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Research Paper

Heart rate variability reactivity and new romance: Cause or consequence?☆,☆☆

Laura K. Bailey*, Ron Davis

Department of Psychology, Lakehead University, Canada

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ABSTRACT

There are documented physiological differences between single and coupled individuals during the "honeymoon period" of nascent romantic relationships. One such difference is in autonomic reactivity, specifically heart rate variability (HRV) reactivity. This finding had previously been interpreted as evidence of a stress buffering effect of relationship formation. The present study explored among university women two competing longitudinal hypotheses conceptualizing differences in HRV reactivity as either a cause or a consequence of romantic relationship formation. Results did not support the hypothesis that HRV reactivity changes as a consequence of beginning a new romantic relationship. Instead, lower HRV reactivity predicted greater relationship formation amongst women with low BMI and higher resting HRV. The functioning of the heart therefore predicted the likelihood that an individual would find love. These interactions may be the result of differing success rates of various mating strategies for women with low and high BMI and HRV.

1. Introduction

Beginning a new romantic relationship is often accompanied by a barrage of emotional and physiological changes. Individuals report experiencing euphoria during the honeymoon period and exhibit differences in hormone and neurotransmitter levels (Marazziti, Akiskal, Rossi, & Cassano, 1999; Marazziti & Canale, 2004), and brain activation patterns (Aron et al., 2005). Recent evidence points toward a link between autonomic reactivity and relationship formation, with new romantic relationships potentially buffering physiological reactivity to negative emotions. Specifically, differences in heart rate variability (HRV) have been detected between single and newly-coupled individuals presented with emotional stimuli (Schneiderman, Zilberstein-Kra, Leckman, & Feldman, 2011).

HRV refers to the variation between successive heartbeat intervals and is extracted through electrocardiography (ECG). A variable heart responds more readily to environmental cues and returns to baseline more quickly. The high frequency (HF) component of HRV (.15–.40 Hz) primarily represents the influence of the parasympathetic nervous system (Thayer, Åhs, Fredrikson, Sollers, & Wager, 2012) which is associated with vegetative and restorative functions. Resting HRV refers to a single measurement taken while the individual is at rest, whereas HRV reactivity measures phasic changes in HRV in response to a stressor.

According to Porges' (1995; 1998) polyvagal theory, the myelinated branch of the vagus nerve exerts parasympathetic influence on the heart and controls the social engagement system. This social engagement system serves as the neurophysiological basis for courting behaviours associated with seduction and the control of facial expression, vocalization, and head tilt. This system communicates reproductive availability and fosters proximity with potential romantic partners (Porges, 1998). In times of stress this system is depressed to allow for the expression of the sympathetic nervous system's fight-or-flight response. HRV may therefore serve as an index of both the vagus nerve's parasympathetic influence on the heart and the activation of the social engagement system. Building on Porges' theory, Schneiderman et al. (2011) found that, in comparison to single participants, individuals who had recently begun new romantic relationships demonstrated lower HRV reactivity in response to negative emotion-inducing videos. They postulated that HRV reactivity decreases during the process of courting associated with new romantic relationships due to increased activation of the social engagement system.

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* Corresponding author at: Department of Psychology, Lakehead University, 955 Oliver Road, Thunder Bay, ON, P7B 5E1, Canada.
E-mail address: lbailey1@lakeheadu.ca (L.K. Bailey).

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The first purpose of the present study is to replicate key findings reported by Schneiderman et al. (2011). A cohort of single women was studied over a 6-month period. The *replication* hypothesis asserts that compared to participants who remained single over the 6-month follow-up, their newly-coupled counterparts will evidence (a) higher HRV during an emotionally evocative negative film clip and (b) lower HRV reactivity, defined as milder change in HRV from positive to negative film clips. Schneiderman et al. interpreted both findings as evidence for love causing a “buffered stress response” to negative stimuli (p. 1318). However, given the cross-sectional nature of their methodology, assertions about cause cannot be claimed with certainty. Thus, two competing longitudinal hypotheses are posited to understand the relationship between HRV reactivity and relationship status:

1. The *consequence* hypothesis asserts that newly-coupled individuals will evidence a drop in HRV reactivity to emotion-evoking film clips as their relationship status changes from single to coupled, while HRV for singles will remain unchanged.
2. The *cause* hypothesis states that single individuals with lower HRV reactivity at baseline will be more likely to enter into a new romantic relationship over a 6-month follow-up interval. Other variables associated with HRV reactivity and relationship formation may serve as potential moderators including: resting HRV, attachment style, emotional distress, self-esteem, and body mass index (BMI).

2. Method

2.1. Participants

Ninety-one single, female postsecondary students who were interested in forming a monogamous heterosexual romantic relationship participated in the study. Eight participants were excluded for technical reasons, excessive ectopic heartbeats, or failure to follow instructions. Of the remaining 83 participants, 47 (57%) returned and completed the follow-up laboratory session and thus comprise the sample of interest. Mean age was 19.09 years (*SD* = 2.23). Mean BMI was 22.31, *SD* = 2.84, range = 17.47–31.01. Twenty-eight (60%) remained single while 19 (40%) became coupled over the 6-month follow-up, operationally defined as entering into a monogamous heterosexual romantic relationship lasting at least 10 days. The length of 10 days was chosen based on Schneiderman et al.'s (2011) 2-week minimum relationship duration. Shorter relationship duration was expected to yield greater differences in HRV in the event that HRV reactivity changed upon beginning a romantic relationship. Mean duration of the romantic relationships at follow-up was 37.2 days (*SD* = 18.23; range 10–66 days).

2.2. Materials

2.2.1. Demographics questionnaire assessing BMI

Demographics Questionnaire Assessing BMI: calculated as BMI = weight (lb.)/(height [in.] x height [in.]) x 703 from self-reported height and weight. Motivation to begin a romantic relationship was assessed using the item “Please rate your motivation to begin a monogamous heterosexual romantic relationship on the following scale” rated on two separate scales. For the first scale, responses ranged from 0 (*I do not want to begin a monogamous romantic relationship)*, to 4 (*I am currently taking action to begin a relationship)*. On the second scale, responses ranged from 0 (*Not at all motivated*) to 7 (*Extremely motivated*). Participants also rated their expectancy to begin a romantic relationship over the follow-up period. Possible responses for the expectancy item ranged from 0 (*Not at all likely*) to 7 (*Extremely likely*).

2.2.2. Rosenberg self-esteem scale (RSES)

Rosenberg Self-Esteem Scale (RSES): a 10-item self-report measure of global self-esteem (Rosenberg, 1965). Responses were given on a 4-point Likert-type scale, ranging from 1 (*strongly disagree*) to 4 (*strongly agree*).

2.2.3. Attachment style questionnaire (ASQ)

Attachment Style Questionnaire (ASQ): a 40-item self-report measure of how individuals currently view their attachment security with other adults (Feeney, Noller, & Hanrahan, 1994). Respondents rated how much they agree with each item on a 6-point scale ranging from 1 (*totally disagree*) to 6 (*totally agree*). The two-dimensional scoring method described by Alexander, Feeney, Hohaus, and Noller (2001) yields two insecure subscales. Individuals who scored high on the Avoidant Attachment subscale were expected to not meet the inclusion criteria of being motivated to form a monogamous romantic relationship. Thus, the Anxious Attachment (ASQ: AN) subscale was chosen as the measure of attachment security.

2.2.4. Kessler psychological distress scale (K6)

Kessler Psychological Distress Scale (K6): a 6-item scale measuring general emotional distress during the past 30 days (Kessler et al., 2002). Respondents rated items on a 5-point scale ranging from 0 (*None of the time*) to 4 (*All of the time*).

2.2.5. Pleasantness questionnaire

Pleasantness Questionnaire: a manipulation check to ensure the film clips produced emotions of the intended affective valence (Rottenberg, Ray, & Gross, 2007). Emotions experienced while viewing the film clips were rated on a 9-point Likert-type scale ranging from 0 (*unpleasant*) to 8 (*pleasant*).

2.3. Apparatus

2.3.1. Electrocardiogram

ECG was recorded using a 72-channel amplifier, sampled at 1024 Hz. Participants were fitted with three electrodes with snap-on Ag-AgCl on cleaned skin located below the right clavicle and below the left rib in a lead-II configuration and a ground electrode below the left clavicle. Raw ECG data was extracted and inspected using ASA-Lab software (Version 16; Advanced Neuro Technology, Enschede, Netherlands) and then imported into Kubios 2.1 HRV specialized analysis software (Biosignal Analysis and Medical Imaging Group; http://kubios.uef.fi/). Using a fast Fourier transformation method, a distinct peak known as an R-spike was identified and interval series between R-spikes were calculated by power spectrum density to derive HFms^2 as the metric of HF HRV (bandwidth = .15–.40 Hz).

2.4. Procedure

The protocol was approved by the Lakehead University Research Ethics Board and was carried out in accordance with the provisions of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. Participants completed an online battery of psychometric questionnaires including the RSES, ASQ, and K6. They then attended a laboratory session before which they refrained from drinking alcohol for 24 h, and eating, drinking caffeinated beverages, or exercising for 2 h as these variables have been shown to affect HRV (Buchheit et al., 2004; Nederkoorn et al., 2000; Sondermeijer, van Marle, Karmen, & Krum, 2002; Weise, Krell, & Brinkhoff, 1986). During the baseline laboratory session, researchers attached ECG electrodes to participants who then viewed four 4:45-min film clips which depicted couples engaging in various tasks. Pilot participant ratings were used to amalgamate shorter clips into three pairs of 4:45-min film clips designed to evoke different emotions (positive, neutral, and negative emotions). Each pair of clips was rated as being equivalent in both affective valence and arousal.

Participants watched film clips in the following order: neutral, positive or negative, neutral, positive or negative. Positive and negative

Table 1
Comparison of Variables by Relationship Status.

		Singles (n = 28)		Newly Coupled (n = 19)				
Variables	Range	*M*	*SD*	*M*	*SD*	F[a]	p	$\eta^2_{partial}$
Age	17.00–29.00	19.18	2.72	18.95	1.22	.12	.73	< .01
Motivation 1	1.00–4.00	1.67	0.56	2.11	0.94	3.97	.05*	.08
Motivation 2	1.00–7.00	3.00	1.59	3.74	1.79	2.20	.15	.05
Expectancy	0.00–7.00	2.25	1.71	3.11	2.18	2.26	.14	.05
BMI[b]	17.47–31.01	23.04	2.94	21.23	2.37	5.10	.03**	.10
RSES	8.00–29.00	3.75	4.54	29.00	5.47	1.42	.24	.03
ASQ: AN	13.00–61.00	41.29	10.80	42.21	13.36	.07	.80	< .01
K6[b]	1.00–21.00	6.21	4.03	7.26	4.87	.79	.38	.02

Note: Motivation 1 = self-reported motivation to begin a romantic relationship from 0 (*I do not want to begin a monogamous romantic relationship*) to 4 (*I am currently taking action to begin a relationship*), Motivation 2 = self-reported motivation to begin a romantic relationship from 0 (*Not at all motivated*) to 7 (*Extremely motivated*), Expectancy = self-reported expectancy to begin a romantic relationship over the 6-month follow-up period, RSES = Rosenberg Self-Esteem Scale; ASQ: AN = Attachment Style Questionnaire Anxious subscale; K6 = Kessler Psychological Distress Scale.

[a] df = 1, 45, except Motivation 1, df = 1, 43

[b] Range, means, and standard deviations are reported using untransformed variables. F, p, and $\eta^2_{partial}$ values were calculated using log transformed variables.

* p = .05.

** p < .05.

clip presentation was counterbalanced between individuals. After each clip, participants rated its affective valence on the pleasantness scale. Participants were asked to return to the laboratory either (a) when they had entered into a monogamous heterosexual romantic relationship that lasted at least 10 days, or (b) at the end of the 6-month follow-up period, if they remained single. When participants returned for their follow-up sessions, the same procedure was followed with the equivalent clips.

3. Results

3.1. Data preparation

Skewed variables were corrected using a log transformation (ln HFms^2, ln K6, ln BMI). Table 1 presents the comparisons between singles and newly coupled participants on demographic and psychometric variables. Ln BMI was significantly lower amongst those who formed romantic relationships (p = .03). One motivation item also showed a trend towards statistical significance (p = .06) indicating that those with higher motivation to form romantic relationships were more likely to become coupled. Both motivation items were highly correlated, r = .713, and a composite motivation score was created and used as a covariate to control for motivation during hypothesis testing. None of the psychometric or demographic variables contained outliers. HRV reactivity (ln Δ HFms^2) at follow-up contained one univariate outlier. The outlier was replaced with the next lowest nonoutlier score.

Film clips evoked emotions of the appropriate valence (effect of clip valence on pleasantness ratings p < .001) with no effects of presentation order or relationship status (ps < .05). There was also a trend towards a significant main effect of clip valence on HRV (ln HFms^2; p = .061), driven by a reduction in ln HFms^2 from the first neutral to the positive clip (p = .028). ECG recordings during the first neutral film clip provided a measure of resting HRV. As in Schneiderman et al.'s (2011) study, within-session HRV reactivity (Δ ln HFms^2) scores were computed by subtracting participants' ln HFms^2 while viewing the negative film clip from ln HFms^2 while viewing the positive film clip. Thus, positive Δ ln HFms^2 scores indicate a reduction in ln HFms^2 from positive to negative film clips.

3.2. Analytic strategy

The primary analytic techniques used for this study were moderated logistic regression, and mixed model analysis of variance (ANOVA) which were performed using IBM SPSS Statistics 20. The replication hypothesis was evaluated using two separate univariate ANOVAs comparing ln HFms^2 during the negative clip and Δ ln HFms^2 for singles and newly coupled participants at follow-up. To test the consequence hypothesis, a 2 (time) × 2 (relationship status) mixed model ANOVA was performed to evaluate within-participant change in Δ ln HFms^2 between baseline and follow-up with a specific, a priori interest in the newly coupled subgroup.

The cause hypothesis was evaluated using five moderated logistic regressions in the prediction of relationship status at follow-up Y (single vs. newly coupled) from Δ ln HFms^2 at baseline X, with separate analysis for each of ln HFms^2, RSES, ASQ: AN, ln K6, and ln BMI as moderators Ms. A simple moderation analysis was conducted for each moderator. Each of the five regressions tested pathways from X to Y, M to Y, and the interaction between X and M to Y. For the logistic regression analyses, all predictor variables were mean centered as it increases interpretability (Hayes, 2013). Data for all analyses were assessed for violations of parametric assumptions to ensure accurate generalizations of the findings.

3.3. Replication hypothesis

The replication hypothesis was evaluated using two univariate ANOVAs comparing ln HFms^2 during the negative clip and Δ ln HFms^2 between singles and newly-coupled participants at follow-up. Contrary to expectations, newly-coupled participants did not differ from their single counterparts at follow-up with regard to (a) ln HFms^2 during the negative clip; Ms = 6.21 (SD = 1.00) and 6.12 (SD = 1.25), for single and newly-coupled participants respectively, F(1,45) = .09, p > .250, η^2 < .01, or (b) Δ ln HFms^2; Ms = −.12 (SD = .37) and .02 (SD = .50), for single and newly-coupled participants respectively, F(1,45) = 1.14, p < .250, η^2 = .03. These results do not provide evidence of a buffered physiological response to negative emotions amongst the newly-coupled participants.

3.4. The consequence hypothesis

It was predicted that newly-coupled participants at follow-up would show reduced Δ ln HFms^2 when compared to their baseline values, whereas Δ ln HFms^2 for singles would remain unchanged over time. A 2 (time) × 2 (relationship status) mixed model ANOVA was conducted to determine if Δ ln HFms^2 varied as a function of time (baseline vs. follow-up) or relationship status (single vs. newly-coupled). No significant effects were observed for time, F(1.45) = .14, p > 250, η^2 < .01, relationship status, F(1.45) = .01, p > .250, η^2 < .01, or their interaction, F(1,45) = 1.03, p > .250, η^2 = .02.

As newly-coupled participants were of particular interest, a repeated measures ANOVA was conducted on this sample ($n = 19$) to investigate the a priori prediction that Δ ln HFms^2 would decrease from baseline to follow-up. Results revealed no significant main effect of time on Δ ln HFms^2, $F(1,18) = .55, p > .250, \eta^2 = .03$. Thus, results do not support the consequence hypothesis that HRV reactivity decreases as a function of beginning a new romantic relationship.

3.5. *The cause hypothesis*

The alternative hypothesis predicted that individuals with higher Δ ln HFms^2 at baseline would be less likely to form new relationships over the course of the follow-up period. Five moderated logistic regressions were performed to test this hypothesis. Mean-centered Δ ln HFms^2 from the first laboratory session was used to predict relationship status at follow-up, with a separate analysis for each of five potential moderators: ln HFms^2, RSES, ln K6, ASQ:AN, and ln BMI.

After controlling for motivation to begin a romantic relationship, only two of the regressions reached statistical significance. The regression moderated by ln BMI revealed a significant overall model, $\chi^2(3) = 13.67$, $p = .008$, and a significant HRV Reactivity × ln BMI interaction, $R^2 = .25$, $b = .68$, $SE_b = .34$, $p = .043$, 95% CI [1.02, 3.81] (Fig. 1). The regression moderated by resting HRV revealed both a significant overall model, $\chi^2(4) = 10.77$, $p = .029$, and a significant HRV Reactivity × Resting HRV interaction, $R^2 = .21$, $b = -1.38$, $SE_b = .78$, $p = .020$, 95% CI [-3.94, $-.31$] (Fig. 2). The models for moderators ASQ: AN, ln K6, and RSES did not reach statistical significance.

4. Discussion

In contrast with Schneiderman et al.'s (2011) findings, no statistically significant differences in HRV were observed between single and newly-coupled participants at follow-up, nor were changes in HRV observed as relationship status changed from single to newly-coupled. Consequently, the contention that beginning a new romantic relationship 'buffers' vagal withdrawal in response to negative emotions was not supported.

Instead, HRV reactivity predicted who would become coupled, when moderated by either BMI or resting HRV. Based on evolutionary theory, BMI serves as a basis for mate selection because it provides a reliable cue to female health and reproductive potential (George, Swami, Cornelissen, & Tovée, 2008) and thus influences mating strategy (Perilloux, Cloud, & Buss, 2012). Low BMI women are chosen more often by their speed dating partners (Asendorpf, Penke, & Back, 2011) and are more particular in choosing a mate (Speakman, Djafarian, Stewart, & Jackson, 2007). Higher BMI women are more likely to settle for less attractive mates to compensate for their own lower levels of mate value. In the current study, however, the results indicate a more complex relationship between BMI, HRV, and relationship formation. Women with lower BMI were more likely to become coupled, but only if they exhibited lower HRV reactivity. Women with higher BMI demonstrated the opposite pattern.

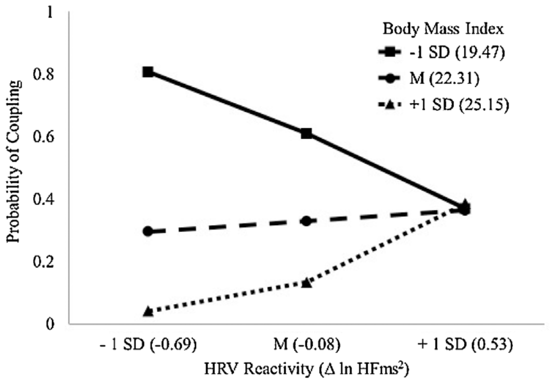

Fig. 1. Probability of coupling over the follow-up period plotted as a function of HRV reactivity (Δ ln HFms^2) moderated by body mass index (BMI) and controlling for motivation to begin a romantic relationship.

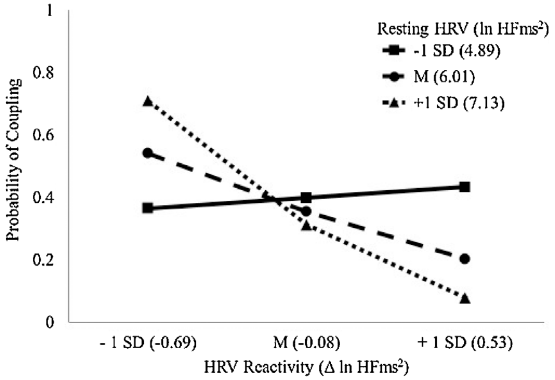

Fig. 2. Probability of coupling over the follow-up period plotted as a function of heart rate variability reactivity (Δ ln HFms^2) moderated by resting heart rate variability (ln HFms^2) controlling for motivation to begin a romantic relationship.

HRV has been linked to mental and physical health, emotion regulation, self-esteem, and social prowess (Martens et al., 2010; Park & Thayer, 2014; Porges, 1998) all of which contribute to one's mate value. Low HRV reactivity may indicate higher mate value, and higher BMI women with this pattern of cardiac reactivity may therefore be choosier when selecting mates; however, selective mating strategies are typically more successful for low BMI women. This explanation would account for the lower relationship formation rates amongst higher BMI women with low HRV reactivity.

The HRV reactivity by resting HRV interaction indicates that HRV reactivity influences coupling success only among those with higher resting HRV. Amongst those with high resting HRV, lower HRV reactivity predicts the highest coupling success (probability = .71) whereas higher HRV reactivity predicts the lowest rates of coupling success (probability = .08). HRV is associated with emotion regulation, a process intimately involved in the attraction and retention of a romantic partner. For instance, higher resting HRV is associated with better overall emotion regulation abilities (Park & Thayer, 2014). Further, lower HRV reactivity is associated with utilizing active emotion regulation strategies (e.g., reappraisal), while higher HRV reactivity is associated with the activation of the sympathetic system to deal with stressors (Park & Thayer, 2014). Neither pattern of HRV response has consistently been found to be associated with superior outcomes; the benefits of each strategy appear to be context dependent. Interpreted from this perspective, amongst those who have better overall emotion regulation abilities, using active emotion regulation strategies to cope with negative emotions confers an advantage in romantic relationship formation.

4.1. *Limitations and conclusions*

While the longitudinal design of the present study provides a strong methodological advancement over previous research, the study was not without limitations. Most apparent was the high dropout rate between the baseline and follow-up laboratory sessions. Less than 60% of eligible participants returned for follow-up, reducing the power of all analyses that included variables measured at follow-up. That being said, the follow-up completers were comparable to noncompleters on most demographic and psychometric variables with the exception of BMI. The moderated regressions also achieved adequate power above the convention of .80 despite the high drop-out rate. In addition, variables such as time of day and the timing of the menstrual cycle may also have had effects on HRV (Bassiouny et al., 2002; Leicht, Hirning, & Allen, 2003) and were not controlled for in this study.

Finally, although it would be inconsistent with Porges' polyvagal theory, it is possible that HRV differences could develop after longer relationship duration or only in satisfying relationships. These questions could not be answered in the present study. Longer follow-up periods, larger sample sizes, and the collection of relationship satisfaction data would allow for the testing of such questions in future studies.

The heart has been associated with love for thousands of years. This study further elucidates the heart-love connection by successfully predicting relationship formation based on cardiac functioning and BMI. The present study failed to directly replicate Schneiderman et al.'s (2011) cross-sectional results of differences between the cardiac reactivity of singles and the newly coupled; however, the main finding is consistent in that pre-existing differences in HRV and BMI make some individuals more likely to form relationships. Despite consistent findings, Schneiderman et al. contention that love buffers vagal withdrawal in response to stress was not supported. Instead, HRV reactivity may be a marker for mate value and emotion regulation and interact with BMI and resting HRV to determine which women will be successful in engaging in intermediate- and long-term mating strategies. Perhaps it is our heart and not our head that determines which of us will find love after all.

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