves in a diagonal as each second is plotted, ending in the upper right.

of coded behavior is presented in Fig. 1. The sequence depicted begins with 2 s in negative engagement/negative engagement,[7] and is followed by 2 s in negative engagement/neutral, 3 s in neutral/neutral, 1 s in neutral/negative engagement, and 2 s in negative engagement/negative engagement.

A key advantage of the SSG methodology is its potential to tap changes in *structure* or relative flexibility/rigidity of interactions as well as variation in *content*. Rigidity can be determined by the number of dyadic states displayed (number of cells visited on the grid), the responsiveness to changes in the environment (number of transitions among cells), and the amount of perseveration (i.e., the mean duration of all the cells). Although in this study we were most interested in structure, the SSG method can also be used to examine the relative rigidity or strength of content-specific, parent–child attractors.

Design

SSG analysis was applied to examine whether individual differences in dyadic rigidity—measured by observations of parent–child interactions in the fall of kindergarten—were related to externalizing and internalizing behavior concurrently and at three subsequent measurement points, each 6 months apart. Each dyad was observed for a total of 2 hr across several different contexts or tasks, providing ample opportunity for children and parents to display a wide range of affective behavior in response to each other and the changing contexts. The data are real-time (simultaneous) dyadic states and long durations in any of these states required that participants each remain in one particular affective expression. Thus, getting "stuck" in a dyadic state is unusual. We expected that children in dyads that flexibly adapt to context change and display frequent change in affect would be well-adjusted. In contrast, we hypothesized that children from dyads displaying fewer affective states, a greater tendency to remain in each state, and fewer transitions among the states would score higher on measures of externalizing and internalizing behavior.

The relation between rigidity and the development of problem behavior was examined using two approaches: (1) the use of SGG measures as linear predictors of externalizing and internalizing behavior problems as continuous variables and (2) the comparison of rigidity measures for children in extreme groups or clusters based on growth profiles of externalizing and internalizing behavior problems. Both categorical and continuous measures provide legitimate measures of child adjustment, each having its own advantages (Hinshaw & Lee, 2003; Pickles & Angold, 2003; Richters & Cicchetti, 1993; Robins & McEvoy, 1990). Both externalizing and internalizing behavior problems were examined because previous research suggests that rigidity may be associated with both types of adjustment problems (Barrett et al., 1996; Crick & Dodge, 1994; Dumas et al., 2001; Field et al., 1985; Gelfand & Teti, 1990; Patterson, 1982).

These primary analyses were followed by an exploration of the specific content of dyadic states to test whether it matters less where a dyad got "stuck" than whether they got "stuck" at all. Four cells from the grid were selected on the basis of theoretical or empirical relevance. The first was mutual negative engagement that has been found to be associated with child externalizing behaviors (Dumas & LaFreniere, 1993, 1995; Patterson, 1982; Patterson et al., 1992). The second was the mutual positivity found to be low for both externalizing (Gardner, 1987, 1994; Pettit & Bates, 1989; Pettit, Bates, & Dodge, 1993) and internalizing (Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Field et al., 1985) problems. The third cell was parent negative engagement with child positive ("parent start-up"), which may be associated with the harsh and overcontrolling parenting implicated in the development of internalizing behaviors (Dumas et al., 1995; Krohne & Hocke, 1991; Wood, McLeod, Sigman, Hwang, & Chu, 2003). The final cell was parent positive with child negative ("child start-up" or permissiveness) that has been associated with externalizing behavior and comorbidity in children (Granic & Lamey, 2002; Patterson, 1982;

[7]Note that the labeling of cells follows the *x*/*y* convention such that the first half of the label is the parent's category and the second half of the label is the child's category.

Patterson et al., 1992). We expected that the overall structural rigidity associated with the development of psychopathology would not be reducible to single dyadic attractors, and that overall rigidity regardless of the content of the interaction would be independently associated with problem behaviors.

METHOD

Participants

The participants were 270 children (138 boys and 132 girls) and their parents who were recruited in three consecutive annual cohorts at kindergarten entry to one elementary school that exclusively served a low-income, mixed industrial–residential neighborhood. The mean child age at kindergarten entry was 5.5 years. All children attending the school were invited to participate, and the achieved recruitment rate was 76%. The sample of children and families who participated in the study were representative of those in the neighborhood and (with the exception of family income) of the metropolitan area (MSA pop. = 350,000) in which the sample was located.

Seventy-one percent of the children were European Americans, 19% were African American, 5% were Hispanic/Latino, and the remaining children were Native and Asian American. At initial recruitment, 43% of the children resided in intact families, 30% in single-parent (almost exclusively maternal) households, 21% in blended families, and 6% in other family configurations. The median per capita annual family income was $8,300; 28% of the children resided in families with incomes below the federal poverty line. The average maternal age at recruitment was 29.9 years. Only 34% of the parents had education beyond high school, and 20% failed to attain a high school degree. No adult family member was employed in 9% of the families.

Data for this study were derived from those dyads who participated in at least one session (92% participated in both sessions) of videotaped observation, resulting in a maximum sample of 240. Included and excluded participants did not differ significantly on any demographic variable. Families chose which parent participated in each session. Mothers were present for both sessions in 86% of the families, fathers were present for both sessions in 9% of the families, and fathers were present in one but not the other session in 5% of the families.

Procedure

Data from 2 hr of parent–child interactions were obtained from 1 hr on each of two occasions during the late fall and early spring of the child's kindergarten year. Children and one parent were invited into a lab setting that was set up as a small playroom. Each session was structured around a series of tasks that included (duration total over two sessions): playing a novel interactive game (60 min), problem discussions related to parent- and child-identified issues that resulted in conflict at home[8] (15 min), planning a fun activity and talking about the child's day at school (15 min), working on age-appropriate numeracy and literacy tasks (20 min), and snack time (10 min). Parent–child interactions during the various structured tasks were videotaped through a one-way mirror, with audio obtained via a microphone in the playroom. A timing code was superimposed on each video recording that was then used to "drive" the computerized coding stations used by the coders.

Coding Procedures

The videotaped observational sessions were coded using the Specific Affect (SPAFF) coding system (Gottman, McCoy, Coan, & Collier, 1996). Each code is based on a combination of facial expression, gestures, posture, voice tone and volume, speech rate, and verbal/motor response content to capture a gestalt of the affective tone of behavior. SPAFF consists of 18 mutually exclusive affect codes that were recorded in real time (i.e., continuously) for each participant separately.

Observers were extensively trained to a criterion of 75% agreement prior to initiating coding of the videotaped interactions. Weekly recalibration training was completed to minimize observer drift. Two observers independently coded 15% of all the sessions to assess coder agreement. Observers were blind to which sessions were used to assess observer agreement. The average between-observer agreement on the occurrence of SPAFF codes (using $a \pm 6$ s window) was 83% ($\kappa = .73$).

SSG Measures

SSGs were constructed from the coded SPAFF data for both sessions for each dyad. The 18 SPAFF codes were collapsed into four categories for each dyad member to create a dyadic SSG as a 4×4 matrix. Reducing the grid categories allows for a more parsimonious

[8]Problem-solving discussions with children of this age are not always appropriate in studies of this kind. However, as discussed in the Introduction, these tasks were expected to elicit a range of affect regardless of the verbal content or the success of the task itself. Indeed, families without problems do not find this task as difficult as families with problems.

SSG with a reasonable number of cells and successful applications of the SSG technique have not exceeded five categories (Granic et al., 2003; Granic & Lamey, 2002; Lewis et al., 1999; Lewis, Zimmerman, Hollenstein, & Lamey, 2004). Furthermore, many of the coded behaviors of the SPAFF coding system were expected to have equivalent social functions (i.e., belligerence and anger). The four categories were formed roughly on the basis of positive, negative, and neutral behaviors. However, two general classes of negative codes in SPAFF differ in social engagement. Thus, the negative codes were split into one category that indicated more active social engagement and another category that indicated more withdrawn or disengaged types of affective behavior. The four categories (and constituent raw SPAFF codes) were Negative Engagement (Criticism, Domineering, Contempt, Belligerence, Threats, Disgust, and Anger); Negative Disengagement (Sadness, Fear/Tension, Defensiveness, Stonewalling, and Whining); Neutral (Neutral—the absence of any other discernable affect); and Positive Engagement (Interest, Validation, Affection, Humor, and Enthusiasm). SSGs were created by plotting each second of the child's behavior on the *y*-axis and of the parent's behavior on the *x*-axis. Because both participants' data were recorded continuously and separately, each cell on the grid represents the simultaneous state of the dyad. As described in more detail earlier (Fig. 1), when the dyad's behavior changed, a new point was plotted and a line was drawn to connect the old and new point; thus, a real-time dyadic trajectory across the session was plotted for each dyad.

Three indices of rigidity were derived from these grids. (1) *Cells*: a count of the number of unique cells visited on the grid. Lower cell counts indicated a restricted range of behavioral states and therefore a greater degree of rigidity. (2) *Transitions* (Trans): a count of the number of movements between cells on the grid. A lower value on this measure indicated less frequent changes of dyadic behavioral states and therefore more rigidity. Trans controlled for slight variations in the duration of each session by transforming counts of transitions to rate per minute. (3) *Average mean duration* (AMD): Each cell's mean duration was calculated by dividing the total duration in that cell by the number of different times the dyad occupied that cell. The average of these 16 values across the whole grid was the AMD value. This variable was designed as an index of the overall degree of "stickiness" of dyadic behavior. High AMD values indicated a more rigid dyad that tended to remain in each state for an extended period of time. Low AMD values indicated more flexible behavior. Note that Trans captures a different dimension than Cells. Two dyads could visit the same number of cells, yet the number of transitions between states could be quite different.

Table I. Means, Standard Deviations, and Correlations of State Space Grid Measures for Each 1-hr Session and for Both Sessions Combined

	Session 1	Session 2	Both Sessions	Test–retest Correlation
Cells	10.97 (2.66)	11.17 (2.58)	11.12 (2.23)	.42***
Trans	13.93 (3.41)	12.55 (3.09)	13.32 (2.93)	.58***
AMD	2.44 (0.73)	2.48 (0.71)	2.45 (0.60)	.39***

Note. Values in parentheses are standard deviations. Trans = Transitions per minute. AMD = Average mean duration. $^{***}p < .001$.

Because 1-hr parent–child interaction sessions were conducted at two time points, we could examine the test–retest reliability of our SSG measures. Item-level means and standard deviations of the three state-space grid variables for each observation session and test–retest stability of these measures are presented in Table I. Correlations between the SSG indices across sessions were moderate, indicating sufficient test–retest reliability. These correlations justified the use of a combined mean of the first and second sessions for each of our whole-grid measures. Preliminary analyses indicated that the three measures were inconsistently associated with the child externalizing and internalizing problems. Therefore, a construct was created to reflect the three different aspects of rigidity by combining the means of Cells, Trans, and AMD. The Cells measure significantly reduced the internal reliability (alpha) among the three measures and was dropped from the construct score. The final construct combined the *Z* scores of Trans (reversed) and AMD at an alpha level of .82 and was labeled *Rigidity*.

Teacher Ratings of Child Externalizing and Internalizing Behavior

Teachers' ratings of child covert (delinquent) and overt (aggressive) antisocial behavior and depressive behavior were obtained in the fall and spring of kindergarten, and the fall and spring of the first grade, using an adaptation[9] of the Teacher Report Form (Achenbach

[9]These data were taken from a larger research project studying competing socialization models of conduct problems in early childhood. The overt antisocial scales differ from Achenbach (1993) aggression scales by the inclusion of two additional items ("not liked by peers" and "not get along with others") and the deletion of two items ("sudden mood changes" and "talks out of turn"). The two additional peer items were added because they loaded very well on this scale in our sample (>.60), considerably higher than their loading on Achenbach's Social Problems scale (.3–.4). "Sudden mood changes" and "talks out of turn" did not load (<.30) on this scale in our sample.

Table II. Means and Standard Deviations of Externalizing and Internalizing Behavior Problems

Time 1[a]	Time 2[b]	Time 3[c]	Time 4[d]
Externalizing			
0.18 (0.26)	0.23 (0.29)	0.24 (0.28)	0.28 (0.34)
Internalizing			
0.14 (0.19)	0.17 (0.19)	0.19 (0.22)	0.25 (0.29)

Note. Values in parentheses are standard deviations. $^{a}n = 236$. $^{b}n = 235$. $^{c}n = 228$. $^{d}n = 212$.

& Edelbrock, 1987). Teachers were asked to rate a child's behavior over the previous 2-month period on a 0–2 scale for each item. Different teachers typically completed these scales in kindergarten and first grade. A score for overt antisocial (aggressive) behavior derived at each developmental point was composed of the mean of 26 items (e.g., argues, cruel/bullies, disobeys, teases, tantrums). Internal reliability of the scale was $\alpha > .93$ at each assessment point. A score for covert antisocial (delinquent) behavior derived at each developmental point was composed of the mean of nine items (e.g., does not feel guilty, lies, steals). Internal reliability of the covert scale was $\alpha > .65$ at each assessment point. The scores on the aggression and delinquency scales were combined into one overall externalizing score (Achenbach & Edelbrock, 1987). A score for child internalizing behavior derived at each developmental point was composed of the mean of 12 items (e.g., lonely, sad, withdrawn). Internal reliability of the scale was $\alpha > .69$ at each assessment point. The items comprising this scale were taken from the withdrawn and anxious/depressed subscales of TRF but, unlike Achenbach and Edelbrock's (1987) internalizing subscale, no items from the somatic complaints subscale were included. Item-level means and standard deviations for the outcome measures at each time point are reported in Table II. All of the outcome measures were censored at zero (i.e., a large proportion of children had a mean of zero on the measures) and positively skewed. To make the distributions more normal, the teacher scales were log transformed.

Analytical Strategy

Three analytical approaches were used to test the hypothesized relationship between rigidity and problem behaviors in early childhood. The first tested the linear relationship between rigidity and the externalizing and internalizing behavior problems as continuous measures. The second, categorical approach compared the rigidity of parent–child interaction for the children whose scores were in the highest 10% of problem behavior with the remaining 90% of the sample. These extreme groups of externalizing and internalizing children roughly correspond to the percent of the sample evidencing *T* scores greater than 70 relative to norms (Achenbach & Edelbrock, 1987). These groups were estimated independently at each wave. Because of the small number of children in these extreme groups, comorbid status was not assessed. The third analytical approach examined the patterns of growth in externalizing and internalizing behavior across kindergarten and first grade. To group children according to growth patterns, a growth curve cluster plotting program (Splus, 2000) for a *k*-means clustering procedure was used to generate cluster membership. The individual growth trajectories were then plotted with one panel per cluster, including the average trajectory within cluster. Children in each cluster were then compared on mean rigidity scores.

To verify that our rigidity measures were not simply a function of behavior in one or a few cells, the mean duration (the total duration divided by the number of events) in each of four cells was calculated: mutual negative engagement (parent negative engagement/child negative engagement), mutual positive engagement (parent positive engagement/child positive engagement), "parent start-up" (parent negative engagement/child positive engagement), and "child start-up" (parent positive engagement/child negative engagement). The zero-order correlations between rigidity and the externalizing and internalizing measures at each time point were recalculated controlling for each of the four mean durations. These partial correlations were expected to be equivalent to their corresponding zero-order correlations, indicating that the rigidity results could not be accounted for by the content of any particular cell.

RESULTS

Three outliers on the rigidity construct were reduced to a value of 3 standard deviations from the mean. Missing data from the outcome measures at each time-point reduced the sample size on an analysis-by-analysis basis. Rigidity scores for boys ($M = -0.05$, $SD = 0.85$) and girls ($M = 0.03$, $SD = 0.93$) were not significantly different, $t(238) = 0.69$, *ns*; therefore, gender differences were not analyzed further. Measures of rigidity from the observation sessions that included fathers ($M = 0.05$, $SD = 0.95$) were not significantly different from those with mothers ($M = -0.02$, $SD = 0.88$), $t(238) = 0.42$, *ns*. Thus, we combined the data for all analyses.

Our first analytic approach was to use the externalizing and internalizing scores as continuous measures.

To test the hypothesis that less flexibility in parent–child interactions is associated with elevated levels of externalizing and internalizing behavior problems, bivariate correlations among the rigidity constructs and the outcome measures were examined. The correlations between rigidity and externalizing behavior were significant at all four time points: $r = .13$, $p < .05$, at Time 1; $r = .16$, $p < .05$, at Time 2; $r = .22$, $p < .01$, at Time 3; and $r = .20$, $p < .01$, at Time 4. The correlations between rigidity and internalizing behavior were only significant at Time 2 but not at the other time points: $r = .12$, $p < .10$, at Time 1; $r = .16$, $p < .05$, at Time 2; $r = .12$, $p < .10$, at Time 3; and $r = .09$ (*ns*) at Time 4.

Because parent–child rigidity may have its most pronounced effects for children who scored highest on externalizing or internalizing measures, a categorical approach was also taken. Rigidity between the highest 10% and the remaining 90% of the sample was examined in relation to each of the outcome measures at each of the four measurement points. Results are shown in Fig. 2. All results were in the hypothesized direction. Mean rigidity scores were significantly higher for the high externalizing subgroup at Time 2, $t(233) = 2.67$, $p < .01$, $d = .48$; Time 3, $t(226) = 3.40$, $p < .01$, $d = .69$; and Time 4, $t(210) = 3.49$, $p < .01$, $d = .73$; but not at Time 1, $t(234) = 0.65$, *ns*. Mean rigidity scores were significantly higher for the high internalizing subgroup at Time 1, $t(234) = 2.38$, $p < .05$, $d = .44$; Time 2, $t(233) = 1.98$, $p < .05$, $d = .36$; and Time 3, $t(226) = 2.00$, $p < .05$, $d = .29$; but not at Time 4, $t(210) = 0.63$, *ns*.

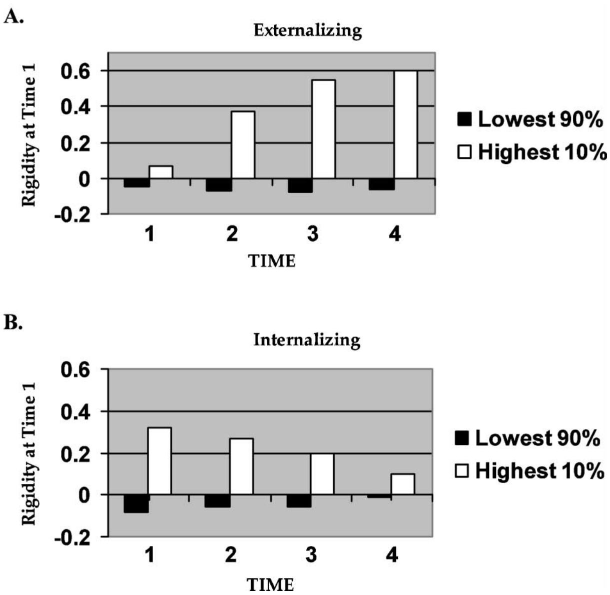

Fig. 2. Rigidity at Time 1 by the highest 10% (white bars) vs. the lower 90% (black bars) of teacher-reported externalizing (A) and internalizing (B) behaviors at each of the four time points.

In a third analytic approach, rigidity in parent–child interactions was examined in relation to profiles of growth in externalizing or internalizing problems. A range of 2–6 cluster solutions were produced for each of internalizing and externalizing scales. For the externalizing scales, a 4-cluster solution was chosen on the basis of the distributions of cluster sizes and the visible deviation from the mean growth trajectories. Figure 3 shows the growth curve clusters for teacher reports of externalizing behavior across the four measurement points. The clusters were labeled "consistently low" ($n = 138$), "desistors" ($n = 29$), "growers" ($n = 32$), and "consistently high" ($n = 9$). Mean rigidity scores for each of these externalizing growth clusters are shown in Fig. 4. A simple contrast comparing the consistently low cluster to each of the other clusters in a univariate ANOVA revealed a significant difference for the growers ($p < .05$) but not for the other clusters. The rigidity scores for the four clusters appeared to form two groupings of two clusters each: consistently low and desistor clusters had low scores ($M = -0.09$, $SD = 0.83$), whereas consistently high and grower clusters had high scores ($M = 0.30$, $SD = 0.81$). A post hoc analysis revealed a significant difference between the low/desistor clusters and the high/grower clusters, $t(206) = 2.70$, $p < .01$, $d = .43$. Children who scored consistently high on teacher-reported externalizing behavior or became increasingly more externalizing over time were significantly more rigid in their parent–child interactions than children who were consistently low or desisted in externalizing problems.

Figure 5 shows the growth curve clusters for teacher reports of internalizing behavior across the four measurement points. As in the previous analysis, a four-cluster solution was the most parsimonious and the clusters were labeled "consistently low" ($n = 87$), "desistors" ($n = 41$), "growers" ($n = 50$), and "consistently high" ($n = 30$). Mean rigidity scores for each of these internalizing growth clusters are shown in Fig. 6. A simple contrast comparing the consistently low cluster to each of the other clusters in a univariate ANOVA revealed a significant difference for the consistently high cluster ($p < .05$) but not for the other clusters. Thus, rigidity in parent–child interactions was related to consistently high levels of teacher-reported internalizing problems.

To control for the possibility that specific dyadic content could account for the association between rigidity and externalizing and internalizing problems, partial correlations between rigidity and each of the outcome measures were calculated and are reported in Table III.

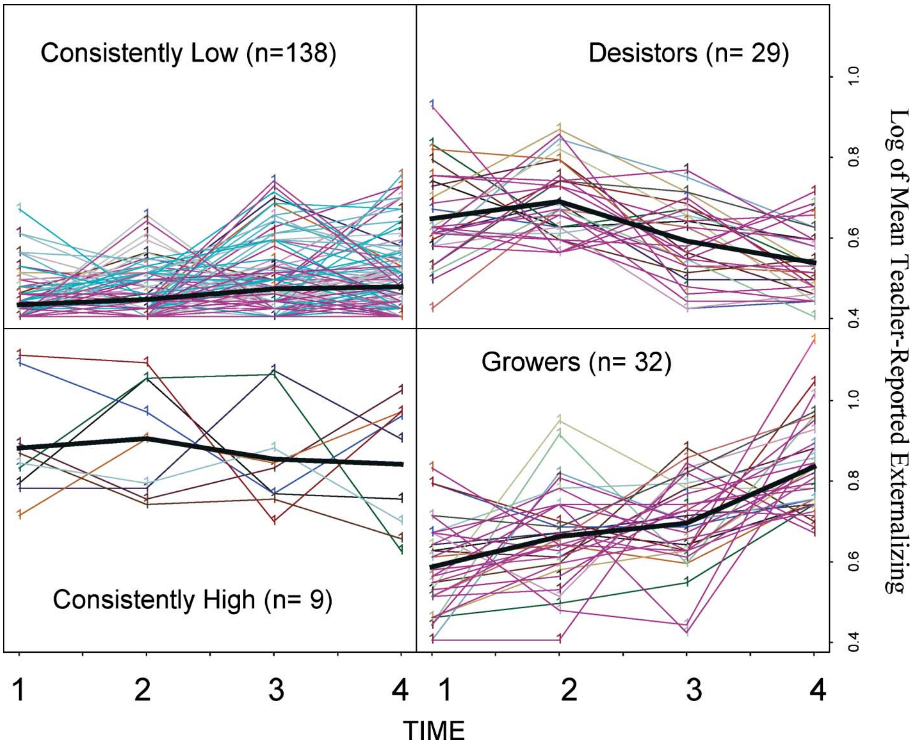

Fig. 3. Externalizing growth curve clusters. Thick line represents mean growth trajectory.

After controlling for the mean durations in each of the four theoretically relevant cells, the strength of the correlations was approximately the same. Thus, rigidity in family interactions in early childhood appears to be associated with externalizing and internalizing problems independent of the degree to which dyads lingered in mutual hostility, mutual positivity, parent start-up, or child start-up. This suggests that rigidity of interactions across the whole state space may be relevant to predicting children's externalizing and internalizing behavior problems.

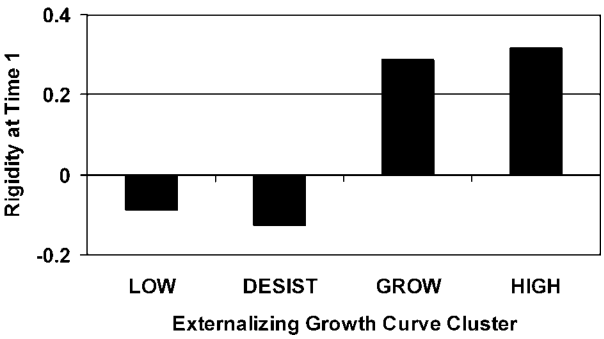

Fig. 4. Rigidity scores at Time 1 for each externalizing growth curve cluster.

DISCUSSION

The goal of this study was to extend past research on parent–child interactions related to problem behavior by exploring the structure or relative flexibility versus rigidity

Table III. Bivariate Correlations Between Rigidity and Externalizing and Internalizing and Partial Correlations Controlling for Mean Durations in Interaction Content

	Time 1	Time 2	Time 3	Time 4
Externalizing				
Bivariate	.13*	.16*	.22**	.20**
Partial (controlling for)				
Mutual negative engagement	.12†	.16*	.22**	.20**
Mutual positive engagement	.13*	.16*	.21**	.20**
Parent start-up	.12†	.14*	.21**	.18**
Child start-up (Permissive)	.11†	.15*	.21**	.19**
Internalizing				
Bivariate	.12†	.16*	.12†	.09
Partial (controlling for)				
Mutual negative engagement	.10	.15*	.12†	.08
Mutual positive engagement	.12†	.16*	.13*	.10
Parent start-up	.12†	.16*	.14*	.10
Child start-up (Permissive)	.11†	.15*	.12†	.09

†$p < .10$. *$p < .05$. **$p < .01$.

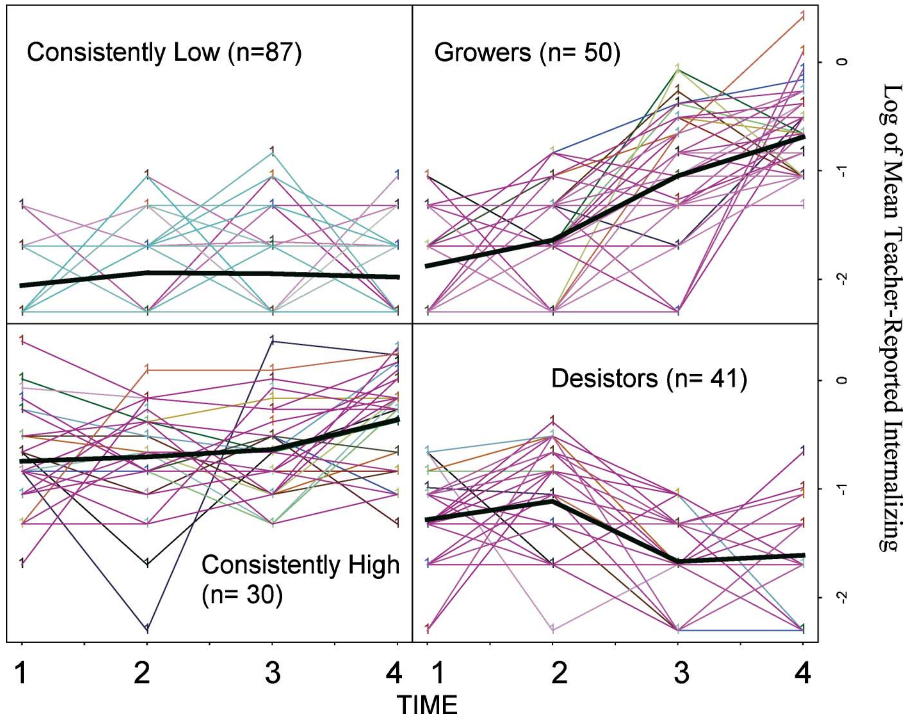

Fig. 5. Internalizing growth curve clusters. Thick line represents mean growth trajectory.

of these interactions. Our hypothesis was that rigidity in parent–child interactions would be associated with externalizing and internalizing behavior in early childhood and that this association would be relatively independent of any specific content of the interactions. The results largely supported this hypothesis.

Correlations with the rigidity construct indicated modest linear relationships with externalizing behavior in fall and spring kindergarten and first grade. High levels of rigidity in parent–child interaction were also associated with child externalizing problems in both the categorical

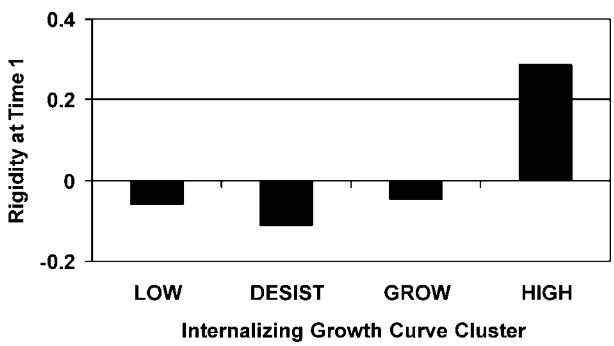

Fig. 6. Rigidity scores at Time 1 for each internalizing growth curve cluster.

and the growth clustering approaches. Parent–child rigidity scores in the high externalizing subgroups were consistently and progressively higher than those in the low externalizing subgroups. Furthermore, the individual growth patterns of externalizing behavior showed that rigidity was highest either for those children who remained high in externalizing throughout kindergarten and first grade or for those children whose externalizing behavior increased over time. It is interesting to note that the "desistor" and "grower" clusters were at approximately the same level of externalizing in early kindergarten. What differentiated these clusters was the amount of rigidity in the interactions with their parents at that first time point when these children could not be discriminated on the basis of their externalizing scores. This result raises the possibility that early differences in parent–child rigidity could aid in the prediction of which children with moderate levels of externalizing behavior will become more problematic in the future.

However, less consistent associations were found for child internalizing behavior problems. Correlations of rigidity with continuous measures of internalizing problems were small and only significant at the end of kindergarten. The relationship between rigidity and internalizing behavior may not be linear. Rather, it may be only in the most extreme cases of psychopathology that are characterized by rigid interaction patterns. Differences in rigidity of extreme groups of high and low in internalizing subgroups of children were more pronounced. However, the association of rigidity with growth clusters held only for the chronically high group and did not predict growth in internalizing problems.

Finally, there is some indication that the association between rigidity in parent–child interactions and the development of psychopathology holds up after controlling for specific behavioral content of the interaction. Mean durations of mutual negative engagement, mutual positive engagement, parent start-up, and child start-up did not attenuate the correlations between rigidity and either externalizing or internalizing measures. These mean durations in dyadic states can be interpreted as the degree to which families got "stuck" in each of these states. As such, rigidity may be an important process in risk for child psychopathology, in addition to the content of parent–child interaction.

There are at least two reasons why structural descriptions of interpersonal behavior may provide unique prediction beyond content: real-time and between-context variability. Children who learn to express a range of emotions also have ample opportunity to modulate those emotions and thus become adept at regulating their social behavior (Gottman, Katz, & Hooven, 1996). Parents who are less accepting of variety in emotional states do not foster those opportunities and thus limit children's capacities to regulate their own behavior (Eisenberg, Cumberland, & Spinrad, 1998; Ramsden & Hubbard, 2002). In the real-time dynamics of parent–child interaction, this pattern of emotional coaching or coregulation may take several forms (i.e., attractors) within the same dyad. For instance, in the coercive cycle described by Patterson and colleagues (Patterson, 1982), the child and parent escalate conflict (i.e., high mean duration in the mutual negativity attractor) and then become "unstuck" when the parent capitulates. During the nonconflict moments, the dyad may become absorbed in mutually positive or parent positive/child negative attractors as the parent actively avoids returning to the discomfort of escalated conflict. Thus, the dyad has actually three attractors, not one, and the degree to which they perseverate in each of these attractors and their propensity to transition to other states is a characteristic of the entire coercive process. Moreover, dyads can differ in the number and type of attractors, yet have a common level of rigidity that exposes the limited dynamics of their emotional coregulation. In this way, structure subsumes content; high rigidity indicates a coregulation style with very few, strong attractors, whereas low rigidity indicates a more diverse set of weaker attractors.

The second advantage of structure is that it exposes the ability to adapt to changing environmental demands. Recall that parents and children in this study were asked to engage in a variety of tasks over a 2-hr observation period. The ability to transition from one task to another and to experience the range of affective states that are potentially triggered by these varied contexts seems to be associated with reduced risk (Cicchetti & Cohen, 1995; Jones, Reid, & Patterson, 1975). Indeed, this sensitivity to context can distinguish children who develop life-course-persistent antisocial behavior from those for whom antisocial behavior is transient and context specific (Moffitt, 1993). Thus, both real-time and context-dependent rigidity are related to the development of problem behaviors in early childhood. The critical next step in this line of research is to examine the structure–content relationship more directly. It is possible that the integration of content and structure is a matter of scale: changes in context elicit changes in structure that is an amalgam of all possible content. The interrelations among these scales and specific content–structure combinations may provide new insights into the development of psychopathology.

Limitations and Future Directions

Although associations between SSG measures of rigidity and problem behaviors in early childhood were observed, these associations were modest in size. The individual variables that were combined to form our rigidity construct were not strongly associated with each other or with the outcomes. Further refinement of these rigidity measures is needed. For example, the Cells measure of rigidity (the range of unique dyadic states) did not reliably combine with the other two rigidity measures in the construct. One potential explanation is that all the parent–child dyads in this study visited more than half of the cells. It is possible that the reduced variance in the Cell measure was an artifact of our categorization scheme. A state space that has a wider distribution of observed states could possibly make the Cells measure more sensitive.

The 2-hr-observation in this study provided a broad window on real-time parent–child dynamics. The variety of interaction tasks offered an opportunity to explore how affective expression during family interaction changes with situational demands. However, the tasks may have not been systematically arranged to optimize measurement of rigidity. A core premise of DS approaches is that perturbations expose the characteristics of a system as it moves away from and back to a stable equilibrium (Granic & Lamey, 2002; Thelen & Ulrich, 1991). Thus, a more methodical manipulation of context that challenges the ability of participants to respond flexibly may reveal how rigidity or flexibility is maintained both within and across contexts.

A final limitation of this study is related to the sample characteristics. Although the sample might be described as at risk, the children were not clinically referred for anxious, depressed, defiant, aggressive, or oppositional behavior. It may be that our weak but significant predictions would be strengthened considerably if rigidity was examined in a clinically referred sample. Moreover, this study did not explore associations with specific disorders or subtypes of externalizing and internalizing behavior in early childhood. Future studies on rigidity will need to examine more narrowband factors, comorbidity, and the relation of rigidity in interactions to risk for psychopathology over a range of child ages.

Previous research has not focused on the socioemotional, psychopathological, or temporal aspects of psychological rigidity. The SSG technique used in this study holds promise for developmental psychopathology research in general and the study of rigidity in particular (Granic & Hollenstein, 2003). The temporal resolution of SSGs allows for analyses at several time scales. It would be possible, for instance, to use this real-time tool in combination with the static assessment of family functioning to create a more integrated family systems model of cohesion and adaptability (Olson, 2000; Yahav, 2002). It may also be interesting to examine how interventions targeted at reducing psychopathological trajectories in childhood have an impact on rigid behavior patterns and, conversely, perhaps how interventions specifically designed to expand flexibility might have an impact on the development of psychopathology. This research represents an initial step in exploring these associations and future research will be necessary to flesh out the relationship between rigidity and psychopathology across the life span. Using a DS approach, we can begin to define *behavioral rigidity* more clearly and test the hypotheses generated by both the DS perspective and the long-standing intuitions of clinical researchers about the nature of psychopathology.

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