Effects of motherhood on physiological and subjective responses to infant cries in teenage mothers: A comparison with non-mothers and adult mothers

Jennifer Giardino [a], Andrea Gonzalez [a], Meir Steiner [b,c], Alison S. Fleming [a,*]

[a] *Department of Psychology, University of Toronto at Mississauga, 3359 Mississauga Rd. N., Mississauga, Ontario, Canada L5C 1C6*
[b] *Department of Psychiatry and Behavioural Neurosciences, and Obstetrics and Gynecology, McMaster University, Canada*
[c] *Women's Health Concerns Clinic and Father O'Sullivan Research Centre, St. Joseph's Healthcare, Hamilton, ON, Canada*

Abstract

The present study was designed to determine whether becoming a mother during the adolescent period changes maternal responsiveness or maternal motivation, assessed through hormonal, autonomic, and hedonic responses to recorded infant cries and interactions with their babies. Fifty-six teen mothers were compared to 58 teen non-mothers and 49 adult mothers. Teen mothers reported more sympathy and alertness in response to recorded infant cries compared to non-mother teens; however, among the teen women there were no differences between mothers and non-mothers in heart rate and cortisol responses to infant cries. In contrast, in comparison to adult mothers, teen mothers reported the same levels of sympathy and alertness to infant cries; however, adult mothers showed an 'alerted' pattern of heart rate and cortisol response to infant cries not seen in the teen mother group. Inclusion of the covariate, fathers' employment classification as an index of SES or time of testing and cortisol sampling did not affect this pattern of results. Taken together, these results show that where self-report is used as a measure of maternal responsiveness, teen mothers are no different in responsiveness than adult mothers; however, where physiological and interactional measures of responsiveness are considered, teen mothers are less likely to show heightened or selective responses to infant cries or respond 'attentively' to the infant.
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There is substantial literature that demonstrates that teenage mothers show less affectionate behavior, fewer positive facial expressions, and engage in fewer vocal exchanges with their infants compared to adult mothers, although they often spend more time performing instrumental activities (Teberg et al., 1983; Krpan et al., 2005).

In the present study, we explore the specific nature of mothering experienced by teen mothers, focusing specifically on the motivating capability of infants' cries. Research with adult mothers shows that in comparison to non-mothers, they experience heightened maternal motivation or responsiveness; they respond with greater sympathy and alertness to cries; they are more successful at discriminating between cries, and express greater feelings of sympathy and alertness in response to high intensity 'pain' cries than to the lower-intensity 'hunger' cries (Stallings et al., 2001). This difference between adult mothers and non-mothers in responsiveness to infant cues likely reflects a combination of differences in endocrine state and in prior experience with infants (Stallings et al., 2001; Fleming et al., 1997a,b).

Adult mothers show a relation between their hormonal profile and maternal responsiveness. Immediately following parturition, their maternal behaviors and responsiveness are positively associated with the glucocorticoid cortisol, a hormone usually associated with stress (Fleming et al., 1997a, b). We find, however, that first-time adult mothers at 2 to 3 days postpartum who have higher baseline levels of salivary cortisol are more positively attracted to their infants' body odor and they

* Corresponding author. Fax: +1 905 569 4326.
 E-mail address: fleming@psych.utoronto.ca (A.S. Fleming).

also engage in more affectionate contact behaviors and more caretaking activities (Fleming et al., 1997b). Moreover, among more experienced mothers, higher baseline cortisol is also associated with more sympathy in response to hunger cries (Stallings et al., 2001). Although the endocrine environment of the perinatal period supports a positive relation between maternal responsiveness measures and cortisol levels, 6 weeks later, the relation seems to be more complex and only holds for a restricted age group between 19 and 25 years, but not at older or younger ages. In older postpartum women, higher cortisol levels are associated with negative mood and fatigue (Krpan et al., 2005).

Other autonomic measures in adult mothers, including heart rate, blood pressure, and skin conductance, have also been used as measures of arousal or responsiveness to infant related stimuli (Frodi and Lamb, 1978; Leavitt and Donovan, 1979; Crowe and Zeskind, 1992; Furedy et al., 1989; LaGasse et al., 2005; Lester et al., 1995; see also Corter and Fleming, 2002). We have previously reported that adult postpartum mothers who are sympathetic to infant cries have a higher baseline heart rate than mothers low in sympathy; they also show small and reliable heart rate accelerations with the onset of pain and hunger cries; in contrast, non-postpartum women tend to show heart rate decelerations in response to cries (Stallings et al., 2001). According to the formulation of Furedy et al. (1989), one could interpret the mothers' acceleratory responses as 'preparatory to action' in response to the cries and the non-mothers' deceleratory pattern as a reflection of alertness to the cries, but with no action intention. Taken together, the literature suggests that with the birth of a child, adult mothers, in comparison to adult non-mothers, experience heightened and intense feelings of nurturance that is reflected in their maternal behavior, in their emotional reactions to infant signals and in their physiology; these are related to one another (Stallings et al., 2001), and are consistent with predictions from the nonhuman literature (Numan et al., 2006).

Based on this same psychobiological literature and the belief that teenagers, like adults, possess the underlying physiology to parent appropriately, we hypothesized that the postpartum period would be associated with elevated maternal motivation or responsiveness in teen mothers, in comparisons with teen non-mothers. However, since, in this culture, teenage mothers often have considerable difficulty interacting with their infants (Krpan et al., 2005) and are, in general, living in more adverse conditions, with greater family and life stresses, less social support and less overall mothering experience (Levine et al., 1985; Garcia Coll et al., 1987; Diehl, 1997; Hudson et al., 2000), we also hypothesized that teenage mothers would be less responsive on many of these same maternal dimensions when compared to the adult mothers. We also explored whether the two types of mothers would show a different pattern of relations between physiological indices of maternal motivation and the behavioral expression of that motivation. Finally, we considered the extent to which the differences in mothering style between teen and adult mothers is a function of chronological age per se or can be attributed to differences in SES, here reflected in the employment status of the significant male partner in the family of the mother (Bornstein et al., 2006).

The overall design of this study was therefore to specifically compare teen mothers, adult mothers and teen non-mothers on their affective, cortisol, and heart rate response to infant cries and in their attitudes towards parenting and infants, with specific attention paid to comparisons between (1) teen mothers and teen non-mothers, and (2) adult and teen mothers. Teen and adult mothers were also compared in their mode of interaction with their infants and these were correlated with their physiological responses.

Methods

Participants

New mothers (adult mothers = 49, teen mothers = 56)

Mothers were recruited from the maternity ward at St. Joseph's Healthcare in Hamilton, Ontario, Canada, and from prenatal and postpartum groups in Mississauga, Brampton, and Hamilton, Ontario, Canada. Teenage mothers were also recruited from St. Martin's Manor and Grace Haven, in Hamilton, Ontario, and the Department of Public Health (Prenatal classes and Healthy Baby, Healthy Mom programs), and local community centers (i.e., YWCA, Kiwanis Club) located in the Greater Toronto Area and in Hamilton, Ontario. These organizations provide support and assistance for new mothers. The samples consisted of predominantly primiparous mothers (adult mothers = 49 and teen mothers = 56). The criteria for inclusion for teen mothers included: age between 14 and 19 years; good general health, and English speaking. The same inclusion criterion was used for adult mothers; however, subjects had to be older than 19 years. All mothers participated in the study within 6–22 weeks postpartum.

Teenage control group (non-mothers teens, n = 58)

Non-mother teens between the ages of 14 and 19 years were recruited through alternative education programs, youth centers, in Hamilton, Georgetown, and Burlington, Ontario, Canada, and from a first-year psychology database at the University of Toronto at Mississauga, Ontario, Canada. Non-mothers were matched to teen mothers by age, income, and education. Non-mothers were tested during the luteal phase of their menstrual cycle (within 20 days of the onset of menses).

As can be seen in Table 1 and described below under Demographics, there were overall differences between teen mothers, teen non-mothers, and adult mothers in education, marital status, and family income.

Study design

Stimuli

Participants were exposed to one of two different conditions: (1) infant 'pain' and 'hunger' cries (cry condition), or (2) neutral voice passages (control condition).

Cry condition

The cry stimuli consisted of four cries: two 'hunger' cries and two 'pain' cries. The two 'hunger' cries were recorded from infants in a newborn nursery just before being taken to their mothers for a scheduled feeding. The two 'pain' cries were recorded during circumcision procedures on healthy newborn males (Stallings et al., 2001). Although the two cry types were not analyzed for their functionality or for their differences in acoustic properties, in this paper we will refer to them as 'pain' and 'hunger' cries based solely on the context in which they were recorded. Each tape consisted of all four cries, each 35 s in length, with a 1-min interstimulus interval.

Control condition

The control stimulus tape consisted of four 'neutral' verbal passages delivered in a 'neutral' tone of voice. Passages described topic such as the mechanical strength of leaves, and campfire fuels. Each tape consisted of four passages, each 35 s in length, with a 1-min interstimulus interval.

Table 1
Demographic characteristics of population studied

Demographic	Teen mothers	Teen non-mothers	Adult mothers
Sample size (N)	56	58	49
Age			
Mean (years)	17.9 (18)	17.5 (19)	30.8 (30)
Age of infant			
Mean	3.3 (3.0)	n/a	3.6 (3.0)
Highest education (%)			
Some high school	75	52	4
High school graduate	16	12	4
Some college/university	9	36	12
College/university graduate	0	0	62
Graduate	0	0	18
Work status (%)[*, a,b]			
Full-time	2	9	7
Part-time	7	17	8
Student/no occupation	86	74	6
Full-time parent	4	0	10
Income ($) (%)[a,b]			
No income	35	23	10
Under 10,000	46	55	4
10,000–30,000	17	19	6
Over 30,000	0	0	78
Marital status (%)[a,b]			
Married/cohabitate	21	2	90
Single	79	98	10
Nursing status (%)[a]			
Nursing	45	n/a	76
Occupation type (%)			
Father (teens)/Partner[a,b]			
Manual	63	35	11
Retail/service	11	9	16
Office/clerk/own business	20	19	9
Professional	6	37	64

*Overall group differences by chi-square $p = .001$. [a]Teen mothers vs. adult mothers, $p = .05$. [b]Teen non-mothers vs. adult mothers, $p = .05$. [c]Teen non-mothers vs. teen mothers, $p = .05$.

Measures

Emotional Response Scores (ERS)

Following presentation of each 35s stimulus segment, during the inter-stimulus interval, subjects completed a set of 100-mm visual analogue scales (ranging from 'not at all' to 'extremely'). Each scale represented different affective states: reflecting reactions that were sympathetic, alert, and negative (for more detail of ERS factors, see Stallings et al., 2001). The ERSs for the two hunger cries and the two pain cries were averaged within cry type to produce separate ERSs of sympathy, alert, and negative for each of the stimuli (see Stallings et al., 2001).

Heart rate monitoring

Subjects were fitted with a heart rate monitoring system (POLAR S810I, Polar Electronics, Lachine, Quebec), which includes a comfortable elastic transmitter belt and a wristwatch monitor (resembling a sports watch). The device allowed for collection of heart rate data at 1-s intervals. The heart rate monitoring was initiated 15 min before the stimulus tape presentation and continued until 15 min after the stimulus period. Data were later downloaded for analysis.

Hormones

Salivary samples for cortisol were collected between 8:50 a.m. and 11:00 am at the following times: baseline (before the presentation of the stimulus tape), and at +20 and +40 min after the presentation of the tapes.

Cortisol salivary samples were collected using salivettes (Sarstedt Canada, St. Laurent, Quebec) and assayed using a highly sensitive enzyme immunoassay kit (Salimetrics, State College, PA). The measured hormone in saliva was approximately 1% of the serum values. The interassay variability was 5.08% (high value samples, 3.75%; low value samples, 6.41%; $n = 12$ each), the intra-assay variation was 3.35%, for samples with low values ($n = 14$) and 3.65% for samples with high values ($n = 18$).

Questionnaires

The questionnaires were filled out either on the day of testing or shortly thereafter. The questionnaires covered a wide range of issues including mood, physical symptoms, maternal attitudes, current experiences as well as demographic information.

Maternal attitude and current experience questionnaires. Factors were created based on response to the Maternal Attitude Questionnaire and the Current Experience Questionnaire.

For the Maternal Attitude Questionnaire, subjects had to rate 83 attitude items using a scale ranging from 'strongly disagree to strongly agree'. The Maternal Attitude factors used in the present study were derived from responses on the same set of 83 attitude items completed by an original population of 667 subjects (Ruble et al., 1990) and another population of 245 subjects (Fleming et al., 1988). These included factors reflecting attitudes such as negativity toward caretaking duties, parental worry, own parental support, and maternal attachment. The teen non-mother group filled out the same battery of questionnaires but all questions referring to issues pertaining specifically to motherhood and having a child were posed as 'hypothetical' statements worded as, "if I become pregnant I would..."

For the Current Experience Questionnaire subjects had to rate 44 current mood, and physical concerns using a Likert-type scale ranging from 'none' to 'extremely'. Items on this questionnaire covered symptoms, such as physical symptoms, depression, anxiety, irritability, feelings of well-being, and fatigue. These mood factors have been found to be reliable and valid for the postpartum population and show consistency over time (see Fleming et al., 1988). Correlation between the current experience scale (CES) and other standardized mood scales (e.g., the MAACL; Zuckerman and Lubin, 1965) are highly significant, ranging from 0.55 to 0.80 in different studies (Fleming et al., 1988).

Testing protocol

Responses to cries. The protocol was identical for both stimulus conditions. Adult mothers, teen mothers and teen non-mothers received the following (1) a detailed explanation of the protocol, (2) fitting for heart rate monitoring, (3) initiation of heart rate monitoring, (4) completion of mood scales, (5) 2-min waiting period (for baseline heart rate), (6) first saliva collection (baseline), (7) 2-min waiting period, (8) first cry or control stimulus, (9) rating of affective responses (ERSs), (10) 1-min interval, (11) repetition of steps 8, 9, 10 for total of 4 cries/stimuli, (12) second saliva collection (+20-min post tape onset), (13) third saliva collection (+40-min post tape onset), (14) discontinuation of heart rate monitoring.

Mother–infant interactions. After the test period, mothers were videotaped individually with their infants for 15 min in a private room within their home or the organization where they were residing. Mothers were given the opportunity to feed and change the infant prior to the video commencement. Behaviors were later coded from the videotape using an S and K Event Recorder (S and K NorPark Computer Design, Toronto). Because the videotaped sessions varied in length between 12 and 15 min, all behavior durations were converted to proportions of total session time. The behaviors that were coded included maternal attention (looking at the baby, looking at and over, looking away, en face, looking at magazine), talking to the infant (motherese, adult voice, quiet talk), grooming/caretaking (wiping face, adjusting clothing/blanket), infant activity (waving arms, fussing/crying), affectionate touching (stroking, palming), proximity (mothers face within 2 in. of infant's body), and poking the

infant (see Fleming et al., 1988, 1997a,b; Krpan et al., 2005). Interrater and intraobserver reliability was ensured by having two observers independently code 10 videotapes of mothers interacting with their infants on two separate occasions. Frequencies and durations of each of the individual behaviors described above highly correlated between and within observers with r values ranging from 0.82 to 1.0.

Data analyses

Initially, all three groups were included, for all analyses, with the SES demographic also included as a covariate. For multivariate analyses on most outcome measures, there were either main effects of group or an interaction of group with another factor (condition). Where overall main group effects were reported, these were followed by Tukey post hoc tests, comparing pairs of groups. However, to circumvent the constraints intrinsic to post hoc comparisons where covariates have been included in the analyses or where the group factor interacts with other factors that are in the form of a repeated measures, most post hoc analyses involved two sets of two group analyses: (1) between teen mothers and teen non-mothers, and (2) between teen mothers and adult mothers. In many analyses a second factor, stimulus condition (cry tape vs. voice tape), was also included. Hence, analyses on outcome measures were done using both a single ANOVA including all three groups and a demographic covariate followed by two ANOVAs separately comparing pairs of groups.

ERS

ERS scores on sympathy, alertness and negativity to infant cries and control stimuli were compared in groups using a series of ANOVAs which took the form of 3 (group: teen mothers vs. teen non-mothers vs. adult mothers) or 2 (group: teen mothers vs. teen non-mothers; teen mothers vs. adult mothers) × 2 (condition: cry tape vs. voice tape) or 2 (cry type: 'pain' cry vs. 'hunger' cry in only the cry tape condition).

Salivary cortisol

Salivary cortisol concentrations were analyzed using a series of ANOVAs (3 and then 2 groups) × 2 (condition: cry stimuli vs. control stimuli) × 3 (cortisol concentrations: at baseline, post time 1 (at end of tape and 20 min after tape onset), and post time 2 (40 min after tape onset). Cortisol values were analyzed both as raw scores and in terms of a proportional change from baseline values.

Heart rate

Because there were no differences in heart rate responses to 'pain' versus 'hunger' cries, for the purpose of analyses, heart rate intervals of 5 s were calculated by averaging beats per min across all cries (combined, 'pain' and 'hunger'). Heart rate was analyzed as follows: to assess group and condition effects, ANOVAs were computed, comparing 3 and then 2 groups × 2 (condition: cry stimulus tape vs. control voice stimulus tape) × 4 (within heart rates: HRs, averaged over 5 s intervals; one baseline HR (average of 3 pre stimulus HRs) and 3 HR averages following the onset of the four cries or voice segments) repeated measures ANOVAs.

Maternal attitude scales and the current experience scales

The different sets of questionnaires items were combined in factors, based on factor analyses performed with an earlier data set (Ruble et al., 1990; Fleming et al., 1988, 1997a,b). Here we discuss factors relating to infants, caregiving, and self-concept as a mother. Maternal attitudes were assessed using a series of one-way ANOVAs comparing three groups (teen mothers vs. teen non-mothers; teen mothers vs. adult mothers). These were followed by Tukey post hoc paired comparisons.

Maternal behaviors

Finally, to determine whether teen mother and adult mothers interacted with their infants differently, the two groups of mothers were compared using a series of one-way ANOVAs on all measures of maternal behavior (frequencies and durations).

Covariates

Given the group differences in demographics, in all three group ANOVA comparisons, analyses were done with the inclusion of one SES factor, father's

occupation/profession, as a covariate. In comparisons between teen and adult mothers, the demographic of 'education' status was not included as a covariate because this factor overlapped 100% with group; as indicated above, none of the teens had completed high school and all of the adults had. There was some variation in group sizes for analyses of the different outcome measures (comparisons between teen mothers and teen non-mothers ranged from $df=1$, 88 to 1, 112 (for heart rate and attitudes, respectively); comparisons between teen mothers and adult mothers ranged from $df=1$, 78 to 1, 100 (for heart rate and attitudes, respectively). Where covariates were included, sample size varied as information on fathers' occupation was not always available (occupation information missing from 9 subjects).

Results

Demographics

As can be seen in Table 1, there were differences between adult mothers, teen mothers and teen non-mothers in income [$\chi^2(6)=106.1$, $p=.00$], education [$\chi^2(8)=137.8$, $p<.001$], and martial status [$\chi^2(2)=125.93$, $p<.001$]. Many of these differences are intrinsic to the age differences between teenagers, who are still in high school, and adults who, for the most part, have completed high school and have been employed. To obtain information on surrounding SES influences on subjects, we also looked at job classification of parents of subjects where these were known. To establish comparability of the three groups in terms of their overall SES, we also considered the jobs held by the adult male parents of the two teenage groups and found no differences in the distribution of the job categories they held. We also compared the occupation of the husbands of the adult mothers with the occupation of the fathers of the teen mothers and non-mothers; these male family members were sometimes of the same generation (father of a 15-year-old mother approximately the same age as the husband of the adult 35-year-old mother). We found that the basic pattern of employment of the significant male in the family was the same across the three groups (see Table 1).

Emotional Response Scores (ERSs)

Cry tape versus control tape

Analyses comparing the three groups on the different ERS responses showed a main effect of group for sympathy [$F(2, 123)=4.32$, $p=.015$], with non-mothers showing the lowest sympathy of the three groups (see below). Post hoc tests indicated that teen mothers showed higher sympathy than non-mothers but did not differ from adult mothers ($p=.05$). There were also main effects of stimulus condition [$F(1, 123)=52.3$, $p<.001$]. Independent of group, women reported more intense feelings of sympathy and alertness, as well as negativity, when hearing the cry tape as compared to when listening to neutral voices (the control tape).

'Pain' versus 'hunger' cry stimuli in cry tape

Teen mothers versus Teen non-mothers. As shown in Fig. 1a, there was a main group effect for alertness [$F(1, 71)=5.88$, $p=.018$] and for sympathy [$F(1, 71)=6.08$, $p=.016$] in res-
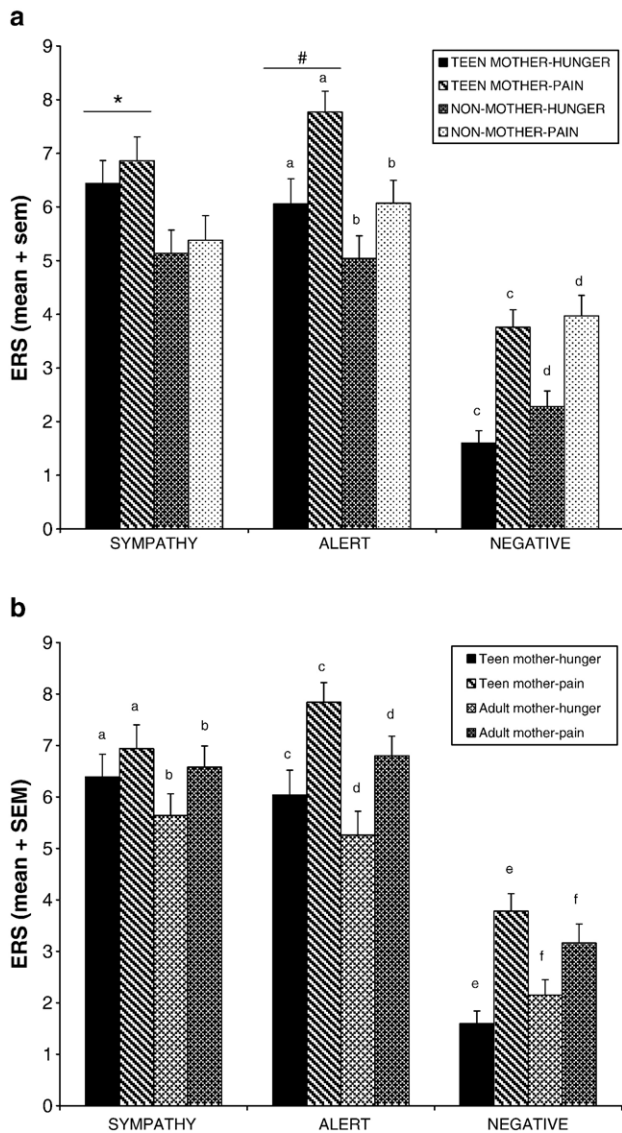
Fig. 1. (a) Emotional Response Scores (ERSs) (mean+SEM) in response to infant hunger and pain cries (teen mother and teen non-mothers). There was a main group effect for alertness and for sympathy in response to both cry types. Bars with symbols (*, #) indicate group differences within the ERS (*p*<.05). There was also a main effect of cry type for alertness and negativity (*p*<.001), with pain cries eliciting higher ratings on alertness and negativity than hunger cries, irrespective of group condition. Bars that share letters (a, b, c, d) are significantly different from one another. (b) Emotional Response Scores (ERSs) (mean+SEM) in response to infant hunger and pain cries (teen mother and adult mother). There were main effects of cry type for sympathy, alertness and negativity. In comparison to the hunger cry, the pain cry produced more sympathy, alertness and negativity in both groups of mothers (*p*<.05). Bars that share letters (a, b, c, d, e, f) are significantly different from one another.

ponse to both cry types; teen mothers were both more alert and more sympathetic to both cry types than were teen non-mothers. There was also a main effect of cry type for alertness [$F(1, 71)=$ 68.51, *p*<.001] and negativity [$F(1, 71)=90.36$, *p*<.001], with the 'pain' cry producing higher ratings on alertness and negativity than did the 'hunger' cry, irrespective of group condition. These analyses did not yield any significant interactions.

Teen mothers versus Adult mothers. As shown in Fig. 1b, there were main effects of cry type for sympathy [$F(1, 61)=$ 7.1, *p*=.008], alertness [$F(1, 61)=36$, *p*<.001], and negativity [$F(1, 61)=66.2$, *p*<.001], but no main effects of group. In comparison to the hunger cry, the pain cry produced more sympathy, alertness, and negativity in both groups of mothers. However, teen mothers were less negative than adult mothers to the hunger cry but more negative to the pain cry, yielding a significant Cry type × Group interaction [$F(1, 61)=8.2$, *p*=.005].

Hormonal responses to infant cries versus control voice stimuli

In a set of analyses to determine whether there was a difference between groups in their hormonal responses to the cry stimuli versus control stimuli, no main effects of group were found. There was, however, a Group×Hormone interaction [$F(2, 120)=4.072$, *p*=.019], with the adult mother group showing lower baseline levels of cortisol than the two teen groups and only a marginal decline over the 40 min period, whereas the two teen groups each showed a precipitous decline. There was also a main effect of condition [$F(1, 120)=$ 7.36, *p*=.008], with all groups showing higher cortisol in the cry condition than in the control voice condition. This difference was apparent even at baseline and persisted throughout the 40-min assessment period. There was also a main effect of time, with cortisol undergoing a decline from baseline to the +20 and +40 min sampling [$F(1, 120)=8.62$, *p*=.004] in all groups in both conditions. These relations persisted when the time of day of the cortisol measurement was included as a covariate.

Teen mothers versus Teen non-mothers

Analyses of the proportional change in cortisol levels from the baseline produced a three-way interaction between cortisol values, group, and condition [$F(1, 104)=4.038$, *p*=.047]. In the cry tape condition, both teen mothers and non-mothers showed a linear decline in cortisol and to the same extent. However, the two groups had different endocrine response to the tapes; in the voice control tape condition, teen non-mothers showed only a slight decline in cortisol over time, whereas the teen mothers showed a decline rate similar to groups who were exposed to the cry tape (see Fig. 2a).

Teen mothers versus Adult mothers

The differential cortisol response between the two mother groups was particularly evident in the cry condition when the proportional change from baseline in salivary cortisol across the three times points was analyzed. As shown in Fig. 2b, adult mothers listening to the cry tape showed initial relative elevations in their cortisol levels, whereas teen mothers showed no elevation and showed circadian declines [Group×Cortisol interaction: $F(1, 56)=26.06$, *p*=.017]. There was also a main effect of group [$F(1, 56)=6.03$, *p*=.017], with teens having proportionately elevated levels of salivary cortisol across the time points. This same pattern was not seen in responses to the control tape.
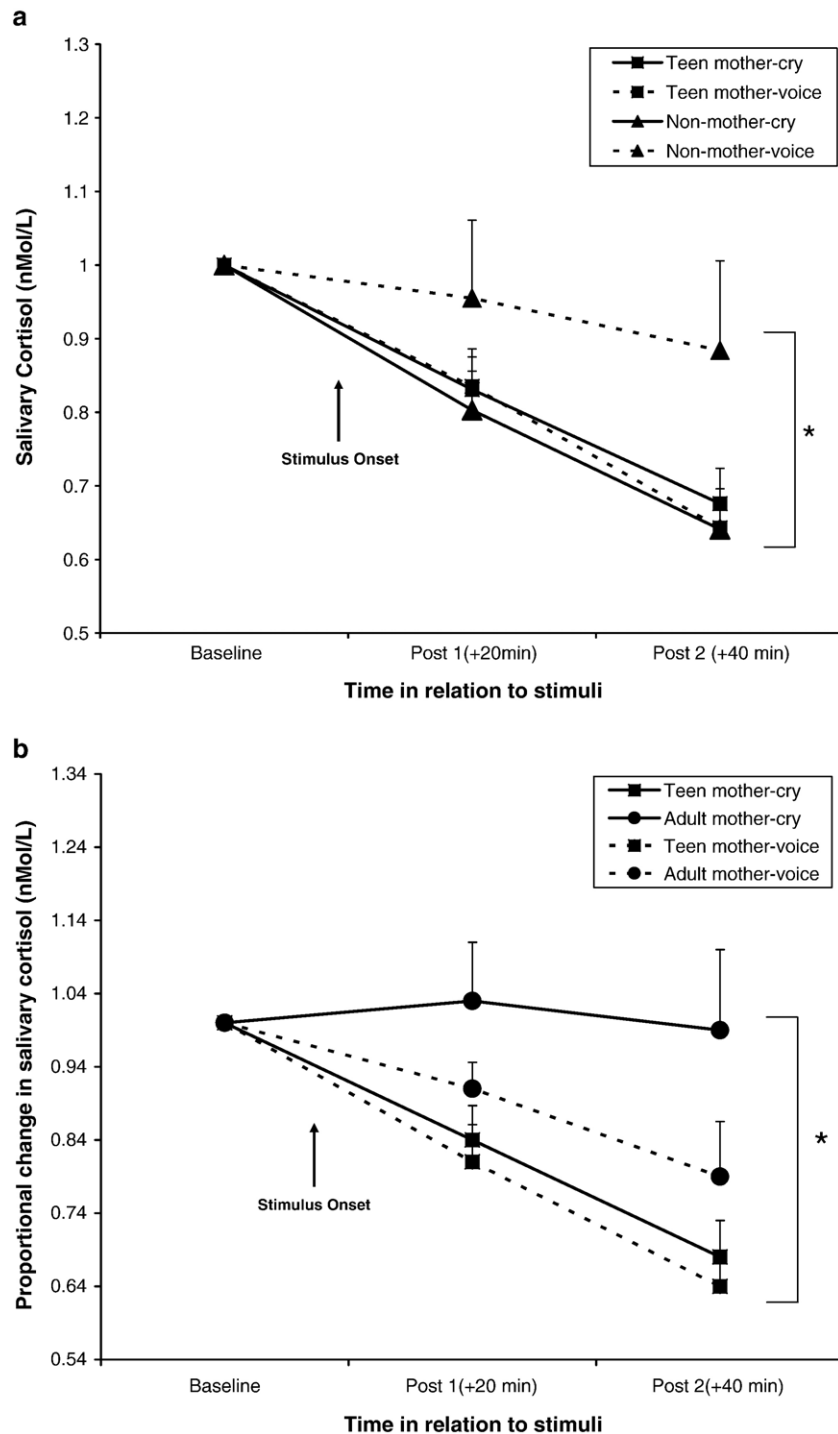
Fig. 2. (a) Salivary cortisol concentrations (proportional change from baseline + SEM) in response to cries and control stimuli (teen mothers and teen non-mother). The paren * represents a three-way interaction between cortisol, group and condition (*p* = .047). (b) Salivary cortisol concentrations (proportional change from baseline + SEM) in response to cries and control stimuli (teen mothers and adult mothers). The paren * represents a Group × Cortisol interaction (*p* = .017).

Heart rate responses to infant cries versus control stimuli

Analyses to determine whether the three groups differed in heart rate as a function of tape condition, showed a significant three-way interaction [Heart rate × Group × Condition; $F(2, 99) = 3.07$, $p = .05$], which takes a quadratic form.

As can be seen in Fig. 3, in the cry condition, non-mothers showed a steep deceleration in their heart rate with the presentation of the cry stimuli, whereas teen mothers showed only a marginal change in heart rate. Adult mothers, in contrast, showed more variable heart rates and showed heart rate accelerations in response to the onset of the cry stimuli. In
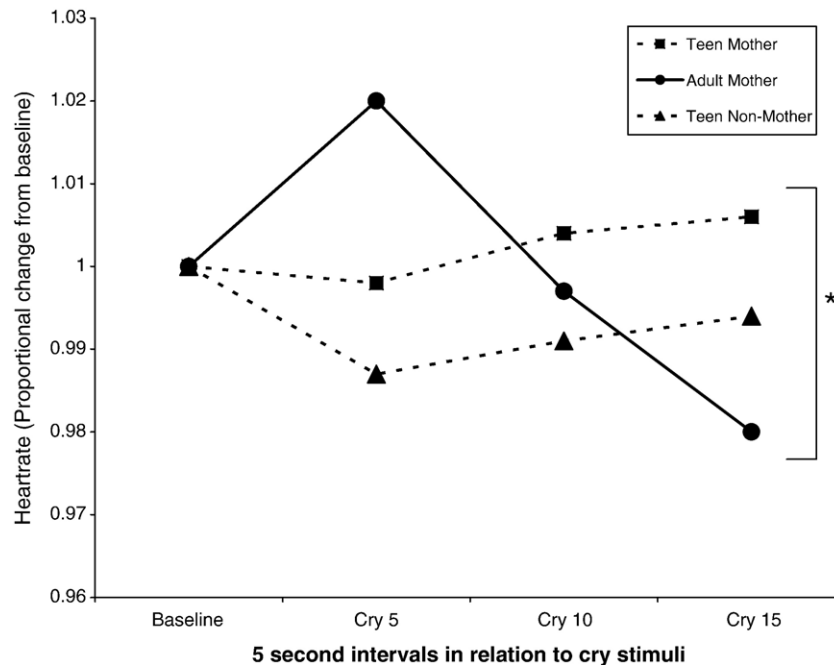
Fig. 3. Proportional heart rate responses are averaged over 5, 10, and 15 s after onset of the cry stimuli. Heart rates at consecutive 5-s intervals after cry onsets are computed as a proportion of baseline heart rates (at 5 s before cry onsets). The paren * represents a Heart rate × Group × Condition interaction ($p = .05$).

contrast, in the voice condition, teen and adult mothers showed an increase in heart rate with the onset of the voice stimuli, and non-mothers show only a marginal change.

Attitudes toward own and other infants, and caregiving, and self-concept and affect assessed through questionnaire (maternal attitude scales and current experience scales)

Attitudes to motherhood and infants

There were significant differences in most measures of maternal attitudes based on the Maternal Attitude Questionnaire. In comparison to the teen and adult mothers' reported experiences, teen non-mothers expected to experience more parental worries [$F(2, 121) = 22.57$, $p < .001$], and to feel more negatively about caretaking attitudes [$F(2, 121) = 9.79$, $p < .001$]. Non-mothers also expected to feel more tied down by an infant [$F(2, 121) = 9.23$, $p < .001$] than did both the teen and adult mothers, who did not differ from one another.

In comparison to expectations reported by non-mothers, the two groups of mothers did not differ from one another, but both groups rated themselves as more confident in their ability to take care of a child [$F(2, 126) = 21.21$, $p < .001$], more attached to their infants [$F(2, 121) = 33.98$, $p < .001$], and more adequate in their ability to be a mother [$F(2, 121) = 21.43$, $p < .001$]. Mothers were also more positive in their current feelings about infants [$F(2, 121) = 3.64$, $p = .029$] and, based on the mothering experience questionnaire, were also more positive about their ratings of previous interactions with infants [$F(2, 124) = 3.9$, $p = .02$]. In the area of mood, both groups of teens had more negative mood than did the adult mother [$F(2, 126) = 4.83$, $p < .01$] and did not differ from one another.

Maternal behavior

As shown in Fig. 4, adult mothers spent more time interacting with their infants [$F(1, 92) = 5.072$, $p = .027$], and teen mothers spent more time looking away from their infants and attending to something else [$F(1, 92) = 4.13$, $p = .045$]. In addition, infants of adult mothers were more active compared to infants of teen mothers [$F(1, 92) = 3.98$, $p = .049$].

Correlations between maternal behaviors, subjective feelings about infant cries, and salivary cortisol levels

When the entire sample of mothers were analyzed together, there were low, but significantly positive, correlations between mothers' time spent interacting positively with their own infants
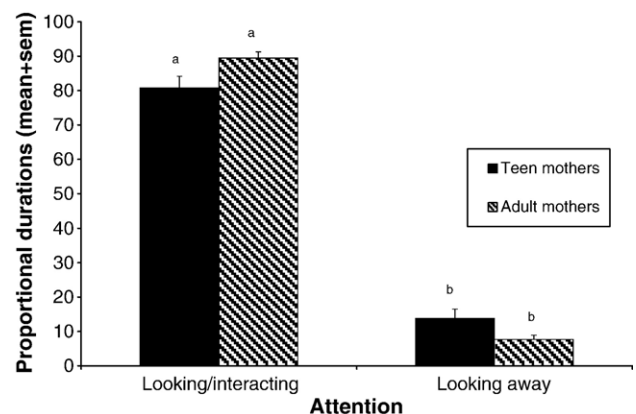

Fig. 4. Maternal behaviors. There were group differences in time interacting with infants and in time spent looking away from the infants and attending to something else. Bars that share letters (a, b) are significantly different from one another.

and (1) feelings of sympathy when hearing the cries ($r = 0.19$, $p = .029$) and (2) cortisol levels at all three time points ($r = 0.16–0.22$, $p = .065–.014$). When the two mother samples were analyzed separately, there was no relation between teen mothers' maternal behavior and either their ERS or CORT measures. However, among the adult women, there was a strong positive relation between positive interactions with the infant and feelings of alertness ($r = 0.31$, $p = .006$), sympathy ($r = 0.267$, $p = .019$) to the cries or the three cortisol measures ($r = 0.23–0.29$, $p = .045–.01$).

Summary and discussion

Our previous work has shown that adult mothers are more responsive to infant cues than are non-mothers, an effect that reflects a motivational state of heightened maternal responsiveness (Stallings et al., 2001; Fleming et al., 1997a,b).

The present study was designed to determine whether teen mothers, in comparison to teen non-mothers, would also show elevated responsiveness, reflected in behavioral and physiological responses to infant cry stimuli. Given our previous findings that teenage mothers are not as affectionate while interacting with their infants (Krpan et al., 2005), we also predicted that teen mothers would not be as responsive as adult mothers to infants' cries in terms of both subjective and physiological indices of responsiveness.

The present results show that motherhood in adolescence results in more positive responses to infant cues over and above the level normally seen in teenage women who are not mothers. For instance, in response to infant cries, teen mothers, in comparison to non-mothers, are more affectively responsive, using subjective self-report measures of sympathy and alertness. In terms of their subjective self-reported feelings of nurturance or attachment, teen mothers again report more positive feelings; and in terms of how they evaluated their experiences with infants in the past, teen mothers describe their experiences as more positive. In contrast to these behavioral measures, when examining physiological measures, in particular, endocrine and autonomic responsiveness, teen mothers and non-mothers do not differ. This indicates that when self-report is used as a measure of responsiveness, teen mothers are more responsive than are non-mothers. However, where physiological responses constitute the measures of responsiveness, the two groups exhibit minor differences and show minimal selective responses to the infant cries. However, both groups exhibit the appropriate level of alertness in response to the higher intensity 'pain' cry (Soltis, 2004; LaGasse et al., 2005).

When comparing teen and adult mothers, we found that in response to infant cries, teen mothers are equally affectively responsive to infant cries compared with adult mothers, using subjective self-report for measures of sympathy and alertness; however, teen mothers report less negativity to hunger cries but more negativity in response to the high intensity infant pain cries. In response to the self-report questionnaire data, there were very few differences as a function solely of age in mothers' attitudes toward infants in general, their own infants, or maternal competence. In terms of physiological measures, a different set of patterns emerge; for endocrine and autonomic responses, teen

mothers do not show the selective and reliable response to infant cries that adult mothers exhibit; adult mothers, in general, show brief and stimulus-linked elevations in heart rate and salivary cortisol with presentation of the cry stimuli; teen mothers do not. These elevations are interpreted as normal attentional responses with the onset of stimuli that have salience. In contrast, teen mothers tend to show delayed heart rate and cortisol elevations and/or marked reductions, reflecting a pattern normally consistent with an 'orienting response' rather than a 'preparation for action' (Furedy et al., 1989). In terms of their interactions with their infants, there were also differences between teen and adult mothers, consistent with our earlier study (Krpan et al., 2005); we interpret these differences as indicating that teen mothers were more easily distracted from focusing attention on the infant.

The salivary cortisol data in this study are consistent with our previous work (Krpan et al., 2005), which shows that teen mothers also have higher baseline salivary cortisol levels than do adult mothers, but they do not show the same elevations (or proportional elevations) in cortisol in response to cries as do the adult mothers. Although we did not have information on the awakening time of our participants, which may differ between teen and adult mothers, the group differences in cortisol were retained after covarying time within the morning that assessments were made (see Tu et al., 2006). The difference between adult and teen mothers in their baseline cortisol levels may also be a simple function of their age difference. Teen mother and non-mothers showed no differences in baseline salivary cortisol, suggesting that the difference between adults and teens is not specific to the postpartum period, but occurs more generally (Kiess et al., 1995). However, the absence of a clear cortisol response with the onset of the stimulus tape in teen mothers, in contrast to the brief elevation seen in adult mothers, suggests the absence of a stimulus-induced arousal in these teens. Finally, with respect to heart rate responses to cries, in comparison to adult mothers, the teen mothers show a heart rate pattern that is more variable with more peaks and decelerations. They are also less likely to show the small heart rate elevations proximal to cry onsets, shown by adult mothers.

Taken together, there are clear differences in physiologic responses to infant cues between adult and teen mothers and in the pattern of relations between the underlying physiology and subjective self-report. Teen mothers express equally positive feelings about infants as do the adult mothers; however, their behavior indicates they are less attentive to the infants themselves and their physiology indicates that they are less attuned to infant cues. These results are certainly consistent with previous reports of parenting in teen mothers where it has been reported that teen mothers show less affectionate contact, fewer facial expressions (smiling behaviors), and reduced verbal contact compared to adult mothers (Teberg et al., 1983; Letourneau, 2001; Krpan et al., 2005).

With respect to the cortisol measures, all analyses indicated that regardless of parity, experience, or stimulus tape condition, there was always a main effect of time of day where cortisol levels decrease over the second and third time periods. This decline most certainly reflects the circadian decline that occurs in humans and other diurnal animals with cortisol peaking in the

morning and dropping through the early morning and afternoon (Buijs et al., 2003). Although there were no differences in the time of sampling across the different groups (all in the morning between 9 and 11 am), we nevertheless included time as a covariate in a number of the analyses of both cortisol and heart rate and found that all reported relations were retained. However, future studies may choose to collect saliva samples during the afternoon hours when cortisol is lower and more stable (Buijs et al., 2003). A larger cortisol stress response would likely occur in the afternoon when baseline levels are low.

In general, adolescents, and especially adolescents from lower socioeconomic status class, are known to engage in many risky behaviors that are often accompanied by negative outcomes (Johnson et al., 2002; Guo et al., 2002a,b; Petridou et al., 1997). If motherhood ensues as a result of an early and unplanned pregnancy, the teenager is often single, stressed, unprepared and usually lacks support from her family or environment (Canetti et al., 1997). In these cases, an abiding and consistent positive response to the infant may be difficult. In addition to these obvious situational and demographic challenges that differentiate many of the teen mothers from their adult counterparts, teenagers are also emotionally and neurologically less mature than are adults. Although they have been pregnant and became mothers, in many ways, teenage mothers do not differ cognitively, emotionally, or physiologically from their non-mother teen peers. In addition to the social and economic challenges confronting teenage mothers that may explain some of the present results, there is also a substantial literature indicating that the medial prefrontal cortex, the brain region important for planning and executive functioning, is still developing through the teenage years, reaching maturity only in the mid-twenties (Toga et al., 2006; Gogtay et al., 2004). As a result of their neural immaturity, these young mothers may be more challenged to adequately attend to their infants and respond appropriately to their cues.

Acknowledgment

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