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Cyclicity and Stability in Mother–Infant Face-to-Face Interaction: A Comment on Cohn and Tronick (1988)

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Cohn and Tronick (1988) found that the onset times of behavioral change in mother–infant face-to-face interaction are stochastic rather than periodic. This comment offers an explanation of why their result replicates that of Kaye and Fogel (1980), in spite of important differences in how interactive behavior is conceptualized, coded, and treated statistically. Furthermore, it is suggested that stochastic variability in onset times has profound implications for our understanding of the process of mother–infant interaction and of the ways in which infants develop in the context of that interaction.

The social system of mother–infant face-to-face interaction during the first year has attracted the attention of scholars from a variety of disciplines. This dyadic relationship has been examined as a setting for infant development of affect and attention, as a paradigm of changes in bidirectional social influences, and as the source of individual differences in attachment and self-regulation. In these ways, the mother–infant face-to-face interaction partakes of the same conceptual issues that drive inquiry in all human development research.

Mother–infant face-to-face interaction studies differ from other social interaction studies because issues of sequence and cyclicity have been brought to the forefront of the inquiry. Research on mother–infant face-to-face interaction uses time as an explicit variable and examines the role of timing in the process of mutual regulation. Although the timing of actions is a general feature of dyadic relationships, it has become salient in studies of early interactions because they are relatively content-free. In early adult–infant interaction it may matter less what specific actions are performed than when and how frequently those actions occur.

Cohn and Tronick (1988) have presented a rigorous analysis of the nature of timing processes in face-to-face interaction. They reject the hypothesis that mutual regulation between mother and infant is achieved by bidirectional entrainment of periodic cycling of each individual's behavior, a view advanced in the work of Condon and Sander (1974) and of Brazelton, Koslowski, and Main (1974). The periodic entrainment hypothesis leaves mother and infant dependent on speeding up or slowing down some presumed internal clocks. Even for the relatively content-free mother–infant face-to-face interaction, this hypothesis oversimplifies and rigidifies the process of mutual adaptation.

Cohn and Tronick's (1988) data, instead, supported the hypothesis that mutual regulation is achieved by short-term bidirectional responsiveness to occurrences, the onsets of which cannot be predicted by the timing of previous events. Their analysis replicated Kaye and Fogel's (1980) findings showing that the timing of behavior onsets during face-to-face interaction is a random, or stochastic, process.

In this comment I would like to make two basic observations. First, I wish to offer an explanation for why the Cohn and Tronick (1988) analysis replicated the Kaye and Fogel (1980) analysis, although the former used a behavioral scaling approach, whereas the latter used a discrete behavior approach. My discussion will raise concerns about the validity of the scaling approach. Second, with respect to conceptual advances made since the Kaye and Fogel (1980) study was published, I would like to offer some additional reasons why a stochastic regulatory process is essential to both change and stability of individual and social behavior.

Scaling Versus Discrete Behavior Approaches

I have already mentioned that issues related to timing of dyadic events have become more salient to researchers than the content of the behavioral events during face-to-face interaction. Nevertheless, mother and infant behavior during this social situation has a function for both participants. I suggest that discrete behavior approaches are better able to illuminate the functional significance of the mother–infant face-to-face interaction than the Monadic Phase scaling approach used by Cohn and Tronick (1988).

Derived from discrete event coding of the interaction, Monadic Phases are meant to "segment the interaction into constituent units of behavior" (Tronick, Als, & Brazelton, 1980, p. 5). In general, the phases are ordered "from positive to negative affect or participation in the interaction" (Tronick et al., 1980, p. 13), however, some categories, such as play and talk, bear no necessary order with respect to each other. The advantage of scaling behavior is the ability to use a variety of elegant statistical tools, such as spectral and time series analysis, that rely on a continuously variable amplitude as a function of elapsed time.

The problem is that the Monadic Phase scaling procedure lacks conceptual and empirical validity. Ostensibly, the scale is meant to reflect the level of interactive "participation" or "en-

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gagement," at least as viewed by the observer. It has not been demonstrated, however, that this construct has functional significance for the participants. Do the phases have psychological significance? Can it be demonstrated—by comparing the results of time and frequency domain analysis using alternative scaling schemes—that the Monadic Phases are the best fit scaling criteria? Do the phases have the same functional significance for infant and for mother?

Even if empirical work validates some functional significance for the Monadic Phases (or some other scaling procedure), by its unidimensional nature, scaling obscures the hierarchical temporal organization of the interaction as described by Fogel (1977). Individuals in a social interaction operate on a number of distinct and embedded time scales. Higher frequency shifts between, for example, infant gaze at and away, or mother and infant smiling onsets are embedded in relatively long duration behaviors, such as maternal maintenance of the baby's body position or maternal gaze at the infant.

Because behavior is organized into temporal hierarchies, there is not one stochastic process but several. Kaye and Fogel (1980) found, for example, that the rate of onsets of infant smiles during times when mother was expressive was significantly different from the rate of smiling during times when mother was not expressive. In both cases, however, the smile onsets stochastically fit an expected poisson distribution.

If Monadic Phase scaling distorts the temporal organization of the interaction, how can we explain the similarity of results between Cohn and Tronick (1988) and Kaye and Fogel (1980)? My hypothesis is that the frequency of amplitude shifts in the Monadic Phase profile approximates the rate of onsets of the discrete behaviors that occur at the highest rate of change. In the analysis presented by Tronick et al. (1980), it was shown that most of the shifts in Monadic Phase occurred one step at a time, that is, to the next nearest step, up or down, on the scale. Although the definition of Monadic Phases does not exclude the possibility of more than one behavior changing at the same time, the expected probability of a simultaneous shift of two infant behaviors in the 1-s sampling time used by Cohn and Tronick (1988) would be extremely small (once every 529 s, as calculated from the base rate for the 3-month-olds in their data). Even jumps of more than one step on the Monadic Phase scale might be due to a change in a single behavior.

In summary, the validity of scaling has not been empirically established, nor has the specific scaling procedure used in the Monadic Phase system been compared with reasonable alternatives. Unidimensional scaling ignores the fact that there are significantly different temporal orders. The Monadic Phase approach, because it is derived from discrete behavior changes, seems to provide frequency information that is redundant with the coding of discrete onsets. I will leave to mathematicians the problem of demonstrating the equivalence between a broadband spectral density peak, when interaction data are treated as a scale, and a uniform rate poisson process, when interaction data are treated as discrete. The conclusion that the intervals between events are stochastic rather than periodic is the same in either case.

Function of Stochastic Processes in Social Interactions

In simple terms, these findings show that infants and mothers display behavior that is repetitive at some mean rate—for example, a baby might smile at mother two times per minute on the average. If a periodic process were operating, these smiles would occur precisely every 30 s, perhaps with some minor variations because of errors or limitations in the motor output. This does not happen in fact. The time interval between infant smiles may vary between 5 s and several minutes. In this way smiling can be said to be cyclic at some mean rate, yet stochastic because the precise time of onset of any one smile cannot be predicted from a knowledge of the previous history of smile onsets. One can only talk about smiles having a certain probability of occurring (e.g., in a 5-min interval one would expect to see about 10 smiles).

One way to conceptualize this type of stochastic process is that of random variability around some mean value. There is more variability here than might be expected from simple performance errors. At the same time, because different behaviors have different mean rates (the mean rate of gaze-at-mother onsets is lower than the mean rate of onset of infant facial expressions) and because the mean rate of a single behavior such as smiling can shift under a variety of interactive conditions, there appear to be constraints on the mean rate that limit the range of variability. Recent conceptualizations of behavior as the dynamically patterned output of a complex organism–environment interaction predict theoretically that behavior should have a stochastic variability around some relatively stable value (Kugler, Kelso, & Turvey, 1982; Thelen, Kelso, & Fogel, 1987).

Some organismic or environmental conditions, however, can increase the inherent variability of a behavioral system past a critical value in such a way that it attains an entirely different base rate, that is, the system exhibits a nonlinear phase shift from one stable rate to another. For example, babies abruptly alter their rate of smiling if mother leaves or enacts a "still-face" or if the baby becomes fatigued.

In short, the variability of behavior is intimately tied to both its stability over specific time periods and its change over longer time periods. A biological system is dynamically adaptive precisely because it generates variability as an inherent aspect of its own functioning.

Considerably more research is needed now to explore the range and limits of stability, variability, and change in developing systems. In a recent article, Esther Thelen and I proposed a dynamic systems approach to the study of the development of communicative behavior in infants (Fogel & Thelen, 1987). The conceptual and methodological propositions in that work rest on the fundamental premise that variability is inherent in the organization of behavior.

Cohn and Tronick (1988) clearly showed that social systems exhibit both stable bidirectional patterns of influence and stochastic variability. This important finding should be followed up in order to explore the theoretical consequences of a social system maintained by dynamic process rather than by static structures. What is the precise relation between stochastic variability and patterns of bidirectional contingent responsiveness? What is the specific process by which dynamic social systems evolve into new patterns of contingent responsiveness (i.e., developmental changes of the kind described by Kaye and Fogel, 1980, and replicated by Cohn and Tronick, 1987)? And, finally, how do infants develop in relation to these social dynamics?

It may be that the onset times of specific behaviors during interaction must be nondeterministic in order to afford a contingent response to a partner whose "turns" vary in content and duration. Differences in the roles of mother and infant during social interaction are in part caused by differential competence for dynamically adapting the timing of the participants' own behavior to fit that of the partner.

At this point our understanding of the role of adults in child development can be advanced by attending to the specific characteristics of the time-dependent and context-specific dynamic processes in mutual social adaptation. Until we clearly understand those processes, we must resist the temptation toward reductionism for the sole purpose of predicting individual differences in outcomes. Cohn and Tronick's (1988) data should lead us to examine whether any particular summary measure of the mother–infant interaction reflects or distorts the observed dynamics of that social process.

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