Developmental Psychology
1989, Vol. 25, No. 3, 373–381

0012-1649/89/$00.75

Effects of Marital Discord on Young Children's Peer Interaction and Health

John M. Gottman and Lynn Fainsilber Katz
University of Washington

Reports an investigation of the effects of marital discord on the peer interactions and physical health of preschool children. A sample of families that ranged widely in marital satisfaction and had a 4- to 5-year-old child participated in several home and laboratory sessions involving marital, parent–child, and peer (with a best friend) interaction. Obtained observational, self-report, and physiological indices. Hypothesized that the ability to regulate emotion would be disrupted in children from maritally distressed homes and that this would result in poor child outcomes. Found support for a path-analytic model correlating the child outcomes of the child's level of play, negative peer interaction, and physical health, using marital satisfaction, the parents' physiology during marital interaction, observations of parent–child interaction, the child's physiology during parent–child interaction, indices of emotion during the directed facial action task, and urinary assays of catecholamine endocrine variables.

Research findings have converged recently to suggest that there are familial correlates of the adjustment of young children. Furthermore, the best familial predictor of childhood behavior problems has been found to be marital discord (see Emery, 1982). The precise nature of this effect is an area of active research. On the whole, studies of the consequences of marital discord for children's adjustment have focused on rather severe forms of child outcomes, and little attention has been paid to more subtle disruptions in the child's life, such as peer relationships. Yet there is ample evidence that one of the best lead indicators of children at psychiatric risk involves the nature of the child's social relationships with peers (Parker & Asher, 1987). There is also initial evidence that suggests family correlates of these social-skill deficits (Putallaz & Heflin, 1986). Nonetheless, the precise nature of the family precursors for the developing child's peer system are not known.

What processes in the child might mediate between the marital and child–peer system? The most vulnerable aspect of social development with respect to marital discord may be the child's ability to regulate emotional states. This notion of the importance of emotional regulation is not new. In fact, the ability to regulate emotional experience and expression has often been described as an important developmental milestone. As examples, developmental psychologists have studied the following: the child's ability to control impulses (Kopp, 1982), the child's use of a reflective rather than impulsive style (Kagan, Rosman, Day, Albert, & Phillips, 1964), the tolerance of frustration (e.g., Van Leishout, 1975), the delay of gratification (e.g., Mischel & Underwood, 1974), and the control of excitement (Redl & Wineman, 1951). Furthermore, there seems to be a particular developmental period that is most important in the development of emotional regulation. Maccoby (1980) targeted young childhood as the most important period in the development of emotional control and regulation. She noted that the *inhibition of action* is the basis for the organization of behavior. We define emotion regulation as consisting of children's ability to: (a) inhibit inappropriate behavior related to the strong negative or positive affect, (b) self-soothe any physiological arousal that the strong affect has induced, (c) refocus attention, and (d) organize themselves for coordinated action in the service of an external goal. In the context of play with a friend, this involves being able to compromise between what one child wants and what the other wants. In the area of peer relations, Gottman (1983) found that being able to coordinate play and manage conflict with an unacquainted peer predicted a child's ability to make friends.

There may be a physiological basis for the development of emotion regulation ability. Porges (1984) suggested that a construct called *vagal tone,* which indexes the tonic level of activation of the parasympathetic branch of the autonomic nervous system, provides a theoretical basis for the child's ability to focus attentional processes and inhibit inappropriate action. In addition to the parasympathetic branch of the autonomic nervous system, it could be useful to consider other parts of the body's response to stressful events—such as the sympathetic branch of the autonomic nervous system, the endocrine system, and the immune system—and the interconnections among these physiological systems.

This research was supported by U.S. Public Health Service Grant NIMH 35997 and by National Institute of Mental Health Research Scientist Development Award K2-00257 to John M. Gottman.

We wish to thank Regina Rushe, Anne Gilles, Charlotte Clarke, Karen Pickard, and Sarah Lee for their dedicated assistance in the data collection phase of the project and Kathleen Zelis for her help in data collection and coding of peer interaction. We would also like to thank Terry Sturdyvin and John Hightower for their valuable administrative assistance.

Correspondence concerning this article should be addressed to John M. Gottman, University of Washington, Department of Psychology, Guthrie Hall, NI-25, Seattle, Washington 98195.

In the past 5 years, a new discipline has emerged linking biological and social processes. This integration has yielded encouraging scientific results that have illuminated important biological events. These results include the ability to predict physical health from salient social processes. For example, in a 9-year prospective study, Berkman and Syme (1979) found that the best set of predictors of whether people live or die concerned the nature of their social relationships, independent of age. Similarly, Kiecolt-Glaser et al. (in press) reported that marital satisfaction and the nature of postseparation attachment to the ex-partner predict direct measures of immunocompetence.

There is some useful theorizing that links specific physiological systems to specific psychological processes. For instance, it is well known that the autonomic and endocrine systems of people undergoing stresses such as bereavement or the chronic illness of their children are affected by these stresses (for a review, see Temoshok, Van Dyke, & Zegans, 1983). An important model linking endocrine functioning and emotional reactions was proposed by Henry and Stephens (1977). They proposed that specific emotional states are connected to the two adrenal endocrine stress systems. According to their model, the sympathetic-adrenomedullary system is activated during active coping and the affective responses of anger and hostility. This biological system is responsible for the secretion of the catecholamines (norepinephrine, epinephrine, and dopamine), which in normal functioning accelerate metabolic rate and the expenditure of energy in the body. The second adrenal endocrine stress system, the pituitary-adrenocortical system, is proposed to be activated during chronic stresses that engage a passive coping response, depression, helplessness, or withdrawal. This biological system is responsible for the secretion of the glucocorticoid cortisol, which is related to glucose metabolism and the maintenance of metabolic processes during normal functioning. There is also some evidence that the chronic activation of both of the Henry and Stephens axes is related to tissue damage, for example, plaque formation in arteries related to atherosclerosis (Taggart & Carruthers, 1971). The Henry and Stephens model provides an interesting theoretical connection between socioemotional and physiological behavior. Chronic marital tension may trigger sadness, helplessness, or anger in the child and may be accompanied by elevations on one or both of the endocrine stress systems. An exploration of the behavioral consequences of endocrine activation may provide some understanding of the mechanisms underlying children's reactions to marital discord.

There is reason to believe that the autonomic arousal of parents may have important consequences for the child. Levenson and Gottman (1983) found that distressed couples exhibited higher physiological linkage than nondistressed couples during a high-conflict task. They reported that indices of autonomic activation during marital interaction strongly predicted changes in marital satisfaction over a 3-year period. All the correlations could be summarized by the statement that the more autonomically aroused the couples were at Time 1, the more their marriages deteriorated over the 3-year interval. To the extent that physiological arousal may be related to the deterioration of the marital relationship, it may similarly affect the quality of the parent–child relationship. Some preliminary evidence that parental physiological arousal may differentially predict parenting behavior can be found in the work of Frodi and Lamb (1978), who found that physiological indices of arousal could distinguish abusive from nonabusive mothers.

Historically, the predominant approach taken to study the transfer of marital discord to the child has been through self-report measures (e.g., Porter & O'Leary, 1980; Rutter, 1971; Shaw & Emery, 1987). Other tools, such as observational methodology, have been used only occasionally (e.g., Hetherington, Cox, & Cox, 1979, 1982). The application of physiological techniques to understanding family interaction has largely been unexplored.

The goal of our research was to establish a multimethod data base from which to develop theoretical models of the processes by which marital discord affects the preschool child's peer social relationships and physical health. We used self-report and observational and physiological measures within a naturalistic social-interactive context to examine the marital and parent–child processes that are predictive of poor peer relationships and physical illness in children. Our research is an attempt to place the phenomenon on one theoretical footing on the basis of psychophysiological notions that emotional interactions within the family affect the child's autonomic functioning and subsequent emotional development. The child's peer relationships and physical health are the major criterion variables that we are attempting to predict and understand using familial and physiological variables.

We used two criterion variables of peer interaction in this research. The first was the children's level of play, which measures the extent to which two children remain at a low level of involvement, such as parallel play, or progress to a level of play that demands a great deal more involvement and social attention (Parten, 1932; Gottman, 1983; Gottman & Parker, 1986). Gottman (1983) reported that young children will escalate and de-escalate the level of play to maximize positive affect and minimize negative affect. The second peer-interaction criterion variable that we used was the amount of negative peer interaction, which was also assessed using observational measures. The amount of negative peer interaction, particularly aggression, is perhaps one of the best correlates of peer rejection in early childhood. The third criterion variable that we used was the child's physical health, which was assessed using the mother's report of a wide variety of childhood health problems.

We explored a theoretical model linking the following seven major constructs: (a) marital satisfaction, (b) parental physiological activity, (c) parenting style, (d) child physiological activity, (e) child emotional expression and regulation, (f) child peer interaction, and (g) child physical health. This model is exploratory and preliminary and was generated for the purpose of building theory. The model proposes that couples experiencing marital distress would display a particular style of parenting that would drive the child's autonomic nervous system to a state of physiological arousal. We predicted that children would express a great deal of negative affect, show low levels of peer play and high negative affect with peers, and have worse physical health.

Method

Subjects

We recruited 56 normal families from the Champaign–Urbana community for this study; 24 families had a male and 32 had a female 4- to

5-year-old child. We developed and used a telephone version of the Locke–Wallace marital satisfaction scale (Krokoff, 1984) to ensure that couples had a wide range of marital satisfaction in our study. Unfortunately, the actual sample was biased in the direction of higher marital satisfaction. The mean marital satisfaction score was 111.1 (SD = 29.6), whereas most studies report a mean of about 100 (SD = 15). However, the range of marital satisfaction scores was large.

Procedures

Overview. Procedures consisted of laboratory sessions and home interviews for both parents and children. We used a combination of naturalistic interaction, highly structured tasks and semistructured interviews. Observational and autonomic data were obtained during all laboratory sessions.[1]

Two difficult procedural problems had to be solved in our laboratory sessions: obtaining good, detailed recording of the child's face and obtaining relatively artifact-free physiological data. Because fantasy play is such a prominent activity of preschool children, it seemed advisable to design a laboratory that would be built around a fantasy-play theme that the children would enjoy and that would by its very nature require the children to move very little yet preserve a naturalistic quality of behavior. In a pilot observational study of games and rides at a Chuck-E-Cheese Pizza House, the most popular children's ride for those in this age group (and irrespective of gender) was an Apollo space capsule, and the most popular games were videogames. On the basis of these data, we constructed a full-scale mock-up of the Apollo space capsule and made astronaut space suits for the children. Children were seated in the space capsule throughout all the laboratory procedures.

Home and laboratory visits consisted of two home visits, one with the marital couple and one with the child, and three laboratory visits, one with the couple only, one with the couple and their 4- to 5-year-old child, and one with the child alone. Visits occurred in the sequence presented below.

Autonomic variables. We assessed the following physiological variables from all three family members (from the parents during marital interaction and from the child only during parent–child interaction): (a) *Cardiac interbeat interval (IBI).* This measure was determined by measuring the time interval between successive spikes (R-waves) of the electrocardiogram (EKG), using electrodes attached to either side of the subject's chest; (b) *Pulse transmission time to the finger (PTT-F).* This was a measure of the elapsed time between the R-wave of the EKG and the arrival of the pulse wave at the finger; (c) *Finger pulse amplitude (FPA).* This was an estimate of the relative volume of blood reaching the finger on each heart beat, detected using a finger photoplethysmograph on the second finger of the nondominant hand; (d) *Skin conductance level (SCL).* This measure was sensitive to changes in levels of sweat in the eccrine sweat glands located in the hand. It was obtained by passing a small voltage between electrodes attached to the first and third finger of the nondominant hand; (e) *General somatic activity (ACT).* To measure somatic activity, the subject's chair was mounted on a platform that was coupled to a rigid base in such a way as to allow an imperceptible amount of "flexing." When the platform flexed it moved a ring magnet slightly in relationship to a coil attached to the rigid base, thus inducing a small current. This current was amplified and integrated by the polygraph and averaged by an LSI 11/23 microcomputer over 1-s intervals.

Stress-related hormones. All three targeted family members were asked to collect a 24-hr sample of urine on the same day. A 24-hr sample was necessary to control for variations of hormones within a day. Assays were conducted to determine urinary dopamine, norepinephrine, epinephrine, and cortisol levels (Dimson, 1984).

Marital laboratory visit. Couples were seen in a lab session whose main function was to obtain a naturalistic sample of the couple's interaction style during a high-conflict task. The high-conflict task consisted of a 15-min discussion of two problem areas in the marriage. Both behavioral and physiological data were monitored in both spouses and synchronized in time.

Parent–child laboratory session. The parent–child interaction session consisted of a modification of two procedures used by Cowan and Cowan (1987). In the first task, parents were asked to obtain information from their child. The parents were informed that the child had heard a story and they were to find out what the story was. The story that the children heard did not follow normal story grammar (Glenn, 1978) and was read in a monotone voice so that it would only be mildly interesting for them. The second task involved teaching the child how to play an Atari game that the parents had learned to play while the child was hearing the story. The interaction lasted 10 min. Observational data were obtained on all three family members, and physiological measures were obtained from the child alone.

Child laboratory session. This laboratory session was conducted individually with the child. Its main function was to assess (a) the child's ability to pose cross-culturally universal facial expressions of emotion as well as an expression that produces equivalent facial-muscle contraction but has no emotional meaning, (b) their tendency to spontaneously express emotion, and (c) their emotion regulation ability. Both observational and physiological data were collected.

Posing facial expressions: The direct facial action task. In this task, children were asked to pose cross-culturally universal facial expressions of emotion. This procedure was an extension of Ekman, Levenson, and Friesen's (1983) assessment of the autonomic signature of emotions in adults. Currently, only the behavioral portion of this task has been analyzed.

Spontaneous expression and emotion regulation. A set of film clips was developed to assess the child's spontaneous expression of emotion and the ability to regulate emotion. The child viewed clips meant to elicit the following emotions from the following six films: (a) humor (*Daisy*), (b) fear (*The Wizard of Oz,* monkey scene), (c) sadness (*Charlotte's Web,* Charlotte dies), (d) disgust (*Meaning of Life,* restaurant scene), (e) anger (*The Wizard of Oz,* taking Toto away), and (f) neutral (fly fishing). Each of the film clips was preceded by an induction, which was another introductory film clip of an actress who portrayed the emotions in the film clip that they were about to see. The function of the emotion induction was to direct the child to identify with the protagonist and experience the specific emotion in question. Each emotion induction and film was preceded by a baseline period and was followed by the child's playing the Atari game. The baseline period consisted of the child listening to a story on headphones. After each Atari game, the child was asked to point to the face template to indicate the feeling that they had while they watched the film. The template included happy, sad, afraid, angry, disgusted, and neutral faces. The order of films was randomized.

Peer interaction home visits. These sessions were included to assess the child's social competence in dyadic interaction. Each child was audiotaped at home in one 30-min dyadic play session with a peer whom the mother had identified as the child's best friend (regardless of gender). A range of social processes tend to occur with best friends that are less likely to occur with an unacquainted peer. Hence, this procedure provides an estimate of maximum social competence. No adults were present during the audiotaping.

[1] This section of the article is necessarily abbreviated because of space considerations. A detailed procedures manual is available on request from the authors.

Variables Selected for Model Building

At this preliminary stage of model building, only a subset of variables have been coded and analyzed. There are 14 variables in the model. Variable selection was based both on theoretical and empirical considerations. A particular variable was selected only if it (a) achieved a theoretical goal (i.e., our desire to tap both branches of the autonomic nervous system) and (b) was significantly correlated with those variables that it was predicted to be related to in our theoretical model. There is an admittedly post-hoc quality to these analyses that will require replication. The 14 variables were as follows:

Marital satisfaction (Variable 1). This was our main independent variable and was operationalized using the telephone Locke-Wallace scale (see Subjects section above).

Parenting style (Variable 2). We coded parenting behavior during the parent–child interaction using the Cowan and Cowan (1987) system. Briefly, this observational system codes parent behavior on dimensions of warmth–coldness, presence or lack of structure and limit setting, whether parents back down when their child is noncompliant, parental anger and displeasure, happiness, unresponsiveness or responsiveness, and whether parents make maturity demands of their child. We created a composite variable that can be described by the following nonlinear equation. Parent = Lack of structure + Unresponsiveness × Coldness. The idea in forming this composite variable was that unresponsiveness and coldness interact rather than having additive effects. On the basis of correlations of this composite variable with the Cowan and Cowan scales, high scores on the composite variable can be described as a parenting style that is cold, shows a lack of pleasure in parenting, is unresponsive, disorganized, angry, low in limit setting, "backs down" in the face of child noncompliance, and is high in maturity demands for the child.[2] This coding system represents our first attempt to examine parent–child interaction, and additional coding systems measuring specific affective responses during parent–child interaction are currently being applied to the data.

Parental physiological activity (Variables 3, 4, and 5). There is widespread agreement among psychophysiologists that no single autonomic or central nervous system measure adequately summarizes the physiological state of the organism. In fact, the thrust of much recent research in psychophysiology has been toward establishing the specificity of response capabilities within the autonomic nervous system, in general, and with respect to patterning related to different emotions, in particular. To be sensitive to these kinds of patterns, it is necessary to obtain a representative sampling from the major functional branches of the nervous system. We selected the three following parent physiology variables to provide such representation: husband's vagal tone, husband's pulse transit time, and wife's skin conductance level during the marital interaction. The work of Porges (e.g., 1983) suggests that the tonic functioning of one of the main nerves of the parasympathetic nervous system, the vagus nerve, can be measured by looking at the strength of the respiratory sinus arrhythmia (RSA) in the EKG. We assessed vagal tone as the proportion of the area under the curve in the interbeat interval spectral density function that was within the respiratory band of cycles for adults. We chose pulse transit time because it has an identifiable biological substrate (it is mainly under control of the sympathetic nervous system). We selected skin conductance level because it is sensitive to changes in levels of sweat in the eccrine sweat glands located in the palms of the hand. As with pulse transit time, skin conductance level is under sympathetic nervous system control.

Child's physiological activity (Variables 6, 7, and 8). Finger pulse amplitude was used as one index of physiological activity in the child during parent–child interaction. This measure was targeted because there is reasonably clear support for an interpretation of emotion specificity in finger pulse amplitude under normal conditions in some recent work by Ekman, Levenson, and Friesen (1983), who found that the hands are hotter in anger than in fear. Given the positive relationship between finger temperature and finger pulse amplitude, this would suggest that anger will be associated with high finger pulse amplitude and fear with low finger pulse amplitude. Finger pulse amplitude was computed as an increase in finger pulse amplitude in the parent–child interaction as compared with a baseline condition. We also selected vagal tone for the child as an estimate of parasympathetic nervous system activity. It was computed from the area under the curve of the spectrum of interbeat interval in the respiratory range of children. Urinary catecholamines were also used to index physiological arousal in the child. One predictor variable representing the child's urinary catecholamine secretion was computed. The child's catecholamine concentrations were highly correlated with one another. In fact, the pattern of correlations was related to their synthesis in the adrenal medulla. Dopamine (DA) is the precursor of norepinephrine (NE), and NE is the precursor of epinephrine (E). A principal-components analysis showed that there was only one component for the catecholamines (cortisol loaded least strongly with the other variables in the principal-components analysis). Hence, we used the child's concentration of dopamine as an index of catecholamine concentration in the child's urine.

Child's emotion regulation ability (Variable 9). Performance on the Atari game was selected as a measure of emotion regulation ability, because successful performance seems to require the four-component processes used in our definition of emotion regulation. We computed a mean of improvement or deterioration on playing the Atari game after the emotion-eliciting films as compared with a baseline score.

Child's emotional expressiveness (Variables 10 and 11). This score consisted of a summary index of the child's willingness and ability to make the facial expressions of anger and disgust. We used the expressions of both anger and disgust because they are most often confused with one another in judgment studies. Furthermore, they are two affects that are often blended together in natural displays. They are also quite similar in affective quality, particularly in response to social stimuli. In fact, in Izard's (Izard & Dougherty, 1982) facial coding system, a major code for children is called "square mouth," which is a combination of anger and disgust facial actions. This combination of anger and disgust is an attempt to create affective specificity in the definition of the vague term *hostility* in the Henry and Stephens (1977) model. We also used the child's unwillingness to make the facial expression of fear (some children refused to do this expression, and some said that they never felt afraid) as an index of emotional expressiveness.

Peer interaction (Variables 12 and 13). We computed the child's level of play with a best friend using a rapid version of a coding system called *MACRO* (see Gottman, 1983). We also used the child's total proportion of negative interaction with a best friend. Interrater reliability was .88 for level of play and .68 for the negative interaction ($p < .01$).

Child's physical health (Variable 14). We assessed child health on the basis of the mother's completion of an extensive health scale from the Rand Corporation Health Insurance Study.

Analysis

We analyzed the data using structural equations modeling using Bentler's program EQS (Bentler & Weeks, 1980). This program is equivalent to LISREL, but it allows for an analysis of data that do not satisfy the normality assumption. For our purposes, the advantage of structural

[2] The precise computation of the composite variable with specific weights for each of the Cowan and Cowan (1987) subcodes is available on request from the authors. A correlation coefficient of interobserver reliability was computed for this composite measure ($r = .48$). This level of reliability is questionable, thus, results using this variable must be viewed as speculative.

Table 1
Correlation Among the Variables in the Model

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Level of play	—							−.02	−.04	.01	−.22*	−.20	−.33**	−.22*
2. Child's vagal tone	.23*	—						.33**	.37**	.13	.06	−.10	.00	−.23*
3. Disgust + anger	−.20	−.04	—					.11	.12	.17	−.21	.34**	.27*	.20
4. Child's dopamine	−.30*	−.12	.18	—				.25*	.05	.13	.34**	−.03	.01	.09
5. Marital satisfaction	.45***	.12	−.14	−.39***	—			−.23*	−.07	.10	−.18	−.17	−.07	.05
6. Husband's pulse transit	.04	.10	−.02	.10	−.01	—		.38**	.10	.17	.28*	.17	.18	−.36**
7. Wife's skin conductance	−.09	−.43***	.14	−.11	.00	.05	—	−.35**	−.17	−.31**	−.09	.17	.06	.13
8. Parent	−.02	.33**	.11	.25*	−.23*	.38**	.35**	—	.26*	.39**	.25*	.27*	.25*	−.31**
9. Emotional regulation	−.04	.37**	.12	.05	−.07	.10	−.17	.26*	—	.26*	.17	.20	.05	−.17
10. Finger pulse amplitude	.01	.13	.17	.13	.10	.17	−.31**	.39**	.26*	—	.27*	.14	.30*	−.15
11. Unwillingness to pose fear	−.22*	.06	−.21	.34**	−.18	.28*	−.09	−.25*	−.17	−.27*	—	−.24*	.29*	−.23*
12. Child illness	−.20	−.10	.34**	−.03	−.17	.17	.17	.27*	.20	.14	.24*	—	.10	.11
13. Negative peer	−.33**	.00	−.27*	.01	−.07	.18	.06	.25*	.05	.30*	.29*	.10	—	−.12
14. Husband's vagal tone	−.22*	−.23*	−.20	.09	.05	−.36**	−.13	−.31**	−.16	−.15	.23*	.11	−.12	—

* $p < .05$. ** $p < .01$. *** $p < .001$.

equations modeling over regression is that one can assess both direct and indirect effects. For example, it is quite likely that not all of the effects of marital discord on the child are mediated through parent–child interaction. There may be direct effects as well, for example, from a child's overhearing a parental argument or observing an upset mother or father. Using structural equations models it is possible to assess the strength of both of these kinds of effects, which is not possible using regression analysis. In forward regression, for example, the second variable stepped into a prediction of a criterion variable is that part of the second variable that is uncorrelated with the first. Thus, it is not possible to assess indirect effects in which one believes that an effect on the criterion of one variable is mediated through another variable. We conservatively used path-analytic techniques to generate hypotheses about possible models that can organize the data, not to suggest causal structure in these correlational data.

Several statistics are traditionally used in the analysis (see Connell & Tanaka, 1987). First, there are goodness-of-fit indices that assess how well the model reproduces the actual covariance matrix. If the model fits, a chi-square will be *nonsignificant*. The Bentler–Bonnet index is also in wide use, the value of which should be close to 1.0 if the model fits the data. The path coefficients assess the strength of the connections between concepts or variables, and the amount of variance accounted for in any variables of interest in the model that are endogenous (i.e., have lines directed at them) can also be estimated.

Results

We conducted a number of data-reduction analyses to prepare the data for structural equations modeling. As discussed, we first computed one predictor variable representing the child's urinary catecholamine secretion.

We then computed correlational analyses to assess the strength of the relationships among our 14 variables (see Table 1).[3] Several correlational relationships are especially noteworthy. For example, marital satisfaction was significantly correlated with the child's level of play ($r = .45$, $p < .001$) and the child's level of dopamine ($r = -.39$, $p < .001$).

The model in Figure 1 fit well, $\chi^2(77) = 81.47$, $p = .342$. The Bentler–Bonnet Fit Index was 0.960 (nonnormed = 0.997). Starting on the left side of the figure, it can be seen that the parent variable can be predicted by low marital satisfaction and a pattern of marital physiology that consists of low husband vagal tone and low sympathetic arousal in both the husband (HPTT) and the wife (WSCL). This is a pattern of physiological *underarousal.* A case for underarousal can be made by comparing the means of wife skin conductance and pulse transit time in this study with those that Levenson and Gottman (1985) obtained in a longitudinal study of change in marital satisfaction. In that study, Levenson and Gottman found that they could predict improvement in marital satisfaction over 3 years using autonomic measures that showed calm during marital interaction and deterioration using autonomic patterns of arousal. Table 2 shows that the skin conductance and pulse transit times of parents high on our composite variable showed far less arousal than the calm couples in the Levenson and Gottman study. Hence, these couples can be said to have been sympathetically underaroused, with poor husband vagal tone. How can we speculate about the meaning of these relationships? Physiologically this could mean that such people might have difficulty mobilizing energy and organizing behavior. This physiological pattern may suggest that they will be less responsive and colder parents who do not set limits or structure the teaching task and that they may be likely to back down in the face of child noncompliance. These parents will probably seem behaviorally detached and emotionally disengaged. On the other hand, parents with a positive style can be described as showing high sympathetic-nervous-system (SNS) arousal in the marital context, with high husband vagal tone. Porges (personal communication, May 1988) suggested that this physiological pattern in the parents can seem behaviorally calm and reflective, but when vagal tone is withdrawn can be extremely expressive.

[3] Increases in skin conductance level imply increased autonomic arousal; however, decreases in pulse transit time and decreases in interbeat interval imply increased physiological arousal.

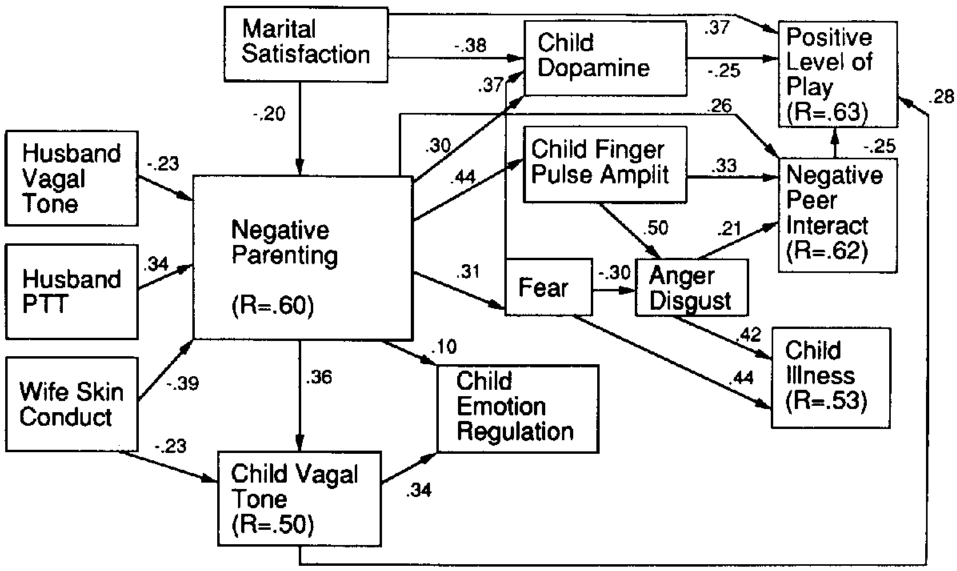

Figure 1. Model of the effect of marital discord on child outcomes.

The parent variable also predicted the child's vagal tone, and the child's vagal tone predicted the child's emotion regulation ability. Note, however, that the direction of the path coefficient from the parent variable to the child's vagal tone was positive. This suggests that the more negative the parents, the higher the child's vagal tone. One interpretation of this is that perhaps the child's vagal tone is acting as if it were the child's buffering system against negative parenting. If this is so, the direction of the arrows may need to be reversed in the structural model. We have performed this analysis, and it did not appreciably alter the coefficients in the model (the multiple correlation for the parent variable became .65 and the path coefficient from WSCL to the child's vagal tone became −.38).

The parent variable was related to a cluster of three variables that may be a candidate for a latent factor in structural equations modeling. This latent variable consisted of the amount of blood in the child's finger, the child's refusal to make the fear face, and the child's willingness to make the anger and disgust faces. Higher hand temperature was found by Ekman, Levenson, and Friesen (1983) to be characteristic of anger, whereas a lower hand temperature was characteristic of fear. It could be that more blood in the hand relates to the child's anger. This interpretation received some support because both blood amplitude in the finger and the child's willingness and ability to make the anger and disgust faces related to the child's negative interaction with the best friend. There are, of course, problems in interpreting the anger and disgust variable. Because the data are derived from the Directed Facial Action (DFA) task, there are problems in interpreting the anger and disgust variables as an index of how angry and disgusted the child is in general or is made by the parent–child interaction. It is well known (Rinn, 1984) that different motor pathways innervate the facial musculature for voluntary, as opposed to spontaneous, facial expressions. Hence, it may not be correct to interpret individual differences even on the anger and disgust parts of the DFA as a measure of how angry or disgusted these children would act or feel in naturalistic social interaction. However, it is not known what relative roles voluntary, as opposed to spontaneous, facial expressions play in actual social interaction. Voluntary expressive behavior might play a large role in children's social–emotional communication. Given our prediction of negative peer interaction, it may be reasonable to interpret the child's posing of anger and disgust in the DFA task as related to the expression of negative affect in actual social interaction. At first we were puzzled by the child's refusal to pose the fear facial expression as an individual differences variable. Several interpretations are possible. The child may have been defending himself or herself against feeling afraid, the refusal could have been part of a "tough" stance with respect to fear, or the refusal could have

Table 2
Comparison of Skin Conductance and Pulse Transit Times in Two Studies: The Case for Underarousal

Group	Wife's skin conductance (micromhos)	Husband's pulse transit time (ms)
Couples deteriorating		
M	30.02	228.12
SD	4.47	13.43
Couples improving		
M	19.20	241.67
SD	6.27	13.06
Positive parenting style		
M	15.70	238.87
SD	8.38	17.28
Negative parenting style		
M	6.65	277.65
SD	1.60	16.59

been part of a construct of anger, stubbornness, and noncompliance. It is unclear what the correct interpretation of this cluster of variables is at this time. The cluster is related to the child's illness, and the Henry and Stephens (1977) model might attempt to interpret this cluster of variables in terms of the combined psychological states of anger and helplessness.

The parent variable and marital satisfaction were both related to the child's level of catecholamines, an index of the SNS-adrenomedullary axis in the Henry and Stephens (1977) model, which was, in turn, related to the affects of anger and hostility. This interpretation was not strongly supported by the data, because dopamine and negative peer interaction were not correlated (r = .01). Nonetheless, the urinary dopamine concentration was correlated with the child's level of play (r = −.30, $p < .05$).

Peer interaction variables were significantly related to the variables in the model. The parent variable and the anger/noncompliance cluster resulted in a multiple correlation of .62. The indirect pathways to the child's-level-of-play criterion were quite as strong as the direct one. The model shows that prediction is quite good for all three criterion variables: for the child's level of play, r = .63; for negative peer interaction, r = .62; and for the child's illness, r = .53.

A surprise in this analysis was that our first operational measure of emotional regulation (in terms of the Atari scores after the emotion-eliciting films were shown) did not correlate with any of the variables in the model. It was related to vagal tone, and the direction of the arrow from vagal tone to emotional regulation is entirely arbitrary. It may be the case that there are problems with our current operational definition, or it may be that emotional regulation is not the unidimensional construct that we assumed it to be and that we are only beginning to map its boundaries.

Discussion

The initial results provide an encouraging beginning in theorizing about how marital discord may affect the child's peer relations and physical health. It was possible to develop a reasonably parsimonious model with direct and indirect pathways that suggest how marital distress may hinder the child's development of social relationships and increase the child's susceptibility to illness. In examining the indirect pathways, there was some support for the hypothesis that, within the context of a teaching task, maritally distressed and physiologically underaroused couples have a parenting style that is cold, unresponsive, angry, and low in limit setting and structuring, and that this interaction style may relate to anger and noncompliance in their children as well as high levels of stress-related hormones. Children from such homes tend to play at a lower level with peers, display more negative peer interactions, and have worse health. The direct pathway through the model shows that maritally distressed couples seem to have children who are under a high level of chronic stress (as indexed by their high level of urinary catecholamines), which is related to their propensity for maintaining low, potentially conflict-free levels of play with their friends.

A negative parenting style was associated with high vagal tone in the child. One interpretation of this is that the children's vagal tone might be buffering them against the deleterious impact of negative parenting. Whereas the short-term consequences of marital discord may invoke what is essentially a biological coping strategy of high vagal tone, the impact of a sustained bad marriage and negative parenting may tax the child's physiology and reduce the child's vagal tone longitudinally (Porges, personal communication, May 1988).

This model avoided using concepts such as "social competence," to keep the criterion variables precise. Why would children from homes in which their parents are unhappily married play at a lower level with their best friend? What is the meaning of this relation? At this junction it will be helpful to refer to Ekman's (1984) concept of flooding. In discussing the transitions from emotions to moods to affective diagnoses (e.g., sadness to dysphoria to depression), Ekman introduced the notion that for some people almost any negative affective experience invokes the particular affect in question. Hence, they will tend to be in that affective state quite often. In other words, almost any negative affect evokes sadness in a depressed person. To this notion we add two others: (a) The affective state is, in some sense, overwhelming in that it is hard for the child to regulate the affect once in this state. (b) The child becomes hypervigilant of cues that may lead to that state. Thus, the child who has a high level of catecholamines and is flooded by anger and disgust will tend both to play at a low level with a peer and have trouble regulating anger once it arises. We will now offer an example of the transcript of a best-friend interaction of one child whose parents were unhappily married that may help to illustrate some of our thinking about the level of play variable and why it might be an important criterion. If children from unhappy-marriage homes are flooded by fear, anger, and disgust, it is reasonable to think that they may avoid interactions in which people are angry at them or that elicit anger in them. It is likely that they will be hypervigilant about such interactions, and that these interactions may be particularly painful and overwhelming to them. The following example of one child in our study illustrates this point. She played at quite a low level with her friend (N). When her friend asked if she could take a toy home with her, the target child (T) said:

> T: Oh you can't take this one 'cause this is my brother's so put it in like that. Oh, that's too big, 'cause Alex would notice and he'd get mad at me. I don't want him to be mad at me. . . .

Later on in the interaction she again referred to her brother's anger:

> T: . . . So you can take, you can take the big ones home, 'cause Alex will know, so he'll get mad at me.
> N: And I don't want Alex to get mad at you.
> T: And, if he comes, and he'll get mad at you too. He'll get mad at both of us. It's not very fun.
> N: It's not very fun for Alex to get mad. When he gets mad, what does he do when he gets mad?
> T: "ZZZOOOM." (Claps hands together very sharply)
> N: What does he do?
> T: He just yeeellls. And, my eyes start to bulge.
> N: I hate yelling.
> T: I do too. I hate spankings. And sometimes when he goes crazy, then I hit him, pow, pow. (Claps hands twice). And then when I'm sitting here getting dressed, and he's going crazy, he hits me

on the head. Turns round and around and hits me on the head. And I'm sittin there and gettin' dressed.

In sum, perhaps she plays at a low level because she is afraid of anger, afraid of people getting angry at her, and afraid of being angry herself. The unfortunate consequence of this style of coping with her fears may be that she avoids a great deal of fun with friends and that she avoids learning the kind of complex interaction skills that are necessary in high levels of shared fantasy play with a peer. This may be the mechanism by which this child will eventually have trouble with her peers in the early school years. These effects may be detectable only in extremely distressed homes in which the children are not buffered from marital conflict.

The proposed model is based on the premise that the direction of causality is from the marital dyad to the parent–child system, which, in turn, affects the child's physiological status and social world. However, the possibility of bidirectional causality cannot be ruled out (Bell, 1968). It is plausible that children who are high in vagal tone and are angry and noncompliant may have parents who adopt a cooler, more distant approach to parenting, and that having a child with these characteristics might also lead to parental disharmony through parent–child interactions.

Unfortunately, the Illinois sample was positively skewed. We recruited families that were quite high in marital satisfaction and underrepresented families that were low in marital satisfaction, and these facts may have tempered some of our results. In fact, when we limit our analyses to families in which the parents are under 130 in the wife's Locke–Wallace score (which is two standard deviations above the population mean of 100), the size of most of our correlations increases. Children that are highly stressed in their families may have a reduced ability to play at a high level with a peer. Children who do not have this problem may learn a whole other set of social skills that children low in the level-of-play variable never get a chance to rehearse with their friends. In terms of the longitudinal prediction of sociometric status, one configuration of family variables may predict which children are later rejected by their peers, and the reciprocal configuration of variables may predict which children are well accepted by their peers.

References

Bell, R. Q. (1968). A reinterpretation of the direction of effects in studies of socialization. *Psychological Review, 75,* 81–95.

Bentler, P. M., & Weeks, G. D. (1980). Linear structural equations with latent variables. *Psychometrika, 45,* 289–308.

Berkman, L. F., & Syme, S. L. (1979). Social networks, host resistance, and mortality: A nine-year follow-up study of Alameda county residents. *American Journal of Epidemology, 109,* 186–204.

Connell, J. P., & Tanaka, J. S. (Eds.). (1987). Structural equations modeling [Special Issue]. *Child Development, 58*(1).

Cowan, P. A., & Cowan, C. P. (1987, April). *Couple's relationships, family styles, and the child's development at three.* Paper presented at the meeting of the Society for Research in Child Development, Baltimore.

Dimson, D. A. (1984). Rapid and selective isolation of urinary catecholamines using a bonded phenyl borate phase. *Current, 3,* 4–5.

Ekman, P. (1984). Expression and the nature of emotion. In K. P. Scherer & P. Ekman (Eds.), *Approaches to emotion.* Hillsdale, NJ: Erlbaum.

Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science, 221,* 1208–1210.

Emery, R. E. (1982). Interparental conflict and the children of discord and divorce. *Psychological Bulletin, 92,* 310–330.

Frodi, A. M., & Lamb, M. (1978). Sex differences in responsiveness to infants: A developmental study of psychophysiological and behavioral responses. *Child Development, 49,* 1182–1188.

Glenn, C. G. (1978). The role of episodic structure and of story length in children's recall of simple stories. *Journal of Verbal Learning and Verbal Behavior, 17,* 229–247.

Gottman, J. M. (1983). How children become friends. *Monographs of the Society for Research in Child Development, 48*(2, Serial No. 201).

Gottman, J. M., & Parker, J. (1986). *Conversations of friends: Speculations on affective development.* New York: Cambridge University Press.

Henry, J. P., & Stephens, P. M. (1977). *Stress, health and the social environment.* New York: Springer-Verlag.

Hetherington, E. M., Cox, M., & Cox, R. (1979). Family interaction and the social, emotional, and cognitive development of children following divorce. In V. Vaughn & T. Brazelton (Eds.), *The family: Setting priorities* (pp. 89–128). New York: Science and Medicine.

Hetherington, E. M., Cox, M., & Cox, R. (1982). Effects of divorce on parents and children. In M. Lamb (Ed.), *Nontraditional families* (pp. 233–288). Hillsdale, NJ: Erlbaum.

Izard, C., & Dougherty, L. (1982). Two complementary systems for measuring facial expressions in infants and children. In C. Izard (Ed.), *Measuring emotions in infants and children.* New York: Cambridge University Press.

Kagan, J., Rosman, B. L., Day, D., Albert, J., & Phillips, W. (1964). Information processing in the child: Significance of analytic and reflective attitudes. *Psychological Monographs, 78*(1, Whole No. 578).

Kiecolt-Glaser, J. K., Fisher, L. D., Ogrocki, P., Stout, J. C., Speicher, C. E., & Glaser, R. (in press). Marital quality, marital disruption, and immune function. *Psychosomatic Medicine.*

Kopp, C. B. (1982). Antecedents of self-regulation: A developmental perspective. *Developmental Psychology, 18,* 199–214.

Krokoff, L. (1984). *The anatomy of blue-collar marriages.* Unpublished doctoral dissertation, University of Illinois, Urbana–Champaign.

Levenson, R. W., & Gottman, J. M. (1983). Marital interaction: Physiological linkage and affective exchange. *Journal of Personality and Social Psychology, 45,* 587–597.

Levenson, R. W., & Gottman, J. M. (1985). Physiological and affective predictors of change in relationship satisfaction. *Journal of Personality and Social Psychology, 49,* 85–94.

Maccoby, E. E. (1980). *Social development.* New York: Harcourt, Brace, & Jovanovitch.

Mischel, W., & Underwood, B. (1974). Instrumental ideation in delay of gratification. *Child Development, 45,* 1083–1088.

Parker, J. G., & Asher, S. R. (1987). Peer acceptance and later interpersonal adjustment: Are low-accepted children "at risk"? *Psychological Bulletin, 102,* 357–389.

Parten, M. B. (1932). Social participation among preschool children. *Journal of Social Psychology, 27,* 243–269.

Porges, S. W. (1983). Heart rate patterns in neonates: A potential diagnostic window to the brain. In T. Field & A. Sostek (Eds.), *Infants born at risk: Physiological, perceptual, and cognitive processes.* New York: Grune & Stratton.

Porges, S. W. (1984). Heart rate oscillation: An index of neural mediation. In M. G. H. Coles, J. R. Jennings, & J. A. Stern (Eds.), *Psycho-*

physiological perspectives: Festschrift for Beatrice and John Lacey. New York: Van Nostrand Reinhold.

Porter, B., & O'Leary, K. D. (1980). Marital discord and childhood behavior problems. *Journal of Abnormal Child Psychology, 8*(3), 287–295.

Putallaz, M., & Heflin, A. H. (1986). Toward a model of peer acceptance. In J. M. Gottman & J. G. Parker (Eds.), *Conversation of friends: Speculations on affective development.* New York: Cambridge University Press.

Redl, F., & Wineman, D. (1951). *Children who hate.* Glencoe, IL: Free Press.

Rinn, W. E. (1984). The neuropsychology of facial expression. *Psychological Bulletin, 95,* 52–57.

Rutter, M. (1971). Parent–child separation: Psychological effects on the children. *Journal of Child Psychology and Psychiatry, 12,* 233–260.

Shaw, D. S., & Emery, R. E. (1987). Parental conflict and other correlates of the adjustment of school-age children whose parents have separated. *Journal of Abnormal Child Psychology, 15,* 269–281.

Taggart, P., & Carruthers, M. (1971). Endogenous hyperlipidaemia induced by emotional stress of race driving. *Lancet, 1,* 363–366.

Temoshok, L., Van Dyke, C., & Zegans, L. (1983). *Emotions and health in illness: Theoretical and research foundations.* New York: Grune & Stratton.

Van Leishout, C. F. M. (1975). Young children's reactions to barriers placed by their mothers. *Child Development, 46,* 879–886.

Received January 15, 1988
Revision received August 2, 1988
Accepted August 10, 1988 ■

Instructions to Authors

Manuscripts for *Developmental Psychology* can vary in length; typically they range from 5 to 40 double-spaced manuscript pages. Manuscripts should be of sufficient length to ensure theoretical and methodological competence. To the extent possible, the Editor will arrange articles thematically as long as inordinate delay in publication can be avoided.

Authors should prepare manuscripts according to the *Publication Manual of the American Psychological Association* (3rd ed.). All manuscripts must include an abstract containing a maximum of 1,000 characters and spaces (which is approximately 100–150 words) typed on a separate sheet of paper. Typing instructions (all copy must be double-spaced) and instructions on the preparation of tables, figures, references, metrics, and abstracts appear in the *Manual.* Also, all manuscripts are subject to editing for sexist language.

APA policy prohibits an author from submitting the same manuscript for concurrent consideration by two or more journals. In addition, piecemeal publication of several reports of the results from a single data base is undesirable (see p. 168 of the *Publication Manual,* 3rd ed.): An author who wishes to divide the report of a study into more than one article should inform the editor before preparing the articles or, if the articles are already prepared, submit all the articles at the same time to the editor. APA policy also prohibits duplicate publication, that is, publication of a manuscript that has already been published in whole or in substantial part in another journal. Prior and duplicate publication constitutes unethical behavior, and authors have an obligation to consult journal editors if there is any chance or question that the paper might not be suitable for publication in an APA journal. Finally, authors of manuscripts submitted to APA journals are expected to have available their raw data throughout the editorial review process and for at least 5 years after the date of publication.

Authors will be required to state in writing that they have complied with APA ethical standards in the treatment of their sample, human or animal, or to describe the details of treatment. A copy of the APA Ethical Principles may be obtained from the APA Ethics Office, 1200 17th Street, N.W., Washington, DC 20036.

Because reviewers have agreed to participate in an anonymous reviewing system, authors submitting manuscripts are requested to include with each copy of the manuscript a cover sheet, which shows the title of the manuscript, the authors' names and institutional affiliations, and the date the manuscript is submitted. The first page of text should omit the authors' names and affiliations but should include the title of the manuscript and the date it is submitted. Footnotes containing information pertaining to the authors' identity or affiliations should be on separate pages. Every effort should be made to see that the manuscript itself contains no clues to the authors' identity.

Five copies of the manuscript should be submitted. All copies should be clear, readable, and on paper of good quality. A dot matrix or unusual typeface is acceptable only if it is clear and legible. Authors should keep a copy of the manuscript to guard against loss. Mail manuscripts to the Editor, Ross D. Parke, Department of Psychology, University of Illinois-Champaign, 603 East Daniel Street, Champaign, Illinois 61820.