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Rhythms of Dialogue in Infancy: Comments on Jaffe, Beebe, Feldstein, Crown, and Jasnow (2001)

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Analysis of coordinated interpersonal timing has become an important tool for the study of infant-adult, peer, and marital interactions. Past research suggests that social coordination is informative about the quality of the caregiver-child social relationship. Does infant experience of certain types of coordination and pattern in early social interactions with caregivers predict better cognitive and social developmental outcomes? The recent monograph "Rhythms of dialogue in infancy" (Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001) provides the strongest evidence to date that it does. Moderately coordinated social interactions in early infancy predicted the most favorable developmental outcomes, and degree of coordination was influenced by contextual factors such as setting and nature of the relationship between the infant and its social interaction partner. This study provides a model for future research in this area and points toward important questions for future research on infant-caregiver social interactions.

KEY WORDS: attachment; infant vocalization; mother-infant communication; rhythm; developmental outcomes.

INTRODUCTION

Research about temporal patterning and coordination of behaviors in social interaction has reached a new stage of maturity in recent years. Early investigators considered fundamental questions such as, Is there a predictable pattern in an individual's vocalizations and pauses? Do partners coordinate and adapt their behaviors during social interactions? What statistics give us the simplest and most useful ways to describe predictable patterns or rhythms in individual behavior, and to capture the ways in which partners coordinate their behaviors? The publication of *Rhythms of dialogue* (Jaffe &

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Feldstein, 1970) was a landmark event in this research area. This study established that on-off patterns of vocalization and pause could be described using a relatively simple classification scheme for types of events (such as interruptive simultaneous speech, switching pauses, and so forth). It also demonstrated that predictable pattern, or rhythm, or serial dependence in vocal activity could be modeled using relatively simple time-series statistics (such as first- or second-order Markov processes). Individual speakers showed reliable and consistent individual differences in patterns of vocal activity, and some kinds of coordination (such as matching of duration of switching pauses between conversation partners) were related to the nature of the social interaction or the relationship.

These early findings led researchers to wonder, How central are timing and coordination to social interaction and to relationships more generally? Does the degree of rhythm and coordination in a brief sample of social interaction for a dyad contain sufficient information about the nature of the relationship to predict later outcomes, such as attachment for the parent-child dyad, or divorce for married couples (Warner, in press)? Can a "thin slice" of behavior (Ambady & Rosenthal, 1992) tell us something crucial about the nature of the relationship and where the relationship is going?

Jaffe, Beebe, Feldstein, Crown, and Jasnow (2001) have produced the most rigorous and sophisticated study addressing this question to date. Their results suggest that we can, indeed, predict important later outcomes for 12-month-old infants (scores on a cognitive test, the Bayley, and attachment status, assessed by the Strange Situation) from the temporal patterning of infant social interactions with caregivers at 4 months. This study clearly establishes the value of a microanalytic analysis as a tool for the assessment of caregiver-infant social interaction. However, these results raise nearly as many questions as they answer. This study can serve as a model for future research in this area and as a stimulus to new questions; it raises a number of interesting issues.

DEFINITIONS OF COORDINATION AND RHYTHM

Coordination

Most researchers who do microanalysis of behavior in social interaction begin with the same basic type of data. A time-sampling frame is set up (for instance, on-off vocal activity was assessed four times per second in Jaffe & Feldstein, 1970). For each participant, a measurement or assessment of behavior is made repeatedly, usually using an automated system, but in some cases using human judges to assign ratings or decide what type of

behavior has occurred. When the variable is on/off vocal activity, as in Jaffe and Feldstein (1970) and the Jaffe *et al.* (2001) monograph, the data initially consist of a time series of dichotomous scores (1 = action present, 0 = action absent) for each participant, as in the following hypothetical example:

Mother: 1111111111000000111000000011111111111000000000000000000000000011110000010100000

Infant: 0000000000111111111111111000000000000000111111110011111111111110000000000000011

There are many things a researcher can do with such simple time-series data. Jaffe and Feldstein (1970) devised a system for coding on-off vocal activity into several different types of behavior states. For instance, a switching pause (SP) occurs when one person stops vocalizing, there is a brief joint silence, and the other person begins to vocalize. They have examined sequential patterns in specific behavior states during social interaction (such as mean durations of SP's). In the present study, for instance, they performed within-dyad time series-regressions to predict mother switching pauses from infant switching pauses (and vice versa). This type of analysis makes it possible to assess whether "tracking" or matching of SP duration occurs dynamically, for instance, if an infant increases its SP duration during the play session, does its mother match this by increasing her SP durations? Time-series regression provides an index of the strength of this type of matching or coordination.

Usually, following the recommendations of Gottman (1981), the statistical definition that researchers have used to quantify "coordination" is the $R^2_{\text{increment}}$ for the prediction of mother behavior from infant behavior (controlling for mother's own recent past behavior). This $R^2_{\text{increment}}$ is one of the indexes that Jaffe *et al.* (2001) used to quantify the degree of coordination in mother-infant interaction. Their success in using this to predict later developmental outcomes is evidence that this statistic provides useful information. However, it should be noted that this definition of coordination is based on a statistical method that partials out or removes within-actor rhythm or predictable pattern; and it is possible that rhythm, as well as coordination, provides useful information about social interaction (Warner, 1992b).

Terms such as *coordination*, *linkage*, and *synchrony* have been widely used by mother-infant social interaction researchers. The operational definitions and statistical methods used to assess these have varied greatly across studies (Booth, Lyons, & Barnard, 1984). Some researchers have used the term *synchrony* to describe global observer judgments (for example, Bernieri,

Reznick & Rosenthal, 1988), whereas others have used the term *synchrony* to refer to synchronized cycles detected by cross-spectral analysis (Goldstein, Field, & Healy, 1990). Burgoon, Stern, and Dillman (1995) suggested consistent terminology for the description of temporal patterns in social interaction Cappella (1988) has also suggested some useful conceptual distinctions among different ways that partners might coordinate their actions overtime.

Jaffe *et al.* (2001) clearly described their statistical analyses, and so their definition of coordination is explicit. This clarity makes it possible for others to replicate their procedure. Their success in using time-series regression as a tool to describe caregiver-infant interaction may well lead other researchers to adopt their methods, but it would be premature to stop investigating other statistical methods that provide different ways of assessing social coordination. It is conceivable that some of these alternative statistics (e.g., Warner, 1992a, 1992b) may also provide useful information about the social interaction process.

This suggestion is not meant as a criticism of the Jaffe *et al.* (2001) study; far from it. We have to begin somewhere, and they have clearly chosen an extremely useful place to begin. Hayes, Meltzer, and Wolf (1970) pointed out that our substantive conclusions about rhythm and linkage depend on methodological decisions we make, such as the sampling frequency of the time-series data. Different sampling frequencies, like different levels of magnification under a microscope, may serve to bring different structures in behavior into view. Jaffe *et al.* (2001) chose a level of magnification that brings extremely useful and informative aspects of the temporal pattern of behavior into view.

Rhythm

Researchers may want to look at within-individual patterning of behavior, or rhythm, in addition to between-person matching or coordination between partners. Like most researchers who have assessed infant-adult and adult-adult social interactions, Jaffe *et al.* (2001) focused their attention primarily on between-person aspects of temporal pattern: social coordination between partners. In fact, the time-series regression analysis they used to assess coordination essentially controls for or partials out within-actor predictable pattern or rhythm (see Warner, 1992b, for further discussion). A few social psychologists (such as Jones & Gerard, 1967) have noted the possibility that within-actor predictable pattern, which Jaffe *et al.* call "rhythm," is also extremely important information about the nature of the social interaction. Warner (1992b) found in a study of adult-adult conversation that within-actor predictable pattern (or "rhythmicity") was actually a stronger predictor of positive evaluations of the conversation than was

between-partner coordination. Could that also be true for infant-caregiver interactions?

Despite the title of the Jaffe *et al.* (2001) monograph ("Rhythms of dialogue in infancy"), their analysis focused primarily on coordination between partners rather than on rhythm within actors. This is not meant as a criticism. This study was extremely ambitious, and in any study, researchers have to set arbitrary limits on the variables that they will include and the analyses that they will perform. Jaffe *et al.*'s (2001) study stands as the most rigorous and dramatic demonstration to date that degree of coordination between infant and caregiver, even in quite brief social interactions, predicts important later developmental outcomes. That is an enormous contribution. However, it may be useful to include rhythm within actor as another kind of information about the temporal pattern of social interaction in future research.

Are Rhythm and Coordination "Good" or "Bad"? Moderate Coordination May Be Best

Biological rhythms researchers have tended to stress the adaptiveness of biological rhythms and the need for coordination among biological processes (e.g., Goodwin, 1970). Some of the earliest researchers on social interaction rhythm (such as Chapple, 1970) assumed that higher levels of coordination would be experienced positively. Many developmental psychologists talked about synchrony in parent-infant interaction as an index of parental sensitivity to infant needs and assumed that high coordination meant that the social interaction was going well (Field, 1985). It is possible that predictable temporal pattern, rhythm, and coordination serve an uncertainty reduction function (*cf*, Berger and Bradac, 1982). If we can predict when the other person will speak, or stop speaking, this information helps us to plan our own actions, and to avoid awkward pauses or potentially rude interruptions.

For the developing infant, if may be extremely important to experience some contingency between one's own actions and the actions of others (as well as environmental events). Lack of any contingency between infant actions and outcomes might well contribute to the development of learned helplessness or even depression (Warner, 1992b).

Other researchers (such as Gottman, 1979) approached the analysis of temporal pattern in social interaction from quite a different background. Gottman commented on the functioning family of family systems, and pointed out that extremely high predictability may be an indication of pathology, such as, when people begin to reciprocate negative affect tit-for-tat or when people repeat the same arguments over and over.

Gottman argued that, other things being equal, highly predictable social interactions were probably bad and that too high a level of rhythm and coordination would indicate loss of adaptability. Actors may become locked into a rigid pattern and lose the ability to try different, possibly more effective, behaviors.

As researchers examined social interaction in various kinds of dyads, however, they began to see other possibilities. It is conceivable that both extremely high and extremely low levels of coordination (and/or rhythm) may be maladaptive and that moderate levels of predictability are experienced more positively (Warner, Malloy, Schneider, Knoth, & Wilder, 1987). Jaffe *et al.* took the possibility of a curvilinear relation between coordination and attachment into account in their assessment of their data. They have obtained the strongest evidence to date that *moderate* levels of contingency or coordination in social interaction lead to the most positive developmental outcomes. Infants who had moderately coordinated social interactions tended to be securely attached, whereas infants who exhibited very weakly or very strongly coordinated social interactions developed less optimal forms of attachment at 12 months.

It is not clear whether coordination is a cause of the later developmental outcomes; is moderately coordinated social interaction something infants really need to experience in order to develop secure attachment? Alternatively, it is possible that social coordination is merely a marker variable that happens to be correlated with other characteristics of infants or caregivers that influence attachment outcomes.

The "value" of social coordination may differ depending on the nature of the relationship between partners (Cappella, 1988). Faraone and Hurtig (1985) suggested that people might prefer more predictably patterned interactions with strangers (because this would reduce uncertainty and anxiety) and less predictably patterned interactions with intimate partners (because this would provide welcome novelty in an otherwise familiar situation).

Future research on the connections between social interaction coordination and various types of short-term and long-term outcomes (such as relationship satisfaction, attachment, and so forth) should continue to use methods that make it possible to detect curvilinear relations between these variables. In fact, if researchers use only simple Pearson *r* values to assess relations between coordination and outcome variables, it is possible that they will not see any connection. Jaffe *et al.*'s (2001) study is the most recent, and also the most powerful, demonstration that at least under some conditions, moderate coordination seems to be optimal.

It is interesting to speculate why infant-stranger coordination was more predictive of cognitive developmental outcomes in the Jaffe *et al.* study than infant-mother coordination. Does this tell us that it is "something about

the infant," and not something about the mother, that is predictive of the later developmental outcomes? It may be premature to reach such a conclusion. Jaffe *et al.* (2001) predicted, and found, that there would be more coordinated social behavior in situations that involved greater novelty (interactions in the laboratory versus the home, and interactions with the stranger versus the mother). It is possible that the infant-stranger situation is simply a more diagnostic one, for purposes of assessing the infant's capabilities of showing coordination, than the mother-infant situation. This could be true, however, for some reasons that are methodological rather than theoretical. The stranger and laboratory interaction tasks were somewhat more standard across infants, and thus, most of the variance in behavior may have been due to individual differences across infants. In the mother-infant interaction, each infant was interacting with a different person, and the home settings may have differed quite a lot in their physical characteristics; therefore, this task may have been in many respects a less standardized one. However, it is also conceivable that the infant-stranger interaction is a better test of the infant's temporal coordination skills, because of the high level of novelty and challenge involved, and the higher levels of coordination that were elicited. It will not be easy to separate out these possibilities.

PHYSIOLOGICAL CORRELATES OF SOCIAL COORDINATION

Another issue that might be examined in future infant-adult research is a possible connection between physiological arousal and the occurrence or nonoccurrence of social coordination. Measures such as heart rate, vagal tone, and other physiological responses are often used in research on infants; although these are not necessarily simple indicators of distress or arousal, they can provide useful information. It would be interesting to know whether infant level of physiological arousal varies as a function of social coordination. This could be one way of assessing whether infants experience very high or very low levels of coordination as arousing, or perhaps even distressing.

DEPRESSION, COORDINATION, AND CONTINGENCY: A POSSIBLE CONNECTION?

Given that depression has been linked to unpredictability, loss of control, and associated feelings of helplessness, it is conceivable that infants who experience little contingency or coordination in their social interactions

early in life may possibly develop learned helplessness or even depression (Warner, 1992b). Several researchers have assessed whether maternal depression influences temporal patterns of behavior in face-to-face social interaction with infants (e.g., Cohn, Campbell, Matias, & Hopkins, 1990; Field, 1988; Zlochower & Cohn, 1996). Cohn, Field, and their colleagues have shown that maternal depression predicts maternal inability to respond contingently and sensitively to infant behaviors; depressed mothers may be unresponsive, or may respond inappropriately in ways that seem intrusive.

More generally, Healy and Williams (1988) have speculated that in some cases, depression might be a rhythm disorder. Depression may be related to breakdown of coordination among physiological rhythms, and between behavioral and physiological rhythms. It is possible that physiological rhythms may be entrained and modulated (or in some cases, disrupted) by infant-caregiver social interactions (Field, 1985; Hofer, 1984). It seems likely that behavioral dialogue is the means though which modulation and entrainment of both behavioral and physiological rhythms, between infant and caregiver, would potentially develop.

There are conceptual connections among contingency, perceived control and predictability, learned helplessness, and depression. This line of thinking suggests that maternal depression may be an important predictor of the occurrence of coordination between infant and caregiver. It would be useful to assess whether infants who experience nonoptimal coordination in their early social interactions later develop symptoms of depression.

COORDINATION: BIOLOGICAL OR LEARNED? INNATE OR TEACHABLE?

One of the most intriguing questions raised by the findings of Jaffe *et al.* is the degree to which the coordination that we see in infant-caregiver interactions represents some sort of innate, hard-wired capacity for social interaction, versus the extent to which this is learned through interactions with adults. It is not clear what sort of data would be needed to address this question. If social coordination is learned to some extent, then it might be possible to modify it through appropriate interventions. One important line of research might involve trying to teach more optimal coordination patterns to mother-infant dyads who are at high risk for poor developmental outcomes (*cf,* Malphurs *et al.,* 1996). Is moderate level of coordination a teachable skill? If so, does teaching this type of coordination to caregiver-infant dyads result in more favorable developmental outcomes?

ESTABLISHING CONNECTIONS BETWEEN THE "OBSERVATION" VERSUS "INTERPRETATION" OF BEHAVIOR

Donald Fiske (1970) called for a rapprochement between two worlds of psychological phenomena: the "observation" vs. the "interpretation" of behavior. The objective, quantitative analysis of vocal activity presented by Jaffe *et al.* (2001) is an outstanding example of the "observation" of behavior; this captures something objective and quantifiable about social interaction process. By contrast, global observer ratings of social interaction "synchrony" (as in Bemieri, Reznick, & Rosenthal, 1988) are examples of the interpretation of behavior; their observers provided qualitative assessments of social interactions. Fiske (1970) pointed out the value of making connections between these two realms. Specifically, that leads us to ask in this case: How are the "coordination" statistics reported by Jaffe *et al.* (2001) in this study related to the more global and qualitative judgments of synchrony that have been examined by other investigators (such as Bemieri *et al.* 1988)? A handful of researchers (such as Cappella, 1997) have started to address this question systematically, by taking a set of social interactions, doing quantitative time-series analysis to come up with objective indexes of coordination, and having independent judges make qualitative ratings.

It would be extremely interesting in future research to see which (if any) qualitative human judgments are related to the statistical indexes of coordination used by Jaffe and his colleagues. Several outcomes are possible, and any of them would be potentially interesting. First, it is possible that the quantitative methods of describing coordination that were used in the Jaffe *et al.* (2001) study are not highly correlated with any qualitative observer ratings of synchrony, rapport, or sensitivity. If that happened, it might suggest that the quantitative analysis tells us something so subtle about social interaction pattern that it is something human observers cannot detect or are not aware of. However, McGarva and Benassi (1997) found that the degree of contingency in patterns of on-off vocal activity could be correctly judged by human observers; thus, at least some forms of temporal pattern in social interaction are detectable by human judges.

On the other hand, it is also possible that the quantitative index of coordination is highly correlated with some subjective observer impressions about the social interaction process. If that were the case, it would suggest that Jaffe *et al.* have discovered the behavioral basis for those qualitative impressions. By analogy, in physics, there is an association between the wavelength of light (the observation) and the perceived color (the interpretation); this discovery helps us to understand better the physical basis of color perception. In a similar way, if human qualitative judgments of synchrony are highly correlated with statistical indexes of coordination in

objective behaviors, we will have a better understanding of what we mean by synchrony.

It may also be important to consider the possibility that the "meaning" of certain kinds of behaviors, such as weak vs. moderate coordination, may differ depending on who evaluates it: the actor, the partner, or an outside observer (Warner, 1992c). In the infant-caregiver situation, of course, only the evaluations of the caregiver and an outside observer could be obtained.

QUESTIONS FOR FUTURE RESEARCH

The Jaffe *et al.* (2001) monograph has answered some important and interesting questions, but it has raised additional questions. Some of these questions could be addressed by further analysis of their rich and interesting dataset and by follow-up assessment of additional developmental outcomes. Other questions will require further research. Among the questions identified here were the following.

(1) Which statistical indexes of temporal pattern (coordination and/or rhythm) in social interaction are most informative about future developmental outcomes?
(2) Is moderate coordination always optimal? Or are there situations in which strong/weak coordination is better?
(3) Are there physiological correlates of social coordination? When infants experience very high and very low levels of coordination, do they show elevated levels of heart rate, cortisol, and other signs of physiological arousal that might be interpreted as signs of distress?
(4) Are there other developmental outcomes that can be predicted from social coordination in early social interactions? In particular, does nonoptimal coordination lead to some form of depression later in infancy or childhood?
(5) Is level of coordination primarily influenced by biological factors, or is it learned behavior, or both? Is it possible to intervene to teach high-risk dyads more optimal forms of social coordination? Would such interventions lead to better developmental outcomes?
(6) What meanings do outside observers (and the participants themselves) attach to different levels of coordination in social interaction?

CONCLUSIONS

Jaffe *et al.* (2001) have demonstrated that an objective microanalysis of behavior in relatively brief social interactions can predict important later

developmental outcomes that are both cognitive and social, and their results suggest that moderate coordination may be most optimal for development. Their research provides a model for other researchers, and it also raises a host of interesting questions. This study is a landmark, but it is not an end point. We have much more to learn about the way face-to-face social interactions shape the course of relationship, and individual, development over the life span.

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