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When couples' hearts beat together: Synchrony in heart rate variability during conflict predicts heightened inflammation throughout the day

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ABSTRACT

Hostile conflict in marriage can increase risks for disease and mortality. Physiological synchrony between partners—e.g., the linkage between their autonomic fluctuations—appears to capture engagement, or an inability to disengage from an exchange, and thus may amplify the health risks of noxious interactions such as marital conflict. Prior work has not examined the unique health correlates of this physiological signature. To test associations between couples' heart rate variability (HRV) synchrony during conflict and inflammation, 43 married couples engaged in a marital problem discussion while wearing heart monitors and provided four blood samples; they repeated this protocol at a second visit. When couples' moment-to-moment HRV changes tracked more closely together during conflict, they had higher levels of three inflammatory markers (i.e., IL-6, stimulated TNF-α, and sVCAM-1) across the day. Stronger HRV synchrony during conflict also predicted greater negative affect reactivity. Synchrony varied within couples, and was related to situational factors rather than global relationship traits. These data highlight partners' HRV linkage during conflict as a novel social-biological pathway to inflammation-related disease.

1. Introduction

A bad marriage can increase risks for age-related disease and death (Liu and Waite, 2014; Robles et al., 2014). Chronic, low-grade inflammation is a hallmark of many age-related chronic conditions (Franceschi and Campisi, 2014), and thus may link marital discord to poorer health. For example, wives who felt less supported by their husbands had higher baseline levels of inflammatory markers, C-reactive protein (CRP) and interleukin-6 (IL-6) (Donoho et al., 2013; Whisman and Sbarra, 2012). In a lab study, couples with more hostile interaction styles had larger increases in proinflammatory cytokines IL-6 and tumor necrosis factor-alpha (TNF-α) compared to less negative couples; increases were more pronounced after marital disagreement than support (Kiecolt-Glaser et al., 2005). In another study, couples whose disagreements were more hostile had higher inflammation throughout the day (Kiecolt-Glaser et al., 2015). Indeed, more discordant, hostile couples tend to have higher circulating inflammation, and their fights may trigger larger inflammatory increases compared to less hostile couples.

Couples' physiological synchrony during interaction, or the degree to which partners' autonomic fluctuations track together, appears to capture an important interpersonal process. This physiological signature, also termed *physiological linkage*, *coregulation*, and *covariation*, emerges when partners are in close proximity (Palumbo et al., 2017; Timmons et al., 2015). Synchrony has been studied in many physiological systems, across time scales, with disparate statistical approaches, and in a range of social contexts, all with varying results. Nevertheless, three excellent synthetic reviews converged on the working conclusion that the relational implications of synchrony depend on its context (Butler, 2015; Palumbo et al., 2017; Timmons et al., 2015). For instance, synchrony may be stronger when unhappy couples have upsetting interactions. In one study, couples' synchrony scores were calculated for a neutral task and a marital problem discussion using a combination of four indices—interbeat interval (IBI), pulse

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transmission time, skin conductance, and movement (Levenson and Gottman, 1983). Couples who synchronized more closely during disagreement had poorer marital quality than those who were less tightly synced, but synchrony during neutral conversation did not relate to marital satisfaction. Synchrony during conflict explained more than half of the variance in marital satisfaction and was independent of couples' negative affect reciprocity, suggesting that it captured an important feature of marital satisfaction, and uniquely characterized the experience of being "locked into [a] destructive interaction" (p. 596, Levenson and Gottman, 1983). A study of skin conductance synchrony replicated these findings in two samples (Chaspari et al., 2015).

Other studies have demonstrated the link between greater synchrony and poorer marital quality, even for tasks intended to be neutral or positive. For example, more discordant couples had more synchronous high-frequency heart rate variability (HF-HRV) during free play with their child (Gates et al., 2015). The respiration cycles of dissatisfied couples fell into sync when they imitated each other, but not at rest or when sharing eye contact (Helm et al., 2012). In a notable exception, more satisfied couples showed stronger HF-HRV linkage, when positive, negative, and neutral topics were aggregated (Helm et al., 2014); the authors attributed the divergent pattern, in part, to the couples' ability to maintain low arousal across the 3-min tasks.

Though it is difficult to draw strong conclusions when the emotional tone of couples' interactions is unclear, it appears that joint increases in arousal during difficult interactions may reflect poorer relationship quality, and that linkage during positive, warm interactions may index the opposite (Timmons et al., 2015). Synchrony may also vary over time (Palumbo et al., 2017; Reed et al., 2013). Additional work is needed to compare synchrony across occasions in well-defined emotional contexts; no research to date has addressed whether synchrony during upsetting interactions independently predicts poorer health.

To assess the health relevance of synchrony during conflict, we examined couples' HF-HRV synchrony during marital disagreement as a predictor of inflammation on two occasions, controlling for relevant inflammatory confounds. We focused on HF-HRV synchrony over other autonomic measures because there was a validated method for calculating synchrony scores with these data (Gates et al., 2015), and according to two excellent reviews, synchrony's interpersonal significance does not appear to systematically differ across physiological streams (Palumbo et al., 2017; Timmons et al., 2015). Thus, we developed predictions based on prior work that was most similar to our study's time course and marital interaction paradigm. Further, vagal activity, indexed by HF-HRV, plays a role in threat appraisal and emotion regulation (Thayer and Lane, 2000), and dampens inflammation (Pavlov and Tracey, 2005). Namely, HF-HRV decreases with stress or potential threat (Thayer and Lane, 2000) and increases with attempts to regulate emotions and engage socially (Butler et al., 2006; Porges, 2007). Thus, HF-HRV synchrony would include moments of coactivation (Timmons et al., 2015), or joint vagal withdrawal, when both partners feel threatened or fail to regulate.

Because greater marital hostility predicts higher inflammation on average (Kiecolt-Glaser et al., 2015), we hypothesized that stronger conflict-based HF-HRV synchrony would be associated with higher inflammation across the day. Consistent with hostile couples' greater inflammatory responsiveness to marital conflict (Kiecolt-Glaser et al., 2005), we also expected stronger synchrony to predict greater inflammatory reactivity to conflict. Specifically, we examined a panel of six inflammatory markers—serum IL-6 and TNF-α, lipopolysaccharide (LPS) stimulated IL-6 and TNF-α, and serum soluble intercellular adhesion molecule 1 (sICAM-1) and vascular cell adhesion molecule 1 (sVCAM-1)—to minimize the likelihood of relying on a single spurious finding. Based on the preliminary evidence that stronger synchrony in negative emotional contexts relates to poorer marital quality (Timmons et al., 2015), we predicted that in follow-up analyses, synchronizing more closely during conflict would be associated with greater negative affect reactivity to the task. We also expected stronger synchrony to predict dampened HF-HRV reactivity, a direct route to heightened inflammation (Pavlov and Tracey, 2005).

With a unique two-visit study design, we aimed to characterize synchrony's stability across occasions. We also examined its associations with a range of interpersonal factors, stable and interaction-specific, with the expectation that stronger synchrony during conflict would track with poorer relationship quality and more ineffective conflict strategies.

2. Method

2.1. Participants

Couples were recruited for a parent study of immune responses to high-fat meals (Kiecolt-Glaser et al., 2015). An initial online screen and follow-up in-person screen determined eligibility. Couples married fewer than 3 years and those who had sensory impairments that would interfere with study completion were excluded. Couples were not considered if either partner had a chronic health problem including anemia or diabetes (HbA1c > 6.5), smoked, abused substances, or used prescription medication other than birth control (n = 5) or levothyroxine (n = 3). Participants fit our exercise criteria if they engaged in a minimum of 2 h of vigorous activity per week for those with a BMI of < 24.99 (normal weight) and 5 h per week for BMI > 25 (overweight or obese).

In the online screen, potential participants completed the 16-item version of the Couples Satisfaction Index; the full version was given at the end of the first visit (Funk and Rogge, 2007). Happier couples were overrepresented among applicants, a general challenge for marital research. Accordingly, in terms of both inclusion and scheduling, we prioritized dissatisfied couples to represent the full range of marital discord. We also spent considerable time and effort to recruit people who were healthy but overweight to address aims relevant to the parent study's meal component. A total of 350 interested individuals were excluded because either they or their spouse did not meet our stringent health criteria.

The sample consisted of 86 participants (43 couples). Participants were 38 years old on average (SD = 8.2, range = 24–61) and primarily White (81%). All couples were married, and the average length of marriage was 11.5 years (SD = 6.6, range = 3–27). Most were employed full-time (70%). Table 1 provides additional sample characteristics.

The sample size of the parent study was planned based on the expected power for a hypothesized three-way interaction (Kiecolt-Glaser et al., 2015). Given that lower-order interactions should be adequately powered for similarly sized effects, it was concluded that the primary hypotheses for the present study were sufficiently powered. Nevertheless, post-hoc power estimates were also calculated. As noted, 86 participants in 43 couples completed study visits on two separate occasions. Based on previous analyses using these data, the intraclass correlation (ICC) for inflammatory markers was estimated to be small, ICC = 0.06, giving an effective N of 81. Power calculations were based on the ability to detect an increase in R^2 due to the addition of the HRV synchrony predictor to the regression model. Studies of marital conflict behavior and post-conflict immunological changes have shown small to medium effects (e.g., Kiecolt-Glaser et al., 2015; Kiecolt-Glaser et al., 2005). With n = 81, α = 0.05, and a two-tailed test, there was 80% power to detect a small to medium effect (Cohen's f^2 = 0.10). Because each partner provided two sessions of data and multiple samples within each session, this is a conservative power estimate for our models.

2.2. Data collection procedure

This research was approved by the Ohio State University (OSU) Institutional Review Board; participants provided written informed consent before participating. Participants completed two full-day study