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The Dance of Smiles: Comparing Smile Synchrony in Nondistressed and Therapy-Seeking Couples

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Dyadic affective processes are key determinants of romantic relationship quality. One such process termed emotional synchrony (i.e., the coupling of partners' emotions) has attracted growing attention in recent years. The present study focused on synchrony in partners' smiles, a nonverbal signal with significant social functions. Specifically, smile synchrony in the interactions of nondistressed couples was compared to smile synchrony in therapy-seeking couples. The former were predicted to show higher levels of smile synchrony. Data from the interactions of 61 (30 nondistressed and 31 treatment-seeking) couples were collected during a laboratory session while they engaged in four 6-min interactions during which they discussed positive or negative aspects of their relationship. FaceReader software was used to continuously code each partner's smile. Compared to treatment-seeking couples, nondistressed couples exhibited higher levels of smile synchrony, and such synchrony occurred in shorter time intervals. These results suggest that smile synchrony may be used as a behavioral signature of relationship quality.

Keywords: synchrony, facial expressions, smiles, couples, relationship satisfaction

Close relationship quality is robustly associated with physical health (Kiecolt-Glaser & Newton, 2001; Robles et al., 2014) and psychological well-being (Braithwaite & Holt-Lunstad, 2017; Whisman & Baucom, 2012). Higher levels of marital quality, for example, are related to a range of positive health outcomes (Robles et al., 2014); notably, the effect sizes are comparable to the associations observed for other indices of health (e.g., diet, body mass; Holt-Lunstad, 2018; Robles et al., 2014). Romantic relationship quality is also one of the strongest predictors of overall psychological well-being (Proulx et al., 2007) and life satisfaction (Fleeson, 2004). Similarly, a recent literature review integrating findings across several different methodologies concluded that relationship distress plays a causal role in the risk of major depression (Whisman et al., 2021). By contrast, a satisfying relationship may buffer the effects of different risk factors for depression, such as stress (Robles et al., 2014).

Sbarra and Coan (2018) argued that affect plays a key role in the association between relationship and health (see also Farrell et al., 2018). Interdisciplinary research in social, developmental, clinical, and health psychology suggests that close relationships operate as interpersonal emotional systems (Butler, 2011; Palumbo et al., 2017; Sbarra & Hazan, 2008; Schoebi & Randall, 2015). In this type of system, the subcomponents of emotion (e.g., subjective experience, physiology, expressions) interact not only within individuals but also between partners. Thus, the emergent properties of the system have predictive value beyond each individual's emotions. One manifestation of the dyadic nature of affective processes within intimate relationships is emotional synchrony, that is, the coupling of partners' emotional experiences (Anderson et al., 2003; Butler, 2011). Several studies have documented partners' tendency to become emotionally coupled or synchronized with each other during interactions (Anderson et al., 2003; Butler, 2011; Golland et al., 2015, 2019; Wilson et al., 2018). However, the implications of this synchrony for partners' relational and personal well-being remain unclear since some studies have found that synchrony is associated with positive outcomes while others have reported negative associations (Butler, 2011; Timmons et al., 2015).

Notably, emotions often involve loosely coordinated fluctuations across the experiential (i.e., subjective experience), behavioral, and physiological channels (Ekman, 1972; Levenson, 1994). This implies

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that emotional synchrony may have a differential impact depending on the affective system under study. For example, Timmons et al. (2015) suggested that whereas synchrony in physiological systems associated with threat (e.g., the sympathetic nervous system) is likely to exert a negative effect (e.g., negative affect contagion, conflict escalation), synchrony in systems associated with affiliation and physiological equilibrium (e.g., the parasympathetic nervous system) may be associated with positive outcomes. Thus, the channel through which synchrony is observed is critical to understanding the association between synchrony and relationship well-being.

Facial Expressions of Emotion

Emotions are often manifested through facial expressions (Yun et al., 2012). Facial expressions play a vital role in communicating nonverbal yet observable information about the expresser's internal state of mind (Calvo & Nummenmaa, 2016; Ekman, 1984). For example, facial expressions can indicate the affective context through which others' verbal expressions are interpreted as communicating positive or negative affect (Ekman & Oster, 1979). A smile, in particular, is one of the most frequently expressed nonverbal signals (Niewiadomski et al., 2010) and one of the few to convey positive affect (Nelson & Russell, 2013). Although facial expressions are not culturally invariant and different cultures manifest emotions in different ways, smiles are recognized across cultures (Jack et al., 2012). Nelson and Russell (2013) reported 88.6% agreement in Western studies and 90.7% in non-Western studies for smile recognition. Smiles are also rapidly recognized (Calvo et al., 2012).

Although facial expressions have key social communicative functions, researchers have only recently begun to pay attention to the dynamic interplay between interactants' facial expressions (e.g., synchrony). Golland et al. (2019) examined synchrony in the zygomatic muscle (responsible for smile production) in pairs of strangers who watched one positive and one negative movie clip. They found that synchrony exceeded chance in both affective contexts (i.e., exceeding the synchrony between pseudo pairs) and that smile synchrony was higher in the positive ($r = .44$) versus the negative ($r = .24$) context. Synchrony also predicted the dyads' affiliative feelings, suggesting that synchrony in this context may reflect a nonverbal, often nondeliberate behavioral index of affiliation and reciprocation of positive feelings. Cheong, Molani, et al. (2023) found that the synchrony of smiles (and not other facial expressions) was the only reliable and significant predictor of affiliation feelings between strangers. Kurtz and Algoe (2015) showed that shared laughter between romantic partners was associated with their global evaluation of relationship quality. In another study, participants from various cultures identified colaughter as a universal indicator of relationship quality (Bryant et al., 2016). Collectively, these findings can be interpreted through the lens of the Positivity Resonance Theory, which argues that shared positive affect, mutual care, and synchrony contribute to relational wellbeing.

Unlike Golland et al. (2019) and Cheong, Molani, et al. (2023), who examined smile synchrony among strangers, the present study focused on the role of synchrony in committed romantic dyads. Specifically, it examined whether smile synchrony could serve as a nonverbal correlate of relationship satisfaction or distress. Responsiveness is the hallmark of satisfying relationships (Farrell et al., 2023; Reis & Clark, 2013). Responsiveness in couples' interactions is often operationalized as verbal communication behaviors that convey reciprocation, listening, validation, and care (Reis & Clark, 2013). Here, it is suggested that smile synchrony—reciprocation of smile and positive affect—may represent one key nonverbal channel through which responsiveness is nondeliberately expressed but nevertheless communicated. Distressed couples are often less responsive to each other, and their interactions are characterized by fewer expressions of positive affect (Osgarby & Halford, 2013). Based on these findings, we predicted that the extent of smile synchrony in couples would be associated with relationship distress.

In addition to investigating the level of synchrony (i.e., the extent to which it is), the timing of this synchrony (i.e., how long it would take for a couple to show evidence of synchrony) may also be important to consider. Barr and Keysar (2006) argued that response time can be used as a behavioral measure of how well people can take each other's perspectives and coordinate their conversation. Faster response times may indicate better coordination and understanding between interactants, whereas slower response times may suggest a breakdown in communication. In a recent study, dyads of friends and strangers participated in 10-min recorded conversations and then continuously rated how connected they felt to their conversation partner (Templeton et al., 2022). Conversations with shorter response times (i.e., the time it took one partner to respond verbally to the other partner) were perceived as more affiliative by both participants and external listeners. Overall, these findings suggest that verbal response times provide a reliable and meaningful signal of whether two people feel close to each other. Based on this pattern of results, we predicted that the time it would take partners to reciprocate nonverbal communication behaviors could reflect relationship closeness. In other words, we expected that individuals in satisfied relationships would reciprocate more quickly with a smile facial expression than those in distressed relationships.

Timmons et al. (2015) suggested that the affective (e.g., positive vs. negative) context is important to consider when examining affective synchrony. Golland et al. (2019) found greater synchrony among strangers in positive versus negative contexts. In negative interactional contexts, committed partners are likely to experience less closeness (Li & Fung, 2013; Salo et al., 2022) and manifest lower levels of smile synchrony. Therefore, we also expected partners to show lower levels of smile synchrony when discussing negative versus positive aspects of their relationships.

The Present Study

The present study examined differences in smile synchrony in treatment-seeking distressed couples and nondistressed couples. A taxometric analysis showed that satisfied and distressed couples represent two qualitatively distinct relationship categories (Whisman et al., 2008). These groupings were used here; namely, for all comparisons, we examined differences between treatment-seeking distressed couples and a sample of younger, community-dwelling couples who reported relatively high relationship satisfaction. All couples engaged in four dyadic interactions (one positive and one negative relational topic generated by each person in the couple), thus allowing us to explore differences in smile synchrony as a function of task valence.

This work was guided by a series of specific hypotheses: (1) In both groups, reflecting a general tendency toward dyadic interdependence between couples, we expected that synchrony between romantic partners' smile expressions would be greater than chance; (2) we expected less smile synchrony in treatment-seeking versus nondistressed couples; (3) we expected that the time it would take treatment-seeking couples to reciprocate a smile facial expression (i.e., to show smile synchrony) would be longer than in nondistressed couples. Finally, (4) we expected to find lower levels of synchrony in negative versus positive relational contexts.

Method

Participants

Sixty-one cohabiting adult couples were recruited for this study. All the couples had an exclusive relationship and had lived together for at least 1 year. Thirty (n = 30) couples were recruited from the community, whereas the other 31 were distressed treatment-seeking couples recruited for an open trial aimed at examining change processes in emotion-focused therapy for couples (Greenberg & Goldman, 2008; Greenberg & Johnson, 1988). The eligibility criterion for the treatment-seeking couples' relationship was a report of satisfaction levels within the clinical range of the 16-item Couple Satisfaction Index (i.e., the partners' average relationship satisfaction level was below 51.5; CSI; Funk & Rogge, 2007). By contrast, the criterion for the nondistressed couples was a report of satisfaction levels within the nonclinical range (i.e., the partners' average relationship satisfaction level was above 51.5). The mean CSI was 71.5 for the nondistressed couples (range = 58.5–79.5, SD = 6.38) and 34.3 for the treatment-seeking couples (range = 19–51.5, SD = 7.60; Cohen's d = 5.38). Although not one of the exclusion criteria, none of the couples in the nondistressed group had previously participated in couples' therapy. Couples in both groups were recruited via posts on social media and local mail lists. All couples self-identified as being in mixed-sex relationships.

The mean age of the nondistressed couples was 25.6 years for the women (range = 22–29 SD = 1.92) and 26.4 years for the men (range = 23–29 SD = 1.69). On average, the nondistressed couples had cohabited for about 2 years (M = 2.06; SD = 1.28, range = 1–6), had been in their current relationship for 1 to 10 years (M = 4.20; SD = 2.73), and had no children. The mean age of the treatment-seeking couples was 37.06 years for the women (range = 19–59, SD = 8.32) and 39.08 years for the men (range = 23–63, SD = 9.39). On average, the treatment-seeking couples had cohabited for about 11.5 years (M = 11.58; SD = 8.48, range = 1–38), had been in their current relationship for 2–38 years (M = 12.90; SD = 8.01), and had about three children (M = 2.91; SD = 2.89). Independent t tests indicated that the distressed couples were significantly older, $t(32.39) = -7.51$, $p < .001$; Cohen's d = 1.93, and in longer relationships, $t(35.38) = -5.45$, $p < .001$; Cohen's d = 1.4.

Procedure

The couples were invited to a laboratory session during which they participated in four 6-min dyadic interactions. For the treatment-seeking couples, this lab assessment session was held 1 week before the therapy commenced. All couples first completed a set of online questionnaires (via the Qualtrics platform), which included the CSI (Funk & Rogge, 2007). Then, each partner was asked to raise and discuss one positive aspect (e.g., a strength of the relationship, something you like about your partner) and one negative aspect (e.g., a source of disagreement, something you want to change in your partner) of their relationship. The topics of the interaction (positive vs. negative) and the first partner to discuss them (men vs. women) were counterbalanced. However, the order of the interactions was thematically based (e.g., if in the first interaction Partner A discussed a positive relational experience, in the second interaction Partner B discussed a positive one). An HD camera (model AXIS M5525-E PTZ Network Camera, with a 10X optical zoom) positioned on the wall in front of each partner recorded their faces throughout these interactions. Due to technical problems, two interactions were not recorded. In addition, the video quality was poor in four interactions so that the facial expressions could not be identified. Hence, in total, 238 interactions were available for analysis (120 from the nondistressed couples and 118 from the treatment-seeking couples). The project was approved by the institutional review board of Ben-Gurion University of the Negev.

Measures

Smiles

We used Noldus FaceReader 8.0 software to automatically denote the participants' facial videos. Employing a network model classifier, the software was trained using a large facial image data set (Den Uyl & Van Kuilenburg, 2005). Each participant's facial expressions were denoted offline at a 25-Hz resolution. The average accuracy rate was generally high (89%) and was the highest when classifying smiles (precision = 0.97, recall = 0.99). In another validation study (Loijens & Krips, 2018), the software demonstrated over 90% accuracy in classifying facial expressions in the Amsterdam Dynamic Facial Expression Database, a standardized image set of facial expressions. Note that the accuracy for the smile facial expression recognition was also the highest. In this study, we implemented the FaceReader smile (i.e., smile/happy) score, a continuous composite score of the following action units: Cheek Raiser (#6), Lip Corner Puller (#12), and Lips part (#25) that ranges from 0 to 1.

The time series data obtained from the FaceReader often involve missing entries when the software does not recognize the facial expression. Based on a simulation analysis, we found that missing data of up to 3 s could be reliably recovered through linear interpolation (i.e., the correlation between the original and the interpolated time series was $r > .99$, SD = 0.006, range = 0.964–0.999; the simulation code can be found at Bar-Kalifa et al. (2024). The interpolation procedure successfully interpolated 10.4% of the missing data, yielding 13.4% missing data.

Relationship Satisfaction

Relationship satisfaction was assessed on the CSI–16 (Funk & Rogge, 2007). Participants rated 16 items, such as "I have a warm and comfortable relationship with my partner." The first item is rated on a 7-point Likert scale ranging from 0 (*extremely unhappy*) to 6 (*perfect*). The remaining items are rated on a 6-point Likert scale ranging from 0 (*not at all true*) to 5 (*completely true*). The total score is computed by summing all items (some of the items are reverse-coded). In the present study, the internal reliability was high (Cronbach's α = 0.98).

Data Analysis

To assess synchrony, we computed the cross-correlation functions (CCF) between the two partners' smile time series as they shifted relative to each other. Since it takes partners some time to observe and reciprocate one another's behavior, synchrony is often calculated as the maximum CCF. The CCF algorithm computes correlation estimates within predefined lags between two time series; for example, when using a ± 3 s window at 25 HZ resolution, it provides 151 (25 frames * 6 s + 1 for the zero lag) estimates for each of the lags at −3 to 3 s between the two time series. As in Golland et al. (2014), we used the maximal correlation (i.e., the max CCF) within a window of ±3 s.[1] For example, if the correlation between the two time series was maximal when one of the time series was shifted 2 s forward, this value at this particular lag was used to represent the synchrony level during this interaction for this couple. In addition, we extracted the time lag in which this maximal synchrony occurred (i.e., the Sync Time lag), which indicated how quickly partners became synchronized with each other (in the example above, it was set to 2). We examined the differences between the two groups on these two indices (i.e., maximal CCF and Sync Time lag). To ensure that extreme values did not disproportionately influence our analysis, we removed outliers that were three standard deviations away from the mean maximal CCF. Overall, one observation was removed from the nondistressed couples (thus leaving 118 interactions from the treatment-seeking group and 119 interactions from the nondistressed group). Note that the pattern of results with the outliers was comparable to the ones reported below (see additional online materials at https://osf.io/fmzk7/). A set of sensitivity analyses was run to account for the potential impact of group differences in partners' raw smile expressions, age, and relationship duration.

No a priori power analysis was conducted. However, we computed sensitivity power analysis to determine the minimum effect size that our data were sufficiently powered to detect. Following Lafit et al. (2021), we used the Monte Carlo simulation method to calculate power in the context of multilevel models. The simulation code is available at https://osf.io/fmzk7/. The simulation indicated that, for Hypothesis 1, the data were sufficiently powered (>.80) to detect a small-sized effect (Cohen's $d = 0.2$). For Hypothesis 2, the data were sufficiently powered (>.80) to detect a medium-sized effect (Cohen's $d = 0.46$). For Hypothesis 3, the data were sufficiently powered (>.80) to detect a small-sized effect (Cohen's $d = 0.36$).

Transparency and Openness

All data, analysis code, and research materials are available at Bar-Kalifa et al., 2024; https://osf.io/fmzk7/. Data were analyzed using R, Version 4.0.0 (R Core Team, 2020) and the packages hydromad (see Andrews et al., 2011, for synchrony computation), nlme (see Pinheiro et al., 2021, for multilevel modeling), and ggplot (see Wickham, 2016, for data visualization). This analysis was not preregistered.

Results

Table 1 presents the descriptive statistics for the study variables. Treatment-seeking couples showed lower levels of synchrony, their maximal synchrony occurred at longer time intervals, and they smiled less than the nondistressed couples. We ran an unconditional multilevel model to compute the interclass correlation index that represents the extent to which synchrony varied at the between-couple versus within-couple level. This model indicated that 44.2% of the variance in synchrony was at the between-couples level, suggesting a substantial level of stability in the couples' synchrony across the four interactions. Specifically, the within-couple correlation between the synchrony computed on the different interactions was high ($r = .67$, $p < .001$ for positive interactions, and $r = .59$, $p < .001$ for negative ones).

Smile Synchrony Within Dyadic Interactions

Figure 1A (for nondistressed couples) and Figure 2A (for treatment-seeking couples) present the distributions of the romantic partners' observed synchrony scores, which yielded an average of 0.46 ($SD = 0.14$) for the nondistressed couples and 0.32 ($SD = 0.23$) for treatment-seeking couples. The solid lines represent the 95% confidence interval.

To examine whether the average romantic couples' synchrony occurred at a higher probability than chance, we created pseudo data by pairing 5,000 random partners and calculated the synchrony for each of these random pairs. The average of this pseudo synchrony sample was 0.06 ($SD = 0.1$), indicating a large effect size for the difference between the observed and pseudo synchrony (Cohen's d of 3.29 for the nondistressed couples and 1.41 for the treatment-seeking couples). To test the observed synchrony's statistical likelihood, we applied a nonparametric bootstrapping procedure that allowed us to compare the average synchrony of the observed data to the sampling distribution of the means constructed from the pseudo data (for a similar approach, see Golland et al., 2014). Figure 1B (for nondistressed couples) and Figure 2B (for treatment-seeking couples) present the sampling distribution of the means for these pseudo couples. As shown, the observed mean synchrony level (marked by a dashed red line) for both the nondistressed and treatment-seeking couples was significantly higher than the mean of the pseudo data; that is, it exceeded the upper limit of the 95% confidence interval of the sampling distribution (solid line). Thus, consistent with our hypothesis, romantic partners' smile expression synchrony during interactions in both groups was greater than chance.

Group Differences in Smile Synchrony

Since the data had a hierarchical structure (each couple provided data from four interactions), to examine the effect of group on smile synchrony, we used a multilevel regression model framework with two levels. Importantly, since Sync Time lag is not normally distributed, we used a generalized mixed linear model with a Poisson's distribution to predict this synchrony variable. These models take into account the nonindependence of repeated measures within couples and can accommodate nonbalanced data due to missing data (see Bolger & Laurenceau, 2013).

[1] The window length to compute synchrony was based on previous works (Golland et al., 2014). However, other studies have found that smile reciprocation may occur within 1 s (Cheong, Jolly, et al., 2023; Dimberg & Thunberg, 1998). Thus, it could be claimed that real synchrony only occurs at lag 0. Therefore, we ran the analyses using lag 0 to compute synchrony. The pattern of results remained the same (see Open Science Framework Table B at https://osf.io/fmzk7/).

Table 1
Descriptive Statistics for the Study Variables

Variable	Total *M*(*SD*)	Nondistressed couple *M*(*SD*)	Treatment-seeking couple *M*(*SD*)
Max CCF	0.39 (0.20)	0.46 (0.14)	0.32 (0.23)
Sync Time lag (in seconds)	0.85 (0.93)	0.62 (0.71)	1.07 (1.05)
Smile men	0.13 (0.14)	0.18 (0.13)	0.09 (0.13)
Smile women	0.24 (0.19)	0.33 (0.20)	0.15 (0.14)

Note. CCF = cross-correlation functions; Sync = synchrony.

The mixed model was:

$$\text{Synchrony\_Score}_{id} = \beta_{0d} + \beta_{1d} \times \text{Group}_{id} + \beta_{2d} \times \text{Positive}_{id} + u_{0d} + e_{\text{sid.}}, \quad (1)$$

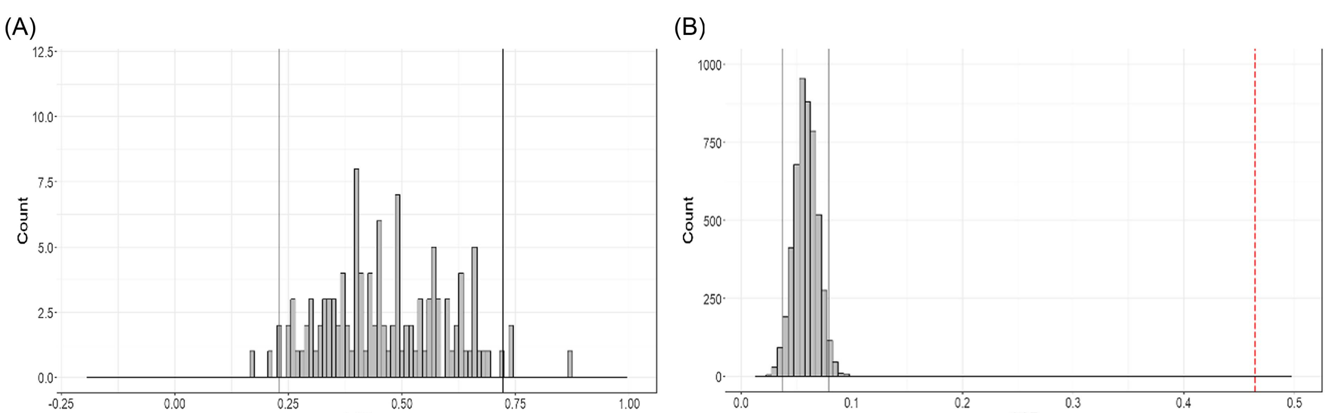
where the synchrony score (max CCF or Sync Time lag) in interaction *i*, from dyad *d*, was modeled as a function of the dyad's group (nondistressed couples = 0, treatment-seeking couples = 1) and the interaction topic (negative relational topic = 0, positive relational topic = 1). To account for the nesting of the data, a random intercept term was included (u_{0d}). This served to partial out consistent between-couple differences from the Level-1 error term ($e_{\text{sid.}}$). Estimating a different Level-1 error variability parameter for each group improved the model fit, max CCF: $\chi^2(1) = 22.25$, $p < .0001$. We therefore allowed each group's Level-1 error variability to differ in predicting max CCF (since Sync Time lag has a Poisson's distribution, the variability of each group was not allowed to be different).

The results of these models are reported in Table 2 and Figure 3. As shown, treatment-seeking couples exhibited lower levels of synchrony ("max CCF") than nondistressed couples (Cohen's $d = -.79$). In addition, the length of the time lag when the maximal synchrony was observed ("Sync Time lag") was longer in the treatment-seeking couples than in the nondistressed couples (Cohen's $d = .50$). The maximal synchrony in positive topic interactions was observed at shorter time lags. We ran additional models to explore whether the interaction between group and interaction type was significant. The results indicated a significant interaction for Sync Time lag ($p = .02$) and a nonsignificant interaction for max CCF ($p = .86$). Follow-up analyses showed that the group effect on Sync Time lag was larger in positive interactions (est. = 0.537, $p = .009$) versus negative ones (est. = 0.406, $p = .047$). In these models, the effect of group remained significant (est. = −0.15, $SE = 0.04$, $p < .001$ for max CCF, and est. = 0.41, $SE = 0.20$, $p = .047$ for Sync Time lag). Thus, overall, smile synchrony was lower in the treatment-seeking couples, and the time interval it took these couples to reciprocate a smile facial expression was longer than in the nondistressed couples.

Sensitivity Analysis

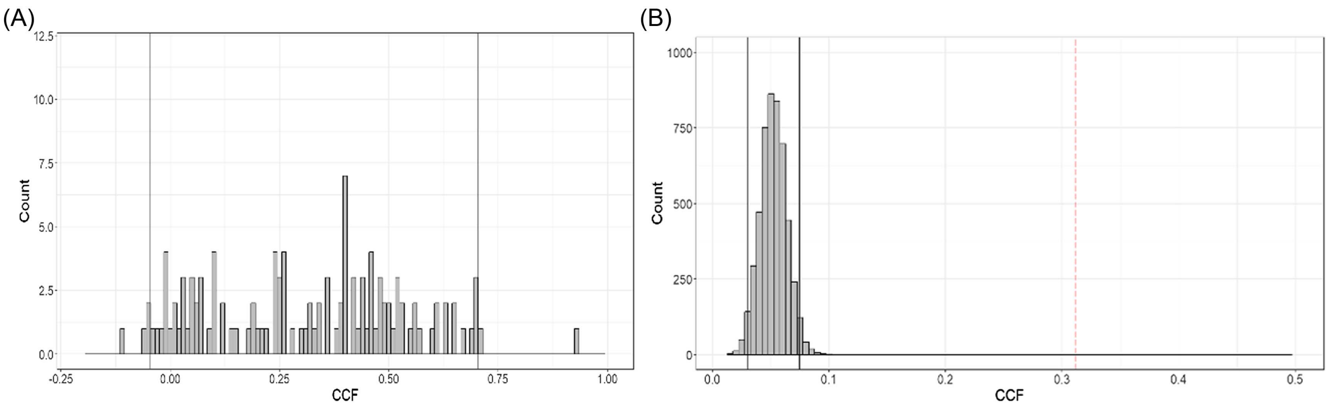
As noted above, the treatment-seeking couples smiled less than the nondistressed couples, were older, and had been in their relationship longer. Therefore, we ran a sensitivity analysis to examine the group differences in synchrony and Sync Time lag above and beyond these differences. Specifically, we reran the multilevel model while controlling for men's and women's smile expressions, age, and relationship duration. In these models, the group effect remained significant in predicting max CCF synchrony (est. = −0.132, $SE = 0.047$, $p = .006$) but not in predicting the lag of maximal synchrony (est. = 0.137, $SE = 0.27$, $p = .62$). In particular, women's smiling was

Figure 1
Nondistressed Couples' Synchrony



Note. The solid vertical lines denote the 95% confidence interval. The dashed vertical lines denote the observed sample's average score. (A) Observed CCF-nondistressed couples. (B) CCF H0 distribution-nondistressed couples. CCF = cross-correlation functions. See the online article for the color version of this figure.

Figure 2
Treatment-Seeking Couples' Synchrony



Note. The solid vertical lines denote the 95% confidence interval. The dashed vertical lines denote the observed sample's average score. (A) Observed CCF-treatment-seeking couples. (B) CCF H0 distribution-treatment-seeking couples. CCF = cross-correlation functions. See the online article for the color version of this figure.

associated with a lower max CCF (est. = −0.181, SE = 0.074, p = .016), whereas men's smiling was associated with a shorter Sync Time lag (est. = −2.493, SE = 0.296, p < .001). Age and relationship duration were not associated with max CCF or Sync Time lag (for the full results with the covariate effects, see Table A in the additional online materials at https://osf.io/fmzk7/).

Additional Analyses. The present study used an extreme group design that involved comparing smile synchrony in a group of treatment-seeking versus nondistressed couples. The additional analyses examined the potential association between smile synchrony and a continuous measure of couples' relationship satisfaction (CSI) as well as whether this association differed between the two groups. A multilevel model indicated a significant interaction effect (est. = 0.012, SE = 0.004, p = .006). Probing this interaction effect revealed that whereas the association between couples' CSI and their max CCF was significant in the treatment-seeking group (est. = 0.009, SE = 0.003, p = .002; r = .432), it was not in the nondistressed group (est. = −0.002, SE = 0.003, p = .374; r = −.182; see Figure A at https://osf.io/fmzk7/). Another generalized multilevel model examining the association between Sync Time lag and CSI found a negative main effect (est. = −0.044, SE = 0.021, p = .041, r = −.284); however, group did not moderate this association (est. = 0.010, SE = 0.028, p = .711).

Since smiling can at times be indicative of a negative communication (e.g., cynicism), we examined the extent to which partners' smiling and smile synchrony were associated with positive and affiliative feelings. Specifically, after each interaction, the participants completed the 20-item Modified Differential Emotion Scale (mDES; Fredrickson, 2013 and an abbreviated three-item measure of Perceived Partner Responsiveness (PPR; Maisel & Gable, 2009; Cronbach's α = 0.93). The mDES positive and negative emotion scores as well as the PPR were positively associated with one's smiling (r = .28, r = −.29, r = .27, ps < .001, respectively) as well as with smile synchrony (r = .30, r = −.27, r = .42, ps < .001, respectively). We also ran a two-level (interactions within dyads) actor–partner interdependence model (Kenny et al., 2006) and found that the actor smiling, the partner smiling, and the dyad's smiling synchrony were positively associated with participants' mDES positive score (actor: est. = 1.37, SE = 0.26, p < .001; partner: est. = 1.69, SE = 0.25, p < .001; synchrony: est. = 0.87, SE = 0.25, p < .001), negative score (actor: est. = −0.66, SE = 0.16, p < .001; partner: est. = −0.86, SE = 0.16, p < .001; synchrony: est. = −0.51, SE = 0.14, p < .001), and PPR (actor: est. = 1.52, SE = 0.393, p < .001; partner: est. = 2.17, SE = 0.391, p < .001; synchrony: est. = 1.80, SE = 0.411, p < .001). These results support the idea that in our context, smiling and smile synchrony were indicative of positive affiliative communication.[2]

Finally, since women are socialized to be more emotionally expressive (Chaplin, 2015; LaFrance et al., 2003), relationally interdependent (Gabriel & Gardner, 1999), and responsible for regulating others' affect (Holt-Lunstad & Smith, 2012; Strazdins & Broom, 2004), we examined gender differences in smiling synchrony behaviors; that is, whether women (vs. men) tended to lead (vs. follow) their partners' smiling. Specifically, we recorded the lag time when the maximal synchrony occurred, with negative numbers indicating men leading and positive number indicating women leading. We then computed the observed sample average of this variable and compared it to the sampling distribution of the averages, constructed from the pseudo data. The observed average (M = 0.8 s, SD = 1.26 s) did not exceed the 95% confidence interval of the sampling distribution (see additional online materials, Figure B at https://osf.io/fmzk7/), indicating that in our context there were no gender differences in the tendency to lead the smiling synchrony.

[2] In response to a reviewer's comment, we used participants' mDES scores to examine the correspondence between affect similarity and smile synchrony. We operationalized "affect similarity" in two ways: the average absolute difference between partners' reports on the 20 items (affect level similarity) and the association between partners' reports on the 20 items (affect pattern similarity; see Levavi-Francy et al., 2020). We reverse-coded the level similarity score so that in both indices, higher scores would represent greater similarity in partners' affect. Smile synchrony was positively associated with affect level similarity (r = .14, p = .02) and pattern similarity (r = .25, p < .001). These results indicate some correspondence between the two phenomena. Note, however, that affect similarity was measured at the level of the interaction (rated once following the interaction), whereas smile synchrony was measured within the interaction (coded at 25 Hz resolution).

Table 2
Fixed Effects of the Multilevel Models

	Outcome			
	Max CCF		Sync Time lag	
Effect	Est. (*SE*)	*p*	Est. (*SE*)	*p*
Intercept	0.447 (0.022)	<.001	2.66 (0.145)	<.001
Group (0 = nondistressed couples, 1 = treatment-seeking couples)	−0.149 (0.032)	<.001	0.464 (0.203)	.022
Interaction type (0 = negative, 1 = positive)	0.038 (0.017)	.029	−0.254 (0.028)	<.001

Note. CCF = cross-correlation functions; Sync = synchrony; Est. = estimates; *SE* = standard error.

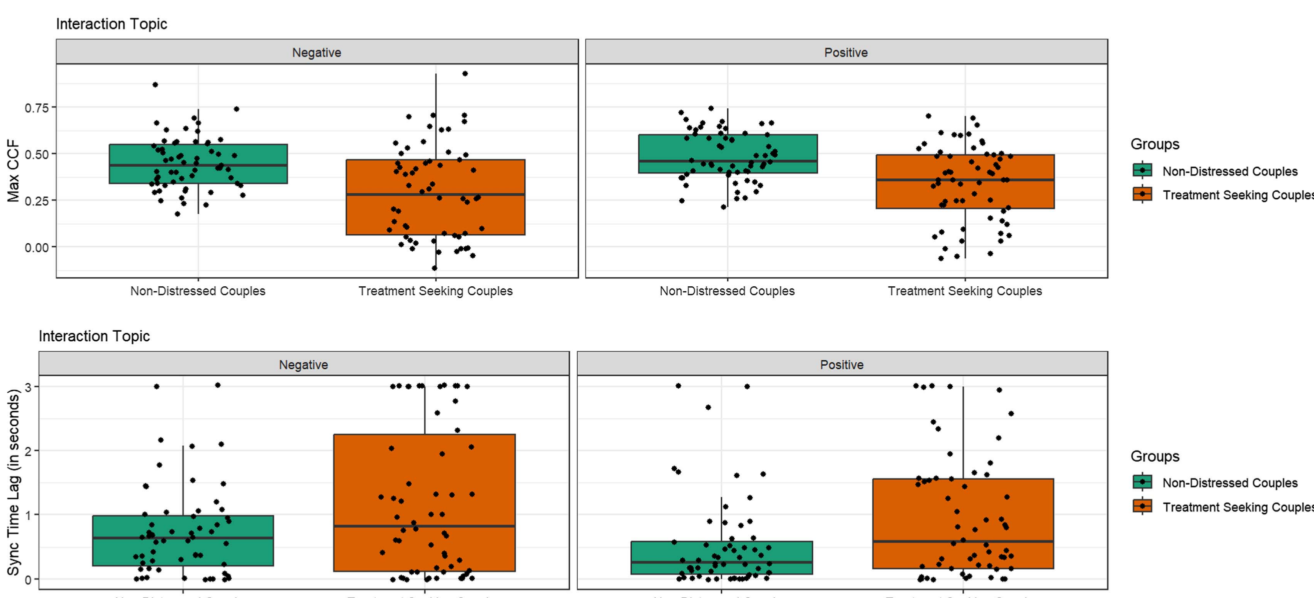
Discussion

Romantic relationship quality is highly associated with individuals' physical and mental health. Affective processes are believed to play a key role in driving these associations (Butler, 2011; Farrell et al., 2018; Sbarra & Coan, 2018). In the context of close relationships, studying emotion synchrony—where one partner's emotional responses are correlated with and dependent on his/her partner's responses—may be one way to characterize relationship quality in specific contexts. This study examined smile synchrony, one of the most prominent nonverbal affective expressions (Niewiadomski et al., 2010). Although facial expressions have significant social value, few studies have addressed synchrony in interactants' facial expressions. To the best of our knowledge, no studies have examined these processes as a correlate of romantic relationship quality using automated behavioral coding methods. Given the importance of partner responsiveness in close relationships (Stanton et al., 2019), this study dealt specifically with smile synchrony as a potential marker of reciprocated affiliative feelings (Cheong, Molani, et al., 2023; Golland et al., 2019).

Data from nondistressed couples and treatment-seeking couples were collected. The couples participated in four dyadic interactions where they discussed positive and negative aspects of their relationship. Supporting our predictions, (a) smile synchrony was evident in both groups, but (b) the treatment-seeking couples showed lower levels of smile synchrony and (c) the time interval it took them to show their maximal smile synchrony tended to be longer. Importantly, these group differences in max CCF (but not in Sync Time lag) remained significant above and beyond the partners' raw smile expressions, age, or relationship duration. In addition, (d) positive interactions yielded higher levels of smile synchrony. Relatedly, it also took couples less time to achieve their maximal smile synchrony in positive interactions.

Dyadic interactions involve both verbal and nonverbal communication. The latter is more spontaneous, less controlled, and thus is often perceived as a more automatic representation of one's internal state (Aviezer et al., 2011; Lavan et al., 2015). At times, nonverbal behaviors in dyadic interactions, which are largely based on facial expressions (Jack & Schyns, 2015), have greater predictive power

Figure 3
Couples' Max Synchrony and Sync Time Lag



Note. Max = maximum; CCF = cross-correlation functions; Sync = synchrony. See the online article for the color version of this figure.

with respect to partners' future satisfaction (Faure et al., 2018). The emergence of automated facial expression coding systems (Cheong, Jolly, et al., 2023) now allows for the extraction of valuable information while significantly reducing the burden of human coding. Although facial expressions are a central channel for emotional expression, synchrony in other nonverbal (e.g., body movement; Sharon-David et al., 2019) and verbal (e.g., pitch; Weidman et al., 2016) correlates of emotional expression have also been reported in the literature. The emergence of automated coding technology for these affective indices may facilitate the examination of synchrony within each index. This will help determine their relative predictive power as well as whether they interact with each other to predict interpersonal outcomes (Tal et al., 2023).

As noted above, it took the nondistressed couples less time to manifest their highest level of synchrony. These findings are consistent with data reported in Templeton et al. (2022), showing that a faster verbal response time predicted a sense of connection between dyads of strangers and dyads of friends (Templeton et al., 2022). They suggested that the partner's response time could signify reciprocity, responsiveness, and listening. Our findings can be interpreted in a similar way to suggest that response time in the nonverbal domain played a similar role by indicating a sense of connection. Interestingly, Templeton et al. showed that it was the partner's (vs. one's own) response time that predicted one's felt closeness. In the present study, differences in reaction time were examined at the dyadic level to compare nondistressed versus treatment-seeking couples. However, future studies could investigate whether the time it takes the partner (vs. the actor) to reciprocate a smile is also more predictive of the actor's relational feelings.

The considerable level of consistency observed in the couples' synchrony across the four interactions (i.e., about 45% shared variance) suggests that smile synchrony is a relatively stable dyadic phenomenon. Coutinho et al. (2019) examined synchrony in romantic partners' electrodermal activity (a physiological index of the sympathetic system that is often used to capture emotional arousal) but found very negligible dyad-level consistency across the different interactions (4% of total variance). Similarly, Wilson et al. (2018) examined synchrony in romantic partners' heart rate variability (a physiological index of the parasympathetic system often used to capture emotional regulation) and also found very negligible dyad-level consistency (1% of total variance). Unsurprisingly, in Wilson et al.'s study, synchrony was related to situational relational outcomes (e.g., postinteraction felt closeness) but not global ones (i.e., general relationship satisfaction). It is likely that stability in synchrony is signal-specific in the sense that synchrony in some signals (e.g., physiological indices) reflects more situational characteristics (e.g., the topic or the behaviors in a particular interaction), whereas in others (e.g., facial expression), reflects more stable characteristics of the dyad (e.g., the couple's satisfaction or communication style). Future studies could investigate synchrony in several modalities to examine the relative stability of synchrony in each signal. This approach would enable the use of different signals to predict either situational aspects (e.g., the quality of a specific interaction) or stable characteristics of the dyad (e.g., the overall quality of the couple's relationship), as well as examine the interplay between different signals. For example, a recent study showed that during a shared experience, the synchronization of facial expressions, electrodermal activity, and cognitive processes collectively contributed as a latent factor predicting social connection and affiliation between strangers (Cheong, Molani, et al., 2023).

The level of consistency of smile synchrony also suggests that it could be used for assessment purposes. Currently, most assessment tools rely on partners' self-reports. While characterized by high face validity, self-report tools are likely to be susceptible to a myriad of biases (e.g., social desirability). They thus can be complemented by more behavioral, nondeliberate assessment tools, such as smile synchrony. This can be used, for example, to identify couples in distress or to monitor treatment progress. Another future direction worth exploring is whether smile synchrony is a characteristic of the dyad as a whole or of the individuals within the dyads since some people may be particularly skilled at matching their partners' smiles, regardless of the partner they interact with. Research focusing on dyadic support indicates that the effect of support is relational (i.e., specific to the dyad; Lakey & Orehek, 2011), suggesting that smile synchrony may also be an attribute of the dyad; however, to comprehensively address this question, future studies should employ a round-robin design (where participants interact with multiple partners) to disentangle the variability of smile synchrony related to individuals or the specific dyads they form.

The variability of smile synchrony in the treatment-seeking couples was greater than in the nondistressed couples. The limited variability of synchrony in the nondistressed couples is consistent with taxonomic analyses indicating that nondistressed couples differ qualitatively from distressed couples (Whisman et al., 2008). However, these findings suggest that whereas nondistressed couples behaved in similar ways, treatment-seeking ones showed more variability in their behaviors. Additionally, self-reported relationship satisfaction (assessed continuously) was only associated with synchrony in the treatment-seeking couples. It is likely that the lack of association in the nondistressed couples was due to the limited variability in their self-reported relationship satisfaction. Given the evidence that pretreatment relationship satisfaction levels predict treatment outcomes (Baucom et al., 2009; Snyder et al., 1993), partners' smile synchrony may potentially also be used for prognosis purposes. For example, future studies could examine whether couples exhibiting higher smile synchrony at the beginning of treatment are more likely to benefit from couple therapy or from certain approaches to couple therapy (e.g., emotion-focused vs. behavioral couple therapy).

Limitations and Future Directions

The findings of this study should be interpreted in light of its limitations. Our study centered on covariations manifested in one specific facial expression, namely, smiling. Smile expressions were selected because of their perceptual clarity, distinctiveness, and high prevalence in social interactions (Calvo & Nummenmaa, 2016; Calvo et al., 2012; Niewiadomski et al., 2010). However, the feature space defining personal, let alone dyadic facial expressions, is much more complex, and the present study did not distinguish between different types of smiles (Duchenne vs. fake smiles; Ekman et al., 1990). Future studies should aim to capture a more complex set of interactions between interactants' facial expressions that may better reflect the quality of couples' communication. It is also important to note that the distressed couples included in this study were seeking treatment, thus indicating their motivation to improve their relationship functioning. Given that most distressed and separated couples do not seek therapy (Johnson et al., 2002; Wolcott, 1986), it is likely that treatment-seeking couples differ quantitatively from other distressed couples. For example, studies have shown that couples with lower incomes are both less likely to seek couple therapy (Williamson et al., 2019, 2020) and tend to express more negative verbal behaviors in dyadic interactions (Williamson et al., 2013). It is therefore likely that this pattern would also be reflected in their nonverbal communication, resulting in even lower levels of smile synchrony. However, recent studies suggest that patterns considered relationally adaptive may have different implications for couples with lower socioeconomic status (Karney & Bradbury, 2020). Thus, future research should examine patterns of smile synchrony and their predictive role across various samples of couples (e.g., distressed couples who are not actively seeking therapy, low socioeconomic status couples).

In addition, due to convenience sampling, the nondistressed couples were younger than the treatment-seeking distressed couples and had no children. Though we controlled for age in our analysis and found no association between age and smile synchrony, age may still have partially accounted for the group differences. For example, Bühler et al.'s (2021) recent meta-analysis indicated that the trajectory of relationship satisfaction follows a U-shaped curve across the lifespan (Bühler et al., 2021). Having children, especially the first one, can also lead to a decline in relationship satisfaction (Mitnick et al., 2009; Twenge et al., 2003). Therefore, it is possible that the group differences in synchrony we found here were related to such normative changes in couples' relationship functioning (rather than to the fact that the treatment-seeking couples reported clinical levels of distress). Future studies should follow couples over a longer period of time to examine these normative changes in simile synchrony over time.

Although the data were sufficiently powered (>0.80) to detect a small- or medium-sized effect, one of the major limitations of the present study has to do with the small sample size. Since it is challenging to recruit distressed couples, future studies should attempt to recruit a larger sample size to replicate the results. Further research is also needed to examine smile synchrony in different contexts. In the present study, couples were invited to discuss features directly related to their relationship. However, to obtain a more comprehensive understanding of the association between smile synchrony and relationship functioning, it is essential to explore the role of smile synchrony in other contexts. For example, capitalization support (i.e., being responsive toward one's partner's positive experiences; Langston, 1994) predicts salubrious relational outcomes (Monfort et al., 2014; Peters et al., 2018). These studies often operationalize responsiveness as partners' overt enthusiastic behaviors. Future studies could examine whether smile synchrony is also involved in constructive capitalization behaviors.

Gordon et al. (2023) suggested that flexibility in synchrony, that is, the extent to which partners go in and out of synchrony according to interactional context, may be a better predictor of interaction outcome than synchrony per se. In the present study, the context was globally characterized as positive or negative. Future studies could go one step further to characterize the context more dynamically (e.g., interactional segments in which partners express humor or negative affect; Bar-Kalifa et al., 2023; Chen et al., 2021) to examine when synchrony is associated with better (or worse) relational outcomes. Future research should examine synchrony as a flexible state that continuously shifts in its timeline, rather than the linear approach that "more is better."

These limitations notwithstanding, the data provided a unique opportunity to explore nonverbal communication in couples from a novel perspective. We found that nondistressed and treatment-seeking couples differed significantly in their dynamics of smile synchrony. We believe that pursuing this research direction can lead to a better understanding of adaptive affective dynamics and the ways in which they promote the better regulation of emotions, as well as relational and personal well-being more generally.

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