PAPER

Reorganization in coping behavior at 1½ years: dynamic systems and normative change

Marc D. Lewis,[1] Sara Zimmerman,[2] Tom Hollenstein[1] and Alex V. Lamey[1]

1. Department of Human Development and Applied Psychology, Ontario Institute for Studies in Education, University of Toronto, Canada
2. Hincks-Dellcrest Treatment Centre, Toronto, Canada

Abstract

By the age of 1 year toddlers demonstrate distinct coping habits for dealing with frustration. However, these habits may be open to change and reorganization at subsequent developmental junctures. We investigated change in coping habits at 18–20 months, a normative age for major advances in social cognition, focusing on the dynamic systems principles of fluctuation and novelty at transitions. Specifically, we asked whether month-to-month fluctuation, novel behavioral habits and real-time variability increased at the age of a normative transition, despite individual differences in the content of behavior. Infants were given frustrating toys while their mothers sat nearby without helping, on monthly visits at 14–25 months (before, during and after the hypothesized transition). State space grids representing patterns of behavioral durations were constructed for each episode and compared over age. As predicted, month-to-month fluctuation in grid patterns increased temporarily between 17 and 20 months, partly independently of a concurrent peak in distress, and new behavioral habits replaced old ones at the same age. Coping habits changed differently for high- and low-distressed toddlers. However, changes in real-time variability did not generally meet our expectations.

Introduction

The everyday lives of infants and toddlers are peppered with frustrations and losses. Mothers get preoccupied or leave, toys break, enticing objects are kept out of reach and children discover that reality does not correspond to their wishes and expectations. Thus the first two years of life are a crucial period for the development of strategies for regulating negative emotions, coping with frustrations and maintaining psychological equilibrium. In this study, we viewed coping or emotion regulation strategies as habits that vary greatly across children but show consistency within individual children. The question that guided the study was: when are such habits open to change? We were particularly interested in whether coping habits, once consolidated, would break down and become reorganized at a period of normative developmental change. We thus examined coping behavior before, during and after a general advance in social cognition at about 18–20 months, using a new dynamic systems method for identifying differences in real-time behavior patterns.

By the end of the first year, individual differences in children's coping habits are relatively stable, suggesting well-organized behavioral repertoires (Rothbart, Ziaie & O'Boyle, 1992). A variety of behaviors can be observed. Gaze aversion and attentional disengagement are available from early infancy (Demos, 1986; Rothbart *et al.*, 1992). But by 1 year infants use their new cognitive and motor skills to manipulate objects with considerable control, and they explore new ways to manipulate objects when caregivers are unavailable (Kopp, 1989). They also use their social-cognitive skills for social referencing, signalling distress and frustration, and eliciting specific forms of assistance from the caregiver (Campos & Stenberg, 1981; Kopp, 1989). Coping strategies can be roughly divided into object-oriented, person-oriented and object-and-person-oriented strategies. The most prominent object-oriented skills available by 1 year are direct manipulation of the object and use of distraction

(e.g. switching objects). Prominent person-oriented skills include proximity or contact seeking, direct pushing or pulling of the caregiver, and whining or demanding vocalizations (Parritz, 1996; see also Calkins & Johnson, 1998). Coping skills that combine object and person orientations include moving the object closer to the caregiver, seeking information about objects, and social referencing (Parritz, 1996). Toddlers also use various forms of self-soothing, remove themselves from stressful situations, or start banging or kicking when frustrated (Calkins & Johnson, 1998). These coping strategies have been observed throughout the second year (Calkins & Johnson, 1998; Grolnick, Bridges & Connell, 1996; Parritz, 1996), though we believe there are fundamental changes in how and when they are used.

A number of theorists have proposed that transitions in socioemotional functioning correspond with more general developmental shifts. For example, Campos and colleagues (e.g. Campos & Barrett, 1984) proposed major changes in infants' emotional interactions with their caregivers as a function of locomotor changes at 8–10 months. Constructivist theorists posit changes in emotional and coping responses corresponding with cognitive developmental advances, such as Piagetian stages and substages (e.g. Sroufe, 1979, 1995). According to neo-Piagetian theorists, fundamental age-related cognitive reorganizations provide situations with new meanings, eliciting new emotions, as well as tools for assembling new coping strategies for regulating those emotions (Case, Hayward, Lewis & Hurst, 1988; Fischer, Shaver & Carnochan, 1990; Lewis, 1993; Lewis, Koroshegyi, Douglas & Kampe, 1997; Mascolo & Griffin, 1998). One such transition is between the stage of sensorimotor operations and the stage of interrelational operations at approximately 18–20 months (Case, 1992; cf. Fischer, 1980).

Indeed, a number of seemingly related social-cognitive and socioemotional shifts have been observed at about 18 months. Children establish an objective or conscious sense of self (Kagan, 1998; M. Lewis, 1995) and become aware of the desires or intentions of others (Repacholi & Gopnik, 1997; Tomasello, 1995). New socioemotional constellations at this age include possessiveness (Lewis & Michalson, 1983), shyness or embarrassment (Lewis, Sullivan, Stanger & Weiss, 1989), negativism (Dunn, 1988), empathy or prosocial behavior (Eisenberg, 1992; Zahn-Waxler & Radke-Yarrow, 1982) and assistance-seeking (Bridges & Grolnick, 1995). Also, some forms of emotional display have been found to peak at 18–21 months, including irritability, crying and temper tantrums (Kopp, 1992) and by some accounts separation distress (Emde, Gaensbauer & Harmon, 1976; Mahler, Pine & Bergman, 1975). These various changes have been explained by advances in the perception of self and other (Dunn & Munn, 1987; Kagan, 1998; Lewis et al., 1989; Zahn-Waxler & Robinson, 1995), changes in memory and representation (Grolnick, McMenamy & Kurowski, 1999; Kopp, 1989; Thompson & Limber, 1990), or more general cognitive reorganizations (Case et al., 1988; Fischer et al., 1990).

Thus, socioemotional changes appear to be related to normative cognitive-developmental shifts. Yet attempts to link specific socioemotional acquisitions (e.g. stranger anxiety, separation distress) with age-specific cognitive-developmental advances (e.g. Stage 4 object permanence) have generally been unsuccessful (Emde et al., 1976). Why might this be so? Socioemotional development is characterized by huge individual differences (Sroufe, 1979; Thompson, 1993; Tronick, Ricks & Cohn, 1982). In the toddler period, diverse emotional and coping habits are the rule, and they appear to reflect temperamental characteristics, familial variables and situational context (Calkins & Johnson, 1998; Grolnick et al., 1996; Parritz, 1996). We suggest that these differences obscure normative (age-specific) trends – trends that influence development in important ways even though they are difficult to observe directly.

It may be best to ask how heterogeneous trajectories change and reorganize at critical developmental junctures rather than postulate the same socioemotional shift for all children in the same age range (Lewis et al., 1997). In other words, what do diverse individual pathways have in common when they cross a normative transition point? To address this question, we hypothesized that changes in social-cognitive development at approximately 18–20 months of age would trigger a reorganization in the coping habits of many children. Specifically, the new representational and social competencies coming on line at this age would challenge the repertoire of coping habits already developed, causing new habits to emerge and old habits to fade or be redeployed in response to frustrating events.

In order to evaluate age-specific reorganizations in coping behavior, we studied a phenomenon drawn from dynamic systems (DS) approaches to development. DS approaches have been particularly useful for analyzing the *structure* of developmental transitions regardless of the *content* of the behavior under investigation (van Geert, 1998). From a DS perspective, developmental transitions are structured as global reorganizations in the patterns of interaction among system elements (e.g. schemas, concepts, skills, neurons). They are characterized by a breakdown in the orderliness (or increase in the variability) of behavior as new organizations replace existing ones. Such reorganizations are called *phase transitions*, defined as abrupt or discontinuous changes in the

state space describing the child's behavioral tendencies, and triggered by an incremental or continuous change in one or more parameters (Kelso, 1990; Thelen & Ulrich, 1991).[1] Because phase transitions are identified in terms of structure rather than content, they should be visible despite wide differences in the content of individual trajectories.

Not all developmental change is discontinuous, and it is important to determine which changes are gradual and which are abrupt (Fischer, 1983). We expected a discontinuous (phase) transition in coping behavior, because many coping strategies are incompatible (e.g. avoidance versus approach, distraction versus assistance-seeking). Thus, new coping strategies would have to replace, not just modify, old ones, at least within a given context. When one behavioral organization is incompatible with another (e.g. walking vs. crawling, conservation vs. nonconservation), DS theorists have found developmental change to be discontinuous (Thelen & Ulrich, 1991; van der Maas & Molenaar, 1992).

Phase transitions are marked by related changes at two time scales: real time and developmental time. In *developmental time*, there is first a period of stability, reflecting an enduring structural regime. This gives way to a period of fluctuation or instability, when old forms or habits alternate with new ones, and these new forms constitute new attractors on the state space. Finally, at least some of these new forms or habits stabilize in development, constituting a new structural regime (Fogel & Thelen, 1987; Granic, Hollenstein, Dishion & Patterson, 2003; Thelen & Ulrich, 1991; van Geert, 1991, 1994). Thus, developmental change is marked by a temporary period of *fluctuation* and *novelty* in the repertoire of behaviors, skills or habits. In *real time*, behavior self-organizes (stabilizes) within seconds or minutes, but this process becomes more variable and behavior becomes more indeterminate during a phase transition (e.g. Kelso, 1995; Thelen & Smith, 1994; van der Maas & Molenaar, 1992).

DS methods have been applied with some success to transitions in motor, cognitive and linguistic development. Through mathematical modeling of interacting system elements, van Geert (1991, 1994, 1998) has generated theoretical growth curves that are then compared to longitudinal data, often demonstrating a good fit between ideal and actual profiles (Ruhland & van Geert, 1998). Neo-Piagetian developmentalists have applied similar procedures to model theoretically deduced cognitive-developmental profiles (Case, Okamoto, Griffin, McKeough, Bleiker, Henderson & Stephenson, 1996;

Rose & Fischer, 1998). Other DS researchers (van der Maas & Molenaar, 1992; van der Maas, 1998) have modeled discontinuities in cognitive-developmental change as movement across a catastrophe cusp, a mathematically modeled transition between two stable states or periods. However, these methods have not been applied to transitions characterized by individual diversity, and it is not clear how they would be adapted to do so. In addition, many psychologists interested in socioemotional development are not comfortable with the mathematical concepts underlying these methods. Therefore, a new method that is conceptually simple, relies on standard statistical techniques and captures phase transitions in diverse individual trajectories was chosen for the present study.

State space grids

State space grids have been shown to capture individual continuity as well as developmental change and to be sensitive to the structure and content of socioemotional behavior (Granic & Hollenstein, 2003; Granic *et al.*, 2003; Granic & Lamey, 2002; Lewis, Lamey & Douglas, 1999). This technique utilizes behavioral observations, such as videotaped infant–mother interactions, to generate variables that define the state space of the child's (or dyad's) behavioral system. Traditional behavioral measures produce independent scales whose interactions, if addressed at all, are examined over occasions and subjects, not in real time. But a state space depiction represents real-time, moment-to-moment interactions among variables (see Smith, 1995). To accomplish this with behavioral data, state space grids utilize two categorical or ordinal scales that can be reliably coded, and that describe most of the interesting variance between them. These scales define the x and y axes of a grid of cells. Each segment of behavior is coded on both scales, thus falling into one cell or another on the grid. The path of behavior can be charted as a trajectory that moves from cell to cell, stopping for long durations in some cells and briefly or not at all in others. Long durations or frequent recurrences of behavior in a particular cell (or cells) suggest an attractor on the state space, and such hypothetical attractors can be tested by simple statistical means (Lewis *et al.*, 1999). Moreover, the overall patterning of behavior, scattered over the cells of the grid, can be compared from session to session to tap developmental change or stability – regardless of the content of behavior. This is critical for charting individual, within-subject changes. Again, simple statistical methods can be used to evaluate such changes.

The purpose of the present study was to apply the state space grid method to test for a hypothetical phase

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[1] The state space is a hypothetical map of all potential states available to a given system, and it is populated by attractors, states where behavior recurs and stabilizes.

transition, common to diverse pathways of coping development, in the middle of the second year. To study the profile of change, we videotaped infants' behavioral adaptations to a potentially frustrating event, before, during and after the predicted transition. Using a fine-grained longitudinal design, we collected 12 waves of data from 14 to 25 months, with the predicted shift about midway through the sequence (18–20 months). Once emotional and behavioral responses were coded, and behavioral patterns were mapped onto grids, our aim was to chart the month-to-month profiles of developmental and real-time variables, and to test for evidence of the expected shift using conventional statistical methods.

Hypotheses

Our hypotheses were guided both by general DS principles concerning developmental phase transitions and by specific theory and research in socioemotional development:

1. The first three hypotheses were derived from general DS principles. A developmental phase transition is indicated when the state space remains stable across occasions, then fluctuates for some time, then restabilizes once more (Thelen & Ulrich, 1991). Thus, an age-specific phase transition in coping strategies would be suggested if month-to-month *fluctuation* in behavior increased at about 18 months and then decreased starting at about 20 months. *We expected many or most profiles to demonstrate this structure despite wide individual differences in the content of coping behaviors.* We thus expected each child's behavior to occupy the same cells (denoting the same regions of attraction) each month during the stable periods (prior to 18 months and following 20 months) and to occupy different cells from month to month during the transitional phase (18–20 months).
2. According to DS principles, old habits or attractors ought to disappear at the time of a phase transition, to be replaced by new ones as the new organization consolidates. Specifically, existing coping habits should break down and new ones should emerge during the period of 18–20 months. Again, we expected this structure to show up for most children regardless of individual differences in the content (e.g. object-oriented, person-oriented or combined strategies) of coping behavior.
3. A third hypothesis derived from DS principles was that real-time (within-session) patterns would change systematically at the time of the developmental transition. Following Thelen and Ulrich (1991), Hartelman and colleagues (1998) and others, we expected real-time stability during periods of developmental

stability, and increased real-time variability, sensitivity and indeterminacy during periods of developmental change. Thus, we predicted that coping behavior would remain stuck in fewer cells before and after the transition, but occupy more cells and shift more often at 18–20 months.
4. The last two hypotheses were derived from theory and research regarding early socioemotional development. As described earlier, various studies have found increased irritability, crying, tantrums and negativism at approximately 18 months. We thus expected to find an increase in negative emotional vocalizations in response to frustration at approximately the time of the hypothesized transition in coping strategies.
5. The finding of increased negative emotion at an age of behavioral reorganization could be explained in several ways. More negative emotion may simply increase variability in behavior, as psychological equilibrium is temporarily compromised. Alternatively, as proposed by neo-Piagetians and other theorists, a general developmental shift (e.g. in social cognition) might be responsible for both the increase in emotionality and the reorganization of behavior. In support of this proposition, we hypothesized that developmental fluctuation in coping habits would be partially independent of increased distress.

Method

Participants

Participants were mother–infant dyads who had been involved in a previous longitudinal study (Lewis *et al.*, 1997). They were initially recruited through radio announcements, flyers distributed to clothing and toy stores, presentations to pre- and postnatal fitness classes, letters to physicians and newspaper advertisements. Of the 39 dyads in the initial study, nearly all were Caucasian and 82% were middle class. Nineteen infants were firstborn. Criteria for inclusion stipulated that the infant be born within 2 weeks of term without serious complications, both parents live at home, the mother be the primary caregiver, and the mother remain at home at least part-time within the first year of the infant's life. These criteria were intended to minimize diversity within the sample. Whereas diversity is desirable in some research designs, the present research was concerned with individual pathways related to a (perhaps culturally) normative timetable.

Of 30 eligible dyads, three were lost to attrition, and two were excluded because their homes lacked a suitable space for conducting the study. One additional dyad was

eliminated because the mother generally did not follow the instructions. Thus, a total of 24 mother–infant dyads participated in the present study.

Procedure

Each mother–infant dyad was visited on a monthly basis when the infants were between 14 and 25 months of age. Subjects were videotaped during four emotion-eliciting tasks. The video camera was set up across the room on a tripod so that both the mother and infant were taped.

Each task involved a toy that became unavailable or unworkable to the infant and a mother who remained unhelpful. The intent of these situations was to elicit a moderate level of frustration that would recruit a range of behavioral strategies but not overwhelm the infant. However, one task frequently elicited high distress, many episodes had to be stopped prematurely and a substantial practice effect became evident in the later waves. Another task elicited little visible frustration and little behavioral adjustment or variation as a result. These two tasks seemed unlikely to provide useful data and were therefore left uncoded. However, they remained part of the procedure in order to ensure consistency across sessions.

Each of the four task episodes began with an initial play period lasting long enough for the baby to become engaged. In two mother-mediated tasks, the mother and baby were seated on the floor together during this phase, while the examiner was outside the room. At the onset of the emotion-eliciting event, the mother moved to a designated area 1.5–2 meters behind the infant, and pretended to read a magazine. In the two tasks not mediated by mother, the initial play period began with the mother already seated 1.5–2 meters behind the infant, and pretending to read a magazine. In these episodes the examiner introduced the toy(s) to the infant. The examiner left the room either prior to or at the onset of the emotion-eliciting event.

Timing began at the onset of each emotion-eliciting event and the baby's reaction was video-recorded for 60 seconds. If the infant approached the mother or made some overt gesture directed towards her, the mother was asked to limit her response to one standard phrase and then continue reading her magazine. This restriction of the mother's involvement was not as contrived as it may first appear. There are many periods during a toddler's day when mother is busy on the phone, reading or working, and remains disengaged for at least a minute at a time. Also, pilot testing suggested that variability in mothers' responses could drown out variability in infant behavior without the use of explicit instructions. Episodes were discontinued after 15 seconds of moderate to high distress for ethical reasons.

A semi-standardized play period followed each task episode to mitigate any negative memory of the experimental toys. During this time, the mother encouraged the baby to resume the activity interrupted by the emotion-eliciting event. The examiner then presented a second toy and allowed the baby to play with it for as long as desired. This play period generally lasted 3–5 minutes. Play periods were extended up to 10 minutes whenever the previous episode had been discontinued due to distress.

Tasks

1. Jack-in-the-box

The mother introduced a jack-in-the-box out of which popped a puppet's head after the crank was turned several rotations. However, the crank of the jack-in-the-box was shortened so that the turning motion would be impossible for an infant. The mother was instructed to operate the toy twice but not to teach the infant how to do it. Once the infant was engaged, the mother stopped working the jack-in-the-box and moved to a designated area to read a magazine, at which point timing began. If the infant made an overt attempt to re-engage her, she was to respond, 'I'm busy now. You try it.' This task elicited mild to moderate distress and was therefore included in the analysis.

2. Enclosed-toy

The examiner emptied three toys from a clear plastic container (a cake container) and placed them in front of the infant. When the infant had focused on one particular toy for 10–15 seconds, the examiner took it from the infant, placed it in the container and snapped on the lid. The container was virtually impossible for the infants to open. The other two toys remained outside the container and continued to be accessible. After placing the one toy inside the container, timing began and the examiner left the room. Again, the mother was not to initiate any involvement and to respond, 'Find something else to play with', if the infant approached or requested help. This situation elicited mild to moderate distress on many occasions and was therefore included in the analysis.

3. Keyboard

The examiner first demonstrated an electric keyboard, and encouraged the infant to play on it. Once the infant was interacting with the toy, the examiner left the room, listened for a steady stream of noises, then unplugged the keyboard surreptitiously and started timing. The mother continued to feign interest in reading the magazine.

If the infant initiated a social interaction, the mother was instructed to respond, 'I'm busy now. You try it.' This task was discarded because it elicited little or no frustration or distress, as noted earlier. The infants seemed perfectly content to use the keyboard to bang on even after it was turned off.

4. Removed-toy

Mother and infant were seated together on the floor with three toys. As the infant played, the mother responded to her child's initiations, but restricted unsolicited physical involvement and verbal suggestions. Once the infant selected a favorite toy, focusing on it for 10–15 seconds, the mother was instructed to say, 'Let's put this away now, because it might break.' She then put the toy on a shelf, and moved to a designated area to read a magazine. If the baby simply shifted attention to one of the alternative toys, the mother followed the same procedure after 10–15 seconds. If the baby made an attempt to engage her, the mother responded, 'Find something else to play with.' As noted earlier, this procedure elicited high distress for many infants and was therefore excluded from the analysis.

All tasks were administered in the above sequence every month. This minimized the possibility that observed month-to-month differences would be due to changes in the presentation sequence rather than developmental change. The sequence was determined by our degree of confidence in the tasks. Pilot research was more conclusive with the first two tasks whereas the second two remained provisional, and the task expected to elicit the most distress was saved for the end to minimize contamination. Indeed, these final two tasks were deemed ineffective several months into the study.

Termination and exclusion criteria

An episode was terminated early or considered spoiled for the following reasons:

1. The infant left the room. This was by far the most common reason for short sessions.
2. The infant met the distress criterion (15 seconds of intense or continuous distress).
3. The mother made an error, for example, instructing the baby on how to access the toy, moving next to the baby, soothing or helping the baby.
4. The toy became accessible to the infant (e.g. the jack-in-the-box opened).
5. Outside interference caused the infant to become distracted (e.g. a family pet entered the room and the infant began to play with it).

6. The infant would not participate by refusing to interact with the experimental toys during the initial play period.

Considering only the two tasks that went on to the analysis phase, the number of episodes scheduled was 576 ($24 \times 12 \times 2$). Of these, 100 were missed due to cancelled sessions that could not be rescheduled or they were considered spoiled for any of the reasons listed above. Of the 476 usable episodes, 63.7% went the full 60 seconds and 75.2% lasted at least 45 seconds. To compensate for shortened episode lengths, some variables were prorated by duration as explained later.

Missing or spoiled sessions were distributed roughly evenly across the age span except for a steep increase in the final 2 months, with 14 (out of 48) episodes missing at 24 months and 19 missing at 25 months. At these ages, missing sessions were primarily due to loss of commitment on the part of the participants and spoiled sessions were often due to practice effects (as when infants avoided the experimental toys or opted for a game of hide-and-seek with the examiner). These problems are not surprising given 12 waves of data collection. To balance between lost data and unreliable group variables, we decided to drop month 25, with nearly half the sessions missing, from all subsequent analyses.

Coding procedures

Each videotaped session was coded twice, the first time for engagement behavior and the second time for distress.

Engagement behavior

Infant behavior was coded on two ordinal scales representing level of engagement with the toy and level of engagement with the mother. As discussed earlier, toddler coping behaviors can be nicely divided into engagements with the caregiver, engagements with objects and a combination of the two. Each scale had 5 levels of engagement, with level 1 representing no engagement at all, levels 2 and 3 representing degrees of passive engagement, and levels 4 and 5 representing degrees of active engagement. Each second of behavior was coded on both scales simultaneously. The levels for each scale and the behavioral guidelines used to identify them are shown in Table 1.

Distress

Although commonly used in research with young infants, facial expression was inadequate as an index of distress in the present study. Increases in infant mobility in the second year limit the opportunity for continuous facial coding, and infants in this study were expected to

Table 1 *Coding scales for engagement with toy and engagement with mother, showing five ordinal levels for each scale*

Code	Behavior
Engagement with toy	
1. No engagement	Complete inattention to toy. No looking at or touching the target toy (may be engaged with other toys in enclosed-toy condition).
2. Low passive engagement	Carrying or touching the toy without looking at it or manipulating it.
3. High passive engagement	Looking at the toy; looking at and touching the toy but not manipulating it; manipulating the toy without looking at it.
4. Nonspecific active engagement	Manipulating the toy in an exploratory manner while looking at it, e.g. turning the jack-in-the-box around or rolling it on the ground, shaking it, throwing it or kicking it.
5. Specific active engagement	Manipulating the toy in a fashion specific to the properties of the toy, e.g. turning the crank of the jack-in-the-box or trying to pull the top open.
Engagement with mother	
1. No engagement	No physical proximity to mother, no gaze at mother, no vocalizations to her nor other attempts to get her attention.
2. Low passive engagement	Sitting near mother without looking at her or otherwise seeking her attention. Approaching mother (taking up to 2 steps in her direction) but not looking at her.
3. High passive engagement	Looking at mother. Approaching her while looking at her, but not attempting to engage her in any way. Talking to mother/saying her name but not looking at her (unless this is followed within 3 s by looking at or approaching mother, in which case it is coded as level 4).
4. Nonspecific active engagement	Approaching mother, or vocalizing to her, while gazing at her. Moving toward mother, or lifting up the toy or pointing to it, while vocalizing toward mother. Standing/sitting directly in front of mother, talking to her.
5. Specific active engagement	Repeated or persistent physical attempts to obtain mother's attention and/or assistance. This code always involves some assertive physical contact with mother. For example, the infant pushes the toy or him/herself at the mother.

be moving about the room between the toys and the mother. As a result, we decided to code distress solely on the basis of vocal expression.

Distress was coded from the audio portion of each videotaped session. Each second was scored either as distress or nondistress, regardless of the intensity of vocalizations. Negative vocalizations ranged from mild discomfort (e.g. sighing, whimpering, whining) to extreme distress (e.g. crying, screaming). Mild to moderate forms of distress were most common, and extreme distress usually met the criterion for termination of the session. A total of 17 sessions representing 13 different infants were terminated because the distress criterion had been reached. No infant reached the distress criterion on more than two occasions. Although the intensity of distress was not captured by this coding system, prolonged distress was usually more intense than sporadic distress vocalizations.

Inter-rater reliability

All data were coded by two assistants who had helped design the engagement scales but who remained blind to the hypotheses until the coding was completed. Fifty-six sessions (19.5%) were coded by both assistants. A subset of infants were randomly selected, and for these infants one episode was selected randomly from each of three age periods: early, middle and late. The final count was an approximate proportion of the total number of coded episodes for each task: 25 jack-in-the-box episodes (21% of total) and 31 enclosed-toy episodes (18% of total).

Inter-rater reliability was assessed using two methods:

1. Concordance was calculated as the proportion of seconds in which there was agreement on the code on both toy and mother scales. A disagreement on one or both scales for a given second was designated a mismatch. Concordance was calculated as 75.9% for jack-in-the-box sessions and 80.8% for enclosed-toy sessions, with an overall mean of 78.5%.
2. Reliability on the toy and mother scales was calculated independently. That is, a mismatch could show up on one scale but not on the other. Using two 5-by-5 inter-rater tables, one for each scale, Cohen's kappa, combined over both tasks, was .79 for the toy scale and .80 for the mother scale.

Calculation of inter-rater reliability on distress was straightforward, yielding a kappa coefficient of .77.

State space grid construction

State space grids were constructed for each episode by plotting the corresponding values of the two engagement scales for each second on a grid of cells. As described earlier in the article, toddler coping behavior can be divided into object-oriented, person-oriented and object-and-person-oriented strategies. All three kinds of strategies can be depicted by the coordinates of these two variables, making them good candidates for the axes of the grid. Indeed, the two engagement dimensions provided unique grid regions representing object-oriented strat-
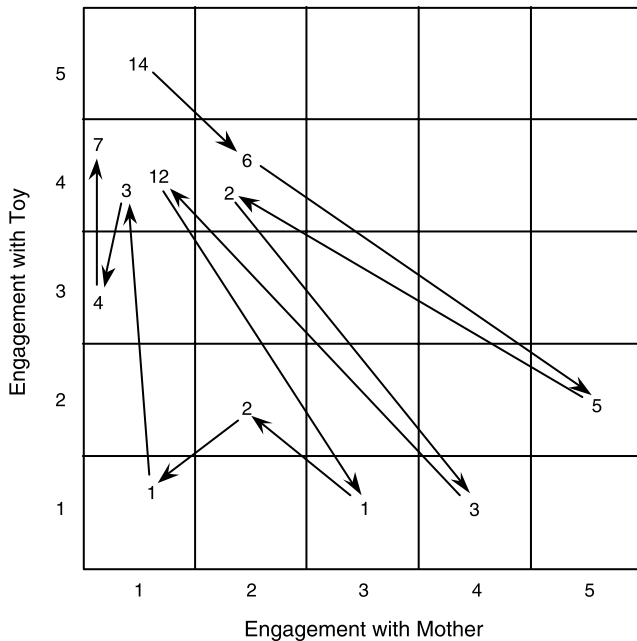
Figure 1   *Example of a coded state space grid. Duration values for each event are displayed in the appropriate cell and connected by arrows showing the flow of real time.*

Table 2   *Means, standard deviations and maximum duration values for grid cells, calculated over both tasks. For sessions under 60 s, cell values were divided by session duration and multiplied by 60, and sessions lasting less than 20 s were not included*

Cell	Mean	SD	Maximum
M1T1	15.63	18.55	60.00
M1T5	13.24	16.54	60.00
M4T2	5.28	8.13	56.00
M2T5	3.83	9.66	53.33
M5T2	3.61	8.62	56.75
M1T4	3.21	6.00	39.00
M1T3	2.99	4.58	30.66
M2T1	2.16	7.04	55.00
M4T1	1.96	4.78	32.00
M1T2	1.61	3.79	32.00
M3T1	1.26	2.90	20.00
M5T1	1.04	3.76	31.00
M2T3	.85	2.69	32.00
M3T2	.67	2.37	25.00
M3T3	.67	1.90	19.00
M2T4	.55	2.40	21.00
M3T5	.41	2.08	25.00
M4T3	.40	1.80	14.00
M2T2	.31	1.53	16.59
M4T4	.10	.89	10.50
M3T4	.10	.81	11.73
M5T3	.06	.72	9.82
M5T4	.05	.60	11.00
M5T5	.00	.00	.00
M4T5	.00	.00	.00

Note: For all cells, minimum duration = 0, $N = 424$.

egies (high-toy/low-mother) and person-oriented strategies (high-mother/low-toy), as well as cells depicting several distinct object-and-person-oriented strategies (see Figure 1). Five levels of engagement with the toy were represented from rows 1 to 5 (that is, along the y-axis), and five levels of engagement with mother from columns 1 to 5 (along the x-axis), producing a 25-cell grid representing all behavioral possibilities (see Figure 1). An enduring behavioral event received a particular code on both scales for several seconds at a time, and brief events were denoted when one or both codes changed in a second or two. Thus, a behavioral event occupied a single cell for some period of time, and movement to a new cell denoted a new behavioral event. For each 60-second episode, duration values for all events were recorded in the appropriate cells of a grid sheet, and duration values within each cell were later summed. A sample of a coded grid is shown in Figure 1.

Of the 25 cells in the grid, one cell (5,5) was never occupied because it represented specific-active engagement with both mother and toy, and this was impossible given the coding rules. Cells 4,5, 4,4 and 5,4 were rarely or never occupied because of the same built-in incompatibilities. However, a few behaviors fit these cells. For example, cell 5,4 usually involved the infant picking up the toy and throwing it at the mother, a specific action with respect to mother and a nonspecific one with respect to the toy. Mean and maximum durations for all cells are presented in Table 2.

Analyses and results

Overall strategy

The analyses were based on developmental profiles and standard descriptive and inferential statistics. Variables were derived from state space grids in a variety of ways, including well-known techniques such as cluster analysis, less known techniques such as sum-of-squared distance scores, and novel but straightforward techniques for analyzing similarity and variability within and between grids. These approaches are advantageous because they are either already familiar or they are easily grasped. They also yield ordinal or continuous data that can be graphed to show longitudinal profiles, and that lend themselves to parametric statistical tests. The parametric test we relied on was repeated-measures ANOVA because, unlike some other DS approaches, our primary interest was in group trends rather than individual profiles.

We also considered the use of time-series analyses. However, our longest developmental time series was 11

months, and this was insufficient even for techniques designed for short series (see Crosbie, 1995). Missing months were common, and month-to-month data were quite variable within subjects, making it difficult to estimate slopes or other parameters on the basis of few observations. Real-time (within-grid) time series were also considered. However, the average number of events (per 60 seconds) was 8.87, insufficient for time-series procedures. Hence, we did not use time-series designs and relied on standard statistics exclusively.

Distress

Monthly distress was calculated as the sum duration of seconds of distress per episode. In order to compensate for shortened episodes, total distress was divided by episode length and multiplied by 60, providing a proportional score corrected to 60 seconds. For enclosed-toy, $M = 5.64$ s, $SD = 10.61$. For jack-in-the-box, $M = 7.31$ s, $SD = 11.14$. Distress ranged from 0 to 60 s, with many episodes (41.6%) showing no distress and only two sessions showing continuous distress. Because the distribution of distress scores was skewed, with a small number of very high values, we replaced high scores with values 3 SDs from the mean for each task independently.

We predicted a peak in distress at the age of 18–20 months. As shown in Figure 2, mean monthly distress peaked at 18–19 months and declined rapidly thereafter for enclosed-toy; monthly distress was noisier but still peaked at 19 months for the jack-in-the-box task. To test these differences statistically, we ran a repeated-measures ANOVA with task and monthly distress as the within-subjects factors. Missing values were replaced with
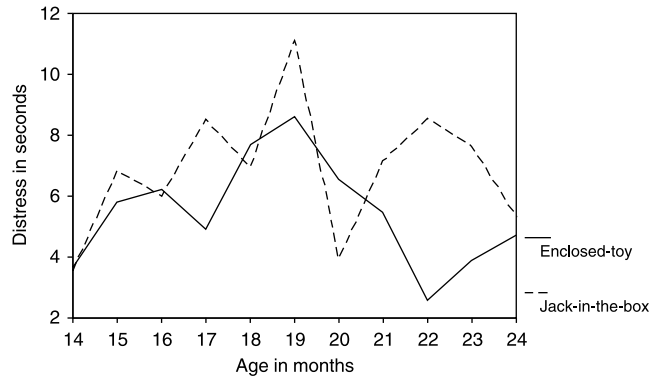

Figure 2 *Mean distress by month for each task. Distress was calculated as seconds of distress per episode divided by session length × 60.*

monthly distress means for each task. Monthly distress showed a significant quadratic effect, $F(1, 20) = 4.31$, $p < .05$, and no linear or cubic trends. Thus, higher distress in the middle months was borne out statistically. We also noted each infant's month of peak distress (on noncapped scores) for each task. The count of infants whose distress was at its peak for each month, summed across the two tasks, is displayed in Figure 3. Again, the highest incidence of distress peaks appeared to be at 19 months, dropping rapidly thereafter.

Developmental analyses of behavior

The analyses in this section began with two series of up to 11 state space grids (14 to 24 months) per infant, one series for each task. For each grid, the sum duration of
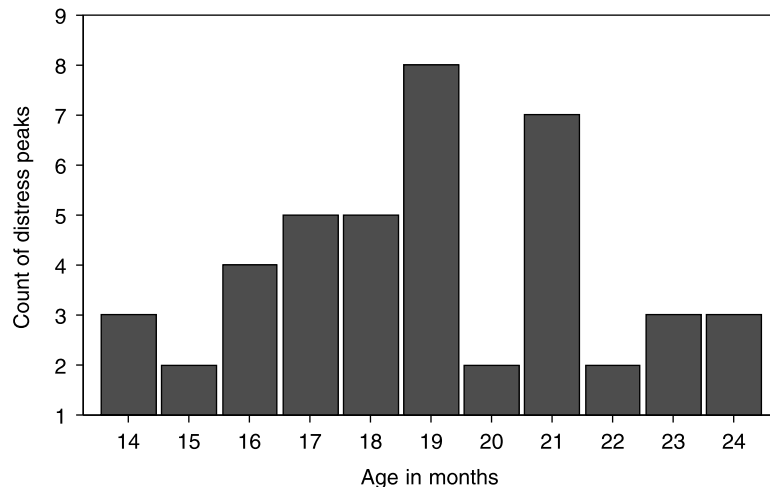

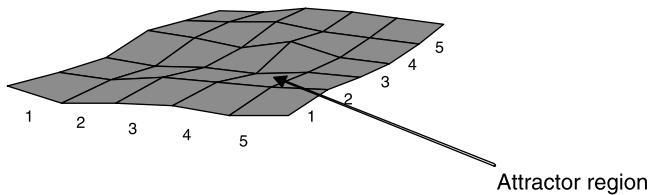**Figure 3** *Incidence of distress peaks per month for both tasks combined.*

Figure 4 *A state space grid represented as a landscape or topography.*

Figure 5 *Mean month-to-month distance scores by task. Values for each month represent total cell distances from the previous month.*

behavior was calculated for every cell, yielding zeroes for most cells and values of 1 or more for the rest. Session length was controlled for by dividing these values by session length and multiplying by 60 seconds. Sessions of less than 20 seconds duration were discarded. It is useful to think of these 25 cell scores as a landscape of behavioral tendencies. As characterized by the sketch in Figure 4, valleys or depressions in the landscape represent regions where behavior accumulates or pools, indicating coping habits that persist or recur often within a session. We were interested in the overall similarity between landscapes, that is, the tendency for valleys and hills to endure from month to month, within individual subjects. Comparing across tasks for the same month within infants, we found little similarity. We thus assumed that each task constrained behavior in a unique way, and that developmental profiles should be assessed by task. For each infant, then, grid-to-grid differences were calculated month by month for each task independently, and task and month were the within-subjects variables analyzed statistically. Two types of analysis were conducted.

1. Intergrid distance

Following DS principles for developmental transitions, we hypothesized that duration patterns on the grids would fluctuate from month to month at roughly 18–20 months but remain comparatively continuous from month to month before and after this period. To assess this prediction, we first analyzed grid-to-grid distance scores. Euclidian distance scores provided a global metric of the difference in behavioral landscapes from month to month, based on the sum of squared differences across all cells. For each grid cell, we calculated the difference in values over two consecutive months, then squared this amount, and then summed these values for all 25 cells. We then took the square root of this sum as the distance score between the two grids.

As shown in Figure 5, the developmental profiles for both tasks were quite uneven. However, peak distance scores were roughly as predicted: 18 and 19 months for the enclosed-toy task, 19 and 20 months for the jack-
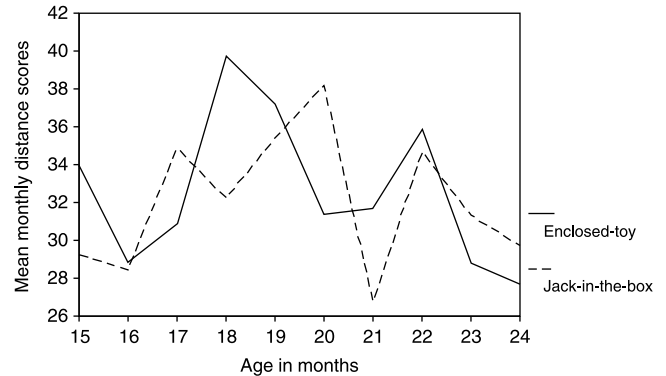
in-the-box task. These monthly scores represent the distance from the previous month. Thus, the greatest grid-to-grid changes were from 17 to 20 months. A repeated-measures ANOVA was conducted with task and month as the within-subjects factors. Missing values were replaced with monthly means for each task. As predicted, the quadratic effect for month was significant, $F(1, 20) = 7.18$, $p < .01$. Linear and cubic effects were low and nonsignificant, and task and month-by-task interaction effects were low and nonsignificant. Thus, month-to-month fluctuation was higher in the middle months than the early and late months of the study.

Next, we wanted to see how much this effect was related to distress during the middle months. If the change in month-to-month fluctuation was only evident for children with corresponding high distress, we might infer that the increased fluctuation was caused by distress rather than by some underlying developmental change. There was no perfect way to remove the effects of distress from month-to-month distance scores. Nevertheless, we entered distress, averaged over months 18–20, as a covariate in the repeated-measures ANOVA. Any remaining quadratic effect for distance would be entirely independent of high distress during these months. Co-varying out 18–20-month distress indeed reduced the quadratic F to 2.40, $p > .10$, indicating that the observed change in distance scores was mostly related to higher distress during the transition period.

Finally, to see what proportion of the sample showed the hypothesized trend, we subdivided profiles into those that fit the quadratic prediction and those that did not. Within-subject variability (across age points) was high, as would be expected when measuring toddler socio-emotional response. We therefore averaged each subject's distance scores within three periods, 14–17 months, 18–20 months and 21–24 months. There were two ways to

evaluate the shape of each subject's profile. First, we asked which period showed the highest mean distance score for each subject and tallied the results across subjects for each task. Only nine subjects (39%) showed the hypothesized profile for enclosed-toy and 11 (52%) did so for jack-in-the-box. Second, we divided the profiles into those with a quadratic shape in the hypothesized direction (middle period higher than the average of the first and third periods) versus those that violated the hypothesis (middle period equal to or lower than the average of the first and last periods). Using this less stringent test, 15 out of 21 scorable subjects (71%) showed the hypothesized profile for enclosed-toy and 12 out of 18 (67%) did so for jack-in-the-box. A binomial test of significance yielded a *p*-level of .04 for the former and .12 for the latter comparison. These analyses indicated that, depending on the test used, many or most subjects fit the predicted profile.

2. Intergrid category change

A second technique for examining month-to-month continuity versus fluctuation was based on the categorical similarity between grids. The first step was to categorize the grids by entering all grids into a k-means cluster analysis (separate analyses for each task). We selected a five-cluster solution because it provided enough categories to effectively classify grids, and produced clusters with roughly equivalent numbers (range 23–126 for enclosed-toy, 15–75 for jack-in-the-box). We then recorded the cluster score for each grid. As confirmed by visual inspection, grids with the same cluster scores were alike topographically, having similar duration values for many of the same cells. Developmental continuity would thus be indicated by a sequence of months (2 or more) with the same cluster score, and developmental fluctuation would be indicated by month-to-month change in cluster membership. A new variable, cluster-change, was assigned a value of 1 if cluster membership changed from the previous month and a value of 0 if it remained the same.

As shown in Figure 6, mean cluster-change scores for both tasks showed the predicted profile: the months of peak change ranged from 18 to 20, and the curves were less noisy than those based on distance scores. As before, a repeated-measures ANOVA was conducted with task and month as the within-subjects factors. The quadratic effect for month was highly significant, $F(1, 20) = 19.36$, $p < .001$. Linear and cubic effects were low and nonsignificant, the task effect was low and nonsignificant, and the month-by-task quadratic interaction effect approached significance, $F(1, 20) = 3.84$, $p < .10$.

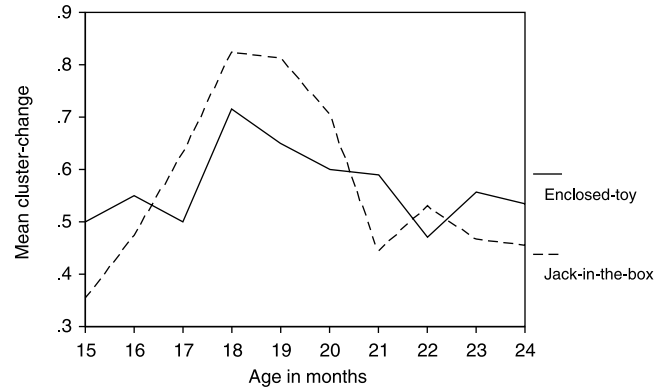Finally, we entered 18–20-month distress as a covariate in the repeated-measures procedure, as before. The

Figure 6 *Mean month-to-month cluster-change scores by task. Values for each month represent change in cluster membership from the previous month.*

quadratic effect for month was again reduced, but it remained significant, $F(1, 19) = 7.03$, $p < .05$. Thus, this analysis provided further evidence for a peak in month-to-month fluctuation in the predicted period, but it also demonstrated partial independence between distress and monthly fluctuation, as hypothesized.

Again, we assessed the proportion of the sample that showed the predicted quadratic trend. Using the more stringent of the two methods for evaluating profiles, the period of highest mean cluster-change was determined for each subject and tallied across subjects for each task. Some subjects were not scorable because of missing values for an entire period. This time the results were stronger, with 8 out of 17 scorable subjects (47%) showing the hypothesized profile for enclosed-toy, and 11 out of 15 (73%) showing the hypothesized profile for jack-in-the-box. Using the less stringent test, based on the quadratic shape of each subject's profile, 12 out of 21 subjects (57%) showed the hypothesized profile for enclosed-toy, and 14 out of 19 (74%) did so for jack-in-the-box. A binomial test of significance yielded a *p*-level of .33 for the former and .03 for the latter comparison. Again, these analyses indicated that most subjects fit the predicted profile.

Behavioral habits

The final developmental analysis concerned the emergence and disappearance of behavioral habits for individual toddlers. A DS approach to developmental continuity hinges on the construct of attractors, but we were not able to define attractors quantitatively with confidence in this study. Unlike previous research using state space grids (Lewis *et al.*, 1999), there was not enough cell-to-cell movement to test hypothetical attractors statistically
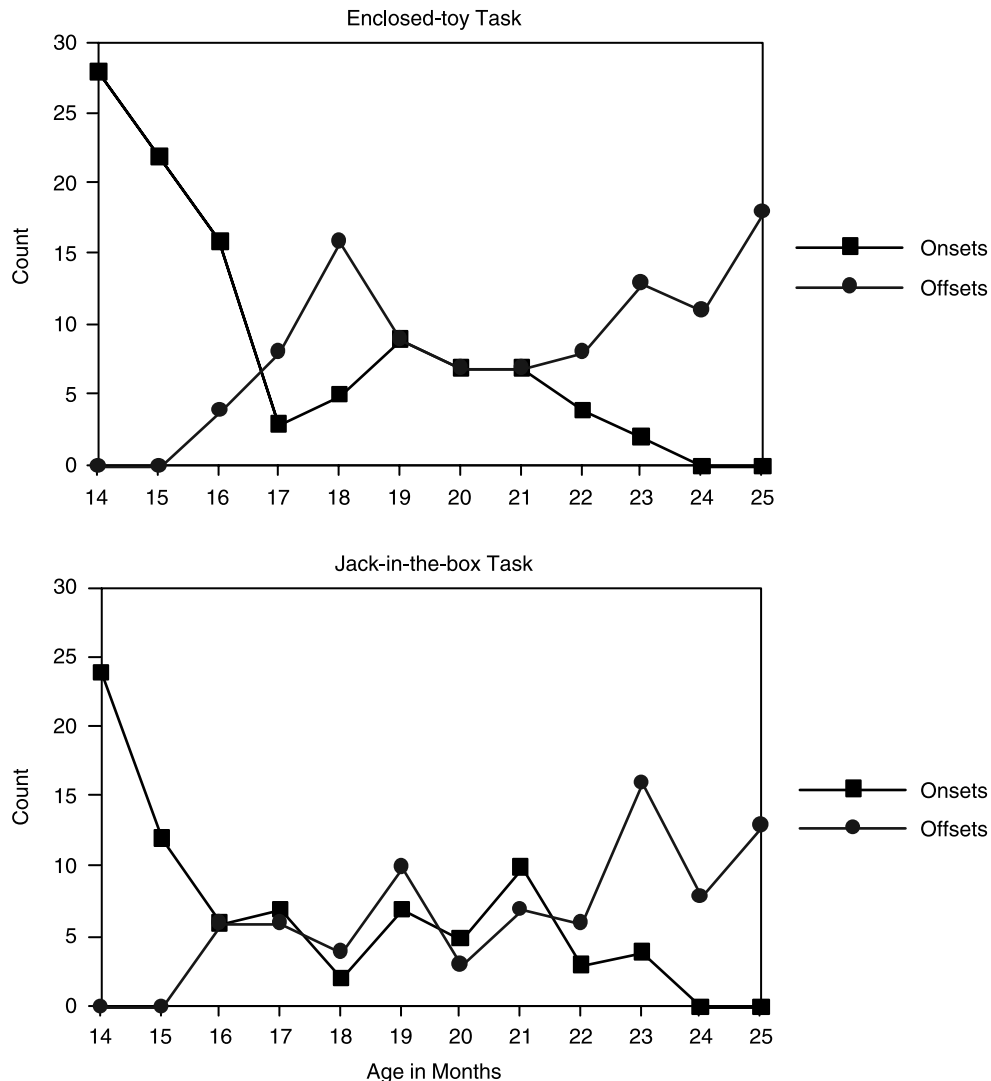
Figure 7 *Onsets and offsets of behavioral habits for each task. Only habits lasting 3 months or more were counted. Month 25 scores were used when available.*

(e.g. by frequency of cell recurrence). We therefore used a common-sense analogy of attractors: we denoted 'habits' as high cumulative durations in a particular grid cell – that is, the tendency for behavior to get 'stuck' in a particular cell or to return frequently to that cell – recurring over several months. The frequency distribution of cell durations showed a sudden drop or scree between 4 and 5 seconds, so we defined habits as cells with at least 5 seconds' cumulative duration for at least two out of three consecutive months. The two-out-of-three rule was useful to compensate for months in which behavior deviated only temporarily from an ongoing pattern.

Onset and offset months were recorded for each habit lasting at least 3 months, and we calculated the frequency of onsets and offsets for each month by task.

Month 25 scores were used when available, to increase precision. As shown in Figure 7, results for enclosed-toy were as hypothesized: early behavioral habits terminated at 18 months far more often than surrounding months, and new habits were most likely to begin at 19 months, with a slow decline thereafter. Results for jack-in-the-box were similar but less convincing, with early habits terminating most often at 19 months and new habits commencing most often at 21 months. Note that the scoring rules did not allow habits to end on months 14 or 15 or to begin on month 24 (and often 23). Therefore, chance alone would predict a gradual decline in beginnings and a gradual rise in endings over the age span, partially accounting for the observed profile. But chance would not predict the peaks observed in the middle months.

Behavioral content

Was there any pattern to the onsets and offsets of habits during the transitional months? For enclosed-toy, habits in cells M1T1, M1T2, M1T3, M1T4 and M4T2 ended most frequently (4 to 10 occurrences) at 18–20 months. Thus, cells representing no engagement with mother were most likely to be abandoned, as was the cell representing passive engagement with the toy and fairly high engagement with mother. However, onsets during this period were distributed quite evenly, with no particular cells standing out. Interestingly, there were 36 offsets compared with 16 onsets during the target period, indicating a substantial drop in the overall number of behavioral habits. For jack-in-the box, only one cell, M2T5, stood out, with 5 offsets during the target period. Other offsets and onsets were distributed fairly evenly. Once again there were considerably more offsets than onsets (21 offsets vs. 13 onsets).

Another way to track developmental trends was simply to display the profile of mean durations for each grid cell across the three periods defined earlier. The cells with highest mean durations and non-static profiles are displayed in Figure 8, grouped by task and by an additional variable – distress-group. Subjects were assigned to either a high distress or low distress group by task based on their overall distress means (across all months). Sorting was based on a scree value of 7 seconds, yielding 15 low-distress vs. 8 high-distress children for enclosed-toy and 12 low-distress vs. 9 high-distress children for jack-in-the-box. The analysis by distress group was intended to explore the relation between distress and coping development.

Patterns were clearly differentiated by task and distress group. For enclosed-toy, M1T1 (disengagement from mother and toy) was occupied far more than any other cell. Behavior in this cell usually indicated self-distraction by means of an alternative toy. The profile of durations started higher and increased linearly (suggesting more self-distraction) for low-distress children, but started lower and dropped in the middle months for high-distress children. Low-distress children also dropped out of M5T2 almost entirely in the middle and late periods, whereas high-distress children increased behavior in this cell during the middle period. M5T2 represents specific/active engagement with mother without disengaging completely from the toy, a strategy that may have elicited more distress. For jack-in-the-box, M1T5 (specific/active engagement with toy) was by far the most occupied cell. Conversely, M1T1 was relatively low. Behavior in M1T5 was higher for low-distress children throughout the age span, indicating more engagement with the toy, and high-distress children's engagement dropped in the last

period, perhaps indicating reduced enthusiasm for solving the problem. Also of interest, low-distress children more than doubled behavior in M2T5 in the middle and late periods, whereas high-distress children changed little. This cell generally indicated intense involvement with the toy while sitting close to mother, suggesting that proximity to mother was an effective coping strategy that developed at the time of the transition.

Real-time analyses

We hypothesized that real-time measures of behavioral fluctuation would mirror the profile of developmental fluctuation. Before and after the transition period, behavior was expected to be more constrained or 'stuck' in a small number of cells, and during the transition period more changeable and more broadly dispersed. To test these predictions, we computed two common-sense measures of behavioral variability: number of different cells occupied and number of events (cell-to-cell changes) controlling for session duration. Again, sessions less than 20 seconds in duration were discarded. For number of cells occupied, range = 1–11, $M = 5.12$, SD = 1.94. For number of events, range = 1–23, $M = 10.15$, SD = 4.22.

Both variables were expected to show quadratic profiles roughly parallel to the profiles of developmental change. However, both profiles were highly variable and difficult to interpret, and no clear developmental patterns were observed. To reduce this variability, we first examined the relationship between real-time measures and distress. With all sessions entered together, $r = .28$ for cells-occupied, $r = .20$ for number of events, both significant at $p < .001$. This meant that real-time variability was partly dependent on monthly distress. To minimize this effect, we discarded sessions with more than 15 seconds of distress, based on a scree value, and reanalyzed both variables for the remaining 89% of the sessions. The developmental profiles were now more easily interpretable, but values generally decreased with age, counter to our predictions. Repeated-measures ANOVAs were computed independently, with task and month as the within-subjects factors, and missing values replaced by monthly means for each task. For cells-occupied, there was a significant linear decrease over age, $F(1, 20) = 10.95$, $p < .01$, but no other significant trends. For number-of-events, there was a linear trend showing a decrease with age, $F(1, 20) = 3.68$, $p < .10$, and a significant quadratic effect with *lower* scores in the middle months, $F(1, 20) = 8.80$, $p < .01$, opposite to our predictions.

Because these findings were ambiguous and yet interesting, we followed up with a post-hoc exploratory analysis. We were interested, as before, in the relationship
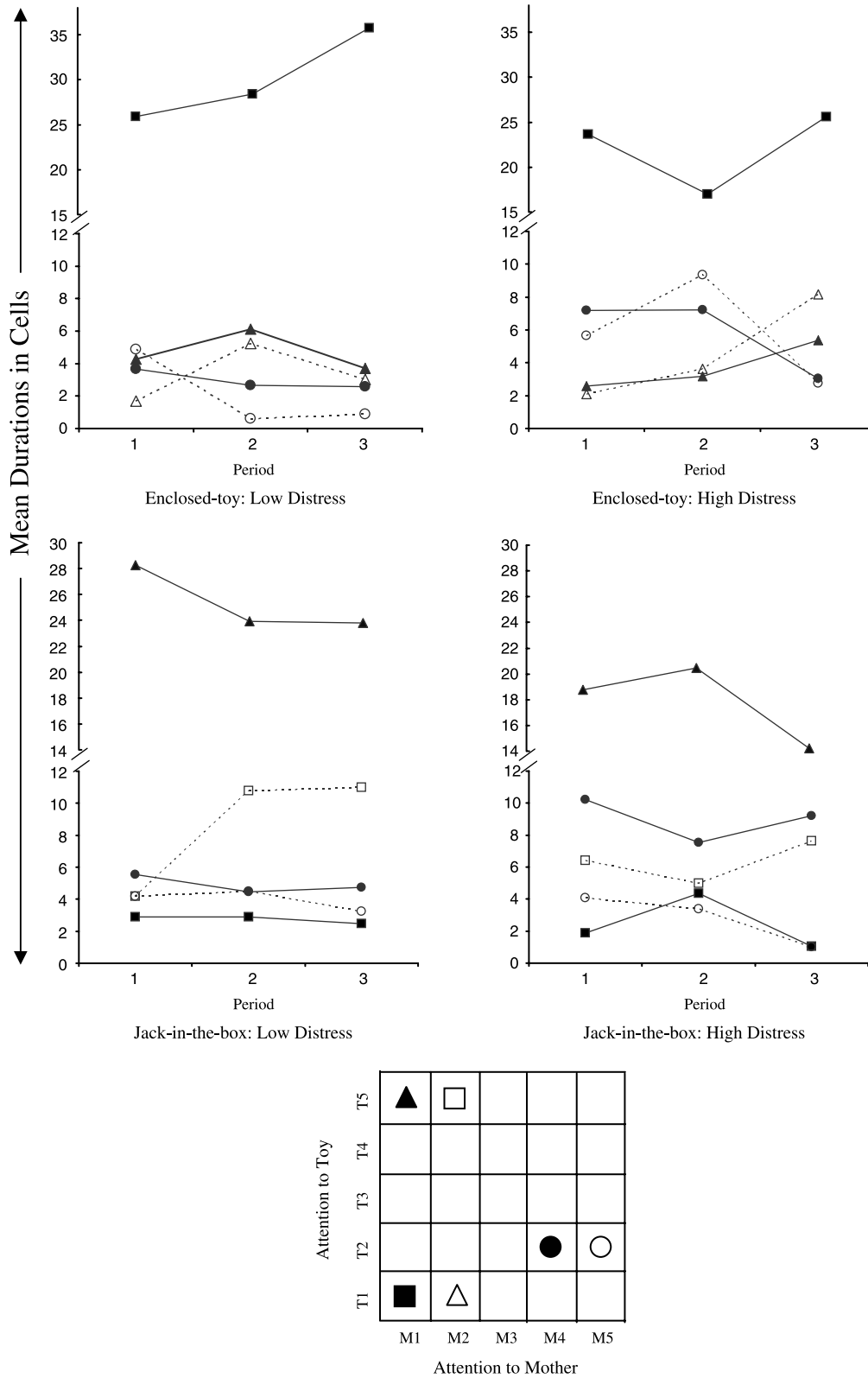
Figure 8 *Mean durations of selected grid cells calculated for three developmental periods. Only cells with high mean durations are displayed. Profiles are grouped by task and distress-group.*

between the quadratic monthly profile (this time in the unpredicted direction) and concurrent distress. Did number-of-events drop in the middle months only for more distressed infants? With mean distress for months 18–20 entered as a covariate in the repeated-measures equation, the quadratic effect for months disappeared, $F(1, 19) = 2.83$, $p > .10$. Thus, infants who were more distressed during the transition period also showed an unexpected drop in the number of behavioral events per session. They appeared to be more frozen.

Discussion

This study was intended to measure a reorganization in coping behaviors at the time of a normative developmental shift at 18–20 months, based on the DS construct of phase transitions. Predictions were generated at two time scales and tested using state space grids subjected to simple statistical techniques. Based on DS principles, we predicted a temporary increase in developmental fluctuation, new behavioral habits and increased real-time variation at 18–20 months, despite individual differences in the content of behavior. Based on theory and research in socioemotional development, we predicted that coping changes would be partially independent of a peak in distress at the same age. All predictions based on developmental measures were borne out to some degree: a transitional period was identified at 18–20 months, characterized by increased month-to-month fluctuation, a rise in distress and new behavioral habits. Also, developmental fluctuations were partly independent of distress on one of two tests. At the scale of real time the results were not as clear, but variability either declined continuously with age or declined in the middle months (as mediated by distress), contrary to expectations.

As predicted, grid-to-grid distance scores and cluster-change scores showed greater variability in the middle of the age span, specifically between 17 and 20 months. We also found a peak in distress at 18–19 months. The rise in distance scores appeared to be mediated by higher distress in the middle months, but the rise in cluster-change scores was partly independent of distress. These findings indicate that coping strategies change for many children in a manner that can be described by a developmental phase transition (Ruhland & van Geert, 1998; Thelen & Ulrich, 1991; van Geert, 1994, 1998). Fluctuation and discontinuity are key characteristics of this profile, suggesting a reorganization in the repertoire of coping strategies rather than a more gradual modification by incremental learning. The partial independence between developmental fluctuation and overt distress

suggests that fluctuation was not merely a result of fussiness. Rather, both may have tapped an underlying age-related change, such as the change in social cognition assumed by many theorists.

This kind of explanation is consistent with neo-Piagetian and other stage accounts of emotional development (e.g. Case *et al.*, 1988; Fischer *et al.*, 1990; Sroufe, 1995), in which changes in socioemotional behavior, including emotional expression and coping strategies, are due to a qualitative shift in cognitive development. Whereas some DS theorists emphasize the individuality of developmental profiles (e.g. Thelen & Smith, 1994), the present findings help to bridge normative (age-related) and idiographic descriptions. This pattern of results was made possible by temporarily ignoring the *content* of behavior, which was expected to be highly diverse, and concentrating instead on age-related change in the *form* of development, particularly the shift from stability to fluctuation and back again.

A second kind of analysis of developmental change looked at the onsets and offsets of behavioral habits, hypothesized to be most frequent during the transitional period (18–20 months). The results could not be statistically analyzed, but the profiles showed inflection points at the predicted age for both tasks. These findings provided convergent evidence for a developmental reorganization, based on the DS principle that novel forms emerge from fluctuations at phase transitions. However, they can only be taken as suggestive, because an ad hoc definition of habits replaced a formal definition of attractors. Other DS researchers have relied on descriptive versions of attractors and other constructs (e.g. Fogel, 1993; Thelen & Smith, 1994), but most are in agreement that more rigorous definitions are desirable (see van der Maas, 1995). For future research using state space grids or similar methods, it will be important to derive scales with greater real-time sensitivity so that measures of cell-to-cell movement can be used to test attractors (see Lewis *et al.*, 1999).

The analysis of behavioral habits permitted us to examine changes in the specific content of coping strategies. One interesting finding was that habits in cells representing no engagement with mother were most likely to be abandoned at the transition period, at least for the enclosed-toy task. Some toddlers may have been driven to coordinate object-oriented and person-oriented coping behaviors at this age, reflecting important advances in social cognition. Coordination is a key construct for analyzing developmental transitions from a neo-Piagetian perspective. Indeed, the coordination of a system of interactions with an inanimate object and a system of interactions with a person has been postulated by Case (1992; Case *et al.*, 1988) to characterize the shift from

sensorimotor to interrelational operations at 18–20 months. It was not the intention of this report to analyze the nature of cognitive-developmental change in this period, but rather to link the timing of this change to the timing of reorganizations in individual coping trajectories. However, this finding lends some support to a neo-Piagetian interpretation. Also, there were many more offsets than onsets of habits at 18–20 months, and this may indicate a general tightening or cohering of the behavioral repertoire. It is consistent with a general DS perspective and with theory in socioemotional development that interpersonal patterns became more organized and more consolidated at this age (e.g. Dunn, 1988; Kopp, 1989).

We also examined the content of coping strategies by comparing cell mean durations (by period) for high- and low-distress toddlers. On enclosed-toy, low-distress children showed a high and linearly increasing profile of self-distraction (M1T1) and a drop to almost zero in high engagement with mother (M5T2). High-distress children showed opposite trends in the transition period but similar trends several months later. These findings suggest that self-distraction 'worked' better as a coping strategy, benefiting children who could ignore mother and switch to alternative toys. Different coping strategies were effective for jack-in-the-box. Low-distress children tended to maintain specific/active engagement with the toy, but shifted from no engagement to low engagement (e.g. proximity) with mother at the transition period (steep rise in M2T5). High-distress children persisted in ignoring mother during this period. This suggests that proximity to mother (not full engagement) facilitated calm concentration on the toy, again suggesting coordination between social and inanimate systems. But not all children seemed able to achieve this strategy. The difference in profiles between the two tasks suggests, not surprisingly, that the presence of alternative toys was an influential control parameter. This highlights the contribution of context to differences in coping behavior (Parritz, 1996).

At the scale of real time, we predicted a temporary increase in the dispersion of behavior across cells and the number of event changes within sessions. However, both number of cells and number of events decreased linearly, and number of events also showed a quadratic-shaped drop during the transitional period. The linear decrease in number of cells might be explained as a gradual shift toward coherence and consolidation, and this would be consistent with a gradual (rather than discontinuous) profile of developmental consolidation. Or, it could be explained as a practice effect that was an artifact of the multi-wave longitudinal design.

The quadratic drop in number of events in the middle months was more difficult to explain. Why would chil-

dren's behavior get stuck in real time during a period of developmental reorganization? The dependence of this effect on distress in the middle months may provide a clue. Infants with more distress at this age may have been frozen into a small number of enduring behavioral states and found it hard to shift out of these states. The idea that negative emotion reduces behavioral (and cognitive) flexibility is consistent with research by Rothbart and colleagues (1992) and theoretical work by Harkness and Tucker (2000) and Lewis (2000). Future research is needed to disembed the effects of distress from the effects of developmental reorganization on both real-time and developmental profiles. This seems particularly important if negative emotion is partly a result of developmental change, as suggested by the present findings.

In conclusion, it is useful to ask what we have learned about the development of early coping behavior from the application of DS principles and methods. Because coping development corresponds to the structure of a developmental phase transition, fluctuations in children's responses to frustration become meaningful. These fluctuations, as frustrating as they may be to caregivers, are not just noise. They are emerging strategies, often incompatible in a given context, competing with each other for adaptive advantage across emotionally challenging situations. As a result, only some of these strategies will endure and consolidate in ongoing personality development. By linking this period of fluctuation and emergence with normative social-cognitive and socioemotional development, it may be possible to identify the cognitive, social and emotional constituents out of which new coping patterns emerge. An ultimate objective of this line of work is to discover how consolidating individual tendencies are tooled by age-specific social, emotional and cognitive forces.

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