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Infant Reminders Alter Sympathetic Reactivity and Reduce Couple Hostility at the Transition to Parenthood

Vered Mosek-Eilon
Bar-Ilan University

Gilad Hirschberger and Yaniv Kanat-Maymon
Interdisciplinary Center (IDC) Herzliya

Ruth Feldman
Bar-Ilan University

The transition to parenthood marks an important developmental stage in adult life, associated with unique challenges to the partners' conflict dialogue in the formation of the family unit. Utilizing a biobehavioral experimental design, we examined the potential positive effects of the infant on the couple's conflict discussion. One hundred forty new parents of 6-month-old infants engaged in a face-to-face marital conflict discussion, while sympathetic reactivity was recorded online from mother and father and conflict interaction was microcoded for hostility and empathy. In the experimental group, a picture of one's own infant appeared on a screen halfway into the interaction, whereas controls viewed an affectively neutral stimulus. Infant reminders decreased mothers' sympathetic arousal, whereas fathers reacted with sympathetic vigilance by preserving sympathetic arousal. For both parents, infant reminders decreased couple hostility in parent-specific ways. Results accord with life-span developmental perspectives, support evolutionary models of mothering and fathering, and suggest that infants may enhance the quality of marital dialogue during this stressful transition.

Keywords: transition to parenthood, sympathetic reactivity, evolutionary theory, parenting, marital relationships

The transition to parenthood defines a new stage in adult development, marked by unique biobehavioral reorganization associated with the two major tasks of the transition—securing infant survival and well-being and establishing a coparental partnership in the formation of the family unit (Belsky, 1981; Cowan & Cowan, 1992; Cox & Paley, 1997; Feldman, 2000). Similar to other developmental transitions across the life span, each of these tasks is associated with unique physiological processes, a distinct behavioral repertoire, and specific risks for less-than-optimal adjustment to the new stage. Since this stage is the first life transition to involve responsibility for another human—the infant—physiological and behavioral systems in the parent coordinate to accommodate the inclusion of the infant into the family and secure infant survival, preserve infant from harm, and enhance the cognitive and motivational salience of the infant to its parent, albeit in somewhat different ways in mothers and fathers (Feldman, 2012).

In addition to infant care, the transition to parenthood entails reorganization of the couple relationship, particularly the need to find new ways to dialogue conflict. Extant research has documented the marital changes typical of this transition and pinpointed the months following the first childbirth as those associated with the greatest challenge to the relationship (Belsky & Rovine, 1990; Hirschberger, Srivastava, Marsh, Cowan, & Cowan, 2009). Research on the effects of marital conflict on children has underscored marital hostility as one of the most harmful ingredients of the couple's conflict that compromises children's social-emotional growth (Cummings & Davies, 2002; El-Sheikh et al., 2009). As such, the current study aims to integrate several literatures on the transition to parenthood, including lifetime developmental perspectives (Elder, 1998; Erikson, 1959), evolutionary models on the neurobiology of mammalian parenting (Carter et al., 2005), research on the marital correlates of the transition to parenthood (Belsky & Rovine, 1990), and cross-generational studies on the detrimental effects of marital hostility on children's lifetime functioning (Conger, Ge, Elder, Lorenz, & Simons, 1994) within an experimental design. We ask not only whether the heightened sensitivity to infant cues at the stage of becoming a parent would result in alterations in parents' sympathetic arousal in response to infant cues but whether infant reminders may activate the parents' nonconscious evolutionary-based drive to preserve the infant from harm. We thus examined through online testing whether mothers and fathers would reduce the most harmful component of their conflict—hostility—in response to infant cues. Such findings

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Vered Mosek-Eilon, Department of Psychology and the Gonda Brain Sciences Center, Bar-Ilan University, Ramat-Gan, Israel; Gilad Hirschberger and Yaniv Kanat-Maymon, School of Psychology, Interdisciplinary Center (IDC) Herzliya, Herzliya, Israel; Ruth Feldman, Department of Psychology and the Gonda Brain Sciences Center, Bar-Ilan University.

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Correspondence concerning this article should be addressed to Ruth Feldman, Department of Psychology and the Gonda Brain Sciences Center, Bar-Ilan University, Ramat-Gan 52900, Israel. E-mail: feldman@mail.biu.ac.il

would indicate that infants may have a positive effect on the parents' relationship, albeit momentarily, and that they may provide, in addition to the well-known burden they place on marriage, some advantage to the parents in facing a challenging aspect of this transition.

The Transition to Parenthood and Couples' Conflict Management Strategies

As a developmental transition, the transition to parenthood poses a great challenge to the couple relationship because it is typically accompanied by increased investment in parenting (Claxton & Perry-Jenkins, 2008) and a marked reduction in the quantity and quality of marital dialogue (Raush, Barry, Hertel, & Swain, 1974). Parents become nearly exclusively focused on the infant and often redirect attention from the marriage, leaving less time to discuss relationship issues during a life stage that requires much dialogue (Woollett & Parr, 1997). First-time parents are burdened by the need to manage new household and childcare tasks and balance work and family roles (Feldman, Masalha, & Nadam, 2001). These challenges may intensify the tension between spouses (Twenge, Campbell, & Foster, 2003) and reduce the quality of sexual relations (Williamson, McVeigh, & Baafi, 2008), possibly leading to greater hostility and lower empathy.

Unlike most research assessing how marital conflict affects the child, we focused on the other side of the marriage–child equation and asked whether brief exposure to infant reminders may positively affect the couple's marital conflict. We employed a well-validated marital conflict interaction paradigm that has been shown to predict relationship quality and stability in research spanning over 30 years (Gottman & Levenson, 2000). This field of research has integrated physiological measures into marital studies and shown links between autonomic reactivity and hostile couple behavior (Robles & Kiecolt-Glaser, 2003). We combined this approach with priming methodology borrowed from social psychology to experimentally determine whether a brief exposure to infant primes would influence the way couples discuss a conflict. In addition, we employed a microlevel observational approach that assesses verbal and nonverbal aspects of the communication. Studies that integrate both explicit and implicit aspects of marital interactions were found to provide a fuller account of the dialogue (Houts, Barnett-Walker, Paley, & Cox, 2008; Seider, Hirschberger, Nelson, & Levenson, 2009). Furthermore, a microlevel process-focused observation of marital dialogue can tap the coparental alliance at the transition to parenthood (Gordon & Feldman, 2008), and microlevel assessment of couple hostility and empathy during conflict dialogue predicted children's social outcomes across the first years of life (Feldman, Masalha, & Derdikman-Eiron, 2010; Feldman, Weller, Sirota, & Eidelman, 2003). We collected continuous indices of sympathetic arousal from each parent during the conflict dialogue. Assessment of continuous autonomic physiology may contribute to the study of relationship quality, as autonomic response is not under the individual's volitional control and can index momentary changes in arousal in each partner (Feldman, Magori-Cohen, Galili, Singer, & Louzoun, 2011). Research has demonstrated that autonomic arousal during conflict interaction predicted marital dissatisfaction and dissolution over time (Gottman & Levenson, 2000). In terms of timing, couples were seen 6 months after the transition, a period when marital conflict is at its peak (Wallace & Gotlib, 1990).

Infant Reminders and the Neurobiology of Mothering and Fathering

Securing offspring survival and well-being is a key feature of evolutionary selection that shapes the biological and behavioral mechanisms underlying the development of parenting (Carter et al., 2005; Geary, 2000). During the postpartum period, multidimensional changes take place in the parent's physiological systems and set the stage for parenting (MacDonald, 1988). Mothers' and fathers' brains undergo changes and become sensitive to their infants' cues (Kim, Leckman, Mayes, Newman, et al., 2010; Swain, 2011). Hormonal systems (Nelson & Panksepp, 1998) and the expression of the species-typical behavioral repertoire (Feldman, Weller, Zagoory-Sharon, & Levine, 2007) are realigned to accommodate the task of parenting. Such multidimensional changes suggest a major reorganization of biobehavioral systems at the time when individuals become parents, which prepares the parents' physiology and behavior to accommodate the important task of infant care and provides the basis for the development of attachment bonds.

The period surrounding childbirth is also marked by alterations in the functioning of the autonomic nervous system (ANS; Boukydis & Burgess, 1982; Stallings, Fleming, Corter, Worthman, & Steiner, 2001), although the nature of these changes and their significance to parenthood are not fully understood. The ANS, which controls visceral functions and regulates the body's homeostasis, is divided into two branches: the parasympathetic and sympathetic nervous systems (Cameron, 2009). Both neural systems originate in the brain stem and function to regulate automatic functions—including heart rate, digestion, respiration rate, salivation, perspiration, and urination—and each function is impacted by the interplay of the two systems (Beauchaine, 2001). The main function of the sympathetic nervous system is to mobilize the body's resources under stress, increase arousal, and induce the fight-or-flight response (Boucsein, 1992; Porges, 1998). The parasympathetic nervous system engages in energy preservation, relaxation of vital organs, and reduction of heart rate reactivity (Porges, Doussard-Roosevelt, & Maiti, 1994). Cardiovascular arousal is an index of the sympathetic branch of the ANS (Casanova, Domanic, McCanne, & Milner, 1994), and its indices, for instance heart rate, are considered important markers of emotion regulatory abilities (Appelhans & Luecken, 2006).

Although parenting involves multiple changes in both mothers and fathers, gender-specific processes have been described in biparental species and humans. Mothers' interactions with their infants are typically linked with a decrease in physiological reactivity and an increase in homeostasis and calm states (Lonstein, 2007). These changes are central for lactation and enable the development of maternal care (Uvnäs-Moberg, 1998). Fathering, on the other hand, is often accompanied by an increase in physiological arousal, heightened vigilance, and fight-or-flight responsivity (Eriksson, Salander, & Hamberg, 2007; Johns & Belsky, 2007). Evidence for gender-specific alterations in new parents is also found in endocrine systems. For instance, oxytocin secretion correlated with calm and soft touch in mothers but with stimulatory and energetic touch in fathers (Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010). Similarly, although fathers' testosterone levels decrease from pre- to postchildbirth (Berg & Wynne-Edwards, 2001), fathers exhibit elevations in testosterone in response to infant cries (Fleming, Corter, Stallings, & Steiner, 2002), which activate paternal resources to protect the infant. It thus appears that the evolution of maternal behavior in mammals necessitated an increase in maternal calmness required for nurturance, while paternal behavior evolved to protect mother and young, augmenting the father's fight-or-flight and increasing vigilance (Geary, 2000; Taylor et al., 2000). We predicted that these gender differences in physiological responsivity in the postpartum period would induce a different autonomic response in mothers and fathers in response to infant cues, reducing sympathetic arousal in mothers but increasing such arousal in fathers.

The Current Study

The current study utilized a biobehavioral experimental interaction design and observed first-time mothers and fathers 6 months after the birth of their child. Couples engaged in a 10-min conflict discussion during which their ongoing interactive behavior and autonomic arousal were recorded. Consistent with previous research, behavioral codes were composited into two constructs—empathy and hostility—that index the negative–destructive versus healthy–facilitative aspects of the couple's relationships (Feldman, Masalha, & Derdikman-Eiron, 2010; Houts et al., 2008; Noller & Fitzpatrick, 1990). Couples were randomly assigned to an infant reminder condition or to an affectively neutral control condition. Sympathetic arousal and measures of empathy and hostility in each partner were assessed before and after the presentation of the infant prime or the neutral prime.

We reasoned that using experimental methods and measuring both physiology and microlevel behavior may reveal a more nuanced picture of the effect of infant cues on relationship quality during this sensitive period in the parents' lives. In light of the aforementioned studies, two hypotheses were formed. First, we expected different sympathetic responses to infant reminders in mothers and fathers. Mothers were expected to decrease sympathetic activity, consistent with the evolution of mothering along the line of increased calm states required for nursing and infant care, whereas fathers were expected to increase sympathetic response, echoing the evolution of fathering in the protection of mother and young. Second, consistent with research showing the negative impact of marital hostility on child well-being and the parents' drive to protect infants from harm (Macfie, Houts, Pressel, & Cox, 2008; Porter, Wouden-Miller, Silva, & Porter, 2003), we examined whether infant primes would improve couples' conflict dialogue, reduce interpersonal hostility, and increase empathy in both spouses.

Method

Participants

One hundred forty parents (70 couples) and their firstborn infants participated in the study. All parents resided in central Israel, were of middle class background, had completed at least high school education, and were physically healthy, and their infants were the first child for both mother and father. For all couples, this was the first marriage, and they were married for an average of 2.37 years (SD = 0.91). Fathers' age averaged 29.04 years (SD = 3.98) and education averaged 15.13 years (SD = 2.55). Mothers' age averaged 27.08 years (SD = 3.95) and education 15.77 years (SD = 1.84). Infants (34 boys, 36 girls) were all healthy and were born in a singleton birth, and their average age was 6.0 months (SD = 1.51; range = 4–9 months). Participants were recruited through ads posted at a university campus and in surrounding areas and through Internet parenting forums. The research was approved by the university's Institutional Review Board and conducted according to ethical standards of the American Psychological Association, and all adult participants signed an informed consent sheet. Participants were paid 200 NIS (about $60) for their participation.

Procedure

Self-report questionnaires were sent to each couple's home and were collected upon their arrival at the lab. Parents were asked to refrain from caffeine, alcohol, or medication 4 hr before the lab session, and a health questionnaire confirmed the participants' general health. Parents arrived at the lab with their infant during a time when the infant was fed and rested. Upon arrival, parents were directed to the psychophysiological lab, and the infant remained at the care of a female assistant in an adjacent room. During this time the infant's face was photographed in a neutral facial expression. The study utilized a procedure developed for marital research (Levenson & Gottman, 1983) and applied to the study of parenting (Feldman, Masalha, & Derdikman-Eiron, 2010). After hand washing, each partner was attached to a multichannel physiological recording device that obtained ongoing physiological data.

The first session was a 5-min baseline during which couples were instructed to sit quietly and avoid interpersonal contact, including eye contact, and ANS arousal was measured at rest. Next, couples completed a marital problem inventory (Gottman, Markman, & Notarius, 1977), in which each partner separately rated the degree of controversy on 14 conflict issues (e.g., sex, finances) on a scale of 0–100. A research assistant trained to moderate conflict discussions selected the item with the highest ratings by both spouses. After initiating conversation, the assistant left the room and asked couples to discuss the topic for 10 min.

Two video cameras that were placed on adjacent walls videotaped the frontal face images and upper torsos of the parents. The two images were combined into a single split-screen image using a special-effect generator. Two lavaliere microphones were used to record the spouses' conversation. The videotaping and the physiological measures were synchronized with a vertical interval time code generator. Couples were randomly assigned to experimental or control conditions. In the experimental condition (infant reminder), a photo of the infant was projected on a television screen located between the parents 5 min after the initiation of the conflict discussion and was presented for 7 s. In the control condition, an affectively neutral picture (umbrella) appeared on the screen in a similar manner. Parents were informed in advance that a picture would appear on the screen, but no further explanation was given. Parents were instructed to disregard the picture and continue with their conversation. Data from six couples could not be used due to difficulties obtaining infant photos, resulting in 29 couples in the experimental group and 35 couples in the control group.

Physiological data collection. Nine physiological measures of autonomic and somatic nervous system activity were collected from each spouse simultaneously using the James Long Company (JLC) system. The system includes an isolated bioamplifier (connected to a battery) with 12-channels and a microcomputer with the following digital and analog output/input capabilities:

1. *Cardiac interbeat interval.* JLC electrodes were placed in a bipolar configuration on opposite sides of the participant's chest, and the interval between successive R-waves of the electrocardiogram (EKG) was measured in milliseconds.

2. *Skin conductance level/response.* Chloride skin conductance electrodes were placed on the medial phalanges of the second and forth fingers of the participant's nondominant hand. JLC skin conductance gel consisting of a citrate salt in a propanediol carboxylate polymer base and having a pH of 6.25 was used as the electrolyte medium. A 0.5-V root-mean-square 30-Hz sine wave excitation signal was applied to the skin, and conductance was recorded with a low-pass filter of 10 Hz.

3. *Finger pulse transmission time.* A UFI photoplethysmograph was attached to the third finger of the nondominant hand. The time interval was measured between the R-wave of the EKG and the upstroke of the peripheral pulse at the finger.

4. *Finger pulse amplitude.* The trough-to-peak amplitude of the finger pulse was measured with the same electrode used for the finger pulse transmission time, providing an index of the amount of blood in the periphery.

5. *Ear pulse transmission time.* A UFI photoplethysmograph was attached to the right ear lobe. The time interval was measured between the R-wave of the EKG and the peripheral pulse at the ear.

6. *Ear pulse amplitude.* The trough-to-peak amplitude of the finger pulse was measured with the same electrode used for the ear pulse transmission time, providing an index of the amount of blood in the periphery.

7. *Respiration.* A respiratory belt that was connected around the chest of the participants measured the breathing rate and relative changes in respiratory volume.

8. *Skin temperature.* An Incutherm thermistor was attached to the palmar surface of the wrist of the dominant hand with surgical tape, and changes in skin temperature were measured.

9. *General somatic activity.* An electromechanical transducer attached to a platform under the participant's chair generated an electrical signal proportional to the amount of body movement in any direction.

According to Levenson (Levenson, Carstensen, & Gottman, 1994; Seider et al., 2009), these measures sample a broad spectrum of autonomic responsiveness, allow for continuous unobtrusive measurement, and are consistent with previous research. The computer was programmed to derive second-by-second averages for each physiological measure for each spouse. Using this data obtained for each physiological measure, we computed two overall means of sympathetic arousal for each spouse, one before and one after stimulus presentation. To compute an overall index of cardiovascular activation, we averaged the five cardiovascular measures (cardiac interbeat interval, ear pulse transmission time, ear pulse amplitude, finger pulse transmission time, and finger pulse amplitude) consistent with previous research (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005; Seider et al., 2009) to create a measure of cardiovascular arousal. Such averaging of cardiovascular measures increases reliability, helps control Type I error by reducing the number of physiological dependent variables, and affords a more comprehensive measurement of cardiovascular arousal (Seider et al., 2009). Because high scores on cardiovascular measures reflect less arousal (i.e., smaller intervals between heartbeats—shorter interbeat intervals—indicate higher heart rate), we multiplied the five cardiovascular measures by (–1) prior to averaging; thus, larger numbers reflect greater cardiovascular arousal.

Behavioral coding. The 10-min marital conflict interaction was microcoded offline on a computerized system (Noldus; The Vaggenigen, Netherlands) using the Marital Coding System (Feldman, Masalha, & Derdikman-Eiron, 2010), a validated microlevel coding system of marital conflict interactions. The coding scheme integrates codes used in parent–infant research with those of marital research, and behavioral coding was used to monitor intervals with milliseconds' precision of couple's behavior and its sensitivity to infant cues. Several categories of verbal and nonverbal behavior were coded in separate runs to ensure unbiased assessments. Interactions were coded by two well-trained assistants who achieved 95% reliability prior to coding. Reliability was computed on 20 interactions and averaged (κ = .81; range = .76–.94). The following nonverbal categories were coded: Spouse Gaze (to partner, to object, gaze aversion); Spouse Affect (positive, neutral, negative withdrawn, negative angry); Spouse Energy (low, stable, high); Spouse Facial Twist (yes, no); Spouse Interruption (yes, no). The following verbal codes were used: Spouse Involvement (engages in conversation, hesitates, withdraws, takes time out—discusses off-topic issue); Spouse Mode of Communication (none, reveals feelings, clarifies opinion, expresses empathy, expresses verbal affection, praises, worries and fears, talks rationally, criticizes or blames partner, puts down partner); and Spouse Conflict Resolution Tactics (offers no solution, initiates a solution, accepts partner solution, rejects partner solution). An uncodable code was added to all categories. The proportion of time each spouse engaged in each of these behaviors was computed. Two composites were created on the basis of previous research suggesting that marital hostility should consider affective quality, verbal content, and facial expressions (Feldman, Masalha, & Derdikman-Eiron, 2010; Heisel & Mongrain, 2004; Houts et al., 2008).

Marital hostility was computed as the mean proportion of time each partner engaged in the following specific behaviors: criticizes partner, puts down partner, expresses angry affect, expresses withdrawn affect, and makes facial twists (α = 0.69 and 0.71 for men and women, respectively). In line with research indicating that marital empathy involves both positive communication skills and nonwithdrawn and active engagement (Houts et al., 2008), marital empathy was computed as the average of the following behaviors: engages in conversation, withdraws engagement (reversed), expresses empathic verbalizations, reveals emotions, and hesitates in expressing feelings (reversed; α = 0.67 and 0.66 for men and women, respectively). Two scores for hostility and empathy were computed for each partner, before and after cue presentation.

Results

To examine the research hypotheses regarding the effects of infant reminders on the parents' empathy, hostility, and cardiovascular arousal, we used multilevel modeling (MLM; Kenny, Kashy,

& Cook, 2006; Raudenbush & Bryk, 2002). MLM enabled us to control for the interdependence between mothers and fathers within each couple across subjects and measurement time points. Ignoring data dependencies may bias significance tests, increase Type I errors, and undermine statistical power (Kenny, 1995). A sample of 70 couples is sufficient for conducting dyadic analysis even under conservative methods of power estimation (Kenny et al., 2006).

Results are presented in three sections. In the first section, descriptive statistics for cardiovascular arousal, marital hostility, and marital empathy are presented for mothers and fathers. In the second section, correlations between all measures were performed to assess two sources of data dependencies: repeated measures dependency and dyadic dependency. Repeated measures dependency is characterized by a potential covariation between the participants' measures prior to and following stimulus presentation (e.g., participants showing high empathy prior to stimulus presentation also showed higher empathy after presentation). Dyadic dependency is characterized by mutual influences that may occur between parents (e.g., wives' empathy levels are associated with their husbands' empathy levels). In the third section, we assessed how the stimulus presentation affected the parents' behaviors and cardiovascular arousal by performing MLM analysis to control for data dependencies.

Part One: Descriptive Statistics of Study Variables

Descriptive statistics for mothers' and fathers' cardiovascular arousal, marital hostility, and marital empathy are presented in Table 1. As seen in Table 1, no significant differences between the two experimental groups concerning mothers' and fathers' cardiovascular arousal, marital hostility, and marital empathy were found before stimulus presentation. Paired-comparison *t* tests showed no gender differences between mothers' and fathers' marital empathy and cardiovascular arousal before or after stimulus presentation. Marital hostility before stimulus presentation, however, was significantly higher in mothers than in fathers, $t(63) = 2.14$, $p < .05$. This gender difference disappeared after stimulus presentation, $t(62) = 0.007$, *ns*.

Table 1
Cardiovascular Arousal, Marital Conflict Behavior, and Marital Satisfaction in Mothers and Fathers Before and After Stimulus Presentation

Condition and measures	Control group		Infant reminders	
	M	*SD*	*M*	*SD*
Fathers				
Before prime				
Cardio	–0.934	0.36	–0.960	0.27
Hostility	1.36	1.88	1.60	2.87
Empathy	57.55	7.77	57.63	8.68
After prime				
Cardio	–0.941	0.35	–0.932	0.26
Hostility	1.95	2.57	1.26	2.29
Empathy	56.93	7.25	55.58	8.89
Mothers				
Before prime				
Cardio	–0.923	0.33	–0.916	0.39
Hostility	1.82	2.71	2.23	3.83
Empathy	57.20	8.17	59.91	7.01
After prime				
Cardio	–0.923	0.34	–0.942	0.35
Hostility	1.99	2.50	1.15	2.25
Empathy	55.78	8.64	57.52	7.13

Note. Cardio = cardiovascular arousal.

Part Two: Correlations Between Study Variables

Correlations between all study variables are presented in Table 2. As seen in Table 2, measures of cardiovascular arousal, marital hostility, and marital empathy before and after stimulus presentation showed high individual stability. These results indicate that the physiological and behavioral measures tested here were relatively stable over time within individuals. High correlations were observed between mothers' and fathers' marital empathy and marital hostility both before and after prime. No associations, however, were found between mothers' and fathers' cardiovascular arousal or between cardiovascular arousal and empathy or hostility for either mothers or fathers.

Part Three: Multilevel Analysis Assessing the Effects of Infant Reminders on Parents' Empathy, Hostility, and Cardiovascular Arousal

The significant associations found between measures of empathy, hostility, and cardiovascular arousal before and after stimulus presentation in both mothers and fathers suggest dependency due to the repeated measure nature of the data. Moreover, high correlations were observed between mothers' and fathers' empathy and hostility. These associations indicate dyadic dependency. Correlations presented in Table 2 also show that small and nonsignificant associations exist between the three dependent measures, suggesting that these measures may capture unique aspects of the conflict conversation and thus call for a separate analysis of each measure.

We employed a three-level model in which repeated measures scores were nested within individuals, and individuals were nested within dyads. This analysis simultaneously controls for dependencies in the same person's reports prior to and following the manipulation, as well as between parents. We used the Hierarchical Linear Model (HLM) Version 7 (Raudenbush, Bryk, Cheong, Congdon, & Du Toit, 2011) software with restricted likelihood estimation to estimate the coefficients (Campbell & Kashy, 2002). Analyses were performed once for each dependent variable (empathy, hostility, and cardiovascular arousal). Results and equations of these analyses (three sets of equations) are presented in Table 3.

Each participant's outcomes in the first level of the model were predicted by a dichotomous dummy variable ($Time_{ijk}$) that represents the two measurement occasions (before and after manipulation). We tested whether the effects of time were equal across parents. Therefore, we modeled Level 1 time slopes as a function of gender at the second level of the model. Finally, at the third level of the model, time and Time × Gender slopes were modeled as a function of prime type (neutral vs. infant).

In the dummy variable time, participants' scores at the baseline prior to the manipulation were coded as –1, and participants' scores following the manipulation were coded as +1. This type of coding ensures that the slopes could be interpreted as a contrast between outcome scores prior to and following the manipulation

Table 2
Correlations Between Mothers' and Fathers' Physiological Arousal and Behavior During Marital Conflict

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Empathy F_1	—	.12	−.05	.77**	.12	−.02	.82**	.16	−.17	.76**	.13	−.15
2. Hostility F_1		—	−.05	.04	.81**	.10	.18	.82**	−.07	.08	.80**	−.08
3. Cardio F_1			—	−.04	−.11	.97**	−.01	−.04	.04	−.03	−.13	.05
4. Empathy F_2				—	.09	−.01	.74**	.07	−.18	.82**	.11	−.16
5. Hostility F_2					—	−.03	.06	.61**	−.12	.10	.94**	−.13
6. Cardio F_2						—	.02	−.03	.05	.01	−.06	.06
7. Empathy M_1							—	.17	−.16	.86**	.07	−.12
8. Hostility M_1								—	−.01	.07	.68**	.01
9. Cardio M_1									—	−.24	−.11	.98**
10. Empathy M_2										—	.11	−.20
11. Hostility M_2											—	−.11
12. Cardio M_2												—

Note. Cardio = cardiovascular arousal; F = Fathers; M = Mothers; subscript 1 = before the manipulation; subscript 2 = after the manipulation.
* $p < .05$. ** $p < .01$.

(Kenny et al., 2006). Each Level 1 group consisted of two scores; thus, the intercept (π_{0jk}) was treated as random, whereas the slope (π_{1jk}) was treated as fixed at Level 2 (Campbell & Kashy, 2002). At the second level, gender was coded as –1 for fathers and +1 for mothers. Again, each Level 2 group had two members, and the coefficients (except for the intercept) were treated as fixed. For the third-level predictor prime type, the neutral prime was coded as 0 and the infant prime was coded as 1.

Results presented in Table 3 show that for empathy, only the main effect of Time emerged as significant, indicating that empathy decreased as the conflict conversation progressed regardless of whether the stimulus was the infant or the control prime. For hostility, a significant Time × Prime interaction was found. Following Preacher, Curran, and Bauer's (2006) guidelines for probing moderation effects in multilevel models, we analyzed two simple slopes of time, one for each type of prime. Under the neutral condition, time was found to have a significant positive effect on hostility (b = 0.19, SE = 0.07, t = 2.61, $p < .01$), indicating that mean hostility levels during the last 5 min of the conflict conversation in the neutral condition were higher than mean hostility levels measured prior to the neutral prime. In contrast, under the infant reminder condition, time was found to have a significant negative effect on hostility (b = –0.34, SE = 0.12, t = 2.87, $p < .01$). These findings indicate that couples presented with their infant prime reduced the level of hostility levels during conflict dialogue.

For the cardiovascular composite, a main effect of time emerged as significant, indicating that cardiovascular arousal decreased as the conflict conversation progressed. Moreover, a significant Time × Gender × Prime Type interaction was found. This three-way interaction was further probed into the simple slopes of time, for each combination of Gender × Prime Type as presented in Figure 1.

Simple slopes analyses indicated that mothers who were primed with a photo of their infant showed a decrease in their cardiovascular arousal (b = –0.013, SE = 0.006, t = 2.27, $p < .05$) following the infant reminder, in comparison with the 5 min of interaction prior to the infant prime. In contrast, mothers viewing a neutral stimulus showed no difference in their cardiovascular arousal over the course of the conflict conversation (b = 0.001, SE = 0.005, t = 0.01, *ns*). For fathers, infant primes did not change their cardiovascular arousal from pre- to poststimulus presentation (b = 0.002, SE = 0.006, t = 0.43, *ns*). On the other hand, fathers in the neutral condition showed a decrease in their cardiovascular arousal (b = –0.015, SE = 0.005, t = 3.04, $p <$ .01) in the second part of the conflict conversation compared with the first part of the conversation prior to the neutral prime.

Table 3
Multilevel Model Results Predicting Empathy, Hostility, and Cardiovascular Arousal From Time, Gender, and Prime Type

Predictors	Empathy		Hostility		Cardiovascular composite	
	b	*SE*	*b*	*SE*	*b*	*SE*
Level 1 (measurement level)						
Time	−0.78**	0.21	−0.05	0.08	−0.008*	0.003
Level 2 (person level)						
Time × Gender	−0.11	0.12	−0.10	0.10	0.002	0.003
Level 3 (dyad level)						
Time × Prime	−0.60	0.52	−0.53**	0.16	0.002	0.005
Time × Gender × Prime	0.11	0.36	−0.06	0.16	−0.015**	0.005

Note. Level 1 equation: $\text{Outcome}_{ijk} = \pi_{0jk} + \pi_{1jk}(\text{Time}_{ijk}) + e_{ijk}$. Level 2 equations: $\pi_{0jk} = \beta_{00k} + r_{0jk}$ and $\pi_{1jk} = \beta_{10k} + \beta_{11k}(\text{Gender}_{jk})$. Level 3 equations: $\beta_{00k} = \gamma_{000} + u_{00k}$ and $\beta_{10k} = \gamma_{100} + \gamma_{101}(\text{Priming}_k)$ and $\beta_{11k} = \gamma_{110} + \gamma_{111}(\text{Priming}_k)$.
* $p < .05$. ** $p < .01$.

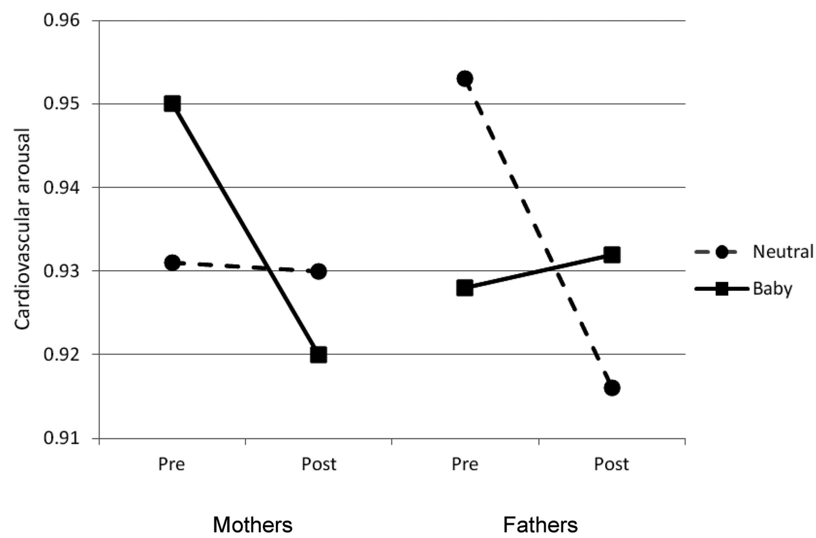

Figure 1. Changes in cardiovascular arousal in mothers and fathers in the experimental and control conditions. Those in the experimental group were exposed to own-infant cues halfway into the interaction. Those in the control group were exposed to affectively neutral stimuli halfway into the interaction.

Discussion

The current study offers a unique viewpoint on the transition to parenthood as a distinct developmental stage in the lives of adults by integrating multiple viewpoints on this transition, borrowing methodologies from various areas of inquiry, and utilizing an experimental research design. Overall, our findings show that the level of mothers' and fathers' sympathetic arousal changed and their expressed marital hostility during conflict discussion decreased following exposure to own-infant cues. Research on the transition to parenthood dates back over a half century and has generated much knowledge on this period in the lives of couples (e.g., Burgess & Wallin, 1953). Within this body of work, developmental research has addressed changes to the marital relationship in the context of family formation and infant development (Belsky & Rovine, 1990; Cowan & Cowan, 1992), whereas marital research (e.g., Gottman & Levenson, 2000) has focused on the couple interactions, particularly on the negotiation of conflict. Most studies, however, used correlational rather than experimental research designs. By integrating evolutionary models into this well-established line of research, our findings may afford specific insights on the dynamic integration of biology and behavior in the service of evolutionary adaptation and the biological mechanisms that establish the saliency and incentive value of the infant to its parents. From a developmental viewpoint, evolutionary models place the transition to parenthood within a lifetime, cross-generational evolutionary arc that begins at birth and culminates in successful reproduction and may thus underscore this transition as a unique stage of individual development. Yet, it should be noted that, similar to most experimental research, we documented the response of new parents to their infant cues at a specific moment in the transition, and it is not possible to know whether the observed positive effects of the infant on the marriage last or whether individual differences in the parents' response strategies shape the trajectories of marital discourse, child development, or family functioning over time.

Parental Physiology and Hostility Are Sensitive to Infant Reminders

Evolutionary models provided the basis for our hypothesis that physiological systems in the parent would be highly sensitive to infant cues and would respond online in a matter of milliseconds in situations that are perceived as posing the slightest risk to infant well-being. Our findings are consistent with evolutionary models on parenting and may contribute to the discussion on the coevolution of mothering and fathering (Geary, 2000) by showing that mothers and fathers synchronize their efforts to jointly protect the infant from harm. Mothers and fathers reduced the level of hostile behaviors toward their partner following infant reminders. These findings are consistent with research demonstrating that the presence of the child tends to reduce the level of parental conflict (Coyne & Anderson, 1988) and with studies pointing to the negative impact of marital discord on infant well-being (Macfie et al., 2008; Porter et al., 2003). Mothers expressed greater hostility at the initiation of the conflict discussion but decreased their hostility in response to infant reminders, whereas fathers showed lower hostility at the beginning and further decreased their hostility following the infant prime. In the neutral condition, on the other hand, both parents increased their hostility toward each other as the conflict progressed. The increase in hostility over the course of marital conflict is in keeping with previous studies indicating that first-time fathers tend to escalate their negotiation styles over the expression of conflict (Bigras, La Frenière, & Lacharité, 1991). The current findings show that infant cues served to regulate the typical course of conflict escalation and significantly tempered mothers' and fathers' explicit displays of interpersonal hostility.

Mothers and Fathers Differ in Their Sympathetic Responses to Infant Cues

Mothers and fathers showed different sympathetic responses to own-infant cues, and these findings are consistent with previous research on the link between parental sympathetic reactivity and infant stimuli (Boukydis & Burgess, 1982; Brewster, Nelson, McCanne, Lucas, & Milner, 1998; Frodi, Lamb, Leavitt, & Donovan, 1978). For example, whereas males were found to react with greater sympathetic arousal than females to infant cry stimuli (Out, Pieper, Bakermans-Kranenburg, & Van IJzendoorn, 2010), no gender differences were found in physiological arousal in response to a smiling infant (Brewster et al., 1998). Recent functional magnetic resonance imaging studies similarly show that parents' brains respond to own-infant stimuli, including infant picture and cries (Ranote et al., 2004), by increased activation in brain areas that are central for the development of parenting (Kim, Leckman, Mayes, Feldman, et al., 2010), with some studies indicating gender differences in brain reactivity to these stimuli (Seifritz et al., 2003; Swain, 2008). Together, these studies suggest gender-specific responses to infant cues that trigger the evolutionary-based need to protect infants from danger, such as from the consequences of a marital dispute spiraling out of control. However, because our study, similar to research on new parents' brain responses to infant cues, was conducted in the first months of the infant's life, it is not possible to conclude whether these mother–father differences in physiological response would attenuate as the infant grows older.

The results may also accord with Taylor's theory on gender-specific modes of stress regulation and its application to bond formation in women and men (Taylor et al., 2000). According to this model, women regulate moments of increased stress through affiliation processes and tend-and-befriend strategies, whereas men deal with stress by increasing arousal and elevating their fight-or-flight behaviors. The current findings indicate that during the stressful period of the transition to parenthood, mothers decreased their sympathetic reactivity when reminded of their infant, a state associated with affiliation, while such reminders led fathers to sustain a state of physiological vigilance. Evolutionary models suggest that because females' investment in pregnancy and nursing is greater than males', their response to stress optimizes strategies for maintaining their own well-being, which is critical for promoting their offspring's ability to thrive. Thus, mothers react with a biologically based increase in homeostasis in response to infant reminders. Such affiliative responses, characterized by quieting, caring for offspring, and blending into the environment, are more effective than "arousing" responses in females, which may put themselves and their offspring in jeopardy.

Infant Reminders During Marital Conflict Do Not Increase Marital Empathy

It is notable that although our findings indicate that infant reminders decreased hostility and organized parent physiology for optimal infant care, there was no significant effect on parental empathy. In fact, marital empathy declined over the course of the conflict interaction in both parents and in both the infant prime and control conditions. A reduction in hostility, therefore, does not connote an increase in empathy. It appears that infant primes do not instantaneously restore marital harmony, but the salience of the infant to its parents triggers a response that is vital for the psychological well-being of the child (Feldman, 2012). Parents seem to be able to set their differences aside when thinking of the baby and prepare themselves for their role as parents by reducing explicit hostility and reorganizing their physiology. The continued decline in empathy over the course of the conflict conversation in a manner unaffected by infant reminders suggests that the conflict still prevails and is manifest in more implicit and subtle behaviors. This pattern of responses should be further investigated in research on the effects of children on parental conflict. Thus, although our physiological findings are consistent with Taylor et al.'s (2000) theory, the behavioral findings do not. Women did not increase their affiliative empathy toward their partners more than did men, and no gender differences emerged in the reduction of hostility.

Limitations of the study should be noted in the interpretation of the findings. First, we used a cross-sectional experimental design and did not follow the families longitudinally to assess whether the momentary positive effect of the infant on the marital discourse observed here is lasting and whether it is predictive of any developmental outcome in the marital relationship or the infant's social-emotional growth. Second, we compared own-infant cues with neutral stimuli and did not include an other-infant condition. Research comparing parental event-related potential response to own infant, other infant, and neutral stimuli (Weisman, Feldman, & Goldstein, 2012) showed that in the first automatic attention-allocation component (N170), there was no difference between mothers' and fathers' response to own versus other infant picture and both were markedly greater than their response to a neutral stimulus, and differences only emerged in the later components that require updating the infant cue with previously stored memory (P3a, P3b). Because the current study examined the response of the brain stem-mediated, phylogenetically ancient sympathetic nervous system, it was not clear whether comparing own and other infant would generate an effect, and we selected to capitalize on the different response of parents to own infant versus neutral stimuli. However, not comparing own infant to other infant is a clear study limitation, and future research should examine whether the effects found here are general to any infant reminders or are specific to the attachment target. Unfortunately, we did not collect information on maternal breastfeeding, and this is a clear study limitation, which precluded the assessment of whether breastfeeding mothers showed greater decrease in sympathetic arousal or hostility. We selected to study parents at the transition to parenthood, and future research is needed to assess whether the findings generalize to later-born infants or are specific to the neurobiology of becoming a parent. Similarly, the findings are specific to the period of 6 months postpartum, and it is not clear how early such effect can be observed and whether it disappears after a certain period of parenting. Our sample included educated, middle-class parents, and further research is required to assess whether the findings are similar for those with a lower socioeconomic status, although our evolutionary-based approach would suggest that "good enough" parenting would be associated with such an automatic response regardless of social class. Furthermore, it is important to examine whether conditions associated with risk to the parent–infant bond, such as premature birth, maternal postpartum depression, or high contextual risk, would also be expressed in a diminished physiological or behavioral response to infant cues.

In sum, this study utilized a biobehavioral paradigm to integrate various perspectives on the transition to parenthood and demonstrate that brief infant reminders may function, although momentarily, to enhance parental conflict dialogue, reduce hostility, and reorganize mothers' and fathers' physiology to support their role as parents. Previous research has shown that learning to negotiate marital conflict is a key issue of the developmental transition associated with becoming a parent and that hostile conflict bears negative long-term consequences for infant growth. Our results accord with evolutionary models of parenting and with life-span developmental perspectives and suggest that although the transition to parenthood may pose a great challenge to the couple relationship and define a critical moment in the life cycle of families, the infant may serve to temper reactions, restrain parents, and enhance the emotional climate of the new family. Future research may assess whether interventions that function to increase the infant's salience to its parents and to find ways to remind parents of their child's well-being during moments of conflict may assist couples during this challenging period of becoming a family.

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