

Mothers' Responses to the Cries of Normal and Premature Infants as a Function of the Birth Status of Their Own Child

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Mothers of premature and full-term infants viewed and heard videotapes of premature and full-term infants. The onset of crying by both infants elicited physiological arousal (evident in blood pressure, skin conductance, and heart rate increases) in the adults. The mothers of premature infants responded with especially marked arousal to the infants' cries. These mothers also reported that they were more attentive and alert while the infant was crying. The subjects responded similarly to the cries of full-term and premature infants. Mothers who described their own baby as easy exhibited a lower increase in diastolic blood pressure and heart rate, and reported being more alert, attentive, and willing to interact with the stimulus babies than those whose own baby appeared "difficult."

In several recent studies, investigators have attempted to determine whether and how infant signals and characteristics affect parental (typically maternal) responses (Lewis & Rosenblum, 1974; Lamb, 1977). Most of the researchers concerned have focused upon the parents' behavioral

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responses. A few studies, however, have monitored psychophysiological indices on the assumption that these may sensitively index autonomic responses and behavioral propensities (e.g., Donovan, Leavitt, & Balling, 1978; Wiesenfeld & Klorman, 1978; Frodi, Lamb, Leavitt, & Donovan, 1978a).

Studies of the latter type have focused mainly on the infant signals, crying and smiling. According to Bowlby (1969) and Lamb (1978), the adaptive purpose of infant smiles is to serve as cues that seduce adults into remaining near the infant, whereas cries lead adults to approach the infant in order to relieve its distress, thereby terminating the cry. If cries elicit responses aimed at active termination of the infant signal, they should be perceived as aversive, and should trigger a physiological response typical of the response to an activating (arousing) and aversive stimulus. Meanwhile, if smiles elicit responses aimed at prolongation of the signal, they should be perceived as pleasant cues, and are most likely to facilitate continuation of the interaction if they do not arouse the adult into activity. In fact, Frodi et al. (1978a) found that smiles and cries had precisely these effects on young parents. Viewing the videotape of a crying baby elicited increases in skin conductance and diastolic blood pressure as well as increased irritation, annoyance, and disturbance. Viewing a smiling and cooing infant elicited negligible physiological changes and pleasant emotions. Frodi and Lamb (1978) have since reported that smiles and cries elicit these patterns of physiological responses and reported emotions in children, adolescents, and parents alike.¹

Frodi, et al. (1978b) have also shown that the cry of a premature infant may elicit greater autonomic arousal than the cry of a full-term infant does. In addition, the cry of the premature infant was perceived as more aversive than the cry of a full-term infant in their study. Both effects were especially pronounced when the premature cry and premature facial configuration were combined. These findings are especially interesting when viewed in the context of Zeskind and Lester's (1978) spectrographic analyses of the cries of infants with high- and low-complication prenatal histories. These researchers found that the cries were indeed very different: the cries of the high-complication infants had an average fundamental frequency of 812 Hz, whereas the cries of the low-complication infants had an average fundamental frequency of 468 Hz. As in the study of Frodi et al. (1978b), the cries of the atypical babies were perceived as more aversive than the cries of the normal infants.

¹ The sound component of the signal—especially the cry signal—is extremely important, as Frodi, Lamb, Leavitt, Donovan, Neff, and Sherry (1978b) demonstrated. This may explain why Donovan et al. (1978) and Wiesenfeld and Korman (1978) failed to obtain the same clear patterns of psychophysiological response using brief soundless videotaped stimuli.

Zeskind and Lester (1978) found no differences between the responses of parents and nonparents, and Frodi et al. (1978a, 1978b) found no differences between mothers and fathers. No study has yet determined, however, whether the birth status of a parent's own child systematically affects his/her response to the atypical infant's signals. This was the goal of the present study. We expected to replicate the finding of Frodi et al., (1978b) that the subjects would all regard the cry of the premature infant as more aversive and would evince greater physiological arousal in response to it than to a full-term infant. Further, we predicted that mothers whose own infants were premature and who thus had had extended experience with the arousing and aversive features of these infants would have become sensitized to the signals of atypical infants. As a result, we expected that they would respond to the cry and face of a premature infant with even greater arousal and more intense negative emotions than would the mothers of full-term infants. Finally, we predicted that generalization would have taken place, such that the mothers of premature infants were more aroused by and more averse to the cries of all infants than the mothers of full-term infants (Lamb, 1978).

METHOD

Subjects

The subjects were 16 mothers of premature infants and 16 mothers of full-term infants recruited through the birth records of a regional hospital situated in a small midwestern town. The study was described by mail to potential participants whose consent was obtained in a follow-up telephone call. Sixty percent of the mothers contacted agreed to participate. Although some mothers had several children it was the status of their most recent infant that determined their subject classification. By definition, the premature infants were all born at least 3 weeks before due date, weighed less than 2400 g at delivery, and required temporary incubator treatment. The full-term infants were all born within 2 weeks of due date, and all weighed more than 3000 g upon delivery. All mothers had their babies at home for about 7 months prior to the study. The mothers in the two groups were matched on age ($\bar{X} = 27.13$ years, $SD = 3.92$), social class ($\bar{X} = 3.93$, $SD = 1.5$ on Hollingshead's (Note 1) Two-Factor Index), number of children, and marital status (all subjects were married).

Apparatus

A four-channel Beckman Type R511A Dynograph recorder (polygraph) was used to record heart rate (HR) and skin conductance (SC). Beckman bipotential standard size (16 mm) electrodes were employed to record SC. Using Johnson & Johnson KY lubricant jelly the SC electrodes were affixed to the palmar surface of the second phalanx of the index and middle finger of the right hand. A constant voltage of 0.5 V was applied to the electrodes from the polygraph SC coupler (Beckman type 9844). Recording sensitivity was 0.5. Heart rate (HR) was recorded on a Beckman type 9857 cardi tachometer coupler via Beckman biopotential miniature electrodes (11 mm) applied with Spectra 350 electrode gel. Systolic (SBP) and diastolic (DBP) blood pressure was assessed using Technical Resources' B-350 sphygmometers with microphone pickups in the cuffs, which were placed on the subjects' left arms. The cuffs were inflated through a 9-ft extension cord from the adjacent room. A digital

readout indicated SBP at the start and DBP at the cessation of a flashing light. The subjects were seated comfortably in separate, adjacent alcoves about 4 ft from the television monitor, and in a room adjacent to the physiological monitoring equipment.

Stimulus Tapes

Two 6-min videotapes were prepared, each divided into three 2-min segments. One tape showed a premature infant and the other a full-term infant. Both infants were filmed while still in the hospital, but both were healthy and were scheduled to go home within 2 days. The premature infant was born at 32 weeks gestation age, weighing 1600 g, and had incubator treatment. The full-term baby was born at term, weighing 2900 g. Within each tape the first and last segments were identical: They showed the baby quiescent. The infant cried audibly during the middle segment. The crying followed the quiescence in a natural way and as if it occurred for no obvious reason. The cry of both stimulus babies was elicited by snapping their heels with two fingers. The sound level was adjusted so that on both tapes the cry reached peaks of 65–70 dB at 4 ft from the sound source. Spectrographic analyses were performed on the soundtrack of both tapes using a Kay Sonagraph 7029A Spectrum Analyzer: the fundamental frequency of the premature infant signal centered around 600 Hz, whereas the fundamental frequency of the full-term cry centered on 330 Hz.² Fundamental frequency is the characteristic of infant cries most often measured and cited (Zeskind & Lester, 1978). By inspection of the spectrograms, however, it was possible to distinguish between the two cries on other criteria (continuity and regularity) as well. The cry of the term baby was continuous and was marked by a clear pattern of harmonics occurring at multiples of the fundamental frequency. By contrast, the premature's cry contained definite pauses and a less clear pattern of harmonics, interspersed with "noise."

Procedure

Design. A 2 (Mother category: premature, full-term) \times 2 (tape order) \times 2 (Cry: premature, full-term) factorial design was employed. The first two factors were between-subjects factors, while Cry constituted a within-subjects factor. Segments of the videotapes (quiescence/crying/quiescence) constituted an additional within-subjects factor.

Two subjects (from the same mother category) were tested simultaneously in the laboratory. A male and a female experimenter alternated in affixing the SC and HR electrodes and the blood pressure (BP) cuffs to the two subjects, and in delivering the instructions. Upon arrival, the subjects were seated in easy chairs, separated by a wall, in front of the TV monitor and encouraged to relax. The procedure was explained and each participant signed a consent form. After attachment of the equipment and a 5-min rest period, one experimenter described the task. Subjects were assigned to the Tape Order conditions randomly, except that the two tested together were always in the same condition. The subjects were simply told that the infant to be viewed on the 6-min videotape was a very young baby.

Thereafter, the first videotape was shown. The order of presentation was varied systematically, so that half of the subjects saw the premature infant in the first videotape and the full-term infant second. After the first videotape was over, the subjects independently completed a mood adjective check list (MACL) and a short questionnaire. This took an

² Unfortunately, the study was already in progress when we learned of Zeskind and Lester's (1978) work and, through this, of Michelsson's spectrographic analyses of the cries of premature infants. Had these findings been available to us sooner, we could have selected as our stimulus signals cries that were more representative of the classes they were supposed to represent. Our results might have differed had the fundamental frequency of the premature infant's cry been in the 800-Hz range, rather than 600 Hz.

average of 10 min, following which the second videotape was shown, and the MACL and questionnaire were again completed. A written version of the Perception of Baby Temperament Questionnaire (Pedersen, Anderson, & Cain, Note 2) as well as a short demographic questionnaire were completed after the subjects moved to a neutral setting.

Dependent measures. SC, DBP, and HR were selected as major dependent variables. Several studies (e.g., Frodi, 1978, Geen, Stonner, & Shope, 1975; Schachter, 1957; Weerts & Roberts, Note 3) have shown that increases in DBP sensitively index aversion, feelings of anger, or a disposition to aggress, while SC is a more general index of autonomic arousal. HR was chosen because it is a measure capable of discriminating between attentive (orienting) and defensive reactions (Lacey, 1967).

SC and HR were measured continuously for 2 min before as well as throughout the two videotape sequences. Data from the first and last 30 sec of each tape segment were selected for analysis. The readings are referred to as Q_1 , Q_2 (Q = Quiescence), C_1 , C_2 (C = cry), Q_3 , and Q_4 , respectively. In all cases, the reading taken in the last 30 sec of the first Quiescence segment (Q_2) was used as a baseline in order to insure adaptation to tape exposure. For SC two measures (expressed in micromhos were: (a) a change score reflecting the total amplitude of deflection from baseline, i.e., the sum of all the responses in the interval, and (b) a change score reflecting the peak or maximum amplitude of the deflection from baseline. Analyses were performed on \log_{10} -transformed scores as suggested by Donovan et al. (1978). Spontaneous fluctuations (SF) of skin conductance were also analyzed, with SF being defined as a deflection corresponding to an SC change of at least $0.05 \mu\text{mho}$ (cf. Kilpatrick, 1972). The mean of the six fastest beats of HR was computed for the first and last 30 sec of each tape segment. Changes from baseline (Q_2) were also analyzed for each one of the 10 sec immediately following onset of the cry (C_1).

SBP and DBP were also measured during the first and last 30 sec of each tape segment, with the readings obtained at Q_2 constituting baseline with respect to which readings were expressed as change scores. Since the Q_2 readings were used as baselines, it is important to note that there were no significant or near-significant condition differences on any of the physiological measures at or before Q_2 , or between the Q_2 s of the first and second tapes.

After each videotape presentation the subjects filled out a mood adjective checklist (MACL) consisting of three parts, each referring to one of the tape segments. Each consisted of 10 adjectives (happy, annoyed, irritated, disturbed, indifferent, attentive, distressed, alert, frightened, and sympathetic). The subjects circled a number from 1 (= not at all) to 5 (= very much) indicating how much the mood applied to them. On a separate questionnaire the parents also indicated what sex they thought the baby was, and on three 5-point scales (ranging from 1 = not at all to 5 = very much) checked (1) how pleasant they found the baby, (2) to what extent they would like to interact with it, and (3) how distressed they thought the baby was while crying.

About 10 min after the presentation of the second tape the mothers completed a questionnaire concerning their own child in a different setting. This questionnaire was a written form of the Perception of Baby Temperament Scale (Pederson et al., Note 2). It contained 54 items, to which the mothers responded by indicating whether each statement applied very much, somewhat, or not at all to their baby or whether they did not know. Six items referred to each of nine subscales (Activity, Rhythmicity, Adaptability, Approach, Threshold, Intensity, Mood, Persistence, and Distractibility; cf. Carey, 1970). The summed scores on Rhythmicity, Adaptability, Approach, Intensity, and Mood comprised the Difficult-Easy dimension. The subjects were not permitted to communicate while completing the questionnaire. They also completed demographic information sheets before the study was discussed and questions answered.

RESULTS

Self-report Responses to the Stimulus Infants

Repeated-measures analyses of variance of the mood ratings across the segments of the two videotapes yielded significant segment effects on 8 of the 10 moods. Inspection of the means indicated that the subjects became significantly less happy, as well as more distressed, alert, sympathetic, irritated, annoyed, disturbed and frightened during the cry than during the quiescent segments of the two videotapes (all p values between .05 and .001).

Repeated-measures analyses of variance across the videotape segments were also conducted on the physiological variables. Values included in the analyses were the change scores obtained at C₁, C₂, Q₃, and Q₄ of each videotape. Analyses of DBP, peak amplitude SC and total amplitude SC, yielded highly significant segment effects for the tape of the premature infant (p values < .01), whereas analyses of the two SC measures yielded corresponding segment effects for the tape of the full-term infant (p 's < .001). For both DBP and SC the response pattern involved increases at C₁ and C₂ with a return to baseline at Q₃ and Q₄. These results indicate that all subjects experienced autonomic arousal, i.e., increases on the physiological indices, in response to the cry. Significant or near-significant interactions between the mother category and the segments factor on peak SC ($F(3, 84) = 2.69, p < .05$) and DBP ($F(3, 84) = 2.43, p < .06$) suggested that the mothers of premature infants exhibited greater arousal in response to the premature cry than did the mothers of full-term infants. There were no significant effects for type of cry.

There were fewer significant effects for order of presentation on the MACL and physiological measures (one for SBP, one on the mood "happy") than one would expect to occur by chance.

Effects of the Cry Characteristics

Since our major interest was in group differences in response to the two cries, we will now focus on the cry segments of the tapes only. There were no significant interactions of Mother category \times Type of Infant cry in the analyses involving the infant cry as a within-groups factor, nor any significant effects for type of infant cry. Thus we will discuss the results from each tape separately.

As shown in Table 1, the cries differentially affected the two groups of mothers. When viewing the premature infant, the mothers of premature infants rated themselves significantly more happy, attentive, and alert than did the mothers of full-term infants, although they found the stimulus infant less pleasant. At C₁, the cry elicited greater increases in DBP, SF, and peak amplitude SC among the mothers of premature infants than

TABLE I
 SELF-REPORTED AND PHYSIOLOGICAL RESPONSES TO THE CRY SEGMENTS

Response mode	Mother category		F (1, 28)	p
	Premature	Full-time		
Premature infant tape				
Reported Responses				
Happy	2.13	1.30	7.54	.01
Attentive	4.31	3.31	4.59	.04
Alert	4.69	3.25	11.12	.002
How pleasant did you find the baby?	3.25	3.94	5.26	.03
Physiological measures (change scores)				
DBP at C ₁	1.25	-1.63	5.03	.03
SC (spontaneous fluctuations at C ₁)	1.94	1.13	4.79	.04
SC (peak amplitude) at C ₁	0.82	0.12	9.08	.005
HR at C ₁	3.00	0.31	9.70	.004
HR at C ₂	3.88	1.25	5.03	.03
Full-term infant tape				
Reported responses				
Happy	2.25	1.50	3.88	.05
Sympathetic	4.88	3.00	11.39	.002
Physiological measures (change scores)				
DBP at C ₁	5.00	2.25	5.40	.03
DBP at C ₂	2.75	-1.63	7.36	.01
SC (peak amplitude) at C ₁	1.59	1.32	5.07	.03
SC (peak amplitude) at C ₂	1.56	1.30	7.32	.01

among the mothers of full-term infants. The cry also had a greater effect on their HR at both C₁ and C₂. Similar group differences occurred while viewing the full-term infant. The mothers of premature infants rated themselves as happier and more sympathetic toward the stimulus baby; they displayed significantly greater DBP and peak amplitude SC responses at both C₁ and C₂ than did the mothers of term infants. There were no group differences on the items asking the subjects to guess the sex of the infants, and the degree of distress evinced.

Analyses of Heart Rate Trend

Second-by-second analyses of HR were performed on the 10 sec following onset of the cries. When necessary, heart rate was averaged within each second. The HR value obtained at Q₂ served as the baseline with respect to which change scores were computed. A 2 × 2 × 10 trend analysis (Mother category × Infant type × Seconds) yielded an overall main effect for seconds ($F(9, 270) = 8.30, p < .00001$) with a significant

linear component ($F(1, 30) = 14.87, p < .006$) indicating that, overall, mothers exhibited an acceleratory HR pattern in response to the infant cries. There was no significant interaction between the type of cry and mother category factors.

Perception of Their Own Infant

On seven of the nine infant temperament dimensions, the mothers of premature and full-term infants did not differ in perception of their own infants. The mothers of prematures, however, rated their babies lower on "Mood" ($F(1, 28) = 8.97, p < .006, \bar{X}'s = 9.38$ and 10.63 for mothers of full-term and premature babies, respectively), "Persistence" ($F = 4.53, p < .04, \bar{X}'s = 8.25$ and 11.25) and on the composite dimension, "Difficulty" ($F = 12.35, p < .002; \bar{X}'s = 49.81$ and 56.00 , respectively).

The temperament questionnaire permits scores on Easy-Difficult to range from 0 to 90. The range in the present sample was 41-67. Arbitrary cutoffs were used to define extreme scorers (above 58 and below 51), whose verbal and physiological responses were then compared. By these criteria, seven mothers of prematures and four mothers of term babies rated their babies as Easy, while three mothers of premature and five mothers of term infants rated their babies as Difficult. Mothers who perceived their own child as easy were more alert ($F(1, 14) = 4.49, p < .05, \bar{X}'s = 4.90$ and 3.00), tended to be more attentive ($F = 3.09, p < .09, \bar{X}'s = 4.80$ and 3.00), and more willing to interact with the stimulus infant ($F = 2.90, p < .10, \bar{X}'s = 4.20$ and 3.44), than those who perceived their infants as difficult. The mothers of "easy" babies also exhibited significantly lower DBP ($F = 8.97, p < .009, \bar{X}'s = 0.22$ and 1.80), and HR ($F = 6.76, p < .02, \bar{X}'s = 0.78$ and 2.10) increases when exposed to the crying baby than did the mothers of difficult babies. These results appear rather striking considering both the small size of the samples ($n's = 11$ and 8) and the relative homogeneity of the groups, in terms of how they perceived their infants' temperaments.

Correlational Analyses

Correlations were computed between reported moods and physiological measures during the cry segments using data from all subjects. The mood "happy" was negatively correlated with SC ($r = -.37$) and with HR ($r = -.35$) change scores. The negative emotions (annoyed, irritated, disturbed, distressed) were highly intercorrelated ($r's \leq .65$) and positively correlated with heart rate ($r's \leq .35$), diastolic blood pressure ($r's \leq .45$) and skin conductance ($r's \leq .32$) change scores. These correlations are similar to those reported by Frodi et al. (1978a). Furthermore, attentiveness, alertness, and willingness to interact with the stimulus baby were negatively associated with the perceived difficulty of the subject's own child (absolute $r's \leq 0.46$).

DISCUSSION

The present study showed once again that infant cries elicit from adults a pattern of psychophysiological response characterized by autonomic arousal (see also Frodi et al., 1978a, 1978b; Frodi & Lamb, 1978). The immediate response to the onset of a cry signal is one of heart rate acceleration, followed by decline to a rate faster than the initial baseline level. In addition to cardiac activity, physiological arousal is evident on measures of skin conductance and diastolic blood pressure. This effect thus appears to be robust and replicable. In addition, the physiological changes were accompanied by verbal reports of irritation and aversion. Positive and significant correlations between verbal reports of this nature and the specific pattern of physiological response (concomitant increases in blood pressure, skin conductance, and heart rate) we observed have now been found in at least seven studies (Geen et al., 1975; Frodi, 1978; Frodi et al., 1978a, 1978b; Frodi & Lamb, 1978; Schachter, 1957; Weerts & Roberts, Note 3). It seems reasonable, therefore, to infer aversion from such a pattern of physiological responses.

Our most important finding was that the nature of the subjects' parenting experiences influenced the manner in which they responded to the cry stimuli. Specifically, mothers whose own infant had been born prematurely evinced greater physiological arousal in response to the cries of both full-term and premature infants. There were no significant interactions between the two major factors—mother condition and type of cry. These results suggest that the mothers of prematures, whose initial experiences were with atypical infants, have come (presumably through a process of generalization) to respond to all infant signals with greater autonomic arousal than that which is typical. It remains possible, of course, that the mothers of premature and full-term infants might have responded differentially to the cries of premature and full-term infants had the stimuli used in the present study been more different from one another or more representative of the classes they were supposed to represent (see below).

Given the clarity of these results, and the high correlation reported between the psychophysiological indices and the self-report measures, we were surprised that the mothers of premature infants did not find the cries more aversive than did the mothers of full-term infants. In fact, although both groups of mothers reported negative emotions, the mothers of prematures reported being more alert, attentive and happy during the cry than did the mothers of full-term infants. Perhaps the mothers of atypical infants have a greater desire to appear in a favorable light (i.e., as "good mothers") when responding to the questionnaire. The pattern of physiological response evinced by both groups of mothers was one indicating aversion.

Women who described their babies as easy reported being more attentive to, more alert, and more willing to interact with the stimulus baby than did the mothers whose babies were seen as difficult infants. In addition, the mothers of easy babies were less aroused physiologically than were the mothers of difficult babies. Although it is not possible to identify the direction of effects, these findings could be viewed as further evidence regarding the effects of mothering experiences on responses to standard infant stimuli. Even without additional investigation into the relationship between perceived temperament and maternal physiological responsiveness, however, the results of the present study demonstrate persuasively that extended experience with atypical babies leads mothers to respond negatively and with an exaggerated physiological arousal to infant cries.

On the other hand, we were unable to replicate the Frodi et al. (1978b) finding that the cry and facial characteristics of a premature infant elicited greater autonomic arousal and were more aversive than the cry and appearance of a full-term baby. Unfortunately, Frodi et al. did not report any information regarding the spectrographically determined characteristics of their cry stimulus. We were, however, able to obtain their videotapes in order to perform spectrographic analyses that might indicate whether stimulus differences accounted for the discrepancy between our findings and those of Frodi et al. (1978b). Our analyses showed that there was indeed a greater difference between the fundamental frequencies of the Frodi et al. stimulus infants than between ours. The fundamental frequency of the Frodi et al. premature infant ranged between 560 and 800 Hz (mean near 710 Hz) whereas the fundamental frequency of their term infant was between 310 and 360 Hz (mean near 330 Hz). The comparable means for our study were 600 and 330 Hz. This may have accounted for the discrepancy between our findings and those of Frodi et al. (1978b). Another difference between the studies is that our subjects had 7-month-old infants and thus may have been less attuned to the differences between the cries of full-term and premature *neonates* than were the Frodi et al. (1978b) subjects, who had 5-month-old infants.

A comparison of the Frodi et al. data with those obtained in the present study indicates that their subjects were more irritated and annoyed by, and less indifferent to, the premature infant than were ours. Their subjects also rated themselves less eager to interact with the infant whom they deemed less pleasant. Further, their premature infant elicited more dramatic changes in diastolic blood pressure, skin conductance, and heart rate than did ours. Similarly, their full-term stimulus infant elicited less irritation, annoyance, disturbance and indifference than ours did, and it elicited fewer dramatic changes in diastolic blood pressure, skin conductance, and heart rate than our full-term infant did. These data indicate that

our failure to replicate the Frodi et al. findings can be attributed to inter- and intrastudy differences between the stimuli employed. Obviously, one important avenue for future research involves systematic determination of the specific characteristics making some infants' cries more aversive than others'.

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