Love Alters Autonomic Reactivity to Emotions

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Periods of bond formation are accompanied by physiological and emotional changes, yet, little is known about the effects of falling in love on the individual's physiological response to emotions. We examined autonomic reactivity to the presentation of negative and positive films in 112 young adults, including 57 singles and 55 new lovers who began a romantic relationship 2.5 months prior to the experiment Autonomic reactivity was measured by Respiratory Sinus Arrhythmia (RSA) to two baseline emotionally neutral films, two negative films, and two positive films. Results demonstrated that RSA in singles decreased during the presentation of negative emotions, indicating physiological stress response. However, no such decrease was found among new lovers, pointing to more optimal vagal regulation during the period of falling in love. Autonomic reactivity, indexed by RSA decrease from the positive to the negative films, was greater among singles as compared to lovers, suggesting that love buffers against autonomic stress and facilitates emotion regulation. Findings suggest that vagal regulation may be one mechanism through which love and attachment reduce stress and promote well-being and health.

Keywords: romantic love, bonding, vagal tone, emotion regulation, RSA

The ability to form enduring and meaningful relationships is a key social capacity of human beings. Parents' bonding to their infant, a child bonding to his or her parents, romantic attachments in adolescence and young adulthood, close friendships, and other forms of human bonding are essential for physiological and psychological well-being. On the other hand, disturbances to the formation of close bonds are a major risk factor for a wide range of psychological disorders, such as clinical depression, generalized anxiety disorder, anorexia nervosa, substance abuse, and autism spectrum disorders (Canetti, Bachar, Galili-Weisstub, De-Nour, & Shalev, 1997; Di Pentima et al., 1998; Enns, Cox, & Clara, 2002; Leckman et al., 2005; Petraitis, Flay, & Miller, 1995; Scinto, Marinangeli, Kalyvoka, Daneluzzo, & Rossi, 1999).

Within the general process of bond formation, two periods have been identified as the most critical and were found to exert a profound influence on the individual's psychological functioning: periods of bond formation and periods of bond dissolution. Since the dissolution of affiliative bonds were shown to carry intense effects on human brain activity and psychophysiology (Fisher, Brown, Aron, Strong, & Mashek, 2010; Freed, Yanagihara, Hirsch, & Mann, 2009; Najib, Lorberbaum, Kose, Bohning, & George, 2004; O'Connor, Gundel, McRae, & Lane, 2007), it is

likely to assume that structural and neural changes take place during periods of bond formation as well. Indeed, changes in brain activity and peripheral hormonal levels were found during the initial stages of a romantic relationship. These include decreased levels of plasma serotonin (Marazziti, Akiskal, Rossi, & Cassano, 1999), higher plasma cortisol (Marazziti & Canale, 2004), and increased brain activation in areas implicated in attachment- and reward-related processes including areas rich in dopamine, oxytocin, and vasopressin (Aron et al., 2005; Bartels & Zeki, 2000; Bartels & Zeki, 2004).

Autonomic reactivity and emotion regulation play an important role in the partners' communication within a romantic relationship (Roisman, 2007) and were found to predict marital dissatisfaction and even divorce (Gottman & Levenson, 1992; Levenson & Gottman, 1983; Levenson & Gottman, 1985). It is thus of interest to examine changes in autonomic nervous system reactivity during the initial stages of a romantic relationship in relation to the individual well-being and emotional distress.

A central component of the parasympathetic nervous system is the tenth cranial nerve, the vagus, with branches originating in the medullary source nuclei. In mammals, the heart is regulated primarily by the evolutionary-recent myelinated vagus. Parasympathetic activity provides the basis of social engagement and support the formation of affiliative bonds (Porges, 1998). During moments of social engagement, the myelinated vagus maintains calm states by providing tonic control over the heart, whereas under stress, vagal control is rapidly attenuated to support fight-and-flight behaviors (Porges, 1997; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). The degree of attenuation of vagal control—vagal reactivity—is thought to index the level of stress experienced by the organism (Porges, 2003). Vagal control over the heart can be indexed by the high frequency component (0.15–.4Hz) of

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heart rate variability (Friedman, 2007; Task Force Guidelines, 1996), described as respiratory sinus arrhythmia (RSA, Porges, 1985, 1995). RSA indexes parasympathetic influences over heart rhythms (Porges et al., 1996) and provides a noninvasive index of vagal activity.

According to the polyvagal theory (Porges, 1995, 1997), myelinated vagal-cardiac nerve activity is tightly related to the ability to process and express emotions. In support, a growing body of research indicates that RSA is involved in processes of emotional perception, responding, and regulation (Beauchaine, 2001). Associations were found between RSA and key aspects of behavior, including attention and affect (Friedman, 2007; Thayer, & Lane, 2000). Resting RSA has been associated with individual differences in emotional reactivity (Beauchaine, 2001), and higher levels of resting RSA correlate with physiological flexibility and adaptability in a changing environment (Beauchaine, 2001). On the other hand, low levels of resting RSA are related to various pathological conditions, including poor emotion regulation and stress vulnerability in infancy and childhood (Porges, 1992; Porges, Doussard-Roosevelt, & Maita, 1994), anxiety and antisocial behavior in adolescence (Mezzacappa et al., 1997), and hostility and psychopathology in adults (Beauchaine, 2001; Vella & Friedman, 2007).

Vagal reactivity, the decrease in RSA from baseline to a challenging situation, is thought to index the degree of physiological stress (Porges, 1995, 2003). In the context of attachment relationships and bonding, close maternal-infant contact functions to attenuate the infant's vagal reactivity to negative emotions. For instance, infants who received maternal touch during the "still-face" procedure, known to elicit physiological and behavioral stress in young infants, exhibited lower vagal reactivity as compared to infants who experienced maternal still-face without touch (Feldman, Singer, & Zagoory, 2010). Similarly, premature infants who received maternal-infant skin-to-skin contact (Kangaroo Care Intervention) in the neonatal period showed lower RSA decrease to the presentation of negative emotions at 10 years of age (Feldman, 2011a). These findings suggest that attachment relationships may function to increase autonomic regulation, particularly during periods of bond formation, similar to the results reported for other mammals (Hofer, 1995).

In light of the above, the present study focused on the period of falling in love and addressed the effects of romantic bond formation on the young lovers' physiological stress reactivity and emotion regulation. Two groups of young adults were recruited: those who were at the initial stage of a romantic relationship and matched singles who were romantically uninvolved. A film exposure paradigm was used for the induction of neutral, negative, and positive emotions in light of previous studies showing that viewing videotaped vignettes elicits a variety of predictable emotions in the same way in most individuals (Hagemann et al., 1999; Philippot, 1993). RSA was assessed during the observations of baseline (emotionally neutral) and four emotion-inducing video vignettes, two eliciting positive emotions and two eliciting negative emotions. Each valence contained one relationship-related vignette (e.g., couple arguing) and one relationship-unrelated vignette.

Consistent with the polyvagal theory on love (Porges, 1998), our overall hypothesis was that periods of bond formation impact the functioning of the autonomic system and would lead to more optimal vagal regulation. Such changes in vagal regulation may underlie the positive effects of close relationships on health and well-being. We thus expected differences in vagal regulation among the two groups. In particular, we hypothesized that love would impact the response to negative emotions and would decrease the degree of physiological stress associated with the experience of negative stimuli. We also expected that changes in vagal reactivity from positive to negative emotions would be milder among new lovers, suggesting that love may attenuate autonomic reactivity to stress. Finally, we expected that indices of the individual's emotional distress, including symptoms of anxiety and depression, would be associated with greater autonomic reactivity to negative emotions, above and beyond group membership, as suggested by research linking vagal regulation with psychopathology and wellness.

Method

Participants

Participants included 112 young adults, with a mean age 23.37, $SD = 2.99$ years (age range: 17–32). Approximately 90% of the participants were college students. The "new lovers" group included 55 individuals (28 men) who began a romantic relationship on average 2.5 months prior to the experiment ($SD = 0.9$: Range = 2 weeks to 4 months) and the "singles" group included 57 (29 men) individuals who were not involved in a romantic relationship. Participants were recruited by ads posted in a university campus, were all healthy, and completed at least 12 years of schooling.

Procedure

After receiving a brief explanation on the experiment procedure and signing an informed consent, participants were positioned in a comfortable chair facing a video monitor in a quiet laboratory room and were attached to physiological sensors. Following, two baseline (emotionally neutral) and four emotion-inducing video vignettes (two positive and two negative, each containing one relationship-related and one relationship-unrelated vignette) were presented. A brief post-presentation questionnaire followed each vignette to minimize carryover (see Rottenberg, Ray, & Gross, 2007b). Participants were instructed to simply watch the films and were left alone during the task.

Intervals between successive R waves (interbeat intervals−IBI) were collected continuously by portable ECG monitor-IBI logger system (12bit, 1000 samples/second/channel, 3992/6-IBI BioLog© System, UFI, Morro Bay, CA). BioLog© System (l.f. filter: −3dB@ 1 Hz., 12 dB/octave; h.f. filter: −3dB@ 50Hz., 12 dB/octave) was equipped with active signal-conditioning electrodes (gain = 1000 dB), attached to participants using three disposable Ag-AgCl skin surface electrode patches. Two active electrodes were placed on the midaxillary and midclavicular line, and the reference electrode was placed on the trapezius muscle. Sampling rate was 1000 Hz. Participants were given a gift of $13 for participation. The study was approved by the University's Ethics Committee.

Measures and Materials

Emotion films.   Two baseline (emotionally neutral) and four emotion-inducing video vignettes were presented to participants in the following order:

1.   Neutral vignette (baseline1)–ocean scene #1 from "The Dragons of Galaagos," National Geographic (1999).

2.   Positive relationship-unrelated (PN)–sport performance from the movie "Bring it On" (2000).

3.   Positive relationship-related (PR)–scene of the first date from the movie "50 First Dates" (2004).

4.   Neutral vignette (baseline2)– ocean scene #2 from "The Dragons of Galaagos," National Geographic (1999).

5.   Negative relationship-unrelated (NN)–scene of a mother looking for her child in a plane from the movie "Flightplan" (2005).

6.   Negative relationship-related (NR)–a quarrel between husband and wife from the movie "The Last Kiss" (2006).

Each vignette lasted for 3–4 minutes. Selection of the episodes was based on criteria recommended by Rottenberg and colleagues (2007b). Our pilot study ($N = 20$) indicated that the video vignettes elicited the expected emotional and physiological response. The first neutral film (baseline1) was intended for measuring resting RSA levels, whereas the second neutral film (baseline2) was intended for both measuring baseline RSA and preventing carryover of residual affective states and possible autonomic changes from the first cluster of films (positive) to the second (negative). Paired comparison t tests did not reveal any significant differences between RSA levels for baseline1 ($M = 6.34$, $SD = 1.03$) and baseline2 ($M = 6.32$, $SD = 1.11$), $t(df = 1, 96) = 0.368$, $p > .05$. To eliminate the effect of order of presentation on RSA, a pilot study was conducted in which the order of the films within each cluster (positive, negative and neutral) and the order of the positive and negative clusters were counterbalanced. Repeated measures ANOVA for all possible orders revealed no order effects on RSA.

After viewing each vignette subjects completed a Post-Film Questionnaire—a self-report instrument that assessed the emotion and feeling states that the video vignettes elicited (Philippot, 1993; Rottenberg et al., 2007b). Participants were asked to evaluate emotions that each film elicited using a 7-point Likert scale. Positive and negative emotions composites were calculated independently. Cronbach's alpha was calculated for emotions in each composite for each film segment independently and alpha ranged from 0.68 to 0.97, indicating an adequate internal consistency for the negative and positive emotion composites in each film.

Self-Report Instruments

The Beck Depression Inventory (BDI).   The Beck Depression Inventory (BDI) is a well-validated instrument for the assessment of depressive symptoms (Beck, 1978). BDI scores ranged from 0 to 21.

The State–Trait Anxiety Inventory (STAI).   The STAI (Spielberger, Gorsuch, & Lushene, 1983). Measures two distinct anxiety concepts by two different questionnaires: state anxiety (how one feels at a particular moment) and trait anxiety (how one usually feels). Each questionnaire is based on 20 items for which a person rates anxiety (state or trait) on a scale from 1 (*almost never*) to 4 (*very much so*). STAI state anxiety scores (STAI-S) of the subjects ranged from 20 to 68 whereas STAI (STAI-T) trait anxiety scores ranged from 21 to 58.

Means for BDI and STAI scores in the two groups appear in Table 1. The standardized BDI and STAI scores were summed to crease a composite of the individual's Emotional Distress.

Family Expressiveness Questionnaire (FEQ).   Family Expressiveness Questionnaire (FEQ) examines the styles of emotional expression in the family of origin (Halberstadt, 1986). The questionnaire consists of 40 scenarios involving emotional expression. Subjects rated the expressions on a scale of 1 (*not at all frequently*) to 9 (*very frequently*) to indicate how often each scenario occurs in their families of origin. The instrument assesses family's overall expressive environment according to four subscales that represent the affect dimension crossed by the power dimension. In this study we used the positive-dominant (FEQ-PD), and positive-nondominant (FEQ-PND) scales, which were found to be associated with the individual's nonverbal communication skills (Halberstadt, 1986).

Data Analysis

The physiological data was later analyzed by MXedit system using the Porges method (Porges, 1985) to derive measures heart period (HP) of RSA. The method is designed for detecting amplitude variations in the rhythmic oscillations of the IBI data in a frequency of respiration. A moving polynomial filter is stepped through the time-series original IBI data in order to detrend not relevant aperiodic processes. The output of this procedure is then subtracted from the raw data. Finally, the resulting trend is band-passed to allow only the variance within the respiratory frequency band (0.15–0.40 Hz) to pass and natural logarithm of this variance quantifies RSA (reported in $\ln(msec)^2$; Porges, 1985). Subjects' RSA levels that differ from the film's RSA mean in more than two standard deviations were not included in the analysis. In addition, heart period (HP) for each subject in each condition was calculated as the time interval between successive R-waves of the ECG. Changes in HP and RSA from the baseline state while subjects watched neutral film vignettes to the positive and negative vignettes were calculated. Correlations between these changes from baseline in heart rate and changes from baseline in RSA were calculated in order to evaluate the vagal contribution to heart rate changes.

Results

Means and standard deviations of study variables are presented in Table 1.

To examine whether new lovers differ from singles in their vagal response to emotions, we computed a Univariate Analysis of Variance (ANOVA) with repeated measure, with RSA as the within subject factor and neutral, negative, and positive valance as the within-subject conditions, and gender and group as the

Table 1
Descriptive Statistics of Study Variables In Singles and New Lovers

	Singles		New lovers		
	M	*SD*	*M*	*SD*	*F*
Depressive Symptoms (BDI)	5.86	5.00	5.13	4.18	NS
State Anxiety (STAI-S)	34.74	10.13	33.69	8.08	NS
Trait Anxiety (STAI-T)	37.02	9.45	35.33	7.88	NS
Emotional distress[a]	.09	1.86	−.22	1.52	NS
FEQ-PD[b]	6.09	1.59	6.16	1.56	NS
FEQ-PND[c]	6.15	1.49	5.85	1.37	NS
Positive Score for NN film[d]	1.34	.80	1.16	.45	NS
Negative Score for NN film[d]	3.31	1.67	3.09	1.57	NS
Positive Score for NR film[d]	1.39	.88	1.21	.88	NS
Negative Score for NR film[d]	3.27	1.53	3.65	1.62	NS
RSA for baseline1 film	6.24	0.93	6.39	1.08	NS
RSA for baseline2 film	6.30	1.09	6.34	1.16	NS
RSA for PN film	6.13	1.03	6.10	1.24	NS
RSA for PR film	6.38	.95	6.45	1.10	NS
RSA for NN film	6.15	.98	6.32	1.01	NS
RSA for NR film	6.11	.95	6.57	1.02	5.46*
HR for baseline1 film (ms)	842.09	119.02	854.28	145.19	NS
HR for baseline2 film (ms)	850.12	109.27	850.26	144.42	NS
HR for PN film (ms)	837.18	108.68	844.70	147.28	NS
HR for PR film (ms)	863.30	109.99	867.64	151.32	NS
HR for NN film (ms)	848.88	105.35	865.17	142.39	NS
HR for NR film (ms)	868.48	110.47	881.31	144.80	NS
RSA reactivity	−.10	.42	.07	.37	4.66*

Note. [a] Calculated by summing a Z-scores of BDI, STAI-T and STAI-S. [b] Positive-Dominant Family Expressiveness. [c] Positive-Nondominant Family Expressiveness. [d] Subjects' evaluation of positive or negative emotions that the films elicited.
* $p < .05$. ** $p < .01$.

between-subjects factors. A significant effect for group was found differences only during the negative films, $F(df = 2, 83) = 3.69$, $p < .05$, $\omega = .082$, with higher RSA for new lovers as compared to singles under the negative emotions condition. No effect was found for gender in any analysis. To examine the source of the effect, two univarate tests were computed: one for the negative relationship-related film and one for the negative relationship-unrelated film. Results showed significant differences in RSA during the relationship-related negative film, $F(df = 1, 84) = 5.46$, $p < .05$, $\omega = .061$. These findings indicate that during the presentation of negative emotions, new lovers exhibit a significantly higher RSA response compared to singles, pointing to lower vagal withdrawal and reduced stress reactivity and that the effect is particularly meaningful during the presentation of relationship-related negative emotions. These findings are presented in Figure 1.

Post-films questionnaires revealed that despite the differences in RSA levels in response to the negative films, the two groups evaluated the emotional impact of the films in the same way. Positive and negative scores given by singles and new lovers for the NN and NR films are presented in Table 1 and show no group differences. Similarly, no group differences emerged in the emotional impact of other films.

However, significant gender differences were found in the emotional reporting of negative emotions that were elicited during the observation of negative films. Women described the impact of both the NN and NR films as more negative ($M_{NN} = 3.54$, $SD_{NN} = 1.63$, $M_{NR} = 3.96$, $SD_{NR} = 1.55$) than men ($M_{NN} = 2.86$, $SD_{NN} = 1.54$, $M_{NR} = 2.95$, $SD_{NR} = 1.46$), $t(df = 1, 108) = 2.25$,

$p < .05$ for the NN film and $t(df = 1, 108) = 3.53$, $p < .05$ for the NR film.

To examine change in vagal response from the positive to the negative films, we computed a "vagal reactivity" index as the difference between the mean RSA during the two positive films and the mean RSA during the two negative films. Univariate Analysis of Variance showed significant group differences in vagal reactivity, $F(df = 1, 97) = 4.66$, $p < .05$, $\omega = 0.19$. While singles decreased their RSA response from the positive to the negative films (negative vagal reactivity index), indicating greater
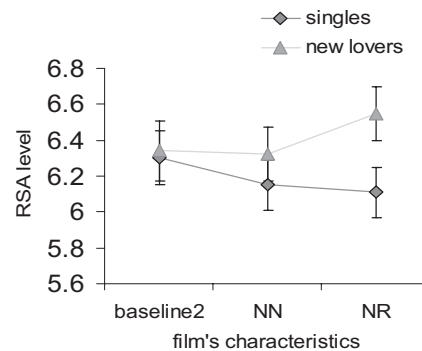

Figure 1. Header: *RSA levels during the observation of neutral and negative films by singles and new lovers* Footer: Error bars represent *SE* mean. NN = negative relationship-nonrelated film; NR = negative relationship-related film.

physiological stress, new lovers increased their vagal response from the positive to the negative film, demonstrating a buffered stress response. These findings are presented in Figure 2.

To examine the associations between RSA levels and the individual's emotional distress, Pearson correlations were performed. Emotional distress was negatively correlated with RSA level for the baseline films, $r = -.23$, $p < .05$, for the NN film, $r = -.22$, $p < .05$, and for the NR film, $r = -.241$, $p < .05$. No significant difference was found in the degree of emotional distress between the two groups, $F(df = 1,111) = .97$, $p > .05$. Associations between RSA and emotional expression in the family of origin were evaluated. The FEQ-PD score, indicating positive-dominant expressive environment in family, was negatively related to RSA in the baseline2 film, $r = -.22$, $p < .05$, the NN film, $r = -.26$, $p < .05$, and the NR film, $r = -.27$, $p < .05$.

Finally, regression analysis was conducted predicting RSA response to the negative relationship-related film. Predictors were entered in three steps. In the first step, group membership was entered as a binary variable to partial variance related to group. The second step included the individual's emotional distress and the third, emotional experience in family of origins. Results indicate that emotional distress and positive-dominant experience in family of origin were each independently predictive of lower RSA during the negative film (greater vagal reactivity) above and beyond group membership. Results of the regression model are presented in Table 2.

To estimate the vagal contribution to change in the heart period, correlations between change from baseline to in HP and change from baseline in RSA to the negative and positive emotions were measured within each group. Moderate but significant correlations were found between these two measures in both groups, as presented in Table 3. Strong association between these two variables illustrates that the changes in both variables are mediated by a common mechanism, that is, vagal regulation of the heart.
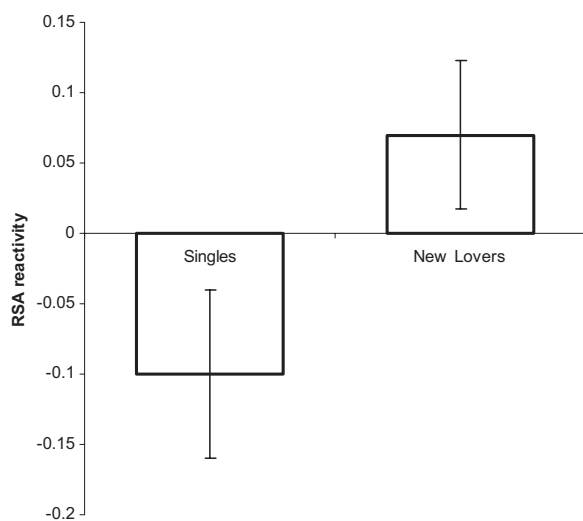

Figure 2. Header: *RSA reactivity from positive to negative films by singles and new lovers* Footer: Error bars represent *SE* mean. PR = positive relationship-related film; NR = negative relationship-related film.

Table 2
Predicting Baseline Autonomic Response (RSA)

	Beta	R^2 change	F change
Group (singles/new lovers)	.21*	.05	4.05*
Emotional Distress[a]	−.25*	.04	3.58
FEQ-PD[b]	−.32**	.10	9.33**

Note. R^2 Total = 0.10 $F(3, 78) = 6.152$, $p < .001$.
[a] Calculated by summing a Z-scores of BDI, STAI-T and STAI-S. [b] Positive-Dominant Family Expressiveness.
* $p < .05$. ** $p < .01$.

Discussion

Despite the importance of romantic love in human life, current knowledge on the physiological changes that occur during the period of falling in love is scant. The present study examined autonomic changes in the early stages of romantic attachment. Results indicated differences in the autonomic processing of negative emotions, particularly negative emotions related to close relationships, by individuals who recently began a romantic relationship. Specifically, group differences were found in the participants' vagal response to the negative relationship-related film. Whereas singles decreased their RSA response during the negative films, indicating physiological stress, such decrease was not observed among new lovers. In addition, vagal reactivity from the positive to the negative films was greater among singles as compared to lovers. Such attenuation of the physiological stress response may indicate that love and attachment provide a buffer against the experience of stress.

Aversive psychological stressors, even mild ones, typically cause vagal withdrawal and the corresponding RSA decrease (Friedman, 2007; Thayer & Lane, 2000) and the present findings indicate that this pattern of reaction was indeed observed among singles. However, the new lovers' autonomic response to the evocation of negative emotions differed from the singles' despite the fact that their reported emotional response was the same, suggesting that some of the effects of love occur at a physiological level and are not captured by more conscious processes. These findings point to subtle changes in autonomic reactivity that occurs during the formation of pair bonds. Consistent with the polyvagal theory on love and close relationships in mammals (Porges, 1998), which suggests that functional changes in the vagal system occur during the initial periods of bond formation in mammals, we found similar alterations in vagal reactivity during the period of falling in love in humans. The failure to show a decrease in RSA during the experience of negative emotions suggests that vagal regulation

Table 3
Correlations Between Change From Baseline Heart Period and Change From Baseline RSA to Negative and Positive Stimuli by Singles and New Lovers

	PN film	PR film	NN film	NR film
Singles	.569**	.289*	.643**	.486**
New Lovers	.335*	.518**	.454**	.476**

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

may be one mechanism by which close relationships reduce stress and promote well-being and health.

One potential mechanism underlying the change in vagal regulation during the initial stages of romantic love may relate to the oxytocinergic system and the joint contribution of oxytocin and the vagal nerve to the formation of affiliative bonds. Oxytocin is a prosocial hormone repeatedly implicated in mammalian attachment, bonding, and social behaviors, which has an anxiolytic effect that enables bond formation (Carter, 1998; Uvnas-Moberg, 1997). Plasma oxytocin levels were found to increase during periods of both parental and romantic bond formation (Gordon, Zagoory, Leckman, & Feldman, 2010; Feldman, 2011b) and Oxytocin inhaling has a direct effect on cardiac functioning (Grippo, Lamb, Porges, & Carter, 2007; Norman et al., 2011). The findings that parent-infant touch and contact increase both oxytocin levels (Feldman, Gordon, Shneiderman, Weisman, & Zagoory-Sharon, 2010) and vagal regulation (Feldman & Eidelman, 2003) suggest that the two systems are interrelated and play an important role in the formation of close bonds. It is thus possible that the vagal system undergoes structural changes in the early stages of romantic relationships under the influence of the oxytocinergic system.

An alternative explanation for the absence of the expected vagal attenuation during the presentation of negative stimuli by new lovers may relate to the general euphoria experienced during the early stages of a romantic relationship (Aron et al., 2005) that may shield new lovers from experiencing physiological stress. It is thus possible that the differences found here are transient and characterize only the early stages of a romantic relationship. Research has pointed to transient neurobiological changes, such as elevated plasma nerve growth factor levels, that are associated only with the early phase of a romantic relationship (Emanuele et al., 2006). Furthermore, romantic love is accompanied by a dynamic brain process and the neural correlates of romantic love change over time (Kim et al., 2009). Further research that includes an additional control group of individuals who are involved in long-term romantic relationships is thus needed to address this issue.

Gender differences were found in the subjective report of emotions and women experienced the negative films as less pleasant than men, consistent with previous research (Bradley, Codispoti, Sabatinelli, & Lang, 2001). On the other hand, no gender differences in autonomic functioning emerged between men and women. Previous studies have similarly described gender differences in subjective report but not in physiological responses between women and men (Codispoti, Surcinelli, & Baldaro, 2008; Wrase et al., 2003) and point to greater disparity between physiological and mental process among women.

Emotional distress, indexed by depressive and anxiety symptoms, was associated with lower baseline RSA. This is consistent with previous studies which point to the relations between low resting vagal tone with depression and anxiety (Licht, de Geus, van Dyck, & Penninx, 2009; Rottenberg, Clift, Bolden, & Salomon, 2007a). In addition, emotionally distressed individuals had a greater vagal withdrawal during the negative stimuli, indicating a greater physiological distress. During the first months of parenting, depressive symptoms and vagal regulation are interrelated and carry both independent and interactive effects on mother-infant social engagement (Feldman & Eidelman, 2009), highlighting the joint impact of emotional distress and autonomic functioning during periods of bond formation. Much further research is required to

assess the specific conditions under which depression and anxiety symptoms are associated with autonomic functioning during the initial stage of a romantic relationship as well as the effects of bond dissolution on both emotional distress and vagal regulation.

The association between emotional expression in family of origin and vagal regulation were inconsistent with previous research pointing to the beneficial effects of a positive dominant family expressiveness on children's emotional development (Kolak & Volling, 2007; Michalik et al., 2007). The current results indicate that individuals who evaluated their family's overall expressive environment as positive-dominant had lower resting RSA level and greater attenuation of the vagal response. Possibly, the links between childhood memories and physiological response weaken by the time children reach young adulthood. It is also possible that a family atmosphere characterized by highly dominant positive expressiveness does not provide children a resilient shield against negative emotions and early environments that integrates both positive and negative expressiveness may be more conducive for preparing the child's physiological systems for the experience of mild stressors. However, this hypothesis is highly speculative and the relations between caregiving environments and adult physiological responsivity require much further research.

Limitations of the study should be considered in the interpretation of the findings. It is important to note that the results do not imply a causal relationship between the development of pair bonds and autonomic changes. In addition, counterbalancing of presentation order of the films may have been conducive in providing additional insight on vagal reactivity. Following new lovers over time would have also provided a more comprehensive assessment on the shift in autonomic reactivity from the period of falling in love to that of a stable romantic relationship.

Future studies that include additional study groups, such as individuals in long-term relationships, those who recently broke up a romantic relationship, or grieving individuals, are required to examine the complex dynamic processes of vagal reactivity associated with bond formation and bond dissolution. The vagus nerve is a major component of the parasympathetic nervous system that is actively involved in interpersonal communication and social behavior and the present findings indicate that its functioning undergoes alterations during the establishment of pair-bonds. Understanding autonomic changes during periods of bond formation and bond dissolution may further illuminate the physiological mechanisms involved in attachment and grief and may enable clinicians to provide more specific interventions under conditions of disruption to the normative bonding process, such as postpartum depression or unresolved grief.

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