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Preliminary Evidence for a Relationship Between Physiological Synchrony and Sexual Satisfaction in Opposite-Sex Couples

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ABSTRACT

Introduction: Over the past 3 decades, our understanding of physiological synchrony (PS) has increased substantially. Research has shown that interpersonal PS is stronger in relationships characterized by emotional closeness and intimacy and that the magnitude of PS is moderated by relational satisfaction. Despite growing momentum for this area of study, no research to date has examined the relationship between PS and sexual satisfaction.

Aim: The current study seeks to elucidate the relationship between PS and sexual satisfaction using study tasks that have been used in previous research to assess PS.

Methods: Heterosexual couples completed several survey measures in a laboratory setting. They were then connected to an electrocardiogram and instructed to complete baseline, gazing, and mirroring tasks. Subsequently, heart rate (HR) data for each dyad were analyzed for PS using a moderated multilevel modeling approach.

Main Outcome Measure: Scores on the Sexual Satisfaction Scale were used to moderate dyadic coherence between male and female partner HRs over time.

Results: PS was detected in our sample, with both men reliably predicting the HR of their female partners, and women reliably predicting the HR of their male partners. Akaike information criterion values indicate the better fitting model for each task was for men predicting the women's HRs. A significant interaction effect was found between observed PS during the mirroring task (with male HR predicting female HR) and overall sexual satisfaction scores. There was no relationship between PS during baseline or gazing and overall sexual satisfaction.

Clinical Implications: Results provide initial evidence for the relevance of PS in sexual dyanmics.

Strengths & Limitations: The current analysis used a dyadic psychophysiological approach to extend the growing body of literature on PS into the theoretically linked field of sexuality. Because of the small sample size and nondirectional nature of the study design, future research is needed to replicate and extend findings.

Conclusion: The ability of couples to co-regulate while attempting actively to synchronize (as in the mirroring task) may be connected to how they perceive and experience their sexual relationship. Conversely, more sexually satisfied couples may be more likely to synchronize physiologically. Taken together, these findings reflect the first evidence that PS and sexual satisfaction may be associated at the couple-level. **Freihart BK, Meston CM. Preliminary Evidence for a Relationship Between Physiological Synchrony and Sexual Satisfaction in Opposite-Sex Couples. J Sex Med 2019;XX:XXX–XXX.**

Key Words: Physiological Synchrony; Sexual Satisfaction; Physiological Coregulation; Physiological Linkage; Dyadic Analysis

INTRODUCTION

Over the past 15 years, there has been a dramatic increase in research focusing on sexual satisfaction, leading to significant advances in both our conceptualization and understanding of the construct (for a review, see Sánchez-Fuentes et al[1]). Sexual satisfaction has been closely linked to other sexual and relational phenomena, including overall relational satisfaction and levels of sexual distress,[2–5] as well as individual-level variables, including psychological and physical health.[6–11] Although, historically, more research attention has been paid to sexual difficulties and dysfunctions,[1] sexual satisfaction may be an equally important area of research focus—shifting attention not only to sexual distress, but to the factors that enhance and improve sexual experiences more broadly.

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Sexual satisfaction has been defined in a variety of ways throughout the literature. One commonly used definition was proposed by Lawrance and Byers[12] in 1995, and posits that sexual satisfaction is "an affective response arising from one's subjective evaluation of the positive and negative dimensions associated with one's sexual relationship" (page 268). This definition underlies much of Lawrance and Byers[12] seminal Interpersonal Exchange Model of Sexual Satisfaction (IEMSS), which uses a social exchange framework of rewards and benefits within sexual relationships to explain between-person variability in sexual satisfaction levels.[13] The IEMSS has received considerable empirical support,[14,15] however, recent research suggests that incorporating other relationship-focused frameworks into the IEMSS strengthens its ability to predict individual sexual satisfaction scores.[16] More specifically, the sexual knowledge and influence model proposes that knowledge of one partner's sexual needs, as gained through communication, maximizes positive sexual experiences and sexual satisfaction more largely.[16–18] It seems that some combination of these frameworks may best predict and explain sexual satisfaction.[16]

Perhaps that is because, by their very nature, both of these models are interpersonal, reflecting an inherent aspect of sexual satisfaction: it is necessarily dependent on interpersonal relationships.[19] Consequently, researchers have increasingly taken a dyadic perspective when studying factors that predict sexual satisfaction, finding that one individual's scores on variables such as relationship satisfaction, sexual frequency, sexual function, physical health, and frequent intimate touching (eg, kissing, cuddling, etc.), can predict their partner's sexual satisfaction levels.[19–22] Although these dyadic studies have begun to illuminate the relational factors that drive individual experiences of sexual satisfaction, one critical area of interpersonal responding remains unexplored. Since Masters and Johnson,[23] almost no research has taken a dyadic psychophysiological approach to studying sexual relationships. This gap is particularly notable, as adult attachment theory suggests that relationship satisfaction and important relationship characteristics, such as empathy, may influence the way partners respond to each other physiologically.[24–26]

As such, one potential avenue for exploring sexual satisfaction from this interpersonal, psychophysiological perspective is physiological synchrony. Physiological synchrony can be thought of as the tendency for individuals with a strong attachment and/or interpersonal relationship to synchronize or covary across multiple physiological signals, such as heart rate (HR), respiration, and skin conductance.[25,27–30] This phenomenon has been tested empirically and observed in the context of many kinds of relationships with varying levels of intimacy and closeness (for a review, see Palumbo et al[27]). Parents tend to be synchronized with their infants, teammates in group athletic settings tend to manifest physiological linkage on the field, and the magnitude of synchrony between therapists and their clients predicts client perceptions of a therapist's empathy.[31–33] Although this phenomenon can be observed across multiple kinds of relationships, research supports the view that interpersonal concordance across physiological systems tends to be greater in magnitude for individuals with relationships characterized by a greater degree of intimacy.[25] In fact, in a study that measured physiological concordance between individuals completing a Spanish fire-walking ritual and audience members with varying degrees of closeness to the fire walker (ie, relatives, acquaintances, and strangers), there was a strong positive relationship between level of synchrony and relationship closeness.[34]

These findings naturally support the idea that physiological synchrony might be an important correlate of outcomes in adult romantic relationships, which are typically characterized by a high degree of intimacy and closeness.[35] Indeed, research has found that relational satisfaction moderates the strength of physiological synchrony such that partners who report greater levels of relational satisfaction show significantly greater coregulation in respiratory sinus arrhythmia signals.[30] Other studies have found that couples with greater levels of physiological synchrony across several indices display increased levels of connectedness and are significantly better at identifying each other's current affective states.[36] This idea has not been uncontested—indeed, some researchers have suggested that synchrony driven by the sympathetic nervous system or synchrony across cortisol levels may predict relational distress rather than relational satisfaction.[37,38] Despite this, there is evidence to suggest that increased closeness and attunement is associated with greater synchrony across several important physiological measures, including respiratory and cardiac measures.[27,29,30]

Given the close link between correlates of physiological synchrony and sexual satisfaction, it follows that the magnitude of physiological synchrony across measures, such as HR and respiration may be moderated by sexual satisfaction in adult romantic relationships. If physiological synchrony is linked with greater relational satisfaction, increased connectedness, and an increased ability to identify a partner's emotional needs, it is feasible that these qualities might extend to the sexual domain as well. Furthermore, the increased connection that is typical of couples with high-levels of physiological synchrony might increase the connectedness experienced during sexual encounters, which may, in turn, serve to increase overall sexual satisfaction. Conversely, it is possible that increased sexual satisfaction itself might lead to increased feelings of connectedness, manifesting in increased levels of physiological coregulation. Despite this logical link, no research to date has examined the connection between physiological synchrony and any sexual variable, including sexual satisfaction.

The aim of the current study is to provide the first empirical examination of the relationship between physiological synchrony and sexual satisfaction among sexually active heterosexual couples. This relationship was tested by examining synchrony in HR

Table 1. Participant characteristics

N = 56	Mean (SD)	Range	*n* (%)
Age	25.88 (12.32)	18–75	
Ethnicity			
African American/Black			0 (0)
Asian			4 (7.14)
White			26 (46.2)
Hispanic			14 (25)
Other			6 (10.71)
Relationship status			
Single, not dating			0 (0)
In a committed relationship			36 (64.28)
Cohabitating			10 (17.85)
Married			10 (17.85)
Relationship length (years)	2.3 (3.4)	0.25–16.3	

data across study tasks that have been used elsewhere to measure physiological synchrony, including baseline, gazing, and mirroring tasks.[29] HR was chosen, specifically, over more precise measures such as heart rate variability, which is measured over 3–5-minute epochs, because it is measured in short, 30-second epochs.[39] As a result, HR allows for a fuller assessment of covariation between partners over time. Based on findings from past research, we expected to reliably capture physiological synchrony across our whole sample and across each of these tasks.[29,30] We hypothesized that sexual satisfaction would moderate the magnitude of physiological synchrony observed during interpersonal tasks (ie, gazing and mirroring), but not during a baseline task in which couples are not interacting.

It is our hope that results on this hypothesis may provide a preliminary examination of the relationship between physiological synchrony and sexual satisfaction, if a relationship in fact exists. It is, however, worth noting that this is a cross-sectional and correlational design, and, as such, results will be nondirectional. Our hypothesis does not specify whether physiological synchrony is a cause or consequence of sexual satisfaction—only that we expect it to moderate the amount of physiological synchrony observed. Positive findings could indicate either that (1) physiological synchrony is predictive of sexual satisfaction, and that the more physiologically attuned and connected a couple is, the more likely they are to be satisfied with their sexual relationship, or (2) couples who are more sexually satisfied in their relationships manifest more physiological linkage as a result of their sexual satisfaction. Both cases reflect compelling directions for future research, and may either indicate that physiological synchrony is relevant for experiences of sexual satisfaction or that physiological synchrony may be an objective marker of such satisfaction in assessment contexts.

MATERIALS AND METHODS

Participants

Recruitment

Couples in sexual relationships were recruited from the local community through fliers and online postings advertising a couples' study, as well as through an Introduction to Psychology course at the The University of Texas at Austin. Participants completed a brief telephone screen that assessed for the following inclusion criteria: (1) each individual in the couple had to be over 18 years old, (2) couples had to identify as being in a monogamous relationship, (3) couples had to identify as having been in their current relationship for more than 3 months (a length chosen specifically to reduce barriers to recruitment), (4) couples had to report engaging in sexual activity with their partner within the past 4 weeks, and (5) both members of the couple had to be able to read and write in English. Based on these criteria, 58 individuals, or 29 dyads were found eligible and participated in the study.

For the current analysis, we were interested in examining potential sex differences in physiological synchrony. More specifically, we examined whether changes in male or female partner HR were more predictive of corresponding changes in partner HR over time. To that end, same-sex couples were excluded from the present analysis. Only one same-sex couple participated in the study, leaving a final analytic sample of 56 individuals, or 28 dyads.

Demographic Characteristics

Participant characteristics largely mirrored the population of Austin, TX from which the sample was drawn. A little less than half of the sample identified as white (46%) and 25% identified as Hispanic/Latinx. Participants largely identified as being in a committed dating relationship (65%), whereas the remainder identified as cohabitating (22.5%) or married (22.5%). On average, participants were 25.88 years old, although a relatively large age spread was observed (SD = 12.32). Mean relationship length was approximately 2 years, although again there was notable variability (in years, SD = 3.4). For more detail on participant characteristics, please refer to Table 1.

Sex-Specific Sample Characteristics

The majority of participants scored above cutoff scores for sexual function, indicating a lack of clinical sexual dysfunction. More specifically, only 14% of female participants fell below the clinical cutoff on the Female Sexual Function Index (FSFI) and only 3.5% of male participants scored below the cutoff on the Erectile Function subscale of the International Index of Erectile Function.[40–43] In the population as a whole, sexual dysfunction is prevalent in approximately 43% of women and 31% of men, suggesting that our sample is more sexually functional than the population at large.[44] This is supported by Shapiro-Wilk (W) normality tests,[45] which suggest that our sample is significantly

left-skewed in terms of both male (W = 0.71; $P < .001$) and female (W = 0.91; $P = .03$) sexual function scores. In addition, male partner sexual function scores demonstrated a moderate to weak positive correlation with female partner sexual function scores in our sample ($r = 0.27$).

The average sexual satisfaction score in this sample was 102.01 (12.19), and average sexual satisfaction scores were notably similar for women (101.37 [12.58]) and men (102.64 [13.44]). Indeed, male partner sexual satisfaction scores were strongly and positively correlated with female sexual satisfaction scores, suggesting similar levels of sexual satisfaction across partners ($r = 0.81$). A Shapiro-Wilk normality test suggests that our sample is left-skewed (W = 92; $P = .002$), and more sexually satisfied than what would be expected if our sample were drawn from a normally distributed population. Despite this, the levels of sexual satisfaction observed in our sample were slightly *lower* than average scores found in other studies using the same scale.[46,47] This suggests that, although our sample might be left-skewed, it is not inconsistent with previous literature, and does not reflect a dramatically more sexually satisfied sample than what is typically found using this measure.

In terms of the relationship between sexual function and sexual satisfaction in this sample, it seems that the constructs are related but distinct. Female partner sexual function scores demonstrated a within-person correlation of $r = 0.35$ with female sexual satisfaction scores, and a between-person correlation of $r = 0.42$ with male partner sexual satisfaction scores. Male partner sexual function scores were not significantly correlated with male ($r = -0.06$) or female ($r = 0.08$) sexual satisfaction scores.

Measures

Demographics

Demographic characteristics and relevant aspects of personal history were measured with a questionnaire that includes items relating to age, sex, race/ethnicity, educational attainment, socioeconomic status, and relationship length.

Sexual Satisfaction

Sexual satisfaction was measured with the Sexual Satisfaction Scale for Women (SSS-W) and an adapted version that has been modified for use in men (SSS-M; Meston, unpublished data).[46] The SSW-W and SSS-M each include 30-items that measure sexual well-being, and include the following subscales: contentment, communication, compatibility, relational concerns, and personal concerns. In its original validation study, the SSW-W demonstrated acceptable psychometric properties, including high internal consistency ($\alpha \geq 0.72$) and moderate test-retest reliability in women with ($r = 0.62-0.79$) and without ($r = 0.59-0.79$) sexual dysfunction. The scoring procedures for the SSS-W and SSS-M are identical, as are the subscales. The only difference between the scales is 2 places where the language was slightly shifted to be applicable to a broader population (eg, "I'm worried that my partner views me as less of a woman because of my sexual difficulties" is shifted to "I'm worried that my partner views me as less of a woman/man because of my sexual difficulties"). In the current sample, the internal consistencies were high for both the SSS-W ($\alpha = 0.90$) and SSS-M ($\alpha = 0.92$).

Sexual Function

Sexual function in women was measured with the FSFI, a validated 19-item measure that includes the following subscales: desire, arousal, lubrication, orgasm, pain, and satisfaction.[40] The FSFI has demonstrated impressive internal reliability ($r = 0.89-0.97$), test-retest reliability across 2-week periods ($\alpha = 0.79-0.88$), and divergent validity with measures of relational satisfaction. The FSFI also has a clinical cutoff score that reliably discriminates between women with and without sexual dysfunction, with scaled scores below 26.5 indicating a clinically significant level of sexual dysfunction.[41] In the current sample, the internal consistency for the FSFI was $\alpha = 0.86$.

Sexual function in men was measured with the International Index of Erectile Dysfunction (IIEF).[42] The 15-item IIEF contains 5 large factors, including erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall satisfaction, and also demonstrates impressive internal consistency ($\alpha = 0.91$). It has been found that scores below 25 on the Erectile Function subscale of the IIEF reliably discriminate between men with and without erectile dysfunction.[43] In the current sample, the internal consistency of the IIEF was $\alpha = 0.87$.

Heart Rate

HR was measured via a 3-channel electrocardiograph (ECG), with a sampling rate of 200 samples per second. The 3 leads of the ECG were placed under the participant's right collarbone, below the left ribcage, and on the right ankle. The signal from the leads was collected with AcqKnowledge version 3.9.3. software (BioPac Systems, Santa Barbara, CA, USA).

Procedure

Eligible couples were invited to the Sexual Psychophysiology Laboratory in the Psychology Department at The University of Texas at Austin to participate in a study on the psychophysiology of relationships. Upon arrival at the laboratory, couples were greeted by a researcher and taken to separate rooms where they were provided with a study overview and invited to read and sign consent forms. Subsequently, each member of the couple separately completed several survey measures, including a demographics questionnaire and a measure of sexual satisfaction.

Couples were then brought into a private testing room with an intercom system that could be used to communicate with the researcher at any point during the session. Participating couples were seated facing each other in comfortable chairs that were approximately 3 feet apart and connected to an ECG. After the ECG leads were connected, the researcher left the room for a 3–5-minute habituation period during which time no

physiological measures were collected. Subsequently, the researcher instructed the couple via intercom to move through a series of tasks that were specifically selected because of their use in previous studies examining physiological synchrony in adult romantic partners.[29,48,49] More specifically, the tasks were selected because they had demonstrated efficacy in (1) detecting physiological synchrony and (2) linking the synchrony observed to dyadic relational outcomes. To that end, although sexual satisfaction is the moderator of interest in this study, the tasks themselves are not immediately sex-related. This reflects the fact that no other studies of physiological synchrony have been undertaken in the sexuality literature, and, thus, no sex-related tasks have been developed and/or validated for such purposes.

Physiological synchrony has been theorized to be strongest during situations that elicit joint emotional altered states, including relational stress or emotional contagion.[28] As such, the tasks themselves are meant to induce various affective states that have been shown to elicit physiological synchrony—a gazing task to induce mild stress, a mirroring task to induce contagion, and a baseline task to serve as a reference. The gazing and mirroring tasks were counter-balanced to protect against carry-over effects. Each task is described in more detail below.

After completing the study session, participants were debriefed, compensated for their time (with either $15 per person or course credit), and provided with information and resources pertaining to sexual and relational health and nearby counseling services. All procedures were approved by the Institutional Review Board at The University of Texas at Austin.

Baseline

A researcher instructed the couple via intercom to place eye masks over their eyes and to relax without sleeping for 5 minutes. During this period, participants were instructed to move as little as possible and to refrain from making any attempts to communicate with their partner, either verbally or nonverbally. This task was designed to collect independent measures of HR for each individual in the dyad.

Gazing

A researcher instructed the couple via intercom to quietly look into each other's eyes for 5 minutes. The couple was instructed to refrain from any intentional facial gestures or vocal noises during this time, and to maintain eye contact to the best of their ability. They were told that, if for any reason either individual becomes distracted, they should refocus on their partner as soon as possible.

Mirroring

A researcher instructed the couple via intercom to actively attempt to mirror one another for 5 minutes (without speaking). Participants were told that the task was meant to be relatively vague and they were not expected to know exactly how to complete it, but rather, they should attempt to mirror one another on a physiological level however they could. Again, participants were instructed to refrain from making vocal noises or facial gestures and to refocus on their partner as quickly as possible if they became distracted.

Data Reduction

Signals from the ECG leads were collected using AcqKnowledge version 3.9.3 software (BioPac Systems, Santa Barbara, CA, USA). Raw ECG data were subsequently exported from AcqKnowledge version 3.9.3 to Microsoft Excel for processing. Movement artifacts in the data were isolated and smoothed through an automatic processing procedure that has been previously shown to be effective in removing outliers and providing results comparable or superior to other automated techniques.[50] This procedure was conducted within the Python environment (Python Software Foundation, version 2.7.16). Data were subsequently binned in 30-second epochs to derive heart rate values (beats per minute), yielding a total of 30 data points per participant (10 data points per task).

Data Analysis

Primary analyses were conducted in R software version 3.2.3[51] using the nlme package for linear and nonlinear mixed effects.[52] To assess concordance between partner's HR over time (ie, whether change in 1 person's HR predicts concurrent change in their partner's HR), a multilevel modeling approach was used. This approach is appropriate for dyadic time series data, in that it accounts for the interdependence inherent in dyadic datasets, and allows for analysis of both within- and between-dyad variability over time.[53] The first step in this process is to look at within-subject effects by examining the intercept and slope of individual regression lines for each dyad. Here, we examined whether a change in the male partner HR predicted a change in the female partner HR for each dyad, as well as the reverse; whether a change in the female partner HR predicted a change in the male partner HR. The slopes and intercepts for these regressions then became the outcome variables in a separate linear model that examined between-subject effects and, in this case, assessed the relationship between continuous HR data for each member of the dyad. Akaike Information Criterion (AIC) values were used to determine which models best fit the data (male partner predicting female partner, or female partner predicting male partner) across tasks.[54] Finally, interaction models were tested to determine whether sexual satisfaction scores, averaged across the couple and included as a continuous variable, moderated the covariation in male and female partner HR over time. Scores were averaged across the couple, rather than assessed as separate dependent variables, in order to maximize statistical power for these analyses.

RESULTS

Physiological Synchrony

During baseline, female partner HR reliably predicted male partner HR ($\beta = 0.48$; $t = 10.58$; $P < .0001$; AIC = 1687.7;

Table 2. Average heart rate and change in heart rate for male and female partners during each study task, all in beats per minute (BPM)

Study task	Average female HR	Average change in HR across task	Average male HR	Average change in HR across task
Baseline	78.18 (5.78)	18.04	75.80 (6.41)	16.73
Gazing	81.97 (6.82)	20.65	78.20 (5.20)	13.85
Mirroring	81.31 (7.14)	21.65	77.09 (5.02)	14.58

HR = heart rate.

semipartial $r^2 = 0.343$) and male partner reliably predicted female partner HR ($\beta = 0.54$; $t = 10.68$; $P < .0001$; AIC = 1629.4; semipartial $r^2 = 0.331$). This pattern was also observed during the gazing task, with changes in female partner HR reliably predicting for changes in male partner HR ($\beta = 0.19$; $t = 2.42$; $P = .01$; AIC = 1790.7; semipartial $r^2 = 0.027$); and significant findings in the reverse direction ($\beta = 0.12$; $t = 2.70$; $P = .007$; AIC = 1711.3; semipartial $r^2 = 0.032$). Finally, the same pattern of results were found in the mirroring task, with significant covariation in models with women predicting men ($\beta = 0.23$; $t = 2.65$; $P = .008$; AIC = 1807.5; semipartial $r^2 = 0.033$) and men predicting women ($\beta = 0.12$; $t = 3.15$; $P = .001$; AIC = 1596.2; semipartial $r^2 = 0.043$). For each of these models, AIC values suggest that the better fitting model is the model wherein the male partner HR was predicting for changes in the female partner HR. For descriptive statistics on average HR change across each study task, please see Table 2.

Individual HR trajectories for each dyad were then plotted, leading to the emergence of a strong picture of between-dyad variability. More specifically, some couples displayed HR trajectories that tracked each other with remarkable precision, whereas for others no detectable synchrony was observed. Cross-partner correlations reveal that a statistically significant level of physiological linkage was detected in 60.7% of couples. For an example of between-dyad variability, please see Figure 1. We predicted that sexual satisfaction, averaged across the couple, would predict differences in between-dyad variability by moderating the amount of synchrony observed. All dyads, not simply those who manifested statistically significant physiological synchrony, were included in this moderation model.

Sexual Satisfaction as a Moderator

As expected, moderation effects were not significant in either direction in the baseline task (for female partner HR predicting male partner HR, $\beta = -0.002$; $t = -0.87$; $P = .43$; AIC = 1691.0; semipartial $r^2 = 0.003$; for male partner HR predicting female partner HR, $\beta = 0.001$; $t = 0.23$; $P = .81$; AIC = 1715.2, semipartial $r^2 < 0.001$). This pattern also held true for the gazing task, wherein the interaction effect was nonsignificant in both directions (for female partner HR predicting male partner HR, $\beta = 0.002$; $t = 0.36$; $P = .71$; AIC = 1794.5; semipartial $r^2 = 0.001$; for male partner HR predicting female partner HR; $\beta = 0.003$; $t = 1.09$; $P = .27$; AIC = 1631.5; semipartial $r^2 = 0.004$). When sexual satisfaction was examined as a moderator for the mirroring task, with female partner HR predicting male partner HR, results were nonsignificant, with an overall trend toward significance ($\beta = 0.007$; $t = 1.73$; $P = .08$; AIC = 1808.5; semipartial $r^2 = 0.014$). Sexual satisfaction did, however, moderate observed synchrony during the mirroring task with male partner HR predicting female partner HR, which reflects the better fitting model according to AIC values ($\beta = 0.004$; $t = 2.62$; $P = .009$; AIC = 1592.1; semipartial $r^2 = 0.015$). This model is controlling for relationship length and sexual function. Simple slopes analyses suggest that it is high sexual satisfaction scores (ie, those falling above one SD above the mean) that are driving this moderation effect ($\beta = 0.21$; $t = 3.36$; $P = .0009$), rather than low sexual satisfaction scores (ie, those falling below one standard below the mean; $\beta = 0.04$; $t = 0.77$; $P = .440$). For a graphical representation of this interaction effect, please see Figure 2.

DISCUSSION

A general lack of dyadic psychophysiological research within the field of human sexuality has led to significant gaps in our understanding of the interpersonal processes that impact human sexual well-being. The current study begins to address this gap by examining the degree to which physiological synchrony can be reliably captured in a sample of sexually active opposite-sex couples and investigating the role of sexual satisfaction in that relationship. Based on previous research, we predicted that physiological synchrony would be detected across all study tasks and that sexual satisfaction would moderate synchrony observed during interpersonal tasks, but not during a baseline task. We found that physiological synchrony could be reliably detected in a reciprocal fashion (ie, male partner HR predicting female partner HR, and female partner HR predicting male partner HR), and that models wherein male partner HR was the predictor seemed to better fit the data. We also found that sexual satisfaction significantly moderated synchrony observed in a male-predicted model during a mirroring task, but not during baseline or gazing tasks. Taken together, our analyses echo previous findings within the extant literature on physiological synchrony and provide initial support for a novel hypothesis: that couple-level experiences of sexual satisfaction may moderate observed synchrony. To that end, these nondirectional results provide the first empirical evidence that sexual satisfaction may be implicated in the degree to which couples covary physiologically under circumstances that induce contagion, or, conversely, that physiological synchrony may result from experiences of dyadic sexual satisfaction.

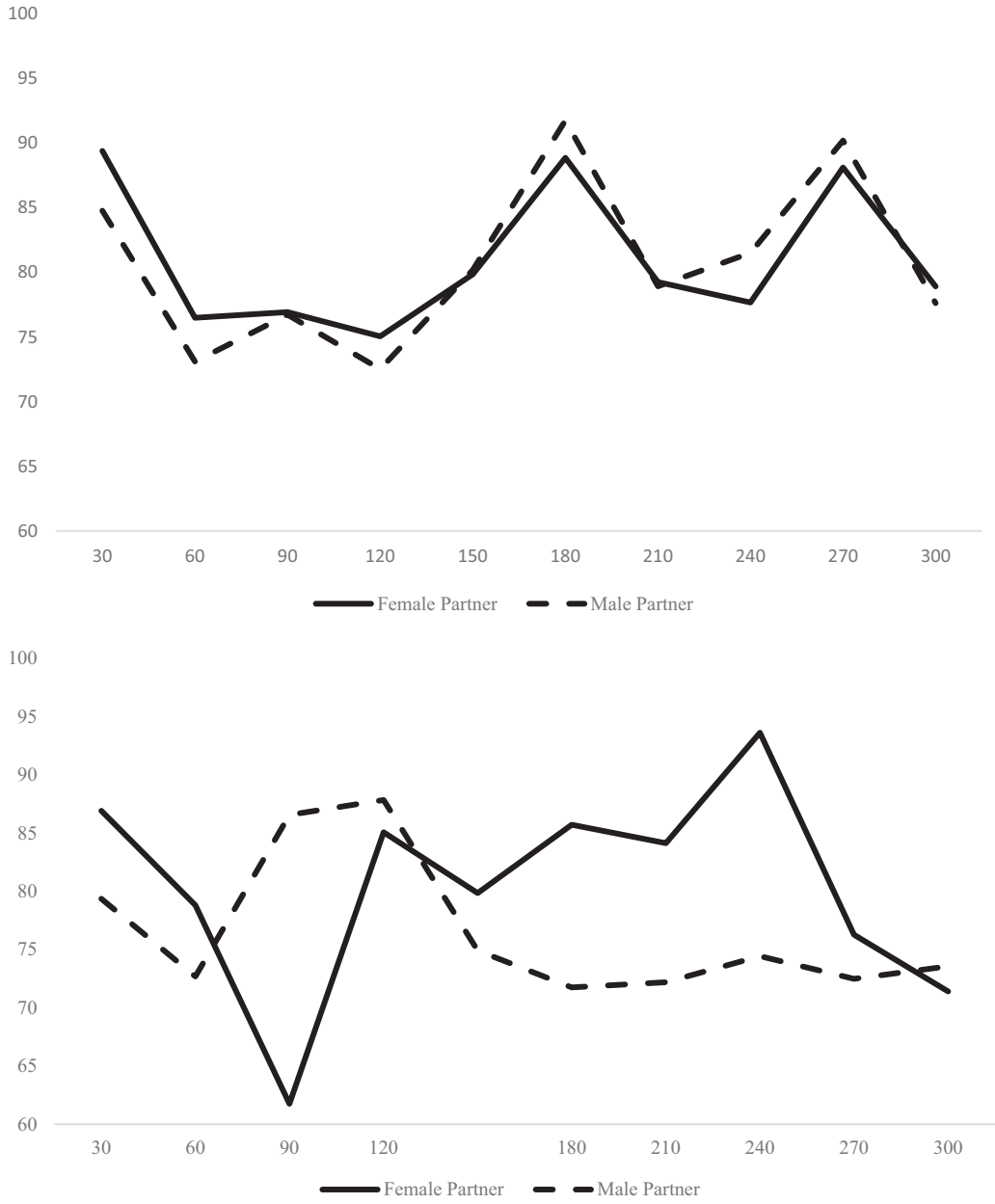

Figure 1. Heart rate trajectories for two individual dyads during the mirroring task.

As predicted, we captured synchrony reliably across our whole sample and across each of the study tasks. This suggests that covariation can, in fact, be detected in adult romantic partners across each of the study tasks used here. Notably, it was found that models in which changes in male partner HR predicted changes in female partner HR reflected a better fit of the data for each model tested. It is important to note that the magnitude of synchrony observed in male-predicted models was not necessarily stronger, but rather that these models minimized more overall error. These findings are consistent with previous research suggesting that physiological coregulation in heterosexual couples tends to reflect a pattern in which female partner responses follow after male responses.[29] Future research should seek to further explore this finding and test moderators that may explain this difference in the directionality of physiological covariation. Perhaps specific relationship characteristics or personality traits result in male partners "leading" autonomic exchanges—or, in other words, being the partner to whom physiological responses are being synchronized. If so, it would be critical to assess whether relevant constructs, such as relational and sexual satisfaction, vary as a function of which partner leads the exchange.

Sexual satisfaction was a significant moderator in a male-predicted model during a mirroring task, in line with our original hypothesis. Based on these data, however, we cannot make any causal claims about whether physiological synchrony is the cause or consequence of sexual satisfaction in this context. It is possible that physiological covariation during a mirroring task may facilitate sexual satisfaction and that lack of physiological

Figure 2. Female partner heart rate (HR) plotted as a function of male partner HR, shown with moderation effects (dyads grouped by high, moderate, and low sexual satisfaction [SS] scores, as defined by whether the sexual satisfaction scores fell below, within, or above one SD of the mean).

synchrony in this context may inhibit satisfaction. Alternatively, it is possible that couples who exhibit physiological connectedness are more empathetic and/or able to identify and respond to partner cues, a feature that could be driving differences in sexual satisfaction. Future research in this area should seek to examine this relationship experimentally to gain further clarity over both the directionality of this relationship as well as its mechanism of action. As no research to date in any discipline has examined physiological synchrony through controlled experimental manipulation, this would be an important step forward for the field at large. If physiological synchrony is a causal factor here, it could potentially be targeted as a treatment mechanism in clinical interventions for couples experiencing low levels of satisfaction. On the other hand, if physiological synchrony arises in response to high levels of sexual satisfaction, it could provide useful clues for how such satisfaction gives rise to partnered autonomic responding and potentially be used as a dyadic marker of sexual satisfaction in assessment contexts.

Importantly, the moderation effect observed during the mirroring task was directional, and findings were nonsignificant (albeit trending toward significance) in a female-predicted model. It is possible this difference can be accounted for by the male-predicted model better fitting the data. It is also possible that there may be sex differences in the relevance of synchrony for sexual satisfaction. It is well-documented that women tend to be better than men at accurately identifying nonverbal cues.[55,56] As such, female partners may be identifying and responding to their partner's cues more effectively than male partners in this sample. This ability would be particularly salient for the mirroring task, wherein identifying and responding to partner states in a nonverbal way was explicitly part of the instruction set. It is possible that this ability to better respond to nonverbal cues would be relevant to sexual satisfaction *and* would also lead female partners to synchronize physiologically to their partner, potentially resulting in the male-predicted model reflecting a better fit of these data.

Counter to our original hypothesis, only the mirroring task, and not the gazing task, demonstrated moderation effects in the current analysis. We expected that covariation in physiological signals observed during any interactive task would be relevant to sexual satisfaction. Instead, it seems to be the case that synchrony and sexual satisfaction are connected only under certain circumstances, and more specifically, under conditions that are thought to induce emotional contagion. To that end, we can speculatively conclude that physiological concordance experienced while attempting to match a partner and respond to their cues is more important for sexual satisfaction than simply looking at them. One potential explanation for this may be that, on its face, the mirroring task is more relevant to sexual contexts, where satisfaction might be a function of identifying, matching, and responding to partner needs.[16] If so, future research may seek to explore whether physiological synchrony is more relevant for experiences of sexual satisfaction when experienced in an arousal-specific context or with study tasks that are more explicitly sex-related.

There are several notable strengths in the current analysis, particularly with regard to the dyadic approach used. The current study extends the growing body of literature on physiological synchrony into the field of sexuality, exploring a relationship that exists theoretically and logically but that has never previously been tested empirically. Furthermore, this study is one of the only studies, to our knowledge, within the larger sexuality literature that has taken a dyadic psychophysiological approach, allowing us to more closely examine the unique ways in which sexual partners respond to each other physiologically. Taken together, these findings provide preliminary evidence that partnered autonomic responding may be important for partnered sexual experiences, and/or that partnered sexual experiences may impact autonomic responding.

Although these findings advance our understanding of the interpersonal factors that impact sexual satisfaction, this study was undertaken as a proof-of-concept and, consequently, there

are several limitations worth mentioning. First, this analytic sample only includes heterosexual couples, which limits the generalizability of these findings to a broader population of romantic partners. Second, given the small sample size, there are several analyses that we are under-powered for, but that may help to disentangle some of the effects observed here in the future. More specifically, future research should seek to use male and female sexual satisfaction scores individually as dependent variables in multilevel modeling analyses to more clearly demonstrate sex effects. Moreover, each individual subscale of the Sexual Satisfaction Scale may be considered for use as a moderator to determine what specific facet of sexual satisfaction is most closely associated with physiological synchrony. Last, additional moderators, particularly those with demonstrated relevance to dyadic sexual satisfaction (ie, relationship satisfaction, sexual frequency, etc.),[19,20] should be included in future modeling to disentangle the independent contributions of related constructs to this larger relationship. Although these analyses are not appropriate for a sample of 28 dyads, future research should aim to recruit many more couples—both to replicate the current findings and to extend them to more nuanced aspects of sexual satisfaction.

In addition, our primary finding for this study involves the mirroring task, but we did not collect any data on what couples were actually doing during this, or any other study task, through video-recording or facial electromyography. For the purposes of a preliminary study, we did not want to introduce observer effects and potentially subtly shift participant behavior in any way. Consequently, it is feasible that some aspect of couples' interactions or dynamics during the mirroring task drove the overall effect in a way we are unable to control for in the present study. Future research should seek to observe and/or record couples during interactive tasks to ensure that moderation effects are truly driven by sexual satisfaction, rather than interactive patterns.

A final limitation is that synchrony is only measured through one psychophysiological index here. As such, the current study lacks the granularity to detect relative differences in sympathetic nervous system (SNS)-driven synchrony and parasympathetic nervous system (PNS)-driven synchrony. As previous literature suggests that these processes impact relational satisfaction differently, with SNS-driven synchrony predicting relational distress and PNS-driven synchrony predicting relational satisfaction, one might hypothesize that these processes would impact sexual satisfaction in a similarly differential way.[30] Alternatively, we might also expect sexual satisfaction to be driven by different mechanisms than relational satisfaction and to be related to overall physiological synchrony regardless of relative PNS or SNS activation, as SNS activation is known to play a facilitatory role in female sexual arousal.[57] To further assess this, future research on the relationship between physiological synchrony and sexual satisfaction should look to isolate PNS- and SNS-driven synchrony using tasks (ie, positive and negative conversations) and measures (ie, respiratory sinus arrhythmia and skin conductance) that separately index PNS and SNS arousal.

Taken together, these results suggest that physiological synchrony can be reliably detected in adult romantic relationships and that couple-level experiences of sexual satisfaction moderate the magnitude of observed physiological synchrony. Methodologically, these results fill an important gap in the sexuality literature: sparse (but emerging) dyadic research and a more specific lack of dyadic psychophysiological research. Future studies should seek to replicate these findings and extend them across different psychophysiological instruments, in arousal-specific contexts, and with same-sex couples. It is our hope that these findings encourage further research into the physiological mechanisms at play in dyadic sexual satisfaction and advance our understanding of the construct more broadly.

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