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Experiential and hormonal correlates of maternal behavior in teen and adult mothers

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Abstract

This study explores the role of cortisol and early life experiences in the regulation of maternal behavior and mood in teen and adult mothers. Primiparous mothers (n = 119) (teen mothers < 19 years, n = 42), young mothers (19–25 years, n = 34), and mature mothers, (>25 years, n = 43) were assessed for their maternal behavior, mood, and hormonal profile at approximately 6 weeks postpartum. Outcome measures were analyzed as a function of age and early life experience. Results showed an interaction between age and type of maternal behavior, where teen mothers engaged in more instrumental (e.g. changing diapers, adjusting clothes) less affectionate (e.g., stroking, kissing, patting) behavior, and mature mothers engaged in more affectionate and less instrumental behavior. When groups were reassessed based on early life experience (consistency of care during the first 12 years of life: consistent care; having at least one consistent caregiver, inconsistent care; having multiple and changing caregivers), an interaction was also found between consistency of care and type of behavior shown, where mothers who received inconsistent care engaged in more instrumental and less affectionate behavior. Compared to mature mothers, teen mothers who were breast feeding also had higher salivary cortisol levels, and high cortisol in teen mothers related to decreased fatigue and increased energy. These results suggest that early life experiences are linked to mothering behavior and are consistent with the emerging human and animal literature on intergenerational effects of mothering style.

Keywords: Maternal behavior; Cortisol; Teen mother; Early life experience

Introduction

The quality of behavior that new mothers show toward their infants is affected by a complex set of factors, including maternal age, early life experiences, physical and mental health, socioeconomic status (SES), present supports and stresses, cultural and societal expectations, and physiology (Corter and Fleming, 2002). This study was designed to assess differences between the quality of mothering shown by teen and adult mothers in relation to their hormones, age, and early life experiences.

In many cultures, it is not only common for females to give birth to their first child during their teen years, but it is also expected. However, in cultures where becoming a mother during adolescence is not the norm, relations between disadvantaged early life situations and maternal age have been observed. In such cases, teen mothers are likely to have grown up in a difficult family situation themselves and to have received inadequate or inappropriate parenting (de Paul and Domenech, 2000; Rebollo and Montero, 2000). Teen mothers are also more likely to come from low socioeconomic levels in urban areas (Furstenberg et al., 1987; Rebollo and Montero, 2000; Hardy et al., 1997), be less well educated, and be more prone to depression (Jackson et al., 2000). Perhaps related to this profile, teen mothers also tend to behave differently than do their adult counterparts when interacting with their infants

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(Elster et al., 1983; Garcia-Coll et al., 1987; Levine et al., 1985; Musick, 1990; Parks and Arndt, 1990). Often, they have unrealistic expectations of their infant, are less verbal, their play behaviors are less sensitive to the needs of the infant, and they provide a lower quality of stimulation to their infants (Garcia-Coll et al., 1987; Musick, 1990; Parks and Arndt, 1990). In addition, during mother–infant interactions, teen mothers tend to prod, pinch, and poke their infants more than do adult mothers, and in ways that show they are less sensitive to infant cues (Sadler and Catrone, 1983). For example, teen mothers have been observed to engage in 'forcing' and 'overriding' behavior toward their infants, exhibit poor 'acknowledgement' of infant behavior, as well as poor dyadic reciprocity and less turn taking during play (Flanagan et al., 1994). Possibly as a consequence, children of teen parents have a poor predicted outcome in a number of life areas (Furstenberg et al., 1987; Geronimous, 1987) and are more likely to become adolescent parents themselves (Maynard, 1996).

In addition to maternal age, we take for granted the fact that early experiences being parented have long-term effects on the infants' development and on their own maternal behavior when they have children (Bowlby, 1969; Plomin, 1989). Young infants clearly learn all sorts of things about their mothers and home environments, and in that process develop secure attachments, ambivalent attachments, or avoidant behaviors in relation to their caregivers (see Belsky, 2003). Longitudinal prospective studies contrasting the quality of parenting received by the infant to the quality of care giving they provide to their own young some 15–30 years later, with a tracking of reasonable biological variables, have not yet been done. However, there is evidence that the attachment status of the infant toward her/his own mother and the adult attachment status of that same individual are indeed correlated (van IJzendoorn, 1995).

In low SES, high-risk groups, these intergenerational effects are even more pronounced when more severely dysfunctional parenting is evaluated. The intergenerational effects are seen among women whose early lives were disrupted by abuse, maternal depression and poor family functioning early in adolescence (Weinfield et al., 2000). For instance, 30% of mothers who were abused as children abuse their own children later in life, whereas only 5% of mothers who were not abused abuse their infants (Knutson, 1995). Consistent with the epidemiological data in retrospective studies, Main and Goldwyn (1984) reported that the experience of maternal rejection as a child is related to the rejection of offspring later in life. This intergenerational effect may account for the cyclic occurrence of premature motherhood among teenagers (de Paul and Domenech, 2000; Rebollo and Montero, 2000). Teen mothers often raise poorly adjusted children who tend to become teen parents themselves (Furstenberg et al., 1987; Geronimous, 1987; Maynard, 1996). Although among human mothers, we know very little about the actual mechanisms of these intergenerational effects of maternal style, among animal models we are beginning to understand some of the underlying physiology of these intergenerational effects.

In the animal literature, there is substantial evidence that early life experiences being mothered have a strong influence on behavior shown by the offspring later in life, including their maternal behavior (Hofer and Sullivan, 2001). For example, vervet monkeys and rats provide their offspring with the level of maternal stimulation as they received from their own mother (for review, see Caldji et al., 2000; Champagne and Meaney, 2001; Fairbanks, 1989, 1996). In terms of how these effects are transmitted, there is growing evidence that early life experiences modulate hormones, neuropeptides, and their receptors, which are known to affect the expression of maternal behavior (Champagne and Meaney, 2001; Fleming et al., 1999, 2002; Rees et al., in preparation). One system known to be affected by early experiences that has received considerable attention in this context is the hypothalamic–pituitary–adrenal (HPA) axis (Bhatnagar et al., 1995; Liu et al., 2000; Plotsky and Meaney, 1993; Rees and Fleming, 2001). In rats, early maternal deprivation is known to alter the development of the HPA stress response (Bhatnagar et al., 1995; Liu et al., 1997, 2000; Meaney et al., 1990; Plotsky and Meaney, 1993; Rees and Fleming, 2001; Rees et al., 2004, submitted). Recent work by Rees et al. (2004, submitted) shows that adrenal glucocorticoids are also involved in some qualitative aspects of adult rat maternal or maternal-like behavior, enhancing it in postpartum mothers, and suppressing it in juvenile or virgin females given foster pups.

In humans also, there is a relation between hormones modulated by the HPA axis and mothers' mood and behavior. In adult human mothers, cortisol, an adrenal steroid, is the only hormone that has been related to maternal responsiveness, and this relationship has only been examined early in the postpartum period. Mothers who had higher plasma levels of cortisol at 3 days postpartum were more physically affectionate with their infants (Fleming et al., 1987), more attracted to their own infant's odor, and better able to identify their own infant's cry (Fleming et al., 1997; Stallings et al., 2001). These findings suggest that in healthy young mothers cortisol functions differently during the postpartum period than at other times in a woman's life; rather than reflecting stress or depression and having a negative impact, cortisol may, instead, be related to arousal, attention, or heightened vigilance (Henry, 1992).

The relations between cortisol and maternal behavior discussed above have not been established later in the postpartum period, in teen mothers, or in women with disrupted early experiences. However, the relations between cortisol and maternal mood during pregnancy and immediately postpartum have been investigated, with mixed results depending on the period postpartum and the age of the mother. Dorn et al. (1993) found a negative relationship

between cortisol reactivity (over a 40-min time period) and anxiety and depression during pregnancy and at 2–3 weeks postpartum among teen mothers. Moreover, lower (not higher) levels of corticotropin-releasing hormone in pregnant teens have also been associated with depression in early and late pregnancy, as well as an increase of symptoms associated with conduct disorder in early pregnancy and early postpartum (Susman et al., 1999).

Whereas among teen mothers, higher cortisol has been associated with positive moods, the opposite has been found among their adult counterparts, although again studies are conflicted (Buckwalter et al., 1999; Ehlert et al., 1990; Pedersen et al., 1993).

This study explores the differences between teen and adult maternal behavior, and the role of maternal age, cortisol, and early life experiences in the regulation of maternal behavior and postpartum mood state. Based on the prior literature, there are a number of objectives to this study. First, to examine the differences between teen and adult mothers with respect to maternal behavior, mood, cortisol levels, and early life experiences; it is predicted that teen mothers will respond less affectionately to their infants and will have come from more disrupted homes. It is unclear whether teen mothers will differ in their mood state or hormonal (cortisol) profile. Secondly, to relate maternal behavior and mood to cortisol levels in mothers of different ages, it is predicted that there will be a different pattern of relations in teen and adult mothers. Finally, to examine the relationship between early life experiences, maternal behavior, and cortisol levels, it is predicted that a disturbed early experience will be related to both maternal behavior and cortisol levels. How age will interact with these early experience effects, we do not know.

General methods

Subjects

Primiparous mothers who had full-term (40 ± 2 weeks) vaginal or cesarean section deliveries were recruited through either the maternity ward of a large urban hospital in Hamilton, Ontario, Canada, or from public institutions that provide aid to new mothers in the same area. The institutions were designed to provide aid to women of all ages who were in need of social, emotional, or financial aid, and provided a residence for these women from conception to 3 months postpartum. These institutions mostly provided aid to teen and young mothers; however, proportions of teen and young mothers in this study were recruited through the hospital. Mothers involved in the programs offered by these institutions received room and board and social support from the staff. High school classes were taught on the premises, in addition to prenatal and parenting classes. Participants were recruited through the institutions because efficient sample sizes were not being achieved via recruiting through the hospital alone. The sporadic nature of adolescence made it difficult to track teen mothers, who were often moving around frequently immediately following the birth of their child. The majority of the mothers recruited through the institutions did give birth to their infant in the hospital where recruiting was taking place on the maternity ward. Clearly, recruiting from these institutions does not allow generalizations to be made to all teen mothers (who generally have less support than those included in this sample). Although less financially stable and unmarried, the teens received an immense amount of social support, making the early postpartum environment more comparable to that of the more mature mothers, who tend to have partners and relatives helping out during the early postpartum months.

All of the subjects were English speaking. The teen mothers' ages ranged from 15 to 18 years; young mothers age varied from 19 to 25 years; and the mature mothers' ages ranged from 26 to 40 years. All subjects were tested before 3 months postpartum (mean = 6.93 ± 2.41 weeks). Teen and young mothers were primarily Caucasian and not religious. Mature mothers were primarily Caucasian and Catholic or 'other religion'. At the time of the study, about 50% of mothers were nursing their babies and groups did not differ in this percentage (see Table 1). There were no differences between groups in the incidence of depression. Thirty-five percent of the teen mothers, 35% of the young mothers, and 43% of the mature mothers reported using some sort of prescription drug (antibiotics, painkillers, or contraceptive medications). Four of the young mothers and two of the mature mothers were taking antidepressants at the time of the study. No teen mothers reported taking antidepressant medications at the time of the study. As

Table 1
Demographic characteristics of population studied

Demographic characteristics	Teen	Young mothers	Mature mothers
Sample size	42	34	43
Age			
Mean (median)	16.7 (17)	21.1 (20)	30.9 (30)
SE	0.13	0.36	0.57
Education (%)			
Some college/university	0	94	37
College/university grad	0	6	63
Work status (%)			
Full-time	0	9	5
Part-time	3	0	5
Maternity leave	7	50	84
Social services	83	38	0
Income (median) ($)	8000	10–19,000	+30,000
Marital status (%)			
Married/cohabitate	13	41	98
Involved in Aid Program	53	39	<1
Nursing status (%)			
Nursing	55	41	58

expected, there were large differences between groups in their own SES, work, and marital status (see Table 1). There were, however, no differences between groups in the SES of their family of origin (i.e., the grandparents SES was comparable between groups) (see Table 2).

Procedures

Mothers were approached before they were 3 months postpartum and were asked to participate in a study concerned with hormones and maternal behavior in new mothers. Mothers were told that the study was comprised of three basic components; a verbally administered questionnaire, saliva samples, and a video recording of the mother with her infant. More specifically, mothers were told that the study involved sucking on three salivettes in order to obtain a sample of the hormone cortisol from their saliva. In addition, mothers were told that they would be videotaped while holding their baby (and not feeding the infant) for a 15-min period in privacy, and then be interviewed. Since the teen mothers were apprehensive that the study was designed to show that teens were poor mothers, recruiters emphasized that the study was not designed to predict who would be a good mother, but rather to look at the different ways of mothering, none of which were 'wrong'.

All testing was done between 10 am and 2 pm. Mothers were asked to not eat, drink, smoke, feed, or hold the baby for 40 min before testing began. The mother was asked not to interact with her baby for the prior 40 min in order to establish a baseline level of cortisol; that is, cortisol levels when the mother had not been interacting with her infant. The mother was then asked to rinse her mouth with tap water and the first salivary sample (time 1) was obtained by having the mother suck on a salivette until it was fully saturated. Immediately following this procedure, the mother was seated and asked to hold her baby while she was video taped for a 15-min period. During this time, the mother was alone with the infant and was asked not to feed the baby.

Table 2
Demographic characteristics of grandparents

Demographic characteristics	Teen (%)	Young mothers (%)	Mature mothers (%)
Grandfathers profession			
Manual labor	50	48.8	40
Retail/Service	5.3	12.9	20
Office/Clerk	18.4	9.7	12.5
Professional	10.5	16.1	27.5
Unemployed	15.8	12.9	0
Student	0	0	0
Grandmothers profession			
Manual labor	21.4	15.2	7.1
Retail/Service	28.6	33.3	38.1
Office/Clerk	23.8	18.2	7.1
Professional	4.8	12.1	16.7
Unemployed	16.7	21.2	31
Student	4.8	0	0

Following a 20-min period, the second salivary sample (time 2) was taken, and the infant was removed from the mother while she completed the verbally administered questionnaires. Cortisol was measured at time 2 in order to assess any changes that occurred during the mother–infant interaction. After a final 20-min interval, the third salivary sample (time 3) was taken in order to reestablish a baseline measure of cortisol. Measurement of hormones at 20-min intervals allowed for analysis of changing free (biologically active) concentrations of cortisol in response to presence and removal of the infant (Fleming et al., 1997; Stallings et al., 2001). The mother was then thanked for her cooperation and given her choice of a set of Winnie the Pooh™ baby books or $20 to compensate for her time.

Measures

Questionnaire

The questionnaire was verbally administered by a researcher. The first four sections of the questionnaire were quite extensive, including a childbirth component, an attitude component, a mood component, and a parenting plans and experience component. See Fleming et al. (1988) for a detailed description of these instruments. The fifth part of the questionnaire was related to breast feeding and was given only to those mothers who were nursing. Components relating to demographics, early life experiences, and mood state are included in this paper. Analyses of attitudes and other parenting issues may be found in Krpan et al. (in preparation).

Early life experience

The difficulty with measurement in the area of early experience is that accuracy of retrospective report for subjective psychological states and family processes has been found to be low (Henry et al., 1994). Further, current depression has been found to augment these recall biases such that most measures of early experience taken from depressed individuals reflect little more than current mood (Prescott et al., 2000). It has been found, however, that the more concrete the questions, the less biased the retrospective report; two measures of early adversity (the Life history Calendar and the Physical Punishment Scale) have demonstrated strong validity. For these instruments, retrospective accounts obtained in adulthood agree well with measurement of the family environment made during childhood (Caspi et al., 1996; Prescott et al., 2000). Here we used an amended form of The Life History Calendar (Caspi et al., 1996), providing a visual representation of the first 12 years of life. Record is made of where the individual was living and who else was living in the house. Counts are derived from this of number of caregiver transitions, parental separations/divorce, and residence transitions. Caregiver transitions and parental separations have been shown to predict adult psychopathology (Amato, 1994; Henry et al., 1994; Yehud et al., 2001). The measures considered in this

paper were whether or not the mother had lived continuously with her biological parents from birth to 12 years of age; number of years spent living with her mother alone; total number of years spent living with her mother; number of years living with both parents; and consistency of care. A mother was said to have received consistent care if there was one primary caregiver present continuously during the first 12 years of life. Some examples of consistent care are having a mother figure present continuously despite multiple and changing father figures, having two parents consistently present, and having a grandparent consistently present. Some examples of inconsistent care are moving back and forth with long intervening periods between parents living in different homes, living in foster care for a period, and living with other family members or friends for a period.

Mood state

The current experience scale assessed the current mood state of the mother. Factors reflective of well being, fatigue, and physical health were used. All current experiences were measured on a 6-point Likert scale ranging from none to extreme. These mood factors have been found to be reliable and valid for the postpartum population across time (Fleming et al., 1988, 1990). Correlations between the current experience scale used in this questionnaire and the mood factors are highly significant and range from 0.55 to 0.80 across studies (Fleming et al., 1988, 1990).

Behavioral observations

Mothers were videotaped with their infant during a single, private, nonfeeding interaction for 15 min. The camera was placed as unobtrusively as possible and mothers were asked to behave as naturally as possible with their infants. Behaviors were recorded later using an S and K Event Recorder (S and K and NorPark Computer Design, Toronto). The behaviors that were coded included looking at the baby (look at, enface, looking over baby), talking to the infant (quiet talk, motherese, adult talk), affectionate touching (affectionate burping, stroking, palming), proximity to infant's face (nose within 2 cm of infant's body), instrumental care taking (instrumental burping, wiping face, adjusting blanket), grooming the infant (cleaning), inappropriate behaviors (poking, overstimulating, or waking the baby, negative affect), and overall infant activity (arm waving, leg movements, crying).

Inter-rater reliability was ensured by having two observers code 10 videotapes of mothers interacting with their infants two times each. All of the behaviors analyzed were highly correlated, with r values ranging from 0.671 to 0.964. Intra-rater reliability was ensured by having the second observer independently code 10 videotapes of mothers interacting with their infants on two separate occasions. All of the behaviors analyzed were highly correlated, with r values ranging from 0.821 to 1.0.

Hormonal assays

Salivary samples were taken using a salivette (Sarstedt Canada, Inc., St. Laurent, Quebec). The mother removed a cylindrical cotton swab from a test tube and chewed or sucked on it for 30–45 s or until it was fully saturated. She then returned it to the test tube and it was immediately frozen. Samples were processed later and were centrifuged for 10 min, 1000 × g at 4°C. This allowed the saliva to pass from the salivette, through the holes in the bottom of the insert tube, and into the clear bottom of the test tube. The concentration of cortisol in the saliva was measured by a solid-phase 125I radioimmunoassay (Coat-A-Count, Diagnostic Products Corp., Los Angeles, CA). The measurement of hormone in the saliva was approximately 1% of the serum values. The assay sensitivity was 1.0 nmol/l. The inter-assay variability was 4.5%, and the intra-assay variation was 3.0%.

Results

Comparisons among the teen, young, and mature mothers

Multivariate analyses, usually one-way ANOVAs, were used to assess differences between groups of mothers in their mood state and behavior. Nursing status and income were entered in these analyses as covariates and were found not to substantially change the pattern of significant results.

Mood

There were no significant differences between teen, young, and mature mothers in depression, well being, or measures of fatigue or physical concerns.

Behavior

There were also no differences in the total time that each group spent actively interacting with their infants (total duration of all behaviors combined). However, when analyses were undertaken on the different kinds of maternal behaviors shown as a function of age of mother (ANOVA with two types of behavior: affectionate vs. instrumental, and three age groups: teen, young, mature), there was a significant interaction between age and type of behavior ($F(2,115) = 4.61$, $P < 0.012$, see Fig. 1). Teen mothers spent more time engaged in instrumental behavior (cleaning the infant, fixing clothes, changing diapers) and less time affectionately engaged with the infant (stroking, patting, palming), whereas mature mothers showed the opposite pattern.

Hormones

Cortisol values were log transformed for statistical analyses; the extremely high baseline and time 3 scores of one outlier were adjusted by a substitution method. Results of analyses done with and without this subject were essentially unchanged.

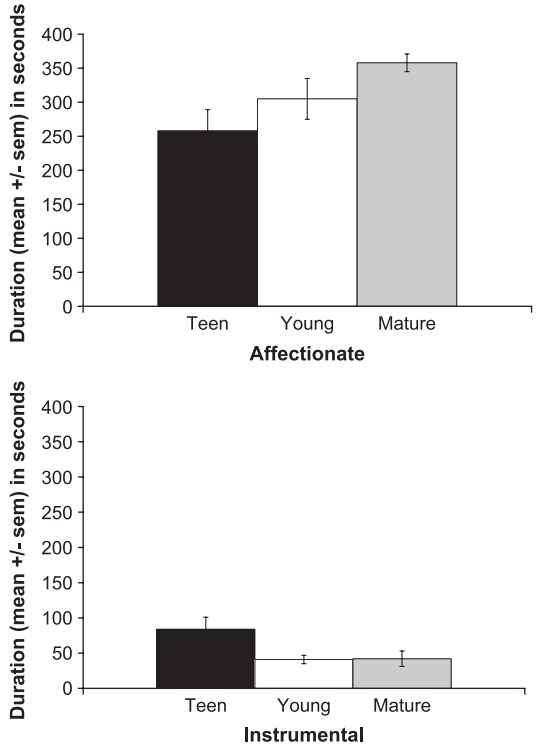

Fig. 1. Interaction between age and type of maternal behavior (affectionate vs. instrumental), $P < 0.012$. Teen, $n = 41$; Young, $n = 34$; Mature, $n = 43$.

A 3 × 3 × 2 (age × time × nursing status) ANOVA was undertaken on levels of cortisol. As shown in Fig. 2 (top panel), this analysis showed a main effect of time, with cortisol levels lower at time 3 than at baseline or time 2 ($F(1,112) = 5.744$, $P < 0.018$). There was also a main effect of age ($F(2, 112) = 5.482$, $P < 0.005$), where by post hoc tests, cortisol concentrations were significantly lower in mature mothers than in either teen mothers ($P < 0.005$) or young mothers ($P < 0.021$), who did not differ from one another. As can also be seen in Fig. 2 (lower panel), there was also an age × nursing status interaction ($F(2,112) = 5.013$, $P < 0.008$) where in teens, mothers who were still nursing (although not nursing during observation) had higher cortisol levels than did mothers who did not nurse, whereas in young or mature mothers, there were no cortisol differences between nursing and non-nursing mothers. When separate age by nursing status analyses were undertaken on baseline cortisol levels (time 1), before any interaction with the infant, it was found that there were also significant main effects of age ($F(2,112) = 4.317$, $P < 0.016$). There was also an age by nursing status interaction ($F(2,112) = 4.85$, $P < 0.019$), with breast feeding teen and young mothers showing higher levels of cortisol than mature mothers (teen vs. mature: $P < 0.01$; young vs. mature: $P < 0.047$). This was similar to analyses with all three time points when mothers had interacted with infants (see above).

Not surprisingly, given the clear cortisol differences among nursing and non-nursing teens, but not among the other groups of mothers, when all groups were combined, there were no main effects of nursing status in any of the analyses.

Early life experience

Teen mothers were less likely than either of the older groups to have lived with both biological parents throughout childhood ($F(2,116) = 16.937$, $P < 0.001$). Post hoc tests showed differences between teen and young mothers as well as teen and mature mothers. Teen mothers were also more likely than either of the two older groups of mothers to have spent time being cared for by a single mother ($F(2,116) = 10.7$, $P < 0.003$). Post hoc tests showed differences between teen and young mothers, and teen and mature mothers (see Fig. 3).

Although there were few differences between groups in their maternal behavior or mood as a function of their age, there were differences as a function of the quality of care they themselves received when they were growing up.

Analyses were done on the three groups of mothers combined, comparing the mothers who did or did not receive consistent care in how they responded to their infants during the 15-min observation period. As can be seen in Fig. 4, these analyses showed that mothers who received consistent care while growing up were more affectionate toward their infants and less likely to engage in care taking activities than those receiving less consistent care ($F(1,116) = 5.604$, $P < 0.02$). When this analysis was

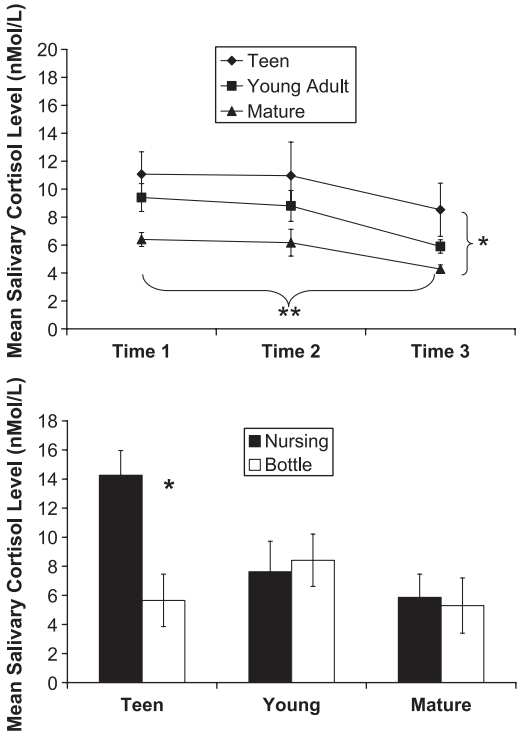

Fig. 2. (Top panel) Mean (±SEM) group differences in cortisol levels at times 1, 2, and 3. *Group: $P < 0.005$; **Time: $P < 0.018$. Teen, $n = 41$; Young, $n = 34$; Mature, $n = 43$. (Bottom panel) Mean (±SEM) group differences in cortisol levels based on nursing status. *Group: $P < 0.008$. Teen, $n = 41$; Young, $n = 34$; Mature, $n = 43$.

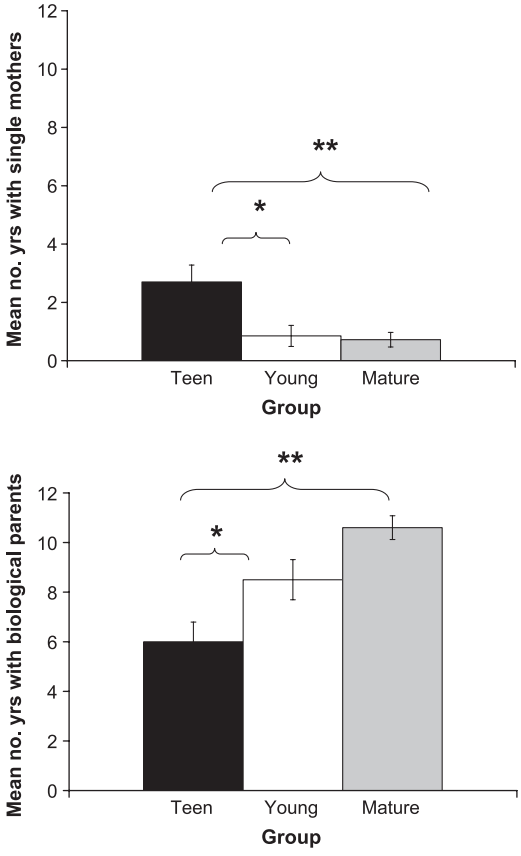

Fig. 3. Mean (±SEM) group differences in early home environment. Single mothers: $P = 0.003$; (*$P < 0.038$; **$P < 0.011$). Both biological parents: $P < 0.001$; (*$P < 0.002$; **$P < 0.001$). Teen, $n = 42$; Young, $n = 34$; Mature, $n = 43$.

done within age groups, the effect was only present in the teen mother group ($F(1, 39) = 4.456$, $P < 0.049$). However, when all subjects were included in the analysis and both age and nursing status were included as covariates, the effect remained, indicating that the effect was primarily one of the nature of the early experience, rather than the age or nursing status of the mother. It should be noted that less than a third of the entire observation period was spent in the two types of behaviors (instrumental and affectionate, combined) by any of the three groups of mothers and that therefore

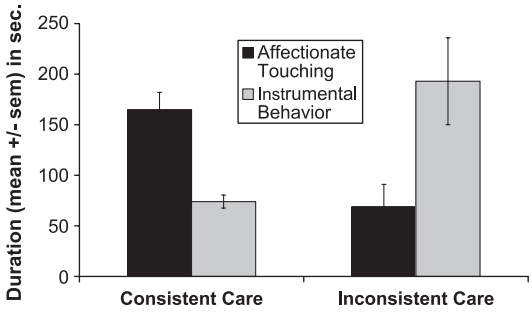

Fig. 4. Interaction between early life experiences (consistent vs. inconsistent care) and type of maternal behavior (affectionate vs. instrumental). $P < 0.02$; Consistent, $n = 106$; Inconsistent, $n = 12$.

exhibition of one type of behavior in no sense precluded the exhibition of the other type of behavior in any group.

Correlations

For these analyses, the relationships between variables were examined first by combining groups and then within each group using Spearman 'rho'. In general, this involved computing six correlation coefficients between each of the six or so major behavior categories (affectionate, instrumental, 'grooming', proximity, look away, etc.) and cortisol levels across all women and then within each group. To control for false-positive outcomes due to multiple correlations, only significance levels of $P < 0.01$ or greater were viewed as significant, although all P values are reported. To ensure that nursing status and income did not influence the pattern of correlations between hormones and other variables, initially parametric partial correlations were computed on all the relevant variables, with nursing status and income included as covariates. Nursing status and income were found to have no effects on the pattern of correlations.

Hormones and behavior

When all groups were combined, there were no relationships between hormones and behavior. Analyses of individual groups showed different patterns of correlations. In the teen mother group, mothers with higher cortisol at times 2 and 3 engaged in less instrumental care taking behavior (rho = −0.366, $P < 0.019$). Young mothers with higher cortisol at each of the three time periods engaged in more affectionate behavior toward their infant ((time 1) rho = 0.443, $P = 0.009$; (time 2) rho = 0.561, $P < 0.001$; (time 3) rho = 0.602, $P < 0.001$). As seen in Fig. 5, young mothers with higher average cortisol across all three time periods engaged in more affectionate behavior toward their infant. There were no significant correlations between hormones and behavior within the mature mother group.

Hormones, mood, and physical state

Few relations were found between cortisol and mood in teen or young mothers, with the exception that teen

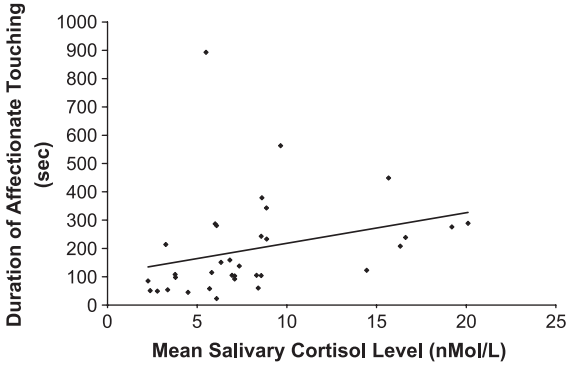

Fig. 5. Correlation between average cortisol and affectionate behavior in young mothers. rho = 0.564, $P < 0.001$. $n = 34$.

mothers with higher cortisol felt less fatigue ((time 1) rho = −0.358; $P < 0.022$; (average of three time points) rho = −0.390, $P < 0.012$.). In contrast, in more mature mothers, there were many more correlations between cortisol levels and mood. In contrast to the teen group, in the mature group, higher cortisol was associated with more fatigue ((time 1) rho = 0.324, $P < 0.036$; (average of three time points) rho = 0.471, $P < 0.002$), as well as more negative moods (rho = 0.3124, $P < 0.043$).

Early life experience and hormones

Mothers who spent more time living with their mother as their only caregiver had higher cortisol at times 2 and 3 on average (time 2) rho = 0.201, $P < 0.029$; (time 3) rho = 0.247, $P < 0.007$; (average) rho = 0.196, $P < 0.003$.

Discussion

There were few differences between primiparous teen, young, and mature mothers in their mood state or in the intensity of their interactions with their infants at 6 weeks postpartum. However, mothers of different ages showed some qualitative differences in their maternal behavior. Teen mothers showed less affectionate and more instrumental behaviors than did the mature mothers during the 15-min observation period. However, age alone probably does not account for these adult–teen differences (Flanagan et al., 1995). Teen mothers also experienced more unstable childhoods, as compared to the mature mothers. When we tested the hypothesis that the pattern of maternal behavior exhibited by teens may be due to their early experiences, we found that teen mothers who received inconsistent care tended to spend more time adjusting clothing, using baby soothers, cleaning, and burping the infant and less time stroking, patting, or kissing the infant. While this effect was significant when all three groups were combined, it was most pronounced when the teen mothers were analyzed separately from the other groups; and it was not evident at all when looking the mature mothers alone. When analyzing the entire population we controlled for age of mother, and the effect was still significant, suggesting that the differences observed were due to both maternal age and early life experience.

Although we do not have information on how these mothers were cared for when they were infants themselves, teen and young mothers were less likely to have lived with both of their biological parents, and were more likely to have spent time living with a mother who was functioning as a single mother. This suggests, at minimum, that the younger mothers in this study had different early life experiences than did the mature mothers. These differences in early life experiences were related to behavior later in life. This finding supports earlier work demonstrating an effect of early mothering style on later maternal behavior in nonhuman populations (e.g., Champagne and Meaney, 2001; Fairbanks, 1996; Fleming et al., 1999; Francis et al., 2002; Gonzalez and Fleming, 2002; Gonzalez et al., 2001; Harlow, 1963; Kraemer, 1992; Lovic et al., 2001). However, caution must be exercised in generalizing from these data. This study examined maternal behavior in a testing situation, over a single 15-min period, which is certainly not representative of daily ongoing behavior, when other demands are being made on the mothers and when mothers' attention is divided between the infant and other individuals and tasks. However, this type of brief observation can detect subtle differences in interaction patterns of mothers, especially in the relatively "unconscious" behaviors like fingering, palming, stroking as opposed to adjusting blankets, clothes, and so on. We acknowledge that although the behavioral findings reported here are thought provoking, no conclusions may be drawn about the transgenerational transmission of mothering style in human beings at this time.

There are no long-term prospective studies linking care received as a child to later care mothers give to their infants in a normative, healthy population. However, there are numerous short-term longitudinal studies connecting consecutive pairs of relations: the sensitivity of mothers (F1) with attachment status in their infants (F2); attachment status in their infants (F2) with the infants' later adult attachment status (F2); the infants' later adult attachment status (F2) with the infants' later maternal sensitivity (F2); and, into the next generation, infants' later maternal sensitivity (F2) with the attachment status of the F3 infants and so on (Belsky, 2003; van IJzendoorn, 1995). Based on van Ijzendoorn's meta-analyses of studies exploring these relations, it is probable that the quality of parenting women receive would be related to the quality of parenting they give to their own offspring—barring major intervening disruptions and stresses disrupting parenting or therapeutic interventions to improve negative parenting (see Belsky, 2003).

Although the age-related behavioral differences reported in this paper are consistent with what has been reported for other populations of high-risk mothers (Field et al., 1985, 1988), teen mothers in this study were much more attentive to their infants and less intrusive than we would have expected based on the literature (Elster et al., 1983; Flanagan et al., 1994; Garcia-Coll et al., 1987; Levine et al., 1985; Musick, 1990; Parks and Arndt, 1990). There are several possible explanations for the absence of intrusive or conspicuously disrupted behaviors in our population of teen mothers. First, and perhaps most importantly, approximately 53% of the teen mothers and 39% of the young mothers examined in this study were involved in a program designed especially to aid and educate expectant and new mothers in difficult situations. Obviously, teen mothers involved in such programs were at an advantage over the general population of teen mothers not benefiting from such programs. In comparison to older mothers, the teens in this study were less likely to be married, had a lower SES, and were less well educated (results that are strongly confounded by age). However, the support programs permitted teen mothers to share experiences with

other mothers and receive the benefits of babysitting services, parenting classes, and playgroups. For this reason, we believe that the teens in this study were more similar to adult mothers (who tended to have multiple supports in the home) than would be the case for the teen mother population at large. In order to have a more realistic picture of the difficulties experienced by teen mothers and their interactions with their infants, it would be necessary to assess teens who do not receive the additional support proffered by the "homes" and in women living with their infants, as single mothers. As well, it would be necessary to assess mothers' adaptation over a longer period, past the first 6 months postpartum, and in a variety of contexts, including the home environment.

Teen mothers in this study had higher average cortisol levels, which were related to increased energy and to a less negative mood. As the high cortisol levels were most evident in the breast-feeding teen mothers, we assessed whether the increased energy may have been related to nursing status. There was no relation between mood and nursing status; not surprisingly, teen mothers who nursed their infants had more physical problems and were somewhat less energetic than those who did not. The elevated cortisol levels in the teen mothers are, we believe, related to breast feeding and the maternal status, not to mothers age. Although we did not assess cortisol levels in non-mothers, Kiess et al. (1995) reported that salivary cortisol levels increase through adolescence, peaking after 17 years of age. Since there is no evidence that non-mothers who are teens have higher cortisol levels than their adult counterparts, we believe that the teen mothers are simply more responsive than are the older mothers to breast feeding stimulation. Whether this is because these mothers nurse more often, because they find nursing to be more stressful, or because their neuroendocrine systems are more responsive to the suckling stimulation, we do not know.

In mature mothers, average cortisol levels were lower, but cortisol related to decreased energy and negative affect. Young mothers, whose age was intermediate to the other groups, showed no relation between cortisol and energy or mood at all. Given that there were no significant differences between average cortisol levels between the teen and young mother groups, this finding suggests that maternal age may be a determinant of the influence of cortisol postpartum, as it clearly related to different physical/mood states dependent upon maternal age. A difference in cortisol levels was not found when the groups were separated by early life experiences alone. That is to say, those mothers who had stable loving home environments early in childhood had the same cortisol levels as those who did not. More work is necessary to delineate the contributions of early life experience, maternal age, and hormones to maternal behavior and mood.

Finally, the results of this study relating cortisol to affectionate behavior in the young mother group are consistent with what we have found previously for primiparous mothers at the higher end of this same age range (Fleming et al., 1987). This also suggests that maternal age, in addition to time postpartum, contributes to the influence of cortisol on postpartum behavior. Had teen mothers, who had virtually the same average cortisol levels as did the young mother group in this study, also exhibited this hormone–behavior relationship, it would have suggested that cortisol concentrations themselves were responsible for the relations between hormones and behavior. However, it is impossible at this time to differentiate conclusively whether cortisol levels, age, or their interaction is most important. At the present time, it is most conservative to suggest that the postpartum cortisol and the HPA axis function differ across time and may be related to age. If the relation is causal, HPA function is likely bimodal in its effects.

Summary

At 6-weeks postpartum, there were virtually no group differences in maternal behavior or in self-reported mood between teen, young, and mature mothers. However, an interaction was found between age and type of behavior, and between early life experiences and type of behavior, suggesting that both factors contribute to mothering style. In addition, as compared to mature mothers, teen mothers had higher levels of salivary cortisol, especially in breast feeding mothers, which related differently to mood and fatigue within groups. As age increased, the relation between higher cortisol levels and mood and fatigue changed from positive to negative. Further work is necessary to understand the interaction of early life experiences with cortisol and what this interaction relates to maternal behavior and mood across age and time.

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