A Dynamic Systems Perspective on the Development of Coping in the Second Year of Life

by

Sara Zimmerman

A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy Graduate Department of Education Ontario Institute for Studies in Education, University of Toronto

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Abstract

Investigations of coping in early life have tended to focus either on normative changes associated with the rapidly expanding repertoire of infant developmental capabilities or on stable individual differences in infant coping styles and their relationship to later psychopathology. This study explored both these aspects of infant coping by utilizing a novel methodology based on dynamic systems principles.

Dynamic systems approaches to emotional development suggest that behavioural change and stability self-organize from repeated associations among lower-order elements (e.g. components of cognitive appraisals) within a complex psychological system. Repeated couplings of cognitive elements are associated with behavioural stability, while a reorganization among these elements is associated with behavioural change. In this study, an underlying reorganization in infant behaviour during emotion-eliciting events was expected to be related to points of global developmental transition and to periods of emotional change.

Twenty-four infants were videotaped in their homes once each month from 14 to 25 months. In each month infants were exposed to four consecutive
emotion-eliciting episodes involving a frustrating toy. Mothers were present, but instructed not to provide assistance. The second-by-second levels of infant attentional engagement to both the mother and the toy during each toy episode were coded and mapped onto a 5-by-5 grid representing the behavioural repertoire as a dynamic system (i.e., a state space map). Monthly levels of infant distress were also recorded for each toy episode.

An unexpectedly large amount of spoiled and missing data made it impossible to evaluate individual differences in infant behaviour while controlling for toy episode. However, developmental reorganizations of infant response to the emotion-eliciting events were explored by examining changes in the series of grids (for two toy episodes) corresponding to each of the three developmental profiles of distress. Results showed a reorganization of infant behaviour occurring around the time of the hypothesized stage transition, but only when there was a decrease in distress (i.e., evidence of coping) beginning at roughly the same age. In addition, the reorganization of infant behaviour was unrelated to the content of infant response to the emotion-eliciting events. These results were discussed in relation to coping development in early life.
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Dedicated to my mother,

Mrs. Judith Zimmerman

and to the memory of my father,

Mr. Herman Zimmerman

my first teachers.
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CHAPTER I
INTRODUCTION

At all periods of development individuals are confronted with challenging situations which can evoke stress, triggering the need for coping responses. "Coping" in this sense is a broad term, encompassing all "efforts to manage (i.e., master, tolerate, reduce, minimize) environmental and internal demands, and conflicts among them, which tax or exceed a person's resources (Lazarus & Launier, 1978, p. 311). The styles of coping utilized by individuals affect their adaptation to myriad life events, and thus may have a significant influence on overall quality of life (Lazarus & Folkman, 1984). Indeed, researchers have begun to study the possible links between coping behaviour and the development of psychosocial and somatic problems in both adults and children, and efforts are being made to identify factors which promote resilience to the negative effects of stress (e.g. Wolchik & Sandler, 1997; Rolf, Masten, Cicchetti, Nuechterlein & Weintraub, 1990; Cummings, Greene & Karraker, 1991; Mrazek & Haggerty, 1994; Lazarus & Folkman, 1984; Monat & Lazarus, 1991; Gore & Eckenrode, 1994).

Although adaptation to stress is important at all ages, research on coping in infancy and early childhood is less comprehensive and more diverse in conceptualization and measurement than the literature dealing with older children, adolescents, and adults (Karraker & Lake, 1991; Compas, 1987). One reason for this difference may be that stress in the young child occurs within the context of dramatic and ongoing developmental transitions (Compas, 1987;
Egeland & Kreutzer, 1991). For example, age-related changes in attention, motor skills, memory and language in the first years of life offer infants increasing resources for coping with stress (Eisenberg, Fabes, & Guthrie, 1997; Kopp, 1989) and also alter the situations which might be considered stressful (Thompson, 1990). Moreover, the possibility that a child will experience a particular event as stressful is unlikely to increase or decrease in a linear fashion with changes in age (Maccoby, 1983). Maccoby suggests that with regard to the development of coping, "individuals go through cycles, moving from periods of stabilization to periods of destabilization," and that "such cycles are sometimes linked to powerful maturational changes such as the onset of walking" (1983, pp. 219-220). A comprehensive understanding of coping in the first years of life, therefore, should include an examination of the developmental changes which occur during this time period.

While the concept of developmental change is particularly relevant to the study of coping during infancy, the notion of individual differences in response to stress is important regardless of the age range under consideration. As Rutter (1990) notes, there is a “ubiquitous phenomenon of individual differences in people’s responses to stress and adversity” (p. 181); some people show predicted adjustment difficulties, while others demonstrate resilience to the negative effects of stress. The recent focus on “protective factors” in developmental risk research has identified a variety of environmental and personal factors (e.g. the nature of the parent-child relationship, infant temperament, the child’s early history of competency) which are related to resilience during early childhood (Garmezy,
1985; Egeland & Kreutzer, 1991; Rolf et al., 1990; Eisenberg, Fabes & Guthrie, 1997). However, there is a complex interrelationship among the various factors which might serve to limit or enhance the experience of stress for a particular child (Rolf, et al., 1990; Egeland & Kreutzer, 1991; Compas, 1997). As noted by Egeland & Kreutzer (1991), "the absence of stress does not cause competence nor does the presence result in a lack of competence...the effects occur within a broader and infinitely more complex system that is mediated and affected by individual, developmental, relationship, and environmental variables" (p.61).

Thus, a comprehensive study of coping in early life should examine both individual differences and developmental changes in infant response to stress. The methodology utilized should be capable of observing change and stability in behaviour over time, particularly since infants are likely to display one or the other of these characteristics at different points across development (Maccoby, 1983). While traditional research has begun to shed light in the area of infant coping, methodological limitations have prevented the simultaneous observation of developmental change and individual differences in early behaviour related to coping. The present study, while exploratory in nature, presents the use of a novel methodology based on dynamic systems approaches as a means of comprehensively examining change and stability of infant behaviour in relation to normative developmental transitions and individual differences in coping style.

This chapter first presents an overview of theoretical approaches to individual differences and developmental change in coping behaviour, followed
by a summary of the limited empirical research on coping in infancy which has been derived from these approaches. Some of the gaps in current knowledge and the limitations of traditional methodologies for addressing these issues are discussed. The application of an alternative theory of self-organization is proposed as a means of furthering our knowledge in the area of infant coping. The use of self-organization theory to explore the development of coping in infancy in turn necessitates the application of a novel methodology based on dynamic systems, and this is described next. Finally, the present study of infant coping from a dynamic systems perspective will be introduced.

1.1. Theoretical Approaches to the Study of Coping in Infancy

1.1.1. Psychoanalytic Theory

One of the original examinations of coping behaviour emerged within the psychoanalytic tradition, specifically among American ego psychologists (e.g. Menninger, 1963; Haan, 1977; Vaillant, 1977). This approach to coping emphasizes a hierarchy of responses to stress based on levels of ego integration. At the highest level are coping responses indicative of a strong ego, such as using humour, or talking about the problem. Below this level are the defenses, also hierarchically arranged and progressing from the psychotic (e.g. denial of external reality) to immature (e.g. projection), neurotic (e.g. reaction-formation), and finally, mature defense mechanisms (e.g. sublimation) (Vaillant, 1977). Below the defenses are serious failures of coping, characterized by regressive or psychotic levels of ego functioning (Menninger, 1963).
The origins of an individual's particular coping style, according to this approach, is largely determined in early childhood. A detailed account of the consolidation of ego structure in infancy has been provided by Mahler, Pine & Bergman (1975). Mahler et al. hypothesize that the infant proceeds through three phases of development during the first four years of life, known as the autistic, the symbiotic, and the separation-individuation phases. Each phase is associated with specific developmental tasks for the infant. Inability to successfully negotiate the demands of each phase is thought to result in weakened ego structure, leading to the development of less effective styles of coping with stress. To the extent that this theory views variation in infant coping behaviour in relation to the unique stresses associated with stages of early development, the approach represents an integration of individual differences with normative developmental change. However, because the ego structures which develop at the end of this period are presumed to be fixed, normative developmental changes are thought to have little effect on style of coping beyond the fourth year of life.

The psychoanalytic approach has been criticized for its emphasis on static ego-structures as the primary mechanism for determining coping behaviour (Lazarus & Folkman, 1984, 1991). Research has shown both inconsistencies and consistencies in coping response over time (e.g. Cohen & Lazarus, 1973), challenging the notion of stable dispositions as a basis for coping. In addition, there has been little empirical support to corroborate Mahler et al.'s rich, albeit anecdotal, findings. In particular, there is little evidence of the relationship between failures to adequately negotiate early developmental phases and later
structural deficits in ego functioning (Campos, Barrett, Lamb, Goldsmith, & Stenberg, 1983).

1.1.2. Attachment Theory

Attachment theory, which emerged from Bowlby’s synthesis of psychoanalytic and ethological ideas (Bowlby, 1969/1982, 1980), posits that infants are instinctually motivated to seek proximity to adults as a means of eliciting necessary protection and care. Attachment behaviours may therefore be viewed as infant coping responses to a class of stressors primarily involving fear and loss of the primary attachment figure (usually mother) (Compas, 1987). Attachment behaviours are goal-directed and biologically-based, and the specific form they take is heavily influenced by the behaviours of the caregiver. The forms of infant behaviour which mediate attachment typically include smiling, locomotion, watching, touching, clinging, and crying (Bowlby, 1969/1982).

Bowlby states that the attachment system becomes consolidated during the latter half of the first year of life, as infant perceptual and cognitive systems permit increasingly greater differentiation and recall of external stimuli. Some normative changes in attachment behaviours are thus recognized, for example an increase in intensity of attachment tends to occur in response to stranger anxiety at about 7-9 months for most infants (Bowlby, 1969/1982). Infant reactions to prolonged separations from mother show qualitative changes at around 18 months, in relation to growth in infants’ capacity to manipulate symbolic representations (Bowlby, 1980). Finally, Bowlby argues that at age three a new phase of attachment
functioning occurs as a result of the child’s improved ability to view mother’s goals and plans from her perspective. This, along with growth in language and conceptual development, allows for improved communication between mother and child, thereby reducing the intensity of attachment behaviours (Bowlby, 1969/1982).

Stability in an individual’s quality of attachment is thought to be mediated by the establishment within the infant of an internal working model of the attachment relationship (Bowlby, 1973; Main, Caplan, & Cassidy, 1985). The internal working model is a mental representation summarizing infant-caregiver interactions during times of fear or uncertainty. A working model based on a caregiver’s prompt and appropriate responses to the infant’s signs of distress creates feelings of security in the infant, who becomes confident in his efforts to explore the world and interact with others. Alternatively, a caregiver’s failure to respond promptly and appropriately is associated with feelings of insecurity in the infant, who is inhibited or anxious regarding his interactions with the environment (Campos, et al., 1983). According to this theory, the internal working model mediates aspects of personality functioning, including coping behaviour, throughout the course of life (Main, Caplan, & Cassidy, 1985).

By what mechanism is the internal working model maintained? Bowlby (1969/1982) suggests that through repeated experiences with the mother, the infant begins to internalize expectations of her responsiveness and sensitivity in times of distress. Sroufe (1983) states that “early prototypes are carried forward through attitudes and expectations the child forms concerning the availability and likely
responses of others and the outcome of his/her own *efforts to cope with stress*” (p. 45, italics added). Thus in Sroufe’s view, infant coping responses represent a core of continuity within the attachment system.

**Empirical Research**

Unlike the psychoanalytic tradition, empirical research in attachment theory has been prolific due to the development of the *strange situation* procedure (Ainsworth and Wittig, 1969). The strange situation is a method of categorizing the quality of the attachment relationship by placing the infant in gradually escalating situations of threat and observing the baby’s subsequent behaviour with the parent. Attachment studies have primarily emphasized the correlates of individual differences in attachment security (e.g. Bridges and Connell, 1991), its persistence over time (see Lamb, 1987, for a review), and later socioemotional and cognitive competencies which are associated with each of the three attachment categories (e.g. Bates et al., 1985).

Although it has been noted that infant behaviours during the strange situation can be viewed as an example of infant coping (Compas, 1987), few studies have attempted to explore this area. Hock and Clinger (1981) analyzed infant coping responses to mother’s absence during the strange situation, and related these responses to maternal attitudes in the first year of life. The categories of infant coping were devised in relation to the infant’s engagement with both the stranger and the toys during mother’s absence. In this study, the separation phases of the strange situation paradigm were utilized to elicit coping responses, and results were not explored in relation to the attachment category of the infants.
A second type of attachment research specifically related to coping has examined the relationship between quality of infant attachment and later coping behaviour in the preschool years (Arend, Gove, & Sroufe, 1979; Erez, 1995). Coping in these studies was defined as the level of ego-resiliency of the preschoolers (Block & Block, 1980). Ego resiliency refers to the ability to respond flexibly and persistently to problem situations, characteristics which have been noted by others as important components of optimal coping (Lazarus & Folkman, 1984; Compas, 1987). In these studies, children's levels of ego-resiliency were measured through teacher interviews, administration of formal tests of problem-solving and flexibility, and naturalistic observation of social interactions. Results showed children rated securely attached as infants were more flexible and persistent in coping with problems and stress in preschool, while children who had been rated as insecurely attached as infants tended to be more rigid and less creative when placed in stressful situations.

**Conclusion**

Attachment theory is predicated on the notion that the infant's use of the attachment figure to regulate distress is related to features of personality functioning throughout life. Attachment security can be measured using the strange situation procedure, permitting principles of the theory to be tested empirically. Research has shown evidence of stability in attachment category over time, and attachment category has been related to other types of coping behaviour in the preschool years.
However, critics of attachment theory (Thompson, 1991; Lamb, 1987) have argued that the data do not fully support the assumption of continuity in attachment style, suggesting that the quality of infant coping may also change fundamentally during the first years of life. These reviewers point out that the actual correlations between early and later attachment category, although statistically significant, are often low. When attachment category does remain stable, the environmental supports to the child have also remained stable. Indeed, even Bowlby (1969/1982) and Arend et al. (1979) note that consistent caregiving is a necessary component of a stable attachment style. Yet, if this is the case, "the security of attachment probably reflects the current, but not necessarily the enduring status of mother-infant interaction" (Thompson, 1991, p. 48), challenging the notion of a static internal working model as mediator of attachment behaviour. Thus both attachment theory and psychoanalytic theory represent incomplete explanatory models of coping due to the relatively minimal attention paid to the nature of change in coping behaviour.

Recognition of the capacity for change in attachment style raises a broader question regarding the general methodology utilized in this research. McCall (1990) points out that when the focus of infant research rests on locating developmental stability, low correlations will be interpreted as "insufficient evidence for stability" (p.145), rather than as evidence of instability or change. Since some infants in attachment research do not maintain their attachment categories, and some show coping responses in preschool which are inconsistent with their earlier attachment behaviour, such changes should be investigated to
enhance our understanding of changes in coping over development.

Unfortunately, the theoretical bias toward stability of developmental forms has limited the empirical focus in this important area.

1.1.3. Theories of Emotional Development

Both psychoanalytic and attachment theories attend primarily to individual differences in early coping behaviour with a view to understanding how various coping styles contribute to emotional health and disturbance later in life. Although these approaches acknowledge the importance of normative developmental changes occurring within the infant (Mahler et al., 1975; Bowlby, 1982/1969; Stayton, Ainsworth & Main, 1973), a detailed examination of these changes and their specific impact on emotional development has not been explored (Case, 1988). Since theorists who study emotional development are interested in the emergence and change of emotion constellations over time, an examination of this literature can assist in a more comprehensive understanding of the possible links between normative developmental change and coping behaviour.

a) Cognitivist Approaches to Emotional Development

The relationship between cognitive and emotional development has been of interest to researchers for several decades. Piaget (1981) tried to integrate Freudian psychoanalytic theory with his model of intellectual development, and other researchers have attempted to describe changes in emotion in relation to the

An example of the cognitivist view of coping adapted to early childhood is the work of Robbie Case (1988, 1996). Case suggests that the way in which children become able to process and understand their environment exerts a formidable impact on their emotional responses and social relationships. Changes in cognitive development are the basis for changes in cognitive appraisal, thereby influencing what constitutes stress at different developmental stages. In addition, cognitive development enhances the coping strategies available to infants. For example, deployment of attention is one of the most important means of coping at all ages (Folkman & Lazarus, 1991); growth in infants' capacity for directing attention, therefore, should permit new coping strategies to become available to the infant (Kopp, 1989).

In Case's theory, movement between stages represents a qualitative shift in development. The schematic units which the infant could initially understand only independent of one another now become integrated and form the schematic units of relationship in the next stage. Thus each stage transition involves an ability to recognize a new higher-order relationship. For example, infants progress from the sensorimotor stage to the interrelational stage of development at approximately 18 months. The interrelational stage can be identified when the infant becomes capable of coordinating the type of schematic units which were established at the end of the sensorimotor stage. The change is most apparent in
their capacity to engage in constructive play. In the previous stage, infants could assemble two different types of schemes: 1) a scheme for controlling the relationship between a "marking object" such as a crayon, and a "background object" such as paper, and 2) a scheme for representing the relationship between two objects (e.g. through the use of prepositions). These two schemes become integrated in the interrelational stage as infants become capable of using the first scheme to generate a goal specified by the second scheme. While before infants could only scribble on a paper, now they can draw with a specified goal in mind. They can copy a line, for example.

In Case's theory, each cognitive shift is associated with a transition in the interpersonal domain as well. In the sensorimotor stage the child learned to regulate proximity to the mother to maintain security needs, and also monitored the mother's relationships with others, showing some capacity to deal with the feelings generated by these relationships. In the interrelational stage, however, infants are able to integrate these schemes into a new higher-order understanding. They begin to recognize that "mother's engagement in some other relationship can affect her emotional availability for relating to themselves" (Case, 1988, p.174). This cognitive awareness constitutes a major new threat to the infant's sense of security, and can elicit feelings of fear, anger and sadness. In addition, in the previous stage, infants displayed a capacity to accept alternatives, for example, when demanding a particular toy from mother, they often would be satisfied with an interesting substitute. In the interrelational stage, the experience of a wish being thwarted becomes interpreted as a rejection or loss of control. Mother's
refusal to comply is seen as her insistence on putting some other relationship before that with her child; the child’s inability to influence this outcome leads to the recognition that mother’s relationships with people or things are outside of the child’s control. The intensity of these feelings of threat to the child result in the significant behavioural disruptions (e.g. temper tantrums) sometimes seen during this stage of development. Again, changes in cognitive appraisal are considered as the basis for changes in the sources of interpersonal stress as well as in the available resources for coping.

Although Case focuses primarily on normative changes in cognition and emotion, he also acknowledges that variations in the mother-infant relationship during the early years of life will greatly influence the course of emotional development (and coping capacity) of individual infants. For example, the extent to which mothers are sensitively available, intrusive, or abusive to their infants as they progress through early developmental stages will be associated with different types and durations of stress experienced by their infants. Ultimately, the “balance of positive and negative emotions” which is felt by each infant in his relationship to mother is believed to influence the quality of infant attachment security (Case, 1988, p. 172). A detailed examination of the possible relationship between stage of cognitive development and individual differences in the content of internal working models is presented recently in Case (1996).

**Empirical Research**

Some theorists with a cognitive focus have placed infants in situations of distress for the purpose of exploring aspects of cognitive functioning which might
be revealed under such conditions. For example, Van Lieshout (1975) placed infants at 18 and 24 months in a series of situations involving a broken and unavailable toy in the presence of the mother. Results of changes in behaviour in relation to mother and toy were analyzed as a way of revealing the kinds of problem-solving hypotheses which are generated by infants both as frustration mounts in real time, and as cognitive capabilities improve in developmental time. Although results implied the use of coping skills, the importance of behavioural strategies for regulating distress was not addressed.

Other studies have been specifically designed to find evidence for the relationship between cognitive and emotional development. Most often in this research infants have been placed in stressful situations so that coping response could be utilized as an index of the change in emotional development. In early studies of this kind, qualitative changes in infant emotional reaction to stressful situations (e.g. stranger anxiety, separation distress) were examined in association with Piagetian cognitive stage transitions (Decarie, 1965; Emde, et al., 1976; Scarr & Salapatek, 1970). Unfortunately, little empirical support for this hypothesis was found in these studies. Lewis et al. (1997) suggest this may be due to the researchers' strong emphasis on normative change, and their relative lack of attention to individual differences in infant development.

In contrast, recent studies examining the relationship between emotional and cognitive development which have integrated individual differences with cognitive stage theory have begun to yield more positive results (Case, et al., 1988; Lewis, 1993; Lewis, Koroshegyi, Douglas & Kampe, 1997). For example, Lewis et al.
(1997) studied infants in the first year of life. They found that individual differences on an emotional variable (i.e., latency to distress) at one stage of development predicted individual differences in cognitive functioning (examined by a series of sensorimotor tasks) at a later stage of development. Furthermore, the direction of this relationship changed at different periods of development, suggesting the existence of a highly complex relationship between cognition and emotion in the young infant.

Although there has been little research thus far showing a direct link between cognitive development and coping behaviour in the second year of life, it is noteworthy that the behavioural changes hypothesized by Case to occur around 18 months have also been identified by researchers from a variety of theoretical backgrounds, including Mahler et al. (1975), Bowlby (1980), Kagan (1983), Emde (1989) and Kopp (1982). Moreover, several authors have also noted an increase in negative emotion at this time, indicating a possible relationship between cognitive changes and infant reaction to stress. For example, Mahler et al. (1975) labeled this period the "rapprochement crisis", and associated the shift in mood with the child's growing awareness of its separateness from mother. Weintraub and Lewis (1977) found that crying behaviour in response to separation reaches a maximum at about 18 months, and declines thereafter. Finally, in their observations of infants in home and laboratory settings, Kopp (1992) noted that, in general, crying behaviour peaks from 18-21 months. These studies provide support for the notion that significant emotional developmental changes occur around 18 months of age, and that changes in negative affect appear to exemplify
them. Taken together, these independent sources suggest that developmental changes in infant coping behaviour might be expected to occur at around 18 months of age.

**Conclusion**

The cognitivist approach represents an important contribution, since it can accommodate the features of both stability and change in coping behaviour over the course of development. In this view, coping is likely to change primarily as a function of cognitive development. Coping may undergo a change at points of cognitive transition, and may be relatively stable at points of cognitive stability. This view is compatible with a focus on individual differences, as well, since the specific cognitive appraisals utilized within a given situation are likely to vary somewhat from infant to infant. Even if all infants undergo changes in stress reaction and coping response in relation to a cognitive transition, there are likely to be particular factors mediating an infant's experience of a given situation, creating differences in infant behaviours within a given context. Indeed, research suggests that the complex relationship between infant coping behaviour and cognitive developmental change may best be explicated in the context of individual differences in cognition and emotion. Recent studies are beginning to take this approach.
b) Functionalist Approaches to Emotional Development

In the functionalist perspective, emotions are seen as related to a person's ongoing interactions with the environment in the context of the individual's goals and their attainment. Emotions are defined as "processes of establishing, maintaining, or disrupting the relations between the person and the internal or external environment, when such relations are significant to the individual" (Campos, Campos, & Barrett, 1989, p. 395). In this view, cognitive variables such as attention and memory are seen to play an important role in influencing infant response to stress; however, other factors such as motor, facial, postural, vocalic, and physiological responses are also considered significant in determining coping behaviour (Barrett & Campos, 1991). It is the complex interaction among these factors within the organism which ultimately leads to both individual differences and developmental change in coping behaviour.

Claire Kopp (1982, 1989) offers a framework for the phases of emotional and behavioural control which are presumed to occur in the first years of life. She suggests that in the first days of life, the need for coping is most likely related to physiological discomfort. Strategies for emotion regulation at this stage are probably derived from the activation of reflexes such as head turning and sucking. By the second or third month, psychological factors such as cessation of social contact become additional sources of infant distress. Maturity of the visual and motor systems allows coping through distraction, such as reaching for objects. By the middle of the first year, infants show some level of communicative competence such as expecting their cries to be responded to; therefore, they may
intentionally use caregivers to help them regulate their emotional states. The rapid developments in the social, cognitive, emotional and motor domains all contribute to a widely increased repertoire of coping behaviours towards the end of the first year. For example, infants are able to communicate distinct needs to caregivers, which presumably assists them in regulating their emotional states. Kopp extends her speculations into the second and third year of life, where cognitive advances allow further developments in the area of coping behaviour, for example, through the use of expressive language and transitional objects.

In her papers, Kopp addresses the importance of individual differences as well as developmental trends in early coping behaviour. For example, it is suggested that impaired cognitive functioning (e.g. language delay) or the onset of a stressful life event (e.g. divorce) could significantly influence individual trajectories of emotion regulation (Kopp, 1982; Vaughn, Kopp & Krakow, 1984).

Although Kopp uses research on early development in a number of different domains to guide her speculations, the research on which these ideas are based was most often not designed to explore coping behaviour, per se. However, recent studies have begun to examine developmental changes in the infant’s capacities for emotion regulation, thereby providing some empirical support for Kopp’s ideas.

**Empirical Research**

Gianno and Tronick (1987) examined the still-face responses of normal infants at 3, 6, and 9 months. In the still-face paradigm, a stressful situation is induced by having mothers suddenly present their young infants with an
affectively neutral expression in the midst of a playful sequence of interactions. Results showed that infant coping responses increased in behavioural complexity and organization with development. Further developmental research based on the still-face paradigm has explored the coordination among hand, gaze, and facial expressions in infants at 3 and 6 months (Toda and Fogel, 1993).

The still-face paradigm has also been used in clinical investigations of individual differences in coping behaviour, for example to explore infant reactions to depressed vs. nondepressed mothers (Cohn, et al., 1987).

Other work examining developmental changes in coping behaviour in early life has been conducted by Rothbart, Ziaie and O'Boyle (1992), who placed infants of 3, 6.5, 10, and 13.5 months of age in situations designed to elicit distress. Infant self-regulation behaviours such as disengagement of attention (e.g. gaze aversion) and tactile self-stimulation (e.g. hand-mouth) were measured and compared across age. As was evident during the still-face studies, developmental changes in self-regulatory behaviours were related to growth in cognitive/communicative capacities and motor skills.

Mangelsdorf, Shapiro and Marzolf (1995) examined emotion regulation strategies in response to strangers in a cross-sectional study of infants at ages 6, 12, and 18 months. Again, results supported Kopp's predictions that coping strategies change in relation to other developmental capacities. For example, the finding that 6-month-olds used gaze aversion more often and avoidance less often than older infants was consistent with the notion that motor development has a significant impact on emotional development. Some individual differences in
coping strategies were also found in this study, and were related to stranger-wariness characteristics of the infants as described by their mothers.

Another cross-sectional study of coping behaviour in 12- and 18-month-old infants was carried out by Parritz (1996). She used a variety of emotion-eliciting stimuli, including a caged rabbit, a mechanical toy, and a stranger, to examine specific coping behaviours in these age groups. Results showed similar overall coping strategies to those identified by Mangelsdorf et al. (1995), i.e., that infants of these ages tend to use a combination of strategies involving mother, self-comforting, and self-distracting behaviours. Differences between infants were found to be a function of age, emotion-eliciting situation, and temperamental characteristics. Both Parritz and Mangelsdorf et al. found that older infants tend to be more active in their attempts to deal with the situation than are younger infants. Using a range of situations enabled Parritz to report that although the types of coping behaviours used by infants varied to some extent across different situations, the 18-month-olds showed less overall variability than the younger infants, suggesting increased cross-situational consistency of coping strategies in older infants.

**Conclusion**

Recent research from the functionalist perspective of emotional development has contributed important information to our understanding of developmental change in coping behaviour. The array of responses to stress which are utilized during different developmental periods has begun to be
elucidated; these responses can include behaviours representing several domains of functioning, such as cognition and motor control. Furthermore, as infant capacities within each of these domains change and evolve over the course of development, the specific coping behaviours which emerge from them frequently become modified. Although this research has revealed normative age-related changes in coping behaviour, the frequent use of cross-sectional experimental paradigms has unfortunately limited the examination of individual trajectories of coping over development.

1.2. Directions for the Present Research on Infant Coping

Research in infant coping has found evidence for individual continuity in coping style using methodologies based on attachment theory. Age-related changes in specific coping behaviours, and the relationship between changes in coping behaviour and other developmental transitions have also been identified by researchers interested in early emotional development. However, as indicated by McCall (1990), and echoed by Lewis (1993; et al. 1997), studies which integrate examinations of normative change with a look at individual differences may be best able to capture the variability and complexity of early developmental transitions. Thus, an examination of coping in the second year of life should attempt to include both types of observations. This broad methodological principle may be addressed empirically by focusing on specific questions derived from cognitivist and functionalist approaches to emotional development:
1) An important aspect of cognitivist models of development is the concept of stage transitions, i.e., significant qualitative changes in cognitive functioning which occur during particular age periods. Since many theorists argue that cognitive appraisal is associated with changes in emotional functioning (Case, 1988; Lewis, 1993; Lazarus & Folkman, 1984; Barrett & Campos, 1991), discontinuous changes in emotional responsiveness should be evident at such cognitive-developmental junctures. Some independent evidence in support of this idea stems from studies showing that emotional reactivity is heightened during hypothesized stage transitions. (Kopp, 1992; Mahler, Pine & Bergman, 1975; Weintraub & Lewis, 1977). Yet, only a few researchers have successfully explored the specific impact of cognitive stage transitions on coping in infancy (Lewis, 1993; Lewis et al., 1997; Case et al., 1986), and only Lewis (1993) used fine-grained longitudinal analyses necessary to pinpoint the change. Specifically, how does the hypothesized 18-month shift in infants' cognitive capabilities (Case, 1985) affect their capacity to cope with a stressful situation? Do behaviours related to coping also undergo a developmental reorganization at this time? These questions are particularly relevant since one of the common time periods for observation of infant coping behaviour has been at age 18 months, the precise age of an expected stage transition.

2) Functionalist approaches to coping development have examined a variety of infant behaviours during situations designed to elicit distress, including cognitive, motor, and emotional responses. In this view, significant change in any domain can lead to a reorganization of behaviours related to coping. One of these
potentially influential domains, however, is that of emotion itself. Specifically, what is the impact of heightened periods of negative emotion on coping in infancy? Studies of emotional distress in young children have looked at normative developmental changes in negative emotion (e.g. Kopp, 1992; Vaughn, Kopp, & Krakow, 1984), and the concurrent effects of stressful events (e.g. routine visit to the doctor) on emotional reactivity (Hyson, 1983). There has been work in the attachment field on the influence of ongoing separation experiences (i.e., hours per week in extrafamilial child care) on separation distress at 18 months (Jacobson & Wille, 1984). However, the potential effect of a period of heightened distress on the developmental trajectory of behaviours related to coping has not been investigated.

3) Even if changes in infant coping do occur in relation to normative stage transitions and/or periods of heightened distress, the specific behavioural changes would most likely not be expressed in a uniform manner across all infants. That is, an increase in cognitive capabilities per se could not be expected to predict the specific cognitive appraisals which will occur in a particular infant within a given situation. Indeed, other than circumstances of extreme stress (e.g. abuse or neglect), individual differences in cognitive appraisal are likely to influence whether an infant even perceives a situation as “stressful” or not. Similarly, since a variety of factors might create significant distress for an infant in a given period of life (e.g. an illness, weaning, or extended absence from mother), reorganizations of behavioural response in relation to negative emotion would also not be expected to occur in an identical manner among all infants. Therefore,
in addition to examining the timing of changes in infant behaviour around the hypothesized stage shift at 18 months and periods of heightened negative emotion, it is also important to explore individual differences in infant response in relation to these junctures.

The present study was therefore designed to explore the development of coping: (a) as related to a cognitive stage shift, (b) in relation to a shift in emotional functioning, and (c) as related to individual differences in behaviour as infants progress through these transitions. In this study, "coping" is defined from a developmental perspective. Specifically, profiles of coping are considered present when a situation which elicited distress in the early months of data collection ceases to elicit distress later on in development. Thus developmental reorganizations and individual differences in behaviour during an emotion-eliciting event are examined in relation to the observation of infant "coping", as signified by a decrease in distress over the course of development. This definition contrasts with previous definitions in which "coping" has been identified as those responses which infants seem to use to modulate their arousal during presentation of an emotion-eliciting event (e.g. Parritz, 1996; Rothbart et al., 1992; Mangelsdorf et al., 1995). The latter definition is weakened by the fact that specific behaviours may be context dependent (Thompson, 1994), or idiosyncratic (Parritz, 1996). Moreover, the lack of data on infant distress reduction in these studies suggests that behaviours which are identified as representing "coping" responses may or may not be associated with modulation of infant emotional arousal.
In the present study, data on infant behaviour and associated levels of distress were collected over a considerable developmental span. A cognitive variable - engagement of infant attention - was chosen as the specific behaviour of interest since this has been identified as an important aspect of infant coping in a number of previous studies (Hock & Clinger, 1981; Rothbart et al., 1992; Mangelsdorf et al., 1995; Parritz, 1996). The data were collected during the second year of life so that shifts in behaviour and emotional distress could be observed in relation to the cognitive stage transition which is hypothesized to occur at 18 months (Case, 1985). Individual differences in the content of behaviour related to coping were also expected to be evident over this period of development, and to demonstrate unique patterns of change at the time of developmental shifts in cognitive and emotional functioning.

Although consideration of these issues is significant in furthering our understanding of coping development, their inclusion in an empirical study creates enormous challenges in research design. Specifically, the study must find a way to look at reorganizations of behaviour, while allowing for individual differences in the content of this behaviour. Principles of self-organization were used in the development of a research strategy which could address this problem.

1.3. The Self-Organization of Developmental Forms

Self-organization is a term used to describe the emergence of orderly patterns of relationship among the individual components of a complex system; interactions among lower order components give rise to higher order structure
without the need for hard-wired, or explicit instructions to guide growth and development (Lewis, 1995; Thelen & Smith, 1994). The interaction of lower order components within the system is an ongoing process, thereby creating a constant flow of opportunities for change. As Butterworth (1993) states: “Once it is accepted that change is the fundamental quality of living systems, then the task is not to explain what causes change, in the sense of a force externally applied to a static organism, but to account for dynamic stability in all its forms.” (p. 174, italics in original).

Perhaps the best way to understand the concept of self-organization is by way of an example from a commonplace physical system (Thelen & Ulrich, 1991). A pot of water contains a large number of molecules which collide randomly at room temperature. This situation will remain stable, unless the pot is heated. As the bottom layer of molecules warms up they become less dense, and attempt to rise. If heating continues, at some critical point the warmer water will rise and abruptly form itself into a remarkably stable and orderly pattern of hexagonal shapes. Further warming leads again to instability (boiling), and the previously orderly pattern is replaced by a another, apparently chaotic, pattern of water flow. As Thelen and Ulrich (1991) point out, at room temperature each water molecule will move about “independently and unpredictably...with maximum degrees of freedom or ways to combine together” (p.7). However, when heat is applied, “the molecules cease acting as individual elements that bounce around randomly and appear, as if by magic, to cooperate with one another” (p.7). Clearly there can be no overall “plan” to coordinate the patterning of individual water molecules; yet,
under certain conditions, they spontaneously interact with one another and create orderly forms. Indeed, the notion of "conditions" is essential to self-organizing systems, and the dependence of self-organization on initial conditions has been a topic of considerable attention (Gleik, 1987).

According to Capra (1996), all living systems may be understood according to the principles of self-organization, since it is the configuration of components, and not simply the presence or absence of the components themselves, which creates the unique character of these systems. Self-organization has been used to describe biological phenomena such as embryogenesis, evolution, and the synchronization of neuronal activity in the brain. Self-organization in the psychological realm may be seen as the emergence of organized thoughts and feelings from the ongoing interactions among numerous elements of mind such as perceptions, memories, schemas and emotions (Lewis, 1995; Fogel, et al., 1992). Since the variety of emotional and cognitive components which are activated during situations of frustration may be expected to interact in this fashion, principles of self-organization are applicable to, and indeed may be expected to facilitate, the comprehensive investigation of coping in the first years of life.

Although, conceptually, self-organization theory is a useful way to capture the behaviour of complex systems, the modeling of such behaviour has presented researchers with a unique challenge. Specifically, what have been needed are techniques capable of capturing discontinuous change in the relationships among components of complex systems. Recently, both mathematical and descriptive tools for modeling self-organizing systems have emerged in the science and social
science literatures (Capra, 1996). Collectively, these methodologies are known as dynamic systems applications. Since the present study views the developmental changes in behaviour during an emotion-eliciting event as the self-organization of a complex psychological system, dynamic systems approaches are used as the basis for the research design.

1.4. General Principles of Dynamic Systems Theory: Stability and Change In Complex Systems

Stability

Although the elements in a self-organizing system may in theory interact with one another in a large variety of ways, under most conditions complex systems will produce patterns which represent only a few degrees of freedom (Thelen & Ulrich, 1991; Thelen, 1989). The compression of degrees of freedom in a complex system results in a simplification, or a reduction in the number of possible states in which the system can reside (Thelen & Smith, 1994). These states are called attractors. Over time the system will move in and out of these attractors, abandoning some, maintaining others, and creating new ones.

Attractors represent a stable relationship between two or more variables in a system (Thelen & Ulrich, 1991). In complex living systems, attractors are not preprogrammed, but emerge in the moment as a function of the system's history combined with current circumstances. Attractors represent "the preferred configuration from a number of initial conditions, and they will be relatively resistant to perturbation" (Thelen, 1989, p.87). The "stronger" the attractor, the
more likely it is to emerge from a wide range of initial conditions, and the less likely it is to be dislodged by perturbations to the system. Although individual attractors always emerge from the configuration of elements in real-time, the repeated real-time emergence of particular attractors creates stability over the course of development.

Attractors may be described as residing on the state space of a dynamic system. The state space is an abstract map of coordinates representing the relationships among elements which are possible for a given system, including the "attractors" which are most frequently observed (Thelen & Smith, 1994). A series of state space models representing the states of a complex system over the course of development will show attractors which re-emerge over a period of months or years.

The concept of an attractor, therefore, denotes features of predictability and stability within a complex system. Yet the fact that an attractor is a dynamic entity, continually emerging "in the moment", makes this concept quite distinct from the idea of a more static structure such as an internal working model.

**Change**

Discontinuous changes in self-organizing systems are represented by phase transitions (Thelen & Ulrich, 1991; Thelen & Smith, 1994; Van Geert, 1991). These changes do not flow gradually and predictably from the previous state of the system, but arise abruptly, in response to perturbations which initiate self-amplifying changes in the ongoing interactions of elements within the system.
Phase transitions occur when the perturbation introduced cannot be absorbed by the system in its current configuration of elements, i.e., by the attractors which are currently available. The system may fall into a state in which no preferred pattern of behaviour, or attractor state, may be discerned, or in which the elements cohere only briefly, resulting in a series of transient quasi-stable states. During phase transitions, fluctuations in the behaviour of the system are at a maximum, with stability at a minimum.

Developmental phase transitions can be seen on a series of state spaces when attractors characterizing a child's response to a given situation or group of situations suddenly disappear, or when different configurations of elements representing new behaviours suddenly appear. The former type of change would represent an inability of previously stable elements to continue to cohere, while the latter type of change would represent the emergence of novel interactions among elements in the system. In the months following a developmental phase transition, the configuration of attractors on the state space would look different. Some or all of the attractors which had characterized the child's behaviour prior to the phase transition could be gone, and/or new attractors, representing stable, novel responses, would be evident. Either occurrence would be an indication that some type of developmental reorganization had occurred.

1.5. Dynamic Systems Research in Developmental Psychology

Work in dynamic systems applications to human development is just beginning. Areas which have been addressed thus far include motor development
(Thelen & Ulrich, 1991; Thelen & Smith, 1994), social development (Fogel, 1990, 1993; Fogel & Thelen, 1987), and cognitive development (Keating, 1990; van der Maas & Molenaar, 1992). Each of these authors questions the traditional assumption that development "is driven towards adult forms by a grand plan (and scheduled by a grand timekeeper)" (Thelen & Smith, 1994, p. 6). For example, the onset of walking at about 1 year has traditionally been assumed to occur as a result of changes in brain structure which in essence "turn on" the command to move the legs in a particular pattern. These changes are thought to be neurophysiological (Konner, 1991) or cognitive (Zelazo, 1984) in nature. Yet detailed monitoring of infant locomotion shows that step-like behaviour does not suddenly appear at a given point in development. Indeed, such behaviour appears and disappears in infants throughout the first year of life (Thelen & Smith, 1994). Dynamic systems-based research by Thelen and colleagues (e.g. Thelen & Ulrich, 1991; Thelen, Fisher, & Ridley-Johnson, 1984) suggests that step-like behaviours emerge as a result of interactions among a series of independently operating lower-order elements including the elasticity of the muscles, the weight of the limbs, and body positioning. Mature walking behaviour represents a phase transition whereby interactions among these individual elements cohere to produce a stable attractor state.

Dynamic systems strategies used in research such as Thelen's assume that change in individual functioning over time should be the focus of developmental studies (Thelen & Smith, 1994). Indeed, Thelen and Smith assert that "developmental pathways can only be constructed with individual data, collected
longitudinally at frequent intervals” (1994, p. 97). In this manner the extent to which the behaviour of individuals conforms to the perceived “developmental norm” can be ascertained. Thus, with regard to infant coping research, the use of a dynamic systems approach should enable us to explore developmental reorganizations in infant behaviour, and still focus on individual differences in content. Infant responses could be mapped onto state space models, such that the presence of attractors representing preferred behaviours could be identified. A series of state space models constructed over a period of time would highlight both change and stability in the attractor landscape over the course of development. Developmental phase transitions representing the reorganization of infant behaviour could be identified by the disappearance of a previous configuration of attractors, or by the emergence of novel attractors on the series of state space models. Since attractors represent preferred configurations of specific behavioural elements, the particular content of infant behaviour could be observed during periods of stability as well as during periods of change. Moreover, evidence for developmental reorganization would be entirely independent of the individual content of infant response to the emotion-eliciting situations.

1.6. Self-Organization of Emotional Development: Previous Research

Studies exploring the self-organization of emotional development have primarily utilized descriptive aspects of dynamic systems approaches. For example, Camras (1992) describes emotional expression as a self-organizing system. She argues that components of emotions develop independently of one
another, and at different rates, rather than emerging in completed form according to a pre-existing maturational timetable. Periodic reorganizations, or phase transitions, would occur as various parameters of emotions (e.g. cognitive, motor) undergo changes during the course of development.

Fogel et al. (1992) describe the importance of social aspects in the development of emotions and emotional responses. Stability and change in emotional patterns is understood as reflecting the organization of components which are intrinsic to the infant (e.g. levels of motor and cognitive development) as well as dyadic relationships within the environment. Fogel et al. note that this view of emotional development parallels current research in brain structure, which suggests that neural pathways do not unfold in a predetermined manner as part of a hard-wired program, but are influenced and modified by the experiences of the individual.

The self-organization of infant emotional behaviour and its relationship to personality development is currently being explored by Lewis and his colleagues (1995, Lewis & Douglas, 1998; Lewis & Granic, in press). Lewis has developed a model of personality development which is based on dynamic systems principles; this model is helping to guide the development of new methods for studying infant emotional development, including the one utilized in the present study.

Lewis (1995, 1996) utilizes cognitive events and emotions as the lower order components in his model. A recursive loop between cognitive appraisal and emotions occurs in real time, as emotion is continuously influenced by changes in cognitive appraisal, and appraisal is continuously adjusted in accordance with
emotional response. Over several iterations, particular cognitive elements (e.g. associations, plans, memories) cohere more strongly, as connections with discrepant elements are minimized or discarded. The resulting stable form of cognitive appraisals, in association with particular emotions, may be described as attractors on a state space.

Whether individual attractors are more or less accessible to a person in a given moment depends on a variety of factors such as recent events, current situational context, associations, and mood (Lewis & Granic, in press). The particular configurations of elements which do emerge on each occasion, however, influence the way those elements will fit together on subsequent occasions; the more often particular configurations appear in a given individual, the more available these configurations will be later on (Thelen & Smith, 1994). Repeated cognitive appraisals emerging in the context of particular emotions over the course of months and years accounts for stability in personality organization, and these configurations (or attractors) will reflect the particular set of traits which are characteristic of the individual's reactions and behaviour (Lewis & Granic, in press; Malatesta & Wilson, 1988).

Change in personality development is modeled by developmental phase transitions, which result in the creation of novel cognition-emotion attractors and the disappearance of old ones, thereby changing the overall repertoire of attractors available to the individual (Lewis, 1995). Developmental phase transitions are significant because it is during these periods that a particular developmental trajectory will be selected. This process can explain why normative developmental
transitions may have varied effects on personality. For example, the onset of separation anxiety at about 8 months (Emde, Gaensbauer, & Harmon, 1976; Campos & Stenberg, 1981; Stayton, Ainsworth & Main, 1973) marks the occurrence of a developmental reorganization in infants, which is associated with the capacity to appreciate the loss inherent in mother's absence; however, the particular cognitive appraisals and emotions (i.e., attractors) which will form in the context of this change will vary from child to child, as is evident from attachment research.

Lewis has begun to test his model of personality development by developing a novel methodology based on dynamic systems approaches (Lewis and Douglas, 1998; Lewis, Lamey and Douglas, submitted). In this work, the self-organization of infant coping has been investigated during reunion with mother, following methods developed by Lewis, Zimmerman, Douglas and Neto-Irving (1995), and Smith (1995). Specifically, the ongoing interaction of cognitive and emotional elements within infants was explored by coding attention and distress variables on two 5-point ordinal scales. The particular parameters chosen in these studies were direction of visual attention (reflecting infant cognition), and level of distress (reflecting infant emotion).

A grid was constructed by plotting distress scores on the y-axis, and attention scores (using angle of eye gaze) on the x-axis of a 5 by 5 grid representing all possible coordinates. Each of the 25 cells in this grid thus represented a possible

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1 Previous research has used infants' gaze as a measure of their expectancies in interpersonal relationships (Tronick, Ricks, & Cohn, 1982). In addition, angle of gaze has been related to different styles of infant self-regulation (Beebe & Stern, 1977).
configuration of attention and distress. The second-by-second interactions between angle of eye gaze and distress for each infant were recorded in appropriate cells of the grid. In this way, the ongoing interaction between cognition and emotion for each infant was able to be observed.

Since attractors represent preferred patterns of cognition-emotion interaction, these were denoted by identifying particular cells or clusters of cells which were the most commonly occupied by the behaviour of a given infant. Each completed grid therefore could be seen as a two-dimensional representation of the state space for a given infant on that occasion. Developmental changes were monitored using this methodology by observing the differences in state space configuration at two developmental periods. However, developmental transitions could not be identified in these studies, since a continuous developmental data set was not utilized.

1.7. The Design of the Present Study

1.7.1. Hypotheses

In the present exploratory study, individual differences and developmental change in infant distress-related behaviour were investigated using a novel methodology based on state space grids. Developmental change and stability in infant behaviour were examined over time as a function of age and negative emotion. Infant behaviour was evaluated by means of two cognitive variables, i.e.,

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2 Lewis, Lamey and Douglas (submitted) have also created a mathematically-based definition of an attractor in an attempt to create a more rigorous design for exploring self-organization of infant behaviour.
infant attentional engagement with the social and nonsocial environment. There were three related hypotheses:

1) A developmental reorganization in infant behaviour was expected to appear around the 18 month period, in relation to the cognitive stage shift which has been hypothesized to occur at that time (Case, 1985).

2) Developmental reorganizations in infant behaviour were expected to be associated with a peak in negative emotion, consistent with theories of emotional development of a functionalist character.

3) Whether associated with a cognitive stage shift or peak in negative emotion, developmental reorganizations were expected to reflect individual differences in the content of infant response to the emotion-eliciting events.

Identification of individual styles and developmental reorganizations in infant behaviour were determined on the basis of attractor configurations as revealed on a longitudinal series of state space grids. In addition, all behavioural changes were studied in relation to observations of decreasing distress developmentally, i.e., "coping".

1.7.2. Description of Study

Infants in the present study were placed in a series of emotion-eliciting situations involving an attractive toy which was in some way inaccessible to the
infant. Mothers were nearby but were instructed to severely restrict their level of responsiveness to their infant, and to offer no form of assistance which might help the infant gain access to the toy. Thus, this situation was designed to elicit responses to two distinct yet interacting stressors: an inaccessible toy and an unhelpful mother. Each series of emotion-eliciting events was repeated on a monthly basis when the infants were between the ages of 14 and 25 months, thereby encompassing the period of developmental reorganization expected to occur at around 18 months.

Since attention has been identified as an important aspect of coping in infancy (Hock & Clinger, 1981; Rothbart et al., 1992; Mangelsdorf et al., 1995; Parritz, 1996), this study focused on the level of infant attention to the two key sources of stress (i.e., the inaccessible toy and the unhelpful mother) during each emotion-eliciting situation. Levels of infant attention to each of these stressors were evaluated on a continuum of engagement. For example, within the age range of 14-25 months, an infant may choose to ignore, look at, approach, or talk to another person, and these behaviours would reflect an increasingly articulated attentional focus of the infant towards the other. Similarly, an infant could choose to gaze at, touch, or play with a toy, and these behaviours would reflect increasingly articulated levels of attentional focus towards the object.

Levels of engagement with toy and mother were coded on two separate 5-point scales once each second, from close-up videotapes, and recorded on the axes of a 5 by 5 grid. Each completed monthly grid therefore represented a unique pattern of behaviour for the infant. This grid design differed from that of Lewis
and colleagues (1998; submitted), who coded an attentional variable on one axis, and an emotional variable on the other. In their investigations, state space grids specified the presence of attractors reflecting configurations of “cognition-emotion” couplings. In contrast, in the present study, two attentional variables were coded on each state space grid, thereby yielding attractors which reflected “cognition-cognition” couplings; however, it was assumed that emotional elements participated in these stable configurations, too. Duration of infant distress was also recorded for each session in the present study, so that monthly changes in behaviour could be observed in relation to developmental changes in negative emotion. The present study was designed in part as a test of aspects of Lewis’ (1995) model, which specifies that personality attractors represent stable configurations of cognitive elements interacting in the presence of a particular emotion, and that these attractors become partially reorganized at transitional periods in development.

The collection of monthly data in this study represented another important variation on the work of Lewis and colleagues (1998; in preparation), who compared infant state space grids from only two developmental time periods. The use of a continuous, longitudinal data set in the present study could allow the timing of developmental reorganizations in infant behaviour to be observed in relation to age and to the timing of changes in emotional behaviour.

Each monthly grid represented the state space of an infant’s level of engagement with mother and toy during one emotion-eliciting episode. Attractors were identified as individual cells on the state space which were occupied for a
minimum duration in a given session. In addition, since attractors represent
stable forms which re-appear on several occasions, continuity over the course of
months was a second requirement for defining an attractor in this study. The
persistence of attractors on the state space grids over several months was
considered a sign of stability in infant behaviour. In addition, a small number of
attractors was considered representative of a more tightly-organized state space
with few degrees of freedom.

Developmental reorganizations in behaviour were expected to appear as
phase shifts in the state space configurations of each infant. Evidence of a phase
shift would be a discontinuous change in infant response to the emotion-eliciting
situations, characterized by the disappearance of some attractors and/or the
appearance of new attractors on a series of state space grids. Regardless of the
specific attractor changes which might be seen, the overall state space
configurations were expected to appear more cohesive; degrees of freedom were
expected to drop as individual behaviour following the phase shift became
confined to relatively few attractors.

Individual differences in infant coping (i.e., decreasing developmental
distress) were identified by examining the timing of developmental
reorganizations in behaviour for each infant. In addition, the content of the
attractors characterizing each infant's particular response pattern was explored. In
this way the diversity of infant behavioural styles during the emotion-eliciting
events could be observed in the context of developmental change.
CHAPTER II

METHOD

2.1. Participants

Participants were mother-infant dyads who were known to the researchers through their involvement in a previous study (Lewis,
Koroshegyi, Douglas, & Kampe, 1997). These participants had been 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 function as 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 might be desirable in some research designs, the present research was concerned with individual differences that would not be reducible to demographic or family variables.

The first 9 infants who were tested for the previous study were ineligible to participate in the present study because they were too old by the time the present study began. Three infants were lost to attrition, and 2 had to
be excluded because their homes lacked a suitable space for conducting the study. One additional subject was eliminated because her mother did not adhere to the instructions. Specifically, she often directed unsolicited comments towards her infant. Thus, a total of 24 mother-infant dyads participated in the present study.

2.2. Procedure

2.2.1. General Overview

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 episodes, described in detail below. The video camera was set up across the room so that both the mother and infant were included on tape.

Each of the emotion-eliciting episodes involved a toy which became unavailable to the infant. In the two “mother-mediated” episodes, the toy became unavailable to the infant as a result of actions taken by the mother. In the two “nonmediated” episodes, the toy became unavailable through activity initiated by the examiner. These differences in the presentation of emotion-eliciting events were implemented as a means of exploring situational variations in the elicitation of infant stress reaction.

Each of the four episodes began with an initial play period lasting long enough for the baby to become engaged. In the two mother-mediated episodes, 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 4-6 feet
behind the infant, and pretended to read a magazine. In the two
nonmediated episodes, the initial play period began with the mother seated 4-6 feet 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 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. Episodes were discontinued after 15 seconds of high distress.

A semi-standardized play period followed each episode to mitigate any negative memory trace associated with the experimental toys. During this time, the mother enabled 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 because the infant met the distress criterion.
2.2.2. Emotion-Eliciting Episodes

a) Condition 1 - Broken Contingency

Nonmediated. This episode involves a contingency which was violated when the baby's own activity suddenly stopped producing the desired effect. The examiner first demonstrated an electric keyboard, and asked the infant to play on it. Once the infant was interacting with the toy, the examiner left the room, listened for a steady rate of play, then unplugged the keyboard and started timing. The mother continued to feign interest in reading the magazine. If, however, the infant initiated a social interaction, the mother was instructed to respond, "I'm busy now. You try it".

Mother-Mediated. Mothers were asked to terminate an interesting activity that required their involvement. The crank of a jack-in-the-box was modified so that the turning motion would be inaccessible to an infant. The mother was instructed to operate the toy twice but not to teach the infant. Once the infant was engaged, the mother stopped working the jack-in-the-box and moved to a designated area to read a magazine. If the infant made an overt attempt to re-engage her, she was to respond, "I'm busy now. You try it."

b) Condition 2 - Unavailable Object

Nonmediated. The examiner emptied three toys from a clear plastic container (a "Tupperware" 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 and placed it in the container. The container was virtually impossible for the infants to open. The other two toys remained outside the container, and continued to be accessible to the infant throughout this episode. After placing the one toy inside the container, timing began and the examiner left the room. Again, the mother was asked not to initiate any involvement with the baby. If the baby approached or made an overt gesture directed towards her, she mother was to respond, "Find something else to play with".

Mother-Mediated. 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 favourite 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 alternate toys, the mother followed the same procedure after 10-15 seconds. If the baby made an attempt to engage her, the mother was to respond: "find something else to play with".

All episodes were administered in a fixed sequence every month. The two classes of events (broken contingency, unavailable object) were presented alternately so that variations in infant behaviour could be examined as a
function of event class, while minimizing the possibility of confounding related to order of presentation.

2.2.3. Exclusion Criteria

a) Toy Episodes

Videotaped data were collected for the four emotion-eliciting episodes. Upon preliminary coding, it was discovered that the nonmediated broken contingency episode (keyboard) elicited very little distress in most subjects, while the mother-mediated unavailable object episode (in which the mother removes the toy) elicited extreme distress in many subjects and often had to be terminated early. As a result, the present analysis was limited to the remaining two episodes:

1) mother-mediated broken contingency, i.e., the “jack-in-the-box” (JB) episode.

2) unmediated unavailable object, i.e., the “enclosed toy” (ET) episode.

b) Sessions

For several of the 24 subjects coded in this study, the series of monthly sessions from one or both of the toy episodes (JB or ET) had to be excluded from the analyses of infant behaviour. In general, the entire series of sessions for a toy episode was excluded if 4 or more monthly sessions were missing or spoiled. In addition, only one missing or spoiled session was permitted in the 17-20 month range, since this was an expected time period of developmental
reorganization and interruptions in the data stream might obscure the profile of change.

**Missed sessions.** For the 24 codable subjects, a total of 16 missed sessions occurred during all months of data collection on the two toy episodes used in this analysis. Missed sessions were due to cancellations which could not be rescheduled.

**Spoiled sessions.** A session was considered spoiled if it had to be terminated before 30 seconds of the emotion-eliciting event had elapsed. A variety of factors contributed to premature termination of sessions:

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 high level continuous distress).

3) The mother made an error, e.g. instructing the baby on how to access the toy.

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, i.e., refused to interact with the experimental toys during the initial play period.
Based on these criteria, 12 JB and 10 ET episodes had to be excluded from the analysis. Seven subjects were excluded from both toy episodes, and therefore were removed from the study. Five subjects met the exclusion criteria for the JB episode only, and 3 met the criteria for the ET episode only.

In total, 26 protocols\(^1\) (12 JB and 14 ET) were included in this analysis, representing data from 17 of the original 24 subjects. Table 2.1 depicts the breakdown of subjects used in this study by gender and toy episode. This table reveals that the majority of the infants were female. Since both toy episodes were included for 3 of the 4 male infants, a total of 7 of 26 protocols (27\%) represented male subjects.

### TABLE 2.1

<table>
<thead>
<tr>
<th>Gender</th>
<th>JB Only</th>
<th>ET Only</th>
<th>Both Episodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

\(^{1}\) A "protocol" represents the series of 12 monthly sessions for a particular toy episode.
c) Months

Missing or spoiled sessions were heavily concentrated in the final two months of data collection, i.e., at 24 and 25 months. Missing sessions were primarily due to subject attrition in the final months. Spoiled sessions which occurred in the later months may have been related to infants' becoming accustomed to the tasks. Some infants refused to interact with the experimental toys, perhaps because they remembered that the situation would become frustrating. Others seemed to reinvent the situation, e.g. focusing on the disappearance of the examiner and attempting to engage her in a game of hide-and-seek.

In total, 12 sessions at 25 months and 9 sessions at 24 months were missing or spoiled. As a result, a balance had to be struck between the need to salvage all usable data and the need to prevent the possibility of biasing the outcome of analyses by including data from relatively few subjects during these particular months. The following decisions were made to address this problem:

1) Since almost half the sample had data missing at 25 months, these data were omitted in all analyses which examined either groupings of protocols or issues for the sample as a whole.

2) The relatively large number of missing sessions at 24 months was felt to have a significant impact on analyses involving groupings of protocols, since summaries in these months tended to reflect the data
from only a small number of protocols. As a result, the group analyses described in Chapter 3 exclude data from sessions at 24 months, as well. 3) Analyses which reflect individual profiles do include both these months when available.

2.2.4. Coding Procedure

Each videotaped session was coded twice, the first time for infant behaviour, and the second time for infant distress.

a) Infant Distress

Although commonly utilized in research of early infancy, the use of facial expression as an index of infant distress was not applicable in the present study. First, increases in infant mobility in the second year would severely limit the opportunity for continuous facial coding, particularly when infant behaviours are being recorded by a stationary camera. Moreover, infants in this study were expected to be particularly mobile, e.g. moving towards mother for assistance during the emotion-eliciting episodes, or playing with a number of different toys in the ET episode. As a result, infant distress in this study was defined purely as vocal expressions of negative emotion.

Distress was coded as a dichotomous variable, using only the audio portion of each videotaped session. Each second of an emotion-eliciting event was scored either as “distress” or “nondistress”, regardless of the intensity of negative emotion which was manifest. Vocalizations of negative emotional
states in the infants ranged from mild unhappiness or discomfort (e.g. whimpering, whining) to extreme distress (e.g. crying loudly, screaming). Mild to moderate forms of distress were most dominant; extreme forms usually met the criteria for termination of the session. Although the intensity of distress was not captured by this coding system, sessions of prolonged distress were felt to be reflective of greater difficulty in coping with the emotion-eliciting event.

Distress analyses included infant distress data from all sessions which were terminated early due to an infant reaching the distress criterion, even if the session was of a duration less than 30 seconds and could not be included in state space analyses. A total of 11 sessions representing 8 different infants were terminated because the distress criterion had been reached; only two of these sessions were under 30 seconds in length. No infant reached distress criterion on more than two occasions in either of the toy episodes used in this analysis.

Because sessions often ended early, a system of prorating distress scores was utilized as a means of estimating what the distress score might have been had the emotion-eliciting event been permitted to continue for the full 60 seconds. This process is described in detail at the end of this chapter (page 65).

b) Infant Behaviour

Infant behaviour was coded on two ordinal scales representing level of engagement with mother and level of engagement with the toy. Thus all possible states of infant engagement could be represented as the intersection
of these two attentional variables. Each scale was composed of a continuum of 5 levels of engagement. Level 1 represents no engagement at all. Levels 2 and 3 represent forms of passive engagement, while levels 4 and 5 represent degrees of active engagement.

The following is an outline of the behaviours which are represented on each of the two behavioural scales:

**Engagement with Toy**

<table>
<thead>
<tr>
<th>Code</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The infant is disengaged from the toy. That is, the infant is neither looking at nor touching the toy.</td>
</tr>
<tr>
<td>2.</td>
<td>(lower level passive engagement with the toy) This includes carrying or touching the toy without looking at it or manipulating it.</td>
</tr>
<tr>
<td>3.</td>
<td>(upper level passive engagement with the toy) This includes: -looking at the toy -looking at and touching the toy, but not manipulating it, or -manipulating the toy without looking at it.</td>
</tr>
</tbody>
</table>
4. **(lower level active engagement with the toy)**

This includes:

- manipulation of the toy in an exploratory manner while looking at the toy. At this level the manipulation is not specific to the toy, e.g., turning the jack-in-the-box around, or rolling it on the ground. This level also includes any aggressive behaviour involving the toy, such as throwing or kicking it.

5. **(upper level active engagement with the toy)**

This includes:

- manipulation of the toy in a goal-directed manner, while looking at the toy. At this level the manipulation is specific to the toy, e.g.,

  - turning the crank or trying to pull the top open on the jack-in-the-box.

---

**Engagement with Mother**

<table>
<thead>
<tr>
<th>Code</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The infant is disengaged from mother. That is, the infant is not near mother, not looking at her, and not attempting to get her attention in any way.</td>
</tr>
<tr>
<td>2.</td>
<td><strong>(lower level passive engagement with mother)</strong></td>
</tr>
</tbody>
</table>

 This includes:
-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. (upper level passive engagement with mother)

This includes:

- looking at mother

- approaching mother 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 seconds by looking at or approaching mother, in which case it is coded as level 4.)

4. (lower level active engagement with mother)

This includes:

- approaching mother or actively signaling to her vocally and while gazing at her visually. This code is applied when the infant moves towards mother, or lifts up the toy or points to it while vocalizing towards mother. It includes time when the infant is directly in front of mother, talking to her.
5. (upper level active engagement with mother)

This includes:

- some persistence by infant in obtaining mother's attention and/or assistance. This code may involve some physical contact with mother.

For example, the infant pushes the toy or him/herself on mother.

State space maps were constructed for each child by plotting the corresponding values of the two engagement variables as x-y coordinates in the cells of a 5 by 5 grid. Engagement with the frustrating toy was plotted on the vertical axis, and engagement with mother was plotted on the horizontal axis (Figure 2.1). Levels of engagement of both variables were coded on a second by second basis during each toy episode at each month of data collection. The trajectory of behavioural change in real time was represented by arrows superimposed on the state space map. The total duration of time spent in each cell during each month was also calculated and recorded on each state space map. A sample of a coded state space map is shown in Figure 2.2.

Because the ordinal scales represent a continuum of engagement with mother or toy, movement between cells on the state space map may be viewed as a change in level of engagement with toy and/or mother. Large movements on either axis will reflect substantial changes in engagement with mother and/or toy, whereas small movements reflect more subtle behavioural adjustments. Since each cell reflects particular types of infant
Figure 2-1
Sample state space map.

Subject#
Toy Episode:
Age:

Seconds During Which There is Vocal Distress:

Engagement with Toy

Engagement with Mother

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>disengage</td>
<td>passive</td>
<td>active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Figure 2-2
Completed State Space Map for One Subject.

Subject#: 47
Toy Episode: JB
Age: 14 Months

Seconds During Which There is Vocal Distress:
22 36-37
25-26 44-46
32-34

Total distress = 7 seconds

Disengage passive active
Engagement with Toy

0-9 (start)
10-21
(Total=20s)

(active)

43-56
(Total=13s)
(distress=2s)

9-10
(Total=1s)

21-43
(Total=22s)
(distress=5s)

56-60
(end)
(Total=4s)

1 2 3 4 5
disengage passive active
Engagement with Mother
behaviour in relation to mother and toy, movements on the state space map can also provide qualitative information as to what the baby might be doing when coded in a particular cell.

Of the 25 cells in the 5 by 5 state space map, two cells (5,5; 4,5)\(^1\) were not occupied in either toy episode because they represented simultaneous active engagement with both mother and toy, which was not possible within the present coding system. Cells 4,4 and 5,4 were rarely occupied because these reflected extreme behavioural responses of aggressive behaviour towards the mother with the frustrating toy (e.g. cell 5,4 usually involved the infant picking up the frustrating toy and throwing it at mother). These two cells were occupied on only 8 occasions, representing data from four infants.

Of the 21 remaining cells on the state space, four were the most commonly occupied for all infants in the two toy episodes. These four cells were identified by averaging the total number of seconds occupied in each of the 21 cells for all infants. Based on these values, the most commonly occupied cells were 1,1 (\(M=16.23\)), 1,5 (\(M=11.15\)), 4,2 (\(M=5.00\)) , and 1,4 (\(M=3.15\)). The remaining 14 of 21 cells on the state space map each had a mean duration of less than 3 seconds per month. The cells of overall highest and lowest mean duration for all infants are depicted in Figure 2.3.

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\(^1\) Note: the x-value represents the code on the horizontal (mother) scale, and the y-value represents the code on the vertical (toy) scale.
Figure 2-3

Most and least commonly occupied cells for all infants.

- Cells with highest mean duration for all infants.
- Cells with lowest mean duration for all infants.
- Unoccupied cells.
2.2.5. Sample Description of Behaviour in the Four Most Commonly Occupied Cells

In order to provide a more comprehensive description of infant behaviour in the 4 most commonly occupied cells, a random sample of videotaped sessions were viewed a second time, following the completion of all coding procedures. Five JB or ET sessions representing all age periods were viewed for a random sub-sample of 6 subjects. For each session, a detailed narrative account of time spent in cells 1,1; 1,5; 4,2; and 1,4, was made. These descriptions demonstrate the range of behaviours captured by the coding scheme utilized in this study, and are summarized below:

**Cell 1.1**

Behaviour in this cell generally differed according to toy episode. In the JB condition, time in this cell most often meant that the infant was about to leave the room before 60 seconds had elapsed. The infant usually put down the jack-in-the-box, got up, and walked out. While some infants left the room in order to locate another toy to play with, some could be heard calling for the examiner, suggesting that they were off to seek her assistance in operating the jack-in-the-box. Thus, duration in this cell during JB episodes was typically short, from 1-8 seconds for most of this sample. One infant had a lengthy time period in this cell on one occasion, as he lay down on the floor and simply looked around for 26 seconds, after his mother would not assist him with the
toy. This behaviour was not characteristic of the sample as a whole, regardless of the type of toy episode.

In the ET condition, time in cell 1,1 ranged from 4 to 37 seconds. Infants were seated 3 to 6 feet from mother. For all infants, time in this cell involved playing with one or more of the alternate toys which had been provided to them by the examiner at the onset of the emotion-eliciting task. In one instance the infant was playing with an alternate toy, then stood up and moved towards the door, while calling the examiner’s name.

Cell 1.5

For this sample, time in cell 1.5 ranged from 3-20 seconds. All infants were seated 3 to 5 feet from mother, and were not engaged with her in any way. Each infant was looking at the frustrating toy, and manipulating it in a specific manner which was clearly designed to gain accessibility. In the JB condition, infants were playing with the crank on the jack-in-the-box, either attempting to turn it or push on it. In the ET condition, infants were manipulating the seal on the closed container.

Cell 4.2

Duration in this cell ranged from 5 to 12 seconds for this sample. All infants were making their way towards mother while holding the frustrating toy. Most of the infants vocalized, as well. This ranged from a grunting sound, to a whiny cry (“eh, eh”) to use of language in a 22 month old (“do it”).
Upon arriving in front of mother, 2 of the 5 infants held the toy in front of her. A third dropped it at her feet. The remaining 2 began to play with the toy themselves. The latter 2 infants both vocalized on the way to mother while holding the toy, presenting a clear request for engagement prior to their becoming re-engaged with the toy. In both these cases coding of 4,2 was terminated when the infant ceased attempts to engage with mother.

**Cell 14**

Duration in this cell ranged from 3-10 seconds among this sample of protocols. Infants were situated 4-6 feet from mother, and were not engaged with her. Infants were looking at the frustrating toy and manipulating it in a variety of ways, none of which were specific to the particular frustrating toy. For example, in one JB episode the infant turned the toy around, as he apparently was attempting to locate the crank. Similarly, in some ET episodes, the infants picked up the container and turned it around while looking at the toy inside. In performing such movements, the infants appeared to be considering the problem which was before them. Other behaviours of infants in these cells included banging on the jack-in-the-box or closed container with their hands. Such behaviours could represent either nonspecific ways of attempting to gain access to the toys or alternate ways of exploring and playing with them.
2.2.6. Inter-rater Reliability

Monthly data for all subjects were coded by two graduate students who had participated in the design of the behavioural scales. Fifty-six sessions (19.5%) were coded by both students in order to assess inter-rater reliability for infant engagement with mother and toy, as well as incidence of distress. All ages were represented in the sample chosen. Twenty-five of the sessions utilized for reliability involved the JB episode, and 31 of the sessions involved the ET episode. This represented 21% of all JB sessions and 18% of all ET sessions.

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 in both toy and mother scales. A disagreement on one or both scales in a given second was designated a non-match. Concordance was calculated as 75.9% in JB sessions, and 80.8% in ET sessions, for a combined concordance of 78.5%.

2) Levels of reliability for coding on the toy and mother scales were also calculated independently. The kappa coefficient on the toy scale was .79, and on the mother scale it was .80. Inter-rater reliability was also assessed for all incidences of infant distress in each session, resulting in a kappa coefficient of .77.
2.2.7. **Attractor Definition**

Any individual cell on the state space map could be designated as an attractor for a particular infant. The identification of attractors was a two-step process reflecting the need for a minimum duration in a given month, and continuity over development.

1) Real time self-organization occurs as behaviour converges to an attractor in seconds or minutes. Thus any cell on the state space which had been occupied for a minimum duration in a given session was considered to demonstrate evidence of real time self-organization. But how should one determine the minimum duration in a cell necessary for it to qualify as an attractor? A cell duration which was too brief would be likely to capture transient behavioural states, while one which was too long would exclude short-lasting stable states.

To determine the minimum cell duration for the present study, the potential outcome of utilizing various cell sizes was explored on a sub-sample of subjects. Four subjects with data in the JB episode and four different subjects with data in the ET episode were randomly chosen. One session from each of these 8 subjects was selected from each of 3 phases of data collection: 1) 14-17 months, 2) 18-21 months, and 3) 22-25 months. Thus a total of 24 protocols (3 sessions of JB from each of 4 subjects and 3 sessions of ET from another 4 subjects) were utilized in this analysis. The sub-sample thus reflected both toy episodes and the full range of subject ages.
The frequency of each cell duration in these 24 protocols was calculated and is shown in Figure 2.4. From this histogram, it was evident that cell durations of 1-4 seconds were most common, with a sharp decrease in frequency occurring at cell durations of 5 seconds. The frequency of durations beyond 5 seconds fell gradually, and leveled off when durations reached about 30 seconds. Thus the distinction between 4 and 5 seconds suggested an inflection point in the continuum of cell duration values. As such, it was decided that a minimum cell duration of 5 seconds (for the sake of brevity, also identified as a "5+ cell") would be required for a cell to qualify as an attractor.

Fig. 2.4. Frequency of Occurrence of Each Cell Duration in Sample Protocols

![Histogram showing frequency of cell durations](image-url)
2) Self-organization in developmental time represents the re-emergence of attractors over the course of months and years. Therefore, the fate of each cell of minimum 5 seconds duration in each infant was followed for the 12 months of data collection. In general, the continuous presence of any 5+ cell over the course of several months was considered to be evidence of an attractor. Once again, however, the question arose of how to operationally define the concept of “several months” of a 5+ cell, in order to enable identification of attractors in the present study. The balance between designating too few vs. too many months was again a concern, just as it had been in determining minimum cell durations for the identification of self-organization in real time. A decision was made that in order to be designated a developmental attractor, a 5+ cell had to be sustained for at least 3 consecutive months, or 3 out of 4 consecutive months. Two consecutive months was considered too brief because of the high frequency of repeated 5+ cells which did not recur again. A minimum of 4 consecutive months was considered unduly strict because it would greatly reduce the number of attractors identified. The inclusion of consecutive 5+ cells in 3 out of 4 months was undertaken to limit the possibility that a single monthly change in behaviour could prevent the identification of newly emerging stable forms.
2.2.8. Calculation of Time in Attractors and Calculation of Distress

In order to explore changes in the state space over time, several parameters were measured which are based on calculations of duration of time in attractors and duration of distress. However, these measurements were complicated by the fact that individual sessions varied in length from 30 to 60 seconds. In total, 33 sessions were under 60 seconds because the infant left the room early. Another 24 sessions were terminated early for one of several other reasons outlined previously. Because there were such an unexpectedly large number of sessions which terminated prematurely, it was necessary to find a means of including these data in our analyses. To deal with this problem, several of the state space parameters analyzed in this study used proportional rather than actual duration values. Similarly, several of the distress scores were adjusted using a system of prorating. The criteria utilized for determining these adjustments, and the nature of the changes which were made, are both described in detail below.

Proportion of Time in Attractors:

The measure of proportion of time in attractors per month for a given protocol was calculated as the percentage of time in each session which was spent in the cell(s) designated as attractors. The cumulative duration of these cells was simply divided by the length of the session. The proportion of time in attractors for a group was identified by averaging the scores for all protocols in the group.
Time in Attractors of High Engagement with Mother or Toy:

Time spent in attractors in cells 4,1; 4,2; 5,1 or 5,2 (high engagement with mother; passive or no engagement with the toy), and cells 1,4; 1,5; 2,4 and 2,5 (high engagement with toy; passive or no engagement with mother) were examined separately from overall proportion of time in attractors. Time in these particular attractors was not calculated as a percentage of session length, but was recorded as the cumulative duration of time occupied in these attractor cells during each session. The measure of proportion of time in these attractors was not used because sessions most often ended early due to infants' leaving the room. On these occasions the infants had clearly made a choice to cease their engagement with both the mother and the toy.

However, some sessions which were terminated early were prorated as a means of estimating the likely duration of these attractors had the full 60 seconds been permitted to elapse. Prorating of sessions as a means of determining time spent in attractors of high engagement with mother or toy occurred only in circumstances when it could be reasonably assumed that the infant would have continued with the specific behaviour had the session not been interrupted prematurely. The following situations fell into this category:

1) The distress criterion had been reached.

2) An outside interruption occurred, such as a family pet walking into the room.
3) In the case of high engagement with toy, when the session ended early because the toy opened while the infant was playing with it. (Usually this happened because the item fell on the ground. In very few sessions did infants succeed in gaining access to the toys independently.)

Using these criteria, the data were prorated in 7 sessions for high-engage-toy cells and in 10 sessions for high-engage-mother cells from a total of 9 different subjects. All but 2 of the prorated cases occurred during JB toy episodes, since the distress criterion was most often reached during this event.

The calculation of time in attractors of high engagement with mother or toy during sessions which were terminated early for any other reason (e.g. the infant left the room) were not prorated, but were recorded as the cumulative duration of time spent in these attractor cells. In these situations the infant had made a clear choice about how to spend his/her time, and the decision did not involve engagement with mother or toy.

**Calculating Distress:**

Distress scores were calculated as the cumulative duration of distress for each infant during each session. As with the calculation of time in attractors of high engagement with mother or toy, decisions regarding the adjustment of distress scores in sessions which were terminated early were
made by considering the likelihood that the infant would have demonstrated
additional distress had the emotion-eliciting event been permitted to take
place for the full 60 seconds. The following criteria were used:

1) If the session ended early because the infant independently found a
solution to the emotion-eliciting event (e.g. leaving the room), then no
further distress from the emotion-eliciting event would be expected.
Therefore, in these circumstances distress was simply scored as the
cumulative duration of distress during the elapsed time of the session.

2) If the session ended for a reason other than the infant finding a
solution to the situation (e.g. a cat wondered into the room and distracted the
infant), then an assumption was made that distress might have continued if
the emotion-eliciting event had been not been interrupted. In such cases, the
distress score was prorated. Prorated distress scores were based on the
proportion of distress measured prior to the early termination of the session,
and were considered to be an estimate of what the distress would have been
had the session been able to continue for the full 60 seconds. All sessions
which were terminated early because the distress criterion was reached were
prorated, even if they had been terminated in under 30 seconds.

3) The maximum distress score for any session was set at 30 seconds. A
maximum score was decided upon because the process of prorating sessions
would have resulted in some infants showing suspiciously high durations of distress - durations which were often far greater than the actual distress durations evidenced in 60-second sessions. (In all 60-second sessions, the maximum distress score recorded was 37 seconds; only 4 sessions had unadjusted distress scores of 30 seconds or more.) Although the process of prorating generally assumes that the variable under consideration increases linearly, this is not true for distress. As a result, prorating distress without designating a maximum score would lead to exceedingly high scores for adjusted sessions. Any analyses involving distress scores might therefore yield spurious results.

Setting the maximum score at 30-seconds seemed appropriate because it allowed for a large range of possible scores to be expressed, while limiting the potential for exaggerating prorated durations of distress.

2.2.9. Converting Distress Scores to Running Averages

Because the development of infant coping in this study was evaluated in relation to developmental changes in distress, it was important to obtain a general idea of the ebb and flow of distress over the course of the 12 months of data collection. Furthermore, some of the analyses which were done required the designation of a single month of peak distress for each of the 26 sets of monthly protocols used in this study. Both the identification of a general pattern of distress over time, as well as the designation of a specific month of peak distress, could be greatly affected by fluctuations in distress
during any one month. To limit this possibility, developmental trends in
distress were identified by converting monthly distress scores to running
averages.

Running averages were calculated as the mean of the distress scores
over floating 3-month periods. The distress score for each month was
replaced by the mean of the distress score for that month and its two adjacent
months.

An additional adjustment to the calculation of running averages was
made for sessions which were not flanked by two adjacent months. This
included the first and last months of data collection for all protocols. For these
months, the distress score was doubled, added to the distress score of the one
adjacent month, and divided by 3.

Estimates of the distress scores for missing or spoiled sessions which
occurred during the middle months of data collection were also calculated
using running averages. Specifically, the distress score for the missing or
spoiled session was estimated as the mean of its two adjacent sessions.

2.2.10. Criteria for Determining Low Distress Protocols

Running averages for distress data were only calculated on sets of
protocols which met the criterion for a minimum monthly duration of
distress. Infants who did not meet this criterion in a particular toy episode
were categorized as "Low Distress". Monthly variability in distress scores for
these Low Distress protocols was not considered meaningful.
The criterion for minimum overall distress was as follows: at least 2 sessions with a minimum of 4 seconds of distress in each session (after any necessary prorating of raw scores was completed). Based on this criterion, 7 protocols (6 JB and 1 ET) were considered Low Distress Protocols, and they were excluded from all analyses which involved peak distress month.
CHAPTER III

RESULTS

In this chapter, the developmental course of distress for all subjects is presented first. Since results of these analyses revealed an unexpected heterogeneity within the sample, the next section focuses on a further exploration of these differences. This exploration culminated in a factor analysis in which three distinct developmental patterns of distress were identified among protocols in this study. Composition of the distress profiles revealed a conflation between individual differences and task differences, necessitating an abandonment of the goal to examine individual differences in behaviour related to coping. A discussion of this confound is presented next.

Analyses of state space configurations are then presented in relation to the three distress profiles. Five measures of state space configuration are reviewed, and changes in the behavioural responses of protocols showing each of the distress profiles are described in relation to these measures. Next, traditional statistical procedures are applied in an attempt to quantify some of the observed changes in state space configuration. Descriptions of the developmental trajectories of behaviour and distress for a subsample of protocols is presented at the end of this section.
Finally, an adjunct analysis examining the correlations between distress and various measures of change in state space configuration is described.

3.1. The Developmental Course of Distress: 14-25 months

Figure 3.1 depicts the monthly mean distress scores for all 26 protocols from 14-24 months. As shown in the graph, mean distress reached a maximum at 18 months, suggesting that for this group of infants, distress levels increased at the time of a hypothesized stage transition. A second, lower peak is also evident at 22 months.

Figure 3.1. Mean Duration of Distress at Each Age for All Protocols.
This method of examining distress is vulnerable to distortion, however, since a few protocols with extremely high distress scores in a given month could unduly influence the overall shape of the graph. Therefore, a second method was also used to illustrate the developmental course of distress. The second method involved identifying a month of peak distress for each protocol, and plotting the total number of peaks for each month.

The month of peak distress for each protocol was identified simply as the month of most distress, based on the running averages profile of distress scores. If a protocol revealed three consecutive months of identical peak distress, the mid-point was chosen. In the event there were two consecutive months of peak distress, a frequency of .5 was assigned to each month. The seven previously identified Low Distress protocols were excluded from this analysis; since overall distress was so low, the designation of a month of "peak" distress was considered spurious.

Figure 3.2 depicts the frequency of peak distress at each month for 19 protocols. The graph reveals that for seven protocols, peak distress occurred at 17 or 18 months. An additional seven protocols displayed a peak during the period from 22-24 months. No subject for whom both toy episodes were utilized had the same peak distress month in both episodes; therefore, no subject was included twice in one month. This graph reveals a developmental pattern of distress for this sample of protocols which is consistent with results of the analysis of mean distress score per month. Specifically, results show evidence of two distinct periods of increases in
distress during this period of development, one of which coincides with a period of a hypothesized stage transition.

Since protocols from the two different toy episodes were combined for use in these distress analyses, the potential influence of each toy episode on the developmental pattern of distress was not known. Therefore, the frequency of peak distress per month was also examined as a function of toy episode. As illustrated in Figure 3.3, the two periods of increased distress existed for subjects in both the JB and ET episodes, suggesting that this pattern of developmental distress was not related to the particular frustrating situation to which the infants had been exposed.
Figure 3.3.
Frequency of Peak Distress at Each Age: ET vs. JB Protocols

ET Protocols

JB Protocols
3.2. Three Profiles of Developmental Distress

Results of the distress analyses revealed a peak in distress at around 18 months, the age of a hypothesized stage transition. While this was true for a subsample of the protocols, another set of protocols revealed increases in distress during the latter months of the second year. A third group, the Low Distress protocols, showed no apparent increases in distress at any time. A factor analysis was performed in order to explore the possibility that the sample fell into two or more distinct profiles, reflecting differential patterns of distress across development.

A principle components factor analysis was utilized, with subjects entered as "variables" and monthly distress scores as values on these variables. Although applying this method violates the assumption of independence of observations, in this case the factor analysis was used as an exploratory tool, for purposes of data reduction.

The seven Low Distress protocols were excluded from the factor analysis because monthly variations in distress were considered insignificant in cases where overall evidence of distress was so minimal. Distress scores per month for the remaining sample of 19 protocols used in the factor analysis were taken from the running averages conversion described in Chapter 2. Although missing data at the beginning or end of monthly sequences were originally ignored in calculating running averages, for purposes of the factor analysis these values were replaced by the average of the two scores succeeding or preceding the missing value.
Using a minimum coefficient of 0.5, 14 of 19 protocols entered into the analysis loaded onto Factor 1. This factor accounted for 50.1% of the variance. The protocols which achieved positive and negative loadings on Factor 1 were seen to reflect distinct profiles of developmental distress. The seven Low Distress protocols which were excluded from the factor analysis represented a third profile, by virtue of their unique pattern of consistently low distress scores.

Figure 3.4 depicts the three patterns of developmental distress demonstrated by most protocols in this study. As shown, one set of protocols demonstrated elevated levels of distress from 14-19 months inclusive, with a peak at 18 months. Negligible levels of distress were evident from 20-23 months. Since this distress pattern showed a decrease in distress over the course of development, these protocols were considered to demonstrate a “Coping” profile. Alternatively, the second set of protocols demonstrated some distress from 14-20 months inclusive, followed by elevated levels of distress in the period from 21-23 months. Since this pattern showed an increase in distress over this time period, these protocols were seen as displaying a “Noncoping” profile. For the sake of simplicity, the term “Nondistressed” was assigned to describe the group of Low Distress protocols in the sample.
3.3. Composition of Distress Profiles and the Impact on Analysis of Individual Differences in Behaviour Related to Coping

Table 3.1 reveals the number of protocols which displayed each distress profile, broken down according to toy episode. It is evident that more ET than JB protocols showed the Coping profile, only JB protocols showed the Noncoping profile, and mostly ET protocols showed the Nondistressed profile. It is notable that, of the infants whose data were included on both toy episodes, none demonstrated the same distress profile on both episodes. These results suggest that individual distress profiles, both between and within infant, were context-dependent; they were highly related to the particular type of emotion-eliciting event which was presented.
The grouping of protocols representing each of the distress profiles presented a serious challenge to the possibility of analyzing individual differences in the content of behaviour related to coping, as anticipated by the third hypothesis. Specifically, one of the main design considerations of this study was to enable the observation of individual patterns of response by examining infant behaviour during four different emotion-eliciting episodes. Two of the four episodes had to be excluded in the early stages of data analyses because distress was found to be too excessive in one case and practically nonexistent in the other. It was then hoped that infant behaviour during the two remaining toy episodes (i.e., JB and ET) could be utilized for this purpose, despite the 50% reduction in data which would be available for each infant.

Unfortunately, this goal could not be achieved. First, the large number of spoiled or missing sessions necessitated the omission of one toy episode for
eight of the 17 subjects in this study (see Table 2.1). Thus for roughly half of
the sample it was only possible to examine behaviour on either the JB or ET
task. Second, the categorization of individual protocols by pattern of
developmental distress revealed a relatively distinct composition of toy
episodes for each distress profile. That is, both the Coping and Nondistressed
profiles are made up primarily of protocols during the ET episode, while the
Noncoping profile consists entirely of protocols during the JB episode. Taken
together, these two circumstances created a clear and insurmountable
conflation between individual differences and task differences. For this
reason the third hypothesis, that developmental reorganizations would
reflect individual differences in the content of behaviour during the
emotion-eliciting events, could not be tested.

Despite the inability to examine individual differences, the present
study was nevertheless able to explore the notion of developmental
transitions in behaviour related to coping by examining changes in the
attractor landscape for protocols from each distress profile. The possibility of
artifactual findings concerning developmental change due to unequal task
compositions of protocols within each distress profile was also considered
serious enough to be carefully monitored. Tests for such artifactual effects
were conducted and are reported on page 91, following presentation of the
main analyses.
3.3. Analyses of Differences Among the Three Distress Profiles

3.3.1. State Space Measures of Differences

To examine the self-organization of behavioural response from state space grids, developmental changes in state space configurations were analyzed for protocols displaying each of the three distress profiles. Although it was clear that the analyses would be based primarily on observations involving changes in attractors, the lack of precedents for this type of work made it difficult to know which particular aspects of the attractor landscape would best detect meaningful changes in behaviour over the course of development. Therefore, five distinct methods of analyzing the state space grids were selected, each one reflecting a different aspect of state space configuration.

a) Number of Cells Occupied on the State Space

Since each cell on the state space grid represents a unique behavioural configuration, the mean number of cells occupied for a protocol in any given month can provide a general indication of the fluctuation in behaviour in a given toy episode during that month. A greater number of cells occupied would suggest that the infant demonstrated several combinations of engagement with mother and toy during the particular frustrating episode, whereas fewer cells occupied would suggest that the overall behavioural response was more consolidated.
Figure 3.5 depicts the mean number of cells occupied per month for protocols from each distress profile. Protocols which showed a Coping profile displayed a fairly consistent level of about 5 occupied cells per month from 14-20 months, followed by a drop to about 4 cells per month or less from age 21-23 months. In contrast, protocols which showed either Noncoping or Nondistressed profiles revealed fluctuating patterns in the number of cells occupied over development. Thus, in terms of this parameter, only protocols which displayed a Coping profile demonstrated a possible developmental pattern, with a shift to a slightly more stable behavioural response taking place in the latter months of the second year.
While the number of cells occupied on the state space is useful as a global indication of behavioural consolidation during each month, this measure in itself is a rather coarse means of capturing meaningful changes in the self-organization of infant response. For example, the fact that several of these cells were occupied for only one second raises the possibility that random fluctuations in behaviour (e.g. a child looking up momentarily after hearing the blast of a car horn outside) could unduly influence the outcome of this analysis.

b) Proportion of Time Spent in Attractors

For each protocol, the mean number of seconds spent in attractors during each month was calculated as a proportion of the total length of the session. Since, by definition, an attractor must recur in at least 3 out of 4 consecutive months, the measure of proportion of time in attractors provided an indication of the extent to which behavioural responses were stable over the course of development.

While in theory it would have been possible for an infant to demonstrate up to 12 different attractor cells during one toy episode in a given month (i.e., minimum of 5 seconds per cell over a 60-second session), in reality, the average number of cells which actually qualified as attractors per month was quite small for this sample of subjects (M=1.52). As a result, the occurrence of a high proportion of time in attractors can be seen as a
reflection of behavioural stability both in real time and during a particular period of development.

Figure 3.6 depicts the proportion of time spent in attractors each month for protocols demonstrating each distress profile. While protocols which showed the Coping profile had a steady increase in proportion of time spent in attractors over the period of study, protocols showing the Noncoping profile fluctuated wildly throughout the 11 month period, with little pattern in evidence except perhaps a drop in the final two months. Finally, Nondistressed protocols displayed a consistently high proportion of time spent in attractors in all months.

This examination of changes in state space revealed a potential relationship between distress and proportion of time spent in attractors: protocols displaying the Coping profile exhibited an increase in the proportion of time spent in attractors over the course of development, which corresponded to a decrease in distress during this period. Nondistressed
protocols, which did not display significant negative emotion in any month, showed a high proportion of time in attractors during all months of data collection. Protocols demonstrating the Noncoping profile, which was associated with increasing levels of distress in the final months of the second year, showed little pattern of change in their proportion of time in attractors, with the exception of a drop in the final two months. These results suggest an inverse relationship between distress and behavioural stability.

c) **Number of Cells of Minimum Five Seconds Duration Which do not Qualify as Attractors ("5+ cells")**

The measure of mean number of 5+ cells per month utilized the attractor concept to examine changes in state space configuration from a
different but complementary perspective. Specifically, this measure identified cells which were occupied for a minimum duration of 5 seconds, but failed to qualify as attractors because they did not appear in 3 out of 4 consecutive sessions. This measure, therefore, was a reflection of local stability, or stability of behaviour in real time during a given month. A low number of 5+ cells indicated that infant behaviour in the particular toy episode during the month was stable, while a high number indicated that the infant was spending time in several different cells, reflecting a greater number of behavioural responses to the emotion-eliciting event.

The number of 5+ cells per month is clearly similar to the measure of the total number of cells occupied per month, with the difference being that any cell of under 5 seconds duration was excluded from the analysis. The use of 5 seconds for the minimum duration of cells was chosen because it reflected the minimum level of real time behavioural organization necessary to meet the requirements of a attractor.

Figure 3.7 depicts the mean number of 5+ cells per month for protocols displaying each distress profile. Protocols showing the Coping profile had a slow decline in the number of 5+ cells occupied over the course of development. As with the measure of the proportion of time spent in attractors, protocols showing the Noncoping profile revealed considerable variability in the number of 5+ cells occupied in all months. Nondistressed protocols displayed relatively few 5+ cells occupied most months. Again,
these results suggest an overall inverse relationship between distress and behavioural stability.

Figure 3.7. Mean Number of 5+ Cells per Month

ET vs. JB Episodes: Testing for Artifactual Results

It might be conceivable that some sort of interaction effect between the pattern of results for the two toy tasks produced these profiles of state space change, and therefore that this outcome was unrelated to distress. In order to test this possibility, changes in state space configuration for protocols showing the Coping profile were also analyzed separately for subjects within each toy episode.
As illustrated in Figure 3.8, protocols representing each toy episode showed a very similar gradient of increase in the proportion of time in attractors over age. A similar comparison was conducted using the two other measures of change in state space configuration, namely the mean number of cells occupied, and the mean number of 5+ cells occupied. In both cases, the direction and gradient of change were similar between JB and ET protocols displaying the Coping profile. Furthermore, the increase in proportion of time spent in attractors for JB protocols in Figure 3.8 is clearly distinct from the irregular pattern demonstrated by the JB protocols showing the Noncoping profile, as revealed in Figure 3.6. While this evidence is not meant to suggest that the type of toy episode played no role in influencing overall infant distress pattern, it does indicate that the developmental changes associated with this pattern of distress affected infants in both toy episodes in a similar manner.
d) **Duration in Attractors of High Engagement with Mother ("Mother Attractors")**

The three measures presented thus far explored overall changes in state space configuration based on criteria that have to do with cell occupation within session and, in some cases, across months. These measures, however, do not distinguish between particular types of infant behavioural responses. Another way of examining potentially significant changes in state space configuration was to isolate specific behaviours of interest, and to look at the self-organization of these behaviours as revealed by changes in the attractor landscape. Since all behaviours in this study reflected some level of engagement with mother and toy, the final two measures were designed to
explore infant responsiveness in these domains during presentation of the two emotion-eliciting events.

Responsiveness to mother over development was investigated by calculating the mean duration per month spent in attractors of high engagement with mother combined with low engagement with the toy (i.e., Cells 4,1; 4,2; 5,1; and 5,2). As seen in Figure 3.9, protocols displaying the Coping profile exhibited a moderate number of attractors of high engagement with mother in the early months with a sharp increase at 18 months followed by a decrease from 20 to 23 months. Protocols showing the Noncoping profile occupied several attractors of high engagement with mother during all months, and the Nondistressed protocols displayed few such attractors in all months. Thus, on this measure, high engagement with mother was associated with high distress for all three groups.
It should be noted that on this measure there was considerable heterogeneity among protocols showing the Coping profile. Specifically, 4 out of 8 of these protocols had no attractors in high engagement with mother throughout the testing period. Of the remaining 4 protocols, 3 showed clear decreases in high engagement with mother, and the final one was ambiguous due to missing data in the later months.

e) Duration in Attractors of High Engagement with Toy ("Toy Attractors")

The mean amount of time per month which protocols occupied in attractors of high engagement with the toy combined with low engagement with mother (i.e., Cells 1,5; 2,5; 1,4; 2,4) is presented in Figure 3.10. The graph
shows consistently low engagement with toy for protocols demonstrating both Coping and Nondistressed profiles. Protocols showing the Noncoping profile had a moderately high number of these attractors, with a peak at 20 months followed by a drop at 22 and 23 months. Although this result indicates that protocols demonstrating the Noncoping profile spent more time overall in toy attractors, the fact that all these protocols were from the JB episode makes this finding difficult to interpret. Since the JB episode did not present infants with toys other than the one designed to elicit distress, the choice of response was more limited.

Figure 3.10. Mean Duration in Toy Attractors
3.3.2. Summary of Changes in State Space Configuration

A summary of the observed developmental changes in state space configuration for protocols displaying each of the three distress profiles is presented in Table 3.2. It is evident from this table that protocols showing the Coping profile demonstrated a consistently identifiable pattern of change in state space measures across development. These changes reflect increases in behavioural stability and consistency over time, and occurred in conjunction with a marked decrease in levels of distress during this period of development.

Protocols showing the Noncoping profile, which reflected increases from moderate to high levels of distress during the JB toy episode in the second year of life, showed considerable variability in all general measures of state space configuration. In measures of specific behavioural responsiveness, these protocols had consistently high durations in mother attractors, and a decrease over development in time in toy attractors.

Finally, protocols showing the Nondistressed profile exhibited little change in state space configuration from early to late months in the second year. The lack of developmental change in either the organization of behaviour, or in the specific nature of their responses, was consistent with a distress profile which was low and stable throughout the recording period.
### TABLE 3.2

**Summary of Changes in the Pattern of State Space Configuration Across Development for 3 Distress Profiles**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Coping</th>
<th>Noncoping</th>
<th>Nondistressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cells Occupied</td>
<td>decrease</td>
<td>variable</td>
<td>variable</td>
</tr>
<tr>
<td>Proportion of Time in</td>
<td>increase</td>
<td>variable</td>
<td>high and stable</td>
</tr>
<tr>
<td>Attractors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of 5+ Cells Occupied</td>
<td>decrease</td>
<td>variable</td>
<td>low and stable</td>
</tr>
<tr>
<td>Time in Mother Attractors</td>
<td>decrease</td>
<td>high and stable</td>
<td>low and stable</td>
</tr>
<tr>
<td>Time in Toy Attractors</td>
<td>low and stable</td>
<td>decrease</td>
<td>low and stable</td>
</tr>
</tbody>
</table>

#### 3.3.3. Differences in Relation to Month of Peak Distress

Because changes in state space organization were expected to be related to changes in distress, an alternate way of exploring differences in state space configuration over development was to examine changes in relation to peak distress month. The peak distress month of each protocol was identified, and measures were taken of state space variability in the months prior to and following the peak. The data from protocols displaying each distress profile were summarized and are presented in Figures 3.11 and 3.12. (Once again, protocols showing the Nondistressed profile were excluded from this analysis because peak distress was not a relevant construct.)
In Figure 3.11, the proportion of time spent in attractors in relation to peak distress month is presented for protocols showing the Coping and Noncoping profiles. While protocols displaying the Coping profile demonstrated an increase in proportion of time in attractors in the months following peak distress, protocols showing the Noncoping profile demonstrated a decrease beginning prior to their peak distress month. In addition, proportion of time in attractors for the Noncoping protocols remained consistently low following peak distress month. The robustness of this difference remains unclear because of the limited data for Noncoping protocols following their peak distress month.

Figure 3.11. Proportion of Time in Attractors and Peak Distress Month

![Graph showing the proportion of time in attractors for Coping and Noncoping protocols relative to peak distress month.](image-url)
For the both groups of protocols, this result provides information about the timing of the developmental changes seen. Specifically, for the protocols showing a Coping profile, the increase in behavioural consistency and stability reflected by increased proportion of time in attractors occurred 1-2 months following the period of peak distress. For protocols showing the Noncoping profile, the proportion of time in attractors remained consistently low following their peak distress period.

A second way of comparing protocols from the two distress profiles in relation to peak distress month is shown in Figure 3.12. In this graph the mean number of 5+ cells per month is revealed for protocols displaying each distress profile, providing information regarding changes in monthly behavioural fluctuation in relation to peak distress. Despite the more limited data for the Noncoping protocols, their graph shows a high number of 5+ cells beginning on the peak distress month, and then a possible decline, whereas the Coping protocols show a steady decrease following their peak distress month. This graph provides further evidence that protocols showing the Coping profile became increasingly more stable in their behaviour following their peak distress month.
3.3.4. Statistical Comparisons Among the Three Distress Profiles

The use of a state space grid approach to data analysis does not preclude the application of traditional statistical procedures. Indeed, traditional methods may be utilized as means of further exploring the changes in state space configuration which were observed above.

a) Developmental Changes in Response to Emotion-Eliciting Events

In order to examine statistical differences in behavioural response among protocols displaying different developmental distress profiles, a
means for each set of protocols in the early (14-17 months) and the late (20-23 months) time periods. Since the purpose of this analysis was to examine changes over time for protocols within each distress profile, the group by age effects were of particular interest. The three groups of protocols reflecting each distress profile were compared on each of the five state space measures described above:

1) Number of cells occupied.
2) Number of 5+ cells occupied.
3) Proportion of time in attractors.
4) Time in mother attractors.
5) Time in toy attractors.

This analysis was conducted even though two distress profiles were evident in infants whose data was analyzed on both toy episodes, and this finding violated the assumption of independence of variables. Since no infant who had data on both toy episodes appeared twice in one group, however, it was felt that this fact would not bias the results in favour of group differences.

Results of the repeated measures ANOVA showed no significant group by age effect on any of the above measures, as seen in Table 3.3. There were no main effects for age, but significant main effects for group (p<.05) were evident on number of cells occupied and proportion of time in attractors. In
addition, time in mother attractors was almost significantly different at the group level (p=.06). Post-hoc Scheffe tests showed that significant group effects were accounted for by differences between protocols showing the Noncoping and Nondistressed profiles.

Because this was exploratory research, it seemed well-advised to look at the data set more closely to see if an age by group effect would have occurred had the groups been designed differently. Upon reviewing the data within groups, it was noted that one protocol showing the Coping profile demonstrated a behavioural pattern which did not match the group trend on two state space measures. Specifically, both in proportion of time in attractors and in number of 5+ cells, this protocol showed a decreasing level of behavioural stability. In addition, on the factor analysis utilized to identify groups, this protocol had the lowest loading on Factor 1 (.63) of all group

<table>
<thead>
<tr>
<th>Measures</th>
<th>Group Effects</th>
<th>Age Effects</th>
<th>Group by Age Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F(2,18)</td>
<td>p-value</td>
<td>F(1,18)</td>
</tr>
<tr>
<td># Cells Occupied</td>
<td>4.85</td>
<td>.02</td>
<td>.19</td>
</tr>
<tr>
<td># 5+ Cells Occupied</td>
<td>1.85</td>
<td>n.s.</td>
<td>.23</td>
</tr>
<tr>
<td>Prop.of Time in Attractors</td>
<td>4.93</td>
<td>.02</td>
<td>.22</td>
</tr>
<tr>
<td>Time in Mother Attractors</td>
<td>3.33</td>
<td>n.s.</td>
<td>.58</td>
</tr>
<tr>
<td>Time in Toy Attractors</td>
<td>2.34</td>
<td>n.s.</td>
<td>.23</td>
</tr>
</tbody>
</table>
members. Furthermore, this protocol also loaded on Factor 2 (-.54), and was indeed the only one demonstrating the Coping profile to load on 2 factors. These outcomes may have been related to the fact that this protocol was missing data in session 21 and 23, which interfered with analyses of state space configuration in the later months. Given these issues, the repeated measures ANOVA was redone without this protocol.

Results of this second analysis revealed similar main effects. However, a significant age by group effect (p<.05) was also found for the three general measures of change in state space configuration:
1) number of cells occupied,
2) number of 5+ cells occupied, and
3) proportion of time spent in attractors

These results are presented in Table 3.4.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Group Effects</th>
<th>Age Effects</th>
<th>Group by Age Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F(2,18)</td>
<td>p-value</td>
<td>F(1,18)</td>
</tr>
<tr>
<td># Cells Occupied</td>
<td>4.61</td>
<td>.03</td>
<td>.86</td>
</tr>
<tr>
<td># 5+ Cells Occupied</td>
<td>1.81</td>
<td>n.s.</td>
<td>1.27</td>
</tr>
<tr>
<td>Prop. of Time in Attractors</td>
<td>5.48</td>
<td>.02</td>
<td>1.76</td>
</tr>
<tr>
<td>Time in Mother Attractors</td>
<td>3.14</td>
<td>n.s.</td>
<td>1.0</td>
</tr>
<tr>
<td>Time in Toy Attractors</td>
<td>2.20</td>
<td>n.s.</td>
<td>.11</td>
</tr>
</tbody>
</table>

TABLE 3.4
Results of Repeated Measures ANOVA
(One Coping protocol omitted from the sample)
In the presence of a significant interaction on three variables in the repeated measures ANOVA, a simple effects test was conducted to determine which group(s) showed a significant age effect from early to late months. As seen in Table 3.5, all the significant differences were found within protocols showing the Coping profile. This was expected, since the graphic representations of state space configuration revealed identifiable patterns of change for this group only.

**TABLE 3.5**
Simple Effects Tests for Age Effect on Repeated Measures ANOVA

a) Number of Cells Occupied

<table>
<thead>
<tr>
<th>Distress Profile</th>
<th>$F(1.17)$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coping</td>
<td>6.77</td>
<td>0.02</td>
</tr>
<tr>
<td>Noncoping</td>
<td>1.35</td>
<td>n.s.</td>
</tr>
<tr>
<td>Nondistressed</td>
<td>0.09</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

(Continued...)
(Table 3.5 Continued...)

b) Proportion of Time in Attractors

<table>
<thead>
<tr>
<th>Distress Profile</th>
<th>F(1,17)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coping</td>
<td>11.21</td>
<td>0.004</td>
</tr>
<tr>
<td>Noncoping</td>
<td>0.19</td>
<td>n.s.</td>
</tr>
<tr>
<td>Nondistressed</td>
<td>0.27</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

c) Mean Number of 5+ Cells

<table>
<thead>
<tr>
<th>Distress Profile</th>
<th>F(1,17)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coping</td>
<td>10.08</td>
<td>0.01</td>
</tr>
<tr>
<td>Noncoping</td>
<td>0.21</td>
<td>n.s.</td>
</tr>
<tr>
<td>Nondistressed</td>
<td>0.45</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

b) Summary of Statistically-Based Differences Among the Three Distress Profiles

Results of these analyses reveal that the state space configuration for protocols showing the Coping profile underwent significant changes during this developmental period, corresponding to a significant decrease in distress. Specifically, the mean number of cells occupied and the mean number of 5+ cells both decreased, while the proportion of time in attractors increased. In
contrast, protocols showing Noncoping and Nondistressed profiles did not undergo significant changes in state space configuration over time, and their distress either increased (Noncoping profile) or remained consistently low (Nondistressed profile). Overall, these results indicate an inverse relationship between distress and state space stability.

Although protocols showing the Noncoping and Nondistressed profiles did not exhibit significant changes in state space configuration over development, the group effect revealed significant differences between protocols from these groups in mean number of cells occupied, and proportion of time in attractors.

3.3.5. An Exploration of Differences in Discrete Behaviours of Protocols Displaying the Three Distress Profiles

The individual developmental trajectories of a subsample of protocols displaying each of the three distress profiles is presented in Figures 3.13-3.17. These trajectories highlight the unique attractor landscapes shown by protocols from each distress profile, and their relationship to discrete behaviours during the emotion-eliciting events. In each case, the lower portion of the figure depicts monthly levels of distress, while the upper portion illustrates the presence of 5+ cells. Distinct icons are used to represent each 5+ cell in which attractors emerged. The presence of attractors is indicated by lines connecting these icons across months. Attractors emerged in the following cells:
(1) the four cells of high engagement with mother
(2) the four cells of high engagement with toy
(3) Cell 1,1 (disengagement from mother and toy)

All remaining 5+ cells appearing in a given month are represented by a general icon. (Note: months which are labeled as "spoiled" were those in which the infant did not remain in the room for the minimum of 30 seconds; therefore, for those months only duration of distress is presented.)

a) Sample Protocols Displaying the Coping Profile:

Figure 3.13 illustrates the developmental trajectory for protocol JB1. A clear peak in distress is evident at 18 months, followed by zero distress from 20-24 months. This protocol had three different attractors: one in a cell of high engagement with toy, and two in cells of high engagement with mother and passive engagement with the toy. While the toy attractor was stable across development, both mother attractors disappeared in the final 3 months of data collection. In months 22 and 23, only the toy attractor was present, indicating that this girl spent virtually the entire session playing with the jack-in-the-box. In this case, consolidation of the state space was accomplished by inhibiting engagement with mother.

The abrupt and enduring disappearance of two attractors of high engagement with mother in this protocol can be viewed as evidence of a behavioural phase transition. Moreover, both the increase in distress which preceded this change, and the disappearance of distress which emerged from
Figure 3.13. JB1: Distress, Attractors, and 5+ Cells Across Development

("HM" & "HT"=Cells of high engagement with mother or toy, respectively)
it, provide support for the notion that developmental reorganizations are associated with, initiated by, or follow changes in emotional responsiveness.

In Figure 3.14, a somewhat different pattern of behavioural change can be seen in an ET protocol which displayed the Coping profile. Four attractors are evident:

1) Cell 1,1
2) High engagement with toy (Cell 1,4)
3) High engagement with mother, passive engagement with toy (Cell 4,2)
4) High engagement with mother, disengaged from toy (Cell 4,1)

Cell 1,1 is a stable attractor across development, indicating that this infant spent a part of most sessions playing with the alternate toys which were provided. Cell 1,4, while present at 15 months, did not emerge as an attractor until 19 months. In contrast to JB1, therefore, this infant only began to become consistently engaged with the frustrating toy in the months following the period of high distress.

The relationship to mother shown in this protocol was also different from that revealed in the profile of JB1. Like JB1, an attractor of high engagement with mother and passive engagement with the toy disappeared in the final months. However, in this protocol, a new attractor involving high engagement with mother appeared from 23-25 months. (While this cell had been occupied at 15 and 17 months, no attractor was present at that time.) It is of note that this new attractor involved disengaging from the toy while engaging with mother. It appears that this infant inhibited her previous
Figure 3.14. ET1: Distress, Attractors, and 5+ Cells Across Development

("HM" & "HT"=Cells of high engagement with mother or toy, respectively)
behaviour of approaching mother for help with the toy, but replaced it by a new way of interacting with mother which did not involve the toy at all.

Thus in this case, a developmental phase shift may also have occurred. Help-seeking behaviour in relation to the toy disappeared, while new behaviours representing independent engagement with both mother and toy emerged during the emotion-eliciting event.

Still another pattern of developmental change in relation to mother and toy is evident in Figure 3.15. This protocol, ET2, shows attractors in Cell 1,1 and Cell 1,4 (high engagement with toy, no engagement with mother). Unlike both ET1 and JB 1, this protocol rarely occupied cells of high engagement with mother. In fact, there were no attractors in any cell of high engagement with mother during any period. Despite this difference, this protocol also demonstrated an apparent phase shift. In this case, the change involved the disappearance of an attractor of high engagement with toy. This infant apparently spent most of her time in the final months playing with the alternate toys which were provided to her. Although this protocol exhibited generally lower levels of distress than the previous two examples, the developmental pattern of distress was similar.

These individual examples are consistent with the evidence for increasing behavioural stability over development in protocols showing the Coping profile, accompanied by a decrease in distress. Further, these examples are suggestive of a phase shift, resulting in a consolidation of behaviour over the course of development. Finally, these examples also reveal the richness of
Figure 3.15: ET2: Distress Attactors & 5+ Cells Across Development

Note: "HM" & "HT"=Cells of high engagement with mother or toy, respectively.
individual variation in behaviour which accompanied such developmental transitions.

b) A Sample Protocol Displaying the Noncoping Profile

Figure 3.16 depicts the developmental trajectory for a typical protocol displaying the Noncoping profile. Two attractors were present during most months: one of high engagement with mother, and one of high engagement with toy. Thus the infant represented by this protocol spent part of most sessions engaged with both the frustrating mother and the frustrating toy. Although these behaviours were not accompanied by distress in the early months, they did become associated with an increase in negative emotion in the latter half of the year. Yet why would behaviours in an identical emotion-eliciting situation suddenly become associated with distress (or in the case of other protocols, with an increase in distress)? Unfortunately, interpretation of this phenomenon is limited in the present study, given the lack of data following change in levels of distress.

This protocol demonstrates the key characteristic of protocols showing the Noncoping profile, i.e., no apparent change in behavioural organization over development, and an increase in distress in the later months.

c) A Sample Protocol Displaying the Nondistressed Profile

Figure 3.17 depicts the developmental trajectory for a typical protocol displaying the Nondistressed profile. Two attractors were present: one in Cell
Figure 3.16. JB2: Distress, Attractors, and 5+ Cells Across Development

("HM" & "HT"=Cells of high engagement with mother or toy, respectively)
Fig. 3.17. ET3: Distress, Attractors, and 5+ Cells Across Development

("HM" & "HT" = Cells of high engagement with mother or toy, respectively)
1,1 (disengaged from both mother and toy), and one of high engagement with toy. Like Figure 3.16, this protocol illustrates a developmentally static situation. During most months in this toy episode, this subject played with the alternate toy and with the frustrating toy. Cells of high engagement with mother also were occupied across months; however, the infant did not occupy the same cell consistently enough to define an attractor. In fact, all four types of cells of high engagement with mother were occupied at various times, suggesting flexibility in the type of engagement with mother which was possible for this infant during this task.

Again, this example reflected the overall character of protocols displaying the Nondistressed profile: low distress accompanied by a consistent behavioural response over development.

3.4. Adjunct Analysis: The Relationship Between Distress and State Space Parameters

This study utilized an exploratory methodology based on dynamic systems theory for examining behavioural change and stability in early development. In addition to the specific research questions addressed above, the use of this novel approach has provided general information regarding the relationship between distress and state space measures which could be useful in developing further dynamic systems-based research designs. Specifically, strong correlations between certain state space parameters and
distress were found to exist among all 26 protocols (including those whose
distress patterns did not match any of the three primary distress profiles).
These results are presented in Table 3.6.

TABLE 3.6

Correlation Between Distress and State Space Parameters for all 26 Protocols.

<table>
<thead>
<tr>
<th>Distress and...</th>
<th>r-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of cells occupied</td>
<td>0.48</td>
<td>0.01</td>
</tr>
<tr>
<td>proportion of time in attractors</td>
<td>-0.59</td>
<td>0.002</td>
</tr>
<tr>
<td>number of 5+ cells</td>
<td>0.29</td>
<td>n.s.</td>
</tr>
<tr>
<td>time in high engage mother attractors</td>
<td>0.77</td>
<td>0.0001</td>
</tr>
<tr>
<td>time in high engage toy attractors</td>
<td>-0.06</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Table 3.6 shows that, in general, distress is associated with an increase in behavioural fluctuation on the state space and that infants tend to spend less time in attractor regions when distressed. These results suggest that distress is associated with a decreased level of consolidation of the state space.

Correlational analyses also demonstrated that infants tend to spend more time with mother when experiencing negative emotion, further illustrating the value of a state-space grid approach in identifying relationships among variables in early development.
The present study investigated the self-organization of behaviour related to coping in the second year of life by observing developmental change and stability in infant response to emotion-eliciting events. Individual differences in infant response could not be evaluated because data were obtained on only one of the two toy episodes for many of the infants in the study, and because the categorization of individual protocols by developmental distress profile revealed a relatively distinct composition of toy episodes within each distress profile, thereby conflating task differences with individual differences. However, the two remaining hypotheses were investigated. Specifically, developmental reorganizations were expected to appear around the 18 month period, in relation to the cognitive stage shift which has been hypothesized to occur at that time (Case, 1988). Developmental reorganizations were also expected to be associated with a peak in negative emotion. These predictions were partially supported.

This chapter begins with a discussion of the developmental course of distress for infants in this study, since these results were somewhat unexpected and influenced the nature of the remaining analyses. The timing of developmental reorganizations and their relationship to distress will then
be reviewed for protocols displaying each of the three distress profiles, followed by remarks on variations in the trajectories of discrete behaviours during the emotion-eliciting events. Presented next is a discussion on the use of a dynamic systems approach to the study of infant coping, including the particular methodological difficulties which were associated with the abandonment of the hypothesis regarding individual differences. The final section deals with implications for future research.

4.1 The Developmental Course of Distress

On average, the 26 protocols in this study demonstrated the highest mean duration of distress at age 18 months, with a second, lower peak, evident at 22 months. These results were partially consistent with findings of previous studies (Kopp, 1982; Mahler, Pine and Bergman, 1975; Weintraub & Lewis, 1977), in which escalations in crying behaviour in the second year were observed to occur around 18 months. The increase in distress at 22 months seen in this study was an unexpected finding, and reflected the month of peak distress for several of the protocols.

When the developmental pattern of distress for each protocol was examined, even more variability in the sample was seen. Two groups of protocols were identified on the basis of their developmental pattern of distress. Another group of protocols showed little distress in all months of data collection, a result which was not predicted. For this group, the emotion-eliciting situation did not actually succeed in eliciting emotion, suggesting
that the behaviours which were demonstrated could not be considered related to coping. The remaining 5 protocols (representing 19% of the sample) demonstrated a pattern of distress which failed to fit into any of the 3 identified distress profiles.

To complicate matters further, the different developmental patterns of distress did not just vary between infants, but within infants, as well. Indeed, of the 9 subjects whose data included both toy episodes, none showed the same developmental pattern of distress in both episodes. Moreover, individual patterns of distress in the two toy episodes fell into all combinations of the three distress profiles plus the "remainder" (i.e., the 5 protocols whose patterns of distress did not match any of the three identified distress profiles). These results suggest that the type of distress pattern an infant showed in one toy situation was not predictive of the type of distress pattern he/she would display in the second toy situation.

The fact that infants showed distinct developmental patterns of distress to different emotion-eliciting events suggests that coping is not a unitary behaviour system. It does not seem to be a skill or style of behaviour which operates in an identical fashion during all situations, particularly under conditions of "everyday" stress, which were encountered by infants in this study. Rather, different aspects of the emotion-eliciting situation may be responsible for variable developmental patterns of distress identified within a given infant.
In this study, there were two key differences between the JB and ET toy episodes. First, the JB episode was initiated by the mother, who terminated an interesting activity with her infant. In contrast, the ET episode was initiated by the examiner, who placed the interesting toy in the container and sealed it. Thus in only one of these episodes was the mother "responsible" for the onset of the stressful situation, and this difference may have been critical in influencing infant distress reactions. Case (1988) argues that the cognitive stage transition at 18 months causes infants to interpret interactions with their mother (or other primary caregiver) in a new way. Demands which are unfulfilled by mother tend to be interpreted as a rejection or a loss of control, as infants begin to realize that she is choosing to give priority to the world of objects, or to another relationship. In this study, only the JB episode would have been likely to elicit such feelings in the infants. Second, during the ET episode infants were given alternative toys to play with, thereby providing them with a potential means of managing their arousal during this situation which was not available during the JB episode. Perhaps these two differences in the emotion-eliciting episodes, combined with the effect of a cognitive stage transition, led to the variety of distress patterns seen between and within infants in this study.

The fact that unique developmental patterns of distress were present within infants suggests that studies of the development of coping should consider the potential impact of particular situational stressors. This conclusion is in keeping with Parritz (1996), who also found that "a number
of infant-specific and situation-specific factors...influence toddlers' display and organization of coping behaviours” (p.177).

The importance of context seen in this study is also consistent with the view of dynamic systems researchers, who emphasize that the self-organization of a complex system is "always context-dependent" (Thelen & Smith, 1994, p. 216). According to Thelen and Smith (1994), two types of order are predicted to emerge over the course of development: 1) diverse contexts will begin to select for similar associations of elements, and 2) the particular contextual details which tend to push the system to reorganize will become more highly differentiated. Unfortunately, because few subjects in this study had complete data sets on both toy episodes, the emergence of patterns of infant behaviour in relation to variations in the stress-inducing context could not be investigated in detail.

Although developmental patterns of distress were inconsistent both within subjects and across toy episodes, results of this study suggest that level of distress may be related to real-time behavioural stability in some systematic way. Specifically, there was evidence that high distress was associated with decreased stability of the state space, while low distress was associated with increased stability of the state space. Protocols displaying the Coping profile, in which level of distress decreased over development, showed a commensurate decline in both the number of cells occupied and the number of 5+ cells, and an increase in proportion of time spent in attractors during this time period. Moreover, in protocols showing the Nondistressed profile, both the number
of 5+ cells and the proportion of time spent in attractors were stable over development, consistent with the pattern seen during the latter months of nondistress for protocols showing the Coping profile. Finally, correlational analyses using all 26 protocols revealed a highly significant relationship between distress and three state space parameters, further suggesting an overall inverse relationship between distress and behavioural stability. Specifically, a positive correlation was seen between distress and both the number of cells occupied and time in attractors of high engagement with mother, while a negative correlation was observed between distress and proportion of time in attractors (see Table 3.6, p. 118). Taken together, this evidence suggests that infants who show similar developmental distress profiles during emotion-eliciting events may undergo similar changes in their organization of behaviour related to coping, even when the distress has been experienced under different contextual circumstances for each infant.

4.2 Developmental Reorganizations in Behaviour

4.2.1. The Coping Profile

At the group level, a developmental reorganization occurred only in protocols which displayed a Coping profile. This was seen as an apparent phase transition on the state space configurations of these protocols which occurred in the latter half of the second year. Specifically, state space grids revealed decreases in the number of cells occupied and in the number of 5+ cells occupied, as well as an increase in the proportion of time spent in
attractors for these protocols. These descriptions were supported by a significant outcome on a repeated measures ANOVA with one subject removed from the sample. The nature of the state space changes seen among protocols displaying the Coping profile reflected a narrowing of the degrees of freedom; individual responses became confined to relatively few attractors, and behavioural fluctuation was minimized. Thus, as predicted, a phase transition appeared to take place at the time of a hypothesized cognitive stage shift. In addition, this transition was associated with a decrease in distress for these protocols.

According to self-organization theorists (e.g. Thelen & Smith, 1994; Lewis, 1995), phase shifts occur within complex systems when interacting elements begin to become coordinated in a new fashion. Previous configurations suddenly lose their ability to cohere, and new stable assemblies of elements, forming new attractors, emerge on the state space of the system. Phase transitions are necessary for the emergence of new forms, because they enhance the potential of the system “to explore new cooperative patterns (or strategies) and select those that provide a functional match to a task” (Thelen & Smith, 1994, p.65). The increased coherence in behavioural responses which were revealed as changes in the attractor landscape in this study may be an example of the emergence of a “functional match” within the psychological realm. Specifically, new, more consolidated patterns of attentional engagement became associated with a decrease in distress for protocols in this group. Whether distress in the early months was associated
with attention to mother or to the frustrating toy, these infants ultimately developed alternate styles of engagement during the emotion-eliciting episode, effectively neutralizing the previously stressful impact of the situation.

From a self-organization perspective, a phase transition in the development of coping may be viewed as a change in the coordination of lower order components within the psychological realm during experiences of stress. Based on the Lewis’s (1995) model, these interacting components may include cognitive appraisals and emotions. Although attractors in this study were reflective of an interaction between two cognitive variables (i.e., attention to mother and toy), it is notable that the identified phase transition for protocols showing the Coping profile only occurred in conjunction with a corresponding change in an emotional variable. Specifically, this group showed an increase in distress at around 18 months, followed by a consistent decrease in distress over the remaining months.

In this study there were two hypotheses regarding a possible impetus for developmental change: 1) a cognitive stage transition at around 18 months, and 2) an idiosyncratic increase in negative emotion. Yet these two conditions overlapped for protocols displaying the Coping profile. As such, this study provided some evidence for both predictions, but only when they coincided with respect to developmental timing.

How can these findings be understood? One possibility is suggested by Case’s (1988) theory regarding the emotional aspects of developmental stage
transitions. Perhaps a cognitive stage transition at about 18 months led to particular changes in the infant's interpretation of events during the emotion-eliciting episode. This resulted in an increase in duration of distress, which prompted the need for a change in behaviour.

Infants demonstrating the Coping profile during an emotion-eliciting event, however, also showed distress in the months prior to 18 months. Why did distress at that time not lead to a change in response? One reason might be that the lower levels of distress earlier in the year were not sufficient for infants to feel the need to change their behaviour during the emotion-eliciting event. Perhaps a minimum threshold of distress is required to induce change to occur, and this threshold was not reached until the cognitive stage transition facilitated a new, more negative interpretation of the emotion-eliciting event.

Alternatively, the increase in duration of distress prior to the developmental reorganization shown in these protocols might not have been the significant factor in initiating the change in behaviour. Perhaps the infants were made uneasy by their distress in the task during the early months of data collection, and would have liked to find a means of reducing distress even at that time. The fact that state space measures for these protocols revealed significantly more behavioural fluctuation in the early months compared to the later months of data collection may be seen as implying a desire to “find” a successful response to the emotion-eliciting event. Yet it was only at the time of the cognitive stage transition that the
infants were able to successfully change their behaviour during this situation, and thereby fully regulate their distress. In this view, therefore, it was not the increase in distress per se which was influential, but rather the timing of two important events: 1) distress during a vulnerable developmental period, and 2) the cognitive stage transition. It was the co-occurrence of these two events which perhaps led to a change in the infant's capacity to cope during the emotion-eliciting event. Distress provided the motivation, while the cognitive stage transition provided the increased awareness and/or flexibility to try out new behavioural possibilities. This latter point is in keeping with Lewis's (1995) suggestion that the interactions between cognitive elements, as well as between cognitive appraisals and emotion, may become increasingly variable and sensitive to perturbation during periods of maturational change such as cognitive stage transitions.

However, it is also possible that the level of distress prior to the developmental reorganization was not influential in inducing a change in infant behaviour. Another explanation could be that infants sharing this distress profile during an emotion-eliciting event became able to shift their attention to nondistressing aspects of the situation purely as a result of attentional changes induced by the cognitive stage transition occurring at about 18 months. This alone might have permitted a reduction in levels of distress during the latter half of the year.

Finally, there is a possibility that a practice effect could explain the apparent developmental reorganization in behaviour and the associated
reduction in distress for this group of protocols. Since infants were presented with identical toy episodes month after month, it is possible that the notion of a cognitive stage shift is not needed to explain these results; rather, this group might simply have learned to anticipate the inaccessibility of the toy and the lack of assistance from mother, and became able to adjust their behaviour accordingly. However, both the abruptness of the developmental reorganization and the fact that it occurred around the time of the hypothesized stage transition (i.e., 18 months) argue against this interpretation of events.

4.2.2. The Noncoping Profile

Evidence of a developmental reorganization was not found among protocols that displayed the Noncoping profile. It is possible that such a reorganization was present, but was simply not captured by the state space measures used in this study. If a developmental reorganization of some sort did occur, however, it certainly was not associated with a decrease in distress, as was evident among protocols showing the Coping profile. In fact, protocols showing the Noncoping profile demonstrated a marked increase in distress at 22 and 23 months, a phenomenon which was not easily explained by the proposed model.

It should be noted that this increase in distress does not seem to reflect a developmental lag for some of the infants in reaching the hypothesized 18-month stage transition, because such an explanation would be inconsistent
with the appearance of a “burst” of distress in the later months. A delay in the stage transition for these infants during this toy episode would more likely have shown up as a gradual series of distress peaks emerging in the time period following 18 months. In addition, the fact that only during the JB episode was the Noncoping profile seen suggests the possibility of a different developmental trajectory of distress for these infants in this particular toy situation.

An alternative possibility for the late peak in distress for some protocols may be derived from evidence of specific developmental changes occurring late in the second year of life. Kagan (1983) reports that smiles of mastery begin to emerge at 19 months, and peak at 25 months. This development is associated with an increase in “anxiety over potential failure” (Kagan, 1983, p. 12). Perhaps such anxiety was induced in some infants in this study as they began to become aware of their “failure” to operate the jack-in-the-box.

Further evidence of change occurring late in the second year of life may be found in the observations of Mahler et al (1975). Specifically, these authors note that individual patterns of behaviour with mother seem to become less predictable at about 21 months of age. At this time, “the vicissitudes of their individuation process were changing so rapidly that they were no longer mainly phase specific, but individually very distinct, and different from one child to the other” (p. 101-102, italics in original). Reactions to separations from mother after 21 months were found to be far less predictable because
they seemed to be increasingly related to a more individualized, yet complex relationship between an infant’s unique relational history and situational variables. Mahler et al. note that despite their close observations of each infant, by the age of 23-months “we found it hard to pinpoint just what it was in the individual cases that produced more anxiety in some and an ability to cope in others...When periods of crisis occurred, it was not always easy to see what the crisis was related to” (p.103). Such seemingly unaccountable variations in infant behaviour may be relevant to the present study, where the distress patterns of Noncoping and Coping protocols diverged most strongly from one another at 22-23 months of age (see Figure 3.4, p. 81). In light of Mahler et al.'s (1975) observations, this finding suggests that situational variations in behaviour related to coping become increasingly pronounced during the latter half of the second year. Although Mahler et al. did not suggest a reason for this change, one possibility is that it is a residual effect of the stage shift occurring at around 18 months. That is, perhaps protocols displaying both the Coping and Noncoping profiles experienced a developmental stage transition at around 18 months; yet, the differences in distress and behaviour which followed were related to the impact of this shift on infant reaction to the unique set of situational factors inherent in each toy episode.

For example, it is possible that for protocols displaying the Noncoping profile, the JB situation was experienced as too stressful, and as a result, changes in behaviour associated with a cognitive shift did not occur. As
indicated above, the extent to which a situation is stressful for a given infant may vary considerably. As such, situations which elicit a certain range of distress, or which include particular factors, may be more amenable to change, or "mastery", given the impact of a cognitive stage transition. Other stressful situations may be beyond the infant's capacity for change, despite the increased cognitive awareness which has occurred. For infants displaying the Noncoping profile during the JB episode, it is possible that the particular combination of circumstances (i.e., the termination of an activity by the mother followed by her lack of availability, combined with the inaccessibility of the interesting toy and the presence of no interesting alternatives), created a highly stressful situation at this point in their development. Whether indeed individual infants would have experienced different amounts of distress in each emotion-eliciting episode remains highly speculative, however, since the distress profiles in this study were largely represented by distinct groups of infants.

Finally, regardless of the reason for the change in distress for protocols displaying the Noncoping profile, its occurrence might be expected to be associated with a developmental reorganization in behaviour, given the functionalist argument that a variety of conditions may influence the course of emotional development. The possibility that a developmental reorganization in behavioural response occurred for this group following their period of peak distress could not be determined, however, because data collection in this study ended at 25 months.
4.2.3. The Nondistressed Profile

Protocols displaying the Nondistressed profile also did not show evidence of a developmental reorganization in the second year of life. Again, evidence for a developmental reorganization might not have been captured by this study due to the fact that the tasks were not able to elicit behaviours which would reflect the presence of a developmental shift. However, since protocols showing the Nondistressed profile did not experience the situations as distressing, behaviour related to coping was likely not elicited.

4.3. Differences in Behavioural Responses Among the Three Distress Profiles

4.3.1. The Coping Profile

Observations of protocols displaying the Coping profile revealed that a developmental reorganization occurred independently of the content of behavioural responses. All but one protocol showing the Coping profile demonstrated a change in overall trajectory of behaviour, which was associated with the disappearance of at least one attractor in the later months of the second year. Some protocols also displayed new attractors during this time period. These changes appear to reflect a developmental reorganization in response to an emotion-eliciting event.

The similarity observed among these protocols in the self-organization of their response to the emotion-eliciting events, however, existed in stark contrast to the rich diversity of behavioural changes also evident in this
group. Mother attractors either did not exist at all, disappeared, or were modified from early to late months. In the ET episodes, toy attractors emerged in some cases and disappeared in other cases in the wake of the developmental reorganization. For the JB protocols, toy attractors were evident throughout most months of data collection, appearing both in months with distress and months without distress. Thus, neither the unhelpful mother nor the inaccessible toy were necessarily sources of negative emotion for these infants during presentation of the frustrating toy episodes; rather, consistent with Mahler et al. (1975), individual personality differences inherent in each infant seemed to interact with situational variables to produce an array of unique responses to these emotion-eliciting situations. For most of these infants, however, coping during the later months was apparently accomplished by ceasing to engage with the object (either mother or toy) which had been associated with distress during the specific toy episode in the first half of the year.

4.3.2. The Noncoping Profile

All protocols displaying the Noncoping profile showed toy attractors throughout most months of data collection. Thus all infants spent at least five seconds in most sessions attempting to operate the jack-in-the-box. With regard to engagement with mother, there was slightly more variability: most infants interacted with mother in most months, however, some showed little engagement with mother throughout the data collection.
It is notable that all JB infants displaying the Coping profile were also engaged with the jack-in-the-box during for a minimum of five seconds during most months of data collection. This similarity likely stems from the fact that no alternative toys were available during this emotion-eliciting episode. However, the JB infants showing the Coping profile had all engaged with mother in the early months, and disengaged from her in the later months. Protocols showing the Noncoping profile, in contrast, did not demonstrate an ability to disengage from mother in the later months, and this may be the reason for the persistence of their distress. Alternatively, the protocols which showed this distress profile might have represented infants who were more highly distressed during this toy episode, and this could have limited their ability to disengage from their mothers. The two infants in this group who had little engagement with mother during this task would presumably have had to disengage from the frustrating toy (for example, by leaving the room) in order to cope with the emotion-eliciting event. Again, these infants did not demonstrate such behaviour during this toy episode.

Thus, like the protocols displaying the Coping profile, either mother or toy could be sources of frustration for protocols showing the Noncoping profile. "Not coping" seemed to be associated with an inability to stop engaging with the frustrating object (either mother or toy), and was unrelated to the particular source of the distress.
4.3.3. The Nondistressed Profile

All protocols displaying the Nondistressed profile exhibited attractors in Cell 1,1, revealing that playing with the alternative toys was a common behaviour among this group of protocols. In addition, only one protocol showed an attractor in high engagement with mother. Thus in relation to behaviour with mother, as well, strong uniformity of behavioural response was apparent. Some differences among protocols in this group did exist in relation to behaviour with the frustrating toy. Some protocols showed attractors involving engagement with the toy, while others did not. In addition, of those who did choose to engage with the toy, the particular cell(s) which constituted the attractor(s) showed some variation among protocols.

Thus these infants seemed content to play with the alternate toys, and in some cases also interact with the inaccessible toy during the emotion-eliciting events. The inaccessible toy did not seem to cause them frustration, however, nor did the fact that mother was unavailable to help them. What characterized these protocols most prominently was simply their ability to remain unbothered by the situations presented.

4.4. The Use of a Dynamic Systems Approach for Examining Coping Across Development

4.4.1. General Implications

The use of a dynamic systems approach to the study of coping permitted the integration of research perspectives which most often are not explored in the same research design. Specifically, this study enabled
observation of both developmental change and stability in behaviour related to coping. Unfortunately, normative developmental change could not be examined in the context of individual differences in infant behaviour, because only one toy episode was able to be analyzed for many of the infants. Still, this methodology permitted differences in the trajectory of behaviour related to coping to be seen among protocols displaying three distinct profiles of developmental distress.

The use of state space grids to map out infant behaviour in this study also generated findings regarding the overall relationship between distress and infant behaviour at this stage in development. Specifically, infant distress, at least during these toy episodes, was related to increased behavioural fluctuation, suggesting that infants at this age might be attempting to find a means of reducing their discomfort. The fact that high distress was also related to engagement with mother in this study suggests that these infants probably had an expectation of mother as a source of attention, relief, or comfort. Engagement with mother was associated with negative emotion for the group of infants as a whole, perhaps because she consistently "refused" to comply with their demands.

Because the use of a dynamic systems approach to coping research is relatively new, there were practical difficulties in the nature of the attractor definition which had to be addressed during the data analysis, and which will need to be reconsidered in future studies of this nature.
Specifically, the concept of a "preferred" behavioural state is extremely vague, and therefore leads to a host of issues involved in defining an attractor for use in psychological research. These issues concern the minimum duration required for a behaviour to be identified as "preferred", as well as how to determine the continuity of such behaviour over development. Furthermore, while use of the state space grid method enables interactions between hypothesized lower order components of an attractor to be observed, the region of the grid which might reasonably be called an "attractor" is not readily apparent. Since each axis of the state space grids used in this study represented continuous levels of engagement with mother and toy, it might have been more useful to define attractors in terms of "regions" rather than "cells" of the state space grid. Indeed, the combining of four cells of high engagement with mother and four cells of high engagement with toy in some analyses suggests that an alternative approach could have been to cluster these cells, and regard time in the entire region as constituting the attractor. The use of mathematical means of defining an attractor may ultimately provide more satisfactory methods for resolving these issues (Lewis, et al., submitted).

4.4.2. Implications of the Abandonment of the Individual Differences

Hypothesis

One of the main purposes of the dynamic systems design of this study was to allow for the simultaneous observation of developmental change and
individual differences in behaviour related to coping. Individual differences could not be analyzed mainly because of the unusually large amount of data which had to be excluded from the study. The need to omit so much data highlights the many difficulties inherent in developing dynamic systems research designs which attempt to integrate the examination of individual differences with developmental change:

1) A sufficient amount of data needs to be generated at relatively close intervals over the course of development under consideration. Data are needed before, during, and after the hypothesized period of reorganization in the attractor landscape, so that the onset of a phase transition may be clearly seen. The collection of data at more frequent intervals (e.g. weekly or biweekly) could perhaps mitigate the impact of missing or spoiled data.

2) There is a need to ensure that a sufficient duration of behaviour is generated per data point. For example, in this study, the fact that infants could choose to leave the room led to a significant loss of data. In traditional research, this type of behaviour might continue to be included in analyses; however, in a dynamic systems study, it is not simply the response, but the self-organization of the response which is of interest. Real-time observation is necessary since attractors represent the self-organization of behavioural components in real-time. In this study, since it was not known what infants did when they left the room, the identification of attractors could not be made. Leaving the room could not be considered an attractor in and of itself;
indeed, this information simply meant that the infant was no longer engaging in behaviour which could be examined.

3) In studies meant to examine the self-organization of emotion and cognition, there is a need to ensure that the tasks chosen will generate a sufficient emotional response for most participants during the developmental period under observation. In this study the amount of distress generated by the ET task was not sufficient to indicate that this toy episode was a stressful experience for infants in the Low Distress group. Thus, the self-organization of cognition and emotion could not be clearly inferred.

4.5. Implications for Future Research on Coping in Infancy

Results of this study have important implications for future research in infant coping. First, evidence of a developmental reorganization in behaviour related to coping and a concurrent peak in distress for some protocols in this study suggests that the common tendency to use 18 months as a point of comparison with younger or older infants should be reconsidered. Specifically, the stage shift occurring at this time may create instabilities in behavioural organization which are temporary, and which therefore may not reflect the organization of behaviour which is likely to become consolidated only a few months later.

Second, research should continue to address the question as to whether developmental reorganizations in behaviour related to coping might occur in association with increases in negative emotion which are not experienced at
the time of a cognitive stage transition. For example, the finding in this study of an increase in negative emotion for some protocols late in the second year might be associated with a developmental reorganization in behavioural response shortly afterward. Another way of approaching this question would be to examine the behaviour of infants prior to and following the impact of a significant change in life circumstances (e.g. mother returning to work), which does not take place during a hypothesized stage transition.

Finally, developmental studies of infant coping could be greatly enriched by continuing to include a focus on individual differences in response to emotion-eliciting events. Although comparisons between infants were not possible in this study, protocols representing the three distress profiles displayed interesting differences in terms of their engagement with the mother and the frustrating toy. Analysis of the potential significance of these differences was beyond the scope of the present study; however, future research might begin to address these differences as a function of relational patterns within the mother-infant dyad. As previously demonstrated with younger infants during interaction with an unresponsive mother (Gianno and Tronick, 1989), individual differences in behaviour related to coping might prove to be a helpful means of identifying infants at risk for later socioemotional disturbance.
REFERENCES


