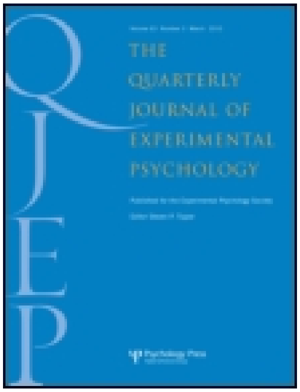

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Argument disrupts interpersonal synchrony

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Rapid communication

Argument disrupts interpersonal synchrony

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Research on interpersonal convergence and synchrony characterizes the way in which interacting individuals come to have more similar affect, behaviour, and cognition over time. Although its dynamics have been explored in many settings, convergence during conflict has been almost entirely overlooked. We present a simple but ecologically valid study comparing how different situational contexts that highlight affiliation and argument impact interpersonal convergence of body movement and to what degree emotional states affect convergence in both conversational settings. Using linear mixed-effect models, we found that in-phase bodily synchrony decreases significantly during argument. However, affective changes did not significantly predict changes in levels of interpersonal synchrony, suggesting that differences in affect valences between affiliation and argument cannot solely explain our results.

Keywords: Interpersonal convergence; Conflict; Interaction; Body movement; Synchrony.

As individuals converse, they begin to exhibit similar patterns of speech and movement in a phenomenon known as *convergence*. Among other benefits, some have concluded that convergence increases joint focus (Richardson, Dale, & Tomlinson, 2009) and mutual comprehension (Brennan, Galati, & Kuhlen, 2010; Shockley, Richardson, & Dale, 2009), facilitating communication and interaction. The process may be automatic (Garrod & Pickering, 2004) and can extend across multiple behavioural channels in a single interaction (Louwerse, Dale, Bard, & Jeuniaux, 2012). One basic finding of this area of research is that interacting individuals subtly match body movements (Shockley et al., 2009), from specific behaviours (Chartrand & Bargh, 1999) to overall levels of movement (Ramseyer & Tschacher, 2008). Interestingly, this effect can be moderated by a host of factors, including affect. For instance, positive affect has been associated with increased levels of convergence (Gonzales, Hancock, & Pennebaker, 2010; Hove & Risen, 2009; Ramseyer & Tschacher, 2008).

However, this research largely focuses on affect-neutral or positively valenced task-based interactions. *Asymmetric* interactions—those involving differences (e.g., in beliefs, goals, power) between individuals—have been largely uninvestigated in relation to convergence. Conflict, especially, has been overlooked. To the authors' knowledge, only one study (Bernieri, Davis, Rosenthal, & Knee, 1994) examines convergence during conflict, but

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its primary interest was methodological (i.e., comparing methods of rating interpersonal synchrony) rather than theoretical (i.e., dedicated to testing differences in interaction types).

Some researchers have posited that context may modulate these behavioural patterns (Garrod & Pickering, 2004), and experimental work on some social factors supports such claims (e.g., Miles, Griffiths, Richardson, & Macrae, 2010). Convergence may therefore function differently during asymmetric interactions, generally, and conflict, specifically. Conflict can be primarily characterized as an inherent clash of goals and perspectives with strongly negative valence (Bell & Song, 2005; Frantz & Janoff-Bulman, 2000), and negative affect has been shown to impact a myriad of interpersonal and relationship outcome factors (Carrere & Gottman, 1999). Given that convergence appears to support collaborative interactions and has been repeatedly linked with rapport, it seems reasonable to suspect that conflict may interrupt this process.

Conflict is a regular part of the human experience. Unfortunately, it has yet to receive close consideration by researchers interested in interpersonal convergence. The present study addresses this by exploring the relation between affect and the convergence of bodily movement during naturalistic interactions aimed at inducing (separately) affiliation and argument. We present data from a within-subjects design, comparing convergence during conversations stemming from affiliative and argumentative prompts based on interlocutors' preexisting beliefs. In doing so, this study aims to better describe the nature of conflict and broaden knowledge about interpersonal convergence.

We approached the present study with three central hypotheses. First, we expected that participants would exhibit convergence of body movement during both argumentative and affiliative conversations, but to a lower degree during argument. Second, we anticipated that changes in positive and negative affect would impact convergence during conversation and, finally, that affect changes and conversational context would interact to influence levels of convergence.

For the purposes of this article, we draw a working distinction between the terms *convergence* and *synchrony*. We recognize that there is a considerable array of terminology within the literature (e.g., *alignment* by Garrod & Pickering, 2004; *coordination* by Richardson et al., 2009; *automatic mimicry* by Chartrand and Bargh, 1999) and no clear consensus on their definitions in relation to one another. Without attempting to solve deeper terminological or theoretical questions, we here use two distinct terms. *Convergence* refers broadly to the ways in which interacting individuals' affect, behaviour, and cognition become more similar over time. We conceive of it as a broader term that encompasses phenomena from implicit alignment (Garrod & Pickering, 2004) to direct mimicry (e.g., Chartrand & Bargh, 1999). *Synchrony*, a narrower term, refers specifically to in-phase patterns of behaviour between interlocutors (e.g., Miles et al., 2010). We primarily use *convergence* in our summary of background literature on patterns of similarities that emerge through interaction. As we move into our own study, we switch to the more specific *synchrony* when we can establish in-phase fluctuations of movement through behavioural analysis.

EXPERIMENTAL STUDY

Method

Participants

Participants were 40 undergraduate students from the University of Memphis (mean age = 22.08 years; females = 32) and 24 undergraduate students from the University of California, Merced (mean age = 20.14 years; females = 18), compensated with extra course credit. All reported conversational fluency in English. Participants signed up individually using each university's online subject pool system and were unable to see their partner's identity before the experiment.

Dyads were primarily female (19 female; 12 mixed-sex; 1 male). Two dyads reported having known each other prior to the experiment. One female dyad was removed from analyses due to experimenter error; two dyads (one mixed-sex, one female) were removed due to incomplete data. Another mixed-sex dyad was removed because their opinions were too similar to achieve argument. While the sample size may seem small, it is comparable to or even much higher than other sample sizes in this area (e.g., 4 dyads, Boker, Rotondo, Xu, & King, 2002; 6 dyads, Schmidt, Morr, Fitzpatrick, & Richardson, 2012; 12 dyads, Dale, Kirkham, & Richardson, 2011; 21 dyads, Ramseyer & Tschacher, 2008; van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009; 24 dyads, Louwerse et al., 2012; 26 dyads, Miles et al., 2010; 37 dyads, Richardson et al., 2009).

Materials and procedure

Participants first individually completed a series of questionnaires, including an affect measure and an opinion survey. The Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988) assessed general emotional state, asking participants to endorse 20 affect-related adjectives (10 positive, 10 negative) using a Likert-style scale from 1 *(very slightly or not at all)* to 5 *(extremely)*. The opinion survey presented a number of political, social, and personal topics (e.g., gay/lesbian marriage, death penalty, abortion, legalization of marijuana). For each topic, participants were instructed to write a description of their opinion and to indicate the strength of their opinion on a 1 (*feel very weakly*) to 4 (*feel very strongly*) Likert-style scale.

Experimenters compared participants' answers and identified the topic on which participants reported strong but differing opinions. This topic became the dyad's argumentative prompt. To encourage an active exchange of ideas, the argumentative prompt also instructed participants to try to convince each other of their opinions.

Secondary and tertiary prompts were also selected using these criteria to ensure adequate discussion material. If participants were unable to sustain a conversation using the primary argumentative prompt, the experimenter issued the secondary prompt; if participants were again unable to continue, the experimenter issued the tertiary prompt. Eighteen dyads (including 2 removed from analyses, noted above) used secondary prompts; 2 dyads (including 1 removed from analyses, noted above) used tertiary prompts.

The affiliative prompt simply asked the dyad to find and discuss media (e.g., television, music) that both enjoyed. All dyads received the same affiliative prompt. This prompt was chosen to encourage naturalistic conversation while emphasizing participants' similarities and promoting mutual empathy.

After completing individual questionnaires, participants sat facing one another in a private room. Participants were recorded in profile in the same frame to track time-locked movement. Conversations were digitally recorded using a Canon Vixia HF M31 HD camcorder, mounted on a Sunpak PlatinumPlus 600PG tripod. Prior to the target conversations, participants held a brief, self-guided introductory conversation to become accustomed to one another and the laboratory setting (~3 minutes)[1] while the experimenter left the room, ostensibly to complete last-minute paperwork.

After the introductory conversation, the experimenter entered the room and issued the prompts in sequential order to generate two 10-min conversations per dyad, one affiliative and one argumentative (see Figure 1). The order of the conversation types (affiliative-first or argumentative-first) was assigned randomly for counterbalancing purposes. Participants were not informed of the conversation topics until they were ready to begin the conversation in question, and the affective valences of the conversations were not foreshadowed by the recruitment material or initial instructions. During the target conversations, the experimenter sat outside of the participants' immediate range of vision beside the camcorder to monitor the conversation and equipment inconspicuously. Following each conversation, participants were brought to separate locations to individually complete additional iterations of the PANAS to measure affective changes. Participants were debriefed and thanked after completing the second set of post-conversation questionnaires.

[1]These introductory conversations were not included in any analyses.

Initial Questionnaire Packet	Introductory Conversation	First Target Conversation (Argument or Affiliative Prompt, Random Order Assignment)	Post-Conversation Questionnaire	Second Target Conversation (Remaining Prompt)	Post-Conversation Questionnaire
-	3 min.	10 min.	-	10 min.	-

Figure 1. *Experimental timeline.*

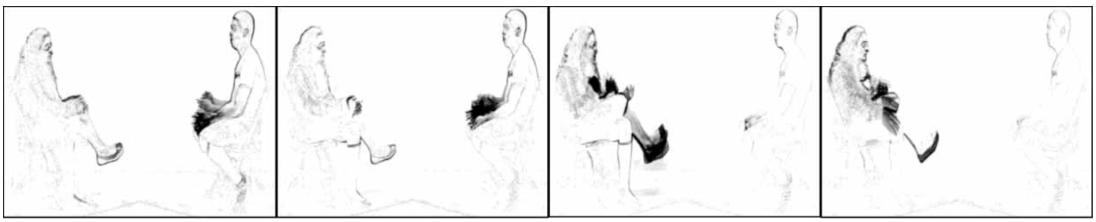

Figure 2. *Sample frame-differencing method (FDM) sequence. FDMs recognize movement as changes in pixels between images. Because of this, static portions of the frames (i.e., pixels that do not change between frames) are ignored. This image sequence demonstrates our FDM across several seconds, with each frame in the sequence containing movement from several original frames for visualization purposes. This figure presents movement for 4 undivided frames, including both interlocutors. In these frames, the interlocutor on the left taps her foot while making a large hand gesture, and the interlocutor on the right gesticulates before sitting still. For more details on the method, see Paxton and Dale (2013).*

Analysis of body movement

Using a *frame-differencing method* (FDM; e.g., Paxton & Dale, 2013), we compared participant movement as pixel changes across image sequences (see Figure 2 for sample visualization). Videos were sampled regularly (8 Hz or 125 ms), generating image sequences for each conversation. Original images were halved, with one participant's movement captured on each half. Movement time series for each participant were derived from these image sequences by comparing each image to its predecessor and standardizing the resulting values. Movement registered as changes in pixels between images; the movement time series reflected the changes in pixels across the image sequences derived from each video. We then applied a second-order Butterworth low-pass filter to each movement time series to account for fluctuations in light. For additional detail on these methods, see Paxton and Dale (2013).

To determine the degree to which a dyad moved together in time, we calculate cross-correlation coefficients between the two participants' movement time series for each conversation at time lags within a ± 3000-ms window (per Richardson et al., 2009). Cross-correlation calculates r between two time series at relative lags (or shifts). A time lag of 0 would reflect synchrony, as time is matched between participants. As lag increases, the correlation reflects more temporally disparate comparisons (e.g., lag of 2 reflects how Participant A's movements at t correlate with Participant B's at $t + 2$). Such analyses afford large amounts of power with relatively few participants (e.g., 4 dyads; Boker et al., 2002). These standardized cross-correlation coefficients (r) serve as our measure of convergence of body movement in the analyses below.

Results

Data were analysed using a series of linear mixed-effects models with a fully specified random-effects structure, with subjects and dyads as (non-nested) random factors, and all intercepts and slopes included (Baayen, Davidson, & Bates, 2008). Conversation type was dummy coded prior to analysis (affiliation = 0; argument = 1).

Figure 3 charts the cross-correlation coefficients for each dyad in our sample, offering a comprehensive

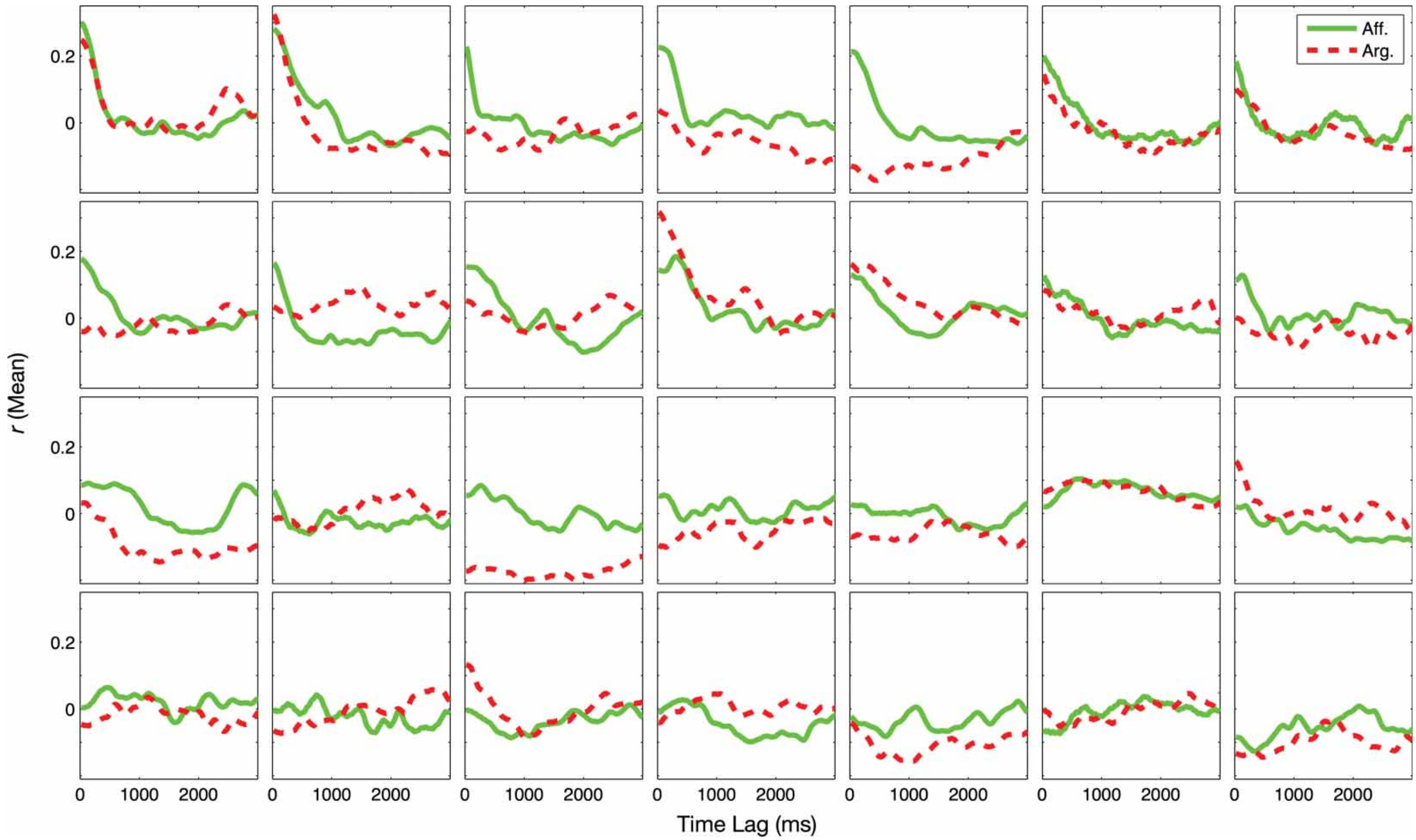

Figure 3. *Matrix of cross-correlation plots for all dyads included in the current analysis, arranged in descending order of maximum* r *at lag 0 in the affiliative conversation. All plots are graphed with the same dimensions for ease of comparison. Each plot charts the cross-correlation profiles for a* $\pm$*3000-ms time lag in the affiliative and argumentative conversations of one dyad. This figure demonstrates the variability of interpersonal synchrony exhibited across the dyads in our sample. Worthy of note is that in a large majority of the dyads, affiliation (aff./green) has a higher profile than argument (arg./red). To view this figure in colour, please visit the online issue of the Journal.*

Table 1. *Results of the linear mixed-effects models*

Model predicting r	B	β	t
Hypothesis 1			
Conversation type (argument = 1)	−0.05	−.52	−3.14**
Time lag (0 to 24, 8-Hz samples)	−0.003	−.22	−4.75***
Interaction	0.001	.07	1.39
Hypothesis 2 (two separate models)			
Positive affect change	0.03	.09	0.54
Negative affect change	−0.06	−.18	−0.83
Hypothesis 3 (two separate models)			
Positive affect change	0.0006	.002	0.17
Conversation type	−0.05	−.52	−3.14**
Interaction (Pos × Conv)	−0.001	−.003	−0.16
Negative affect change	0.0001	.0003	0.03
Conversation type	−0.05	−.52	−3.14**
Interaction (Neg × Conv)	0.0002	.0007	0.03

**$p < .01$. ***$p < .001$.

display of the variability in participants' cross-correlation profiles. These plots show that, generally, the affiliative profile tends to be higher than the argumentative. We can also see that levels of synchrony vary widely, ranging from relatively strong to very weak patterns across the dyads. By factoring random effects for each subject along with other nested slopes, linear mixed-effect models accommodate this variability to ensure that our findings are not due to idiosyncratic patterns of one dyad.

Below we describe the coefficients from these models using beta weights rather than unstandardized values, as the unstandardized values are in scales of r and have no clear anchors: While the raw r magnitudes cannot be easily assayed for strength of outcomes, beta weights are more conceptually tractable, as they may be interpreted as effect sizes.[2] (See Table 1 for full unstandardized and standardized results.) To obtain beta weights with linear mixed effects, all variables and interaction terms are standardized before inclusion in the model.

Conversation type and time lag

Our first model tested our two key hypotheses: that there is *in-phase* bodily synchrony during conversation and that argument disrupts that synchrony. This model examined the role of conversation type (affiliative versus argumentative) and time lag (125-ms increments) on convergence of body movement. We hypothesized that convergence (r) would decrease during argument and as time lag increased in both conversations. The latter would indicate in-phase *synchrony* during conversation, since convergence would be highest at lag 0. Consistent with previous findings (Paxton & Dale, 2013), r decreased with increases in time lag ($\beta = -.22$, $p < .01$): Regardless of conversation type, r dropped as a function of temporal lag, suggesting that individuals engage in more similar magnitudes of body movements closer in time (Figure 4).

Crucially, we found that argument has a strongly negative effect on convergence, with r decreasing during argument as compared with affiliation ($\beta = -.52$, $p < .001$). The interaction term ($\beta = .07$) suggested that, during affiliation, interpersonal synchrony peaked higher around time lag 0 and dropped more dramatically as time lag increases. However, the interaction term did not reach significance.

We wanted to confirm that, at lag 0, r was significantly greater than no convergence and so created an additional linear mixed-effects model using raw time lag (0–3000 ms) and conversation

[2]For information on interpreting beta weights, see Keith (2005).

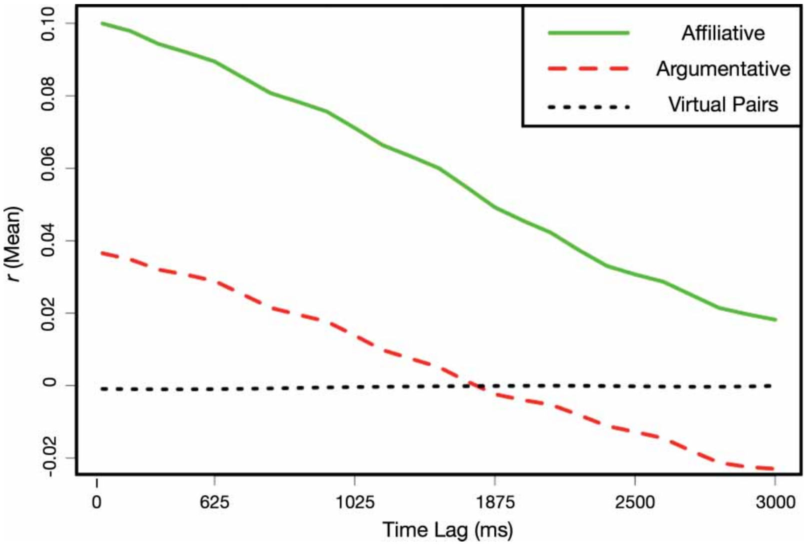

Figure 4. *The figure illustrates our findings from the first linear mixed-effects model run on the data, testing the effects of conversation type and time lag on bodily synchrony (r). Although dyads in both conversation types trended toward interpersonal synchrony, only dyads in affiliative conversations achieved levels of interpersonal synchrony that significantly differed from 0. Virtual pairs—comparisons of body movement between participants who did not interact during the experiment—provide a measure for how much bodily synchrony would be expected by chance*

type to predict r. The intercept (lag = 0 ms) was significantly positive in affiliative ($p < .001$) but not argumentative conversations ($p = .3$). Therefore, while bodily synchrony dropped across temporal lag during argument, overall synchrony was so low that it did not significantly differ from a correlation of 0. Synchrony was significantly greater than a correlation of 0 in affiliation, supporting the modulation of synchrony by context.

Virtual pairs analyses. To further ensure that a minority of dyads did not drive our results, we performed a virtual pairs analysis (e.g., Dale et al., 2011) to provide a statistical baseline of synchrony expected by chance. We created 20 sets of 14 virtual pairs by randomly pairing (without replacement) the original movement time series of an individual from one interacting dyad with the time series of an individual from another interacting dyad. Conversation types were preserved within each virtual pair. For each set of virtual pairs, we created linear mixed-effects models predicting r with time lag, conversation type, and their interaction, with original dyad and virtual pair as random effects with fully specified slopes. Averaged over all virtual pair models, time lag (mean $p > .55$), conversation type (mean $p > .38$), and the interaction term (mean $p > .53$) did not reach significance.[3] These results support the view of interpersonal synchrony as a dyad-specific and context-dependent phenomenon (see Figure 4).

Positive and negative affect

For our second hypothesis, we created affect change scores by subtracting participants' preconversation PANAS scores from their postconversation PANAS scores. We averaged then standardized the positive and negative items separately to obtain

[3]Of course, one would expect that some of the models of virtual pairs would reach significance by chance. Conversation type reached significance ($p < .05$) in one of the 20 virtual pair set analyses, and the interaction term reached significance ($p < .05$) in one other. Neither reached significance remotely close to the level reached in the models for our original data.

change scores for positivity and negativity after each conversation. Interestingly, change scores for positive and negative affect were positively correlated with one another, $r(110) = .58$, $p < .001$. This did not seem implausible for many combinations, as one can be *active* (positive item) and *hostile* (negative item) simultaneously. However, we report negative and positive affect variables in separate models to avoid collinearity.

We anticipated that mean *increased* positivity would predict higher r and the reverse for mean negativity. Negative affect change trended in the anticipated direction but not significantly ($\beta = -.18$, $p = .4$). Similarly, positive affect change was also in the anticipated direction but not significant ($\beta = .09$, $p = .59$).

Affect and conversation type

The final set of models investigated how affect and conversation type impact bodily synchrony. We again ran two separate models, predicting r with conversation type and one affect change score per model (i.e., one with negative, one with positive). Argument again significantly predicted a drop in r for both models ($\beta = -.52$, $p < .01$). However, neither affect type nor the interactions with conversation type reached significance. In general, as measured by PANAS, affect did not seem to relate to bodily synchrony nor interact with conversation type.

GENERAL DISCUSSION

Interpersonal convergence during affiliative or affect-neutral situations has been well established (e.g., Chartrand & Bargh, 1999; Hove & Risen, 2009; Lakin, Jefferis, Cheng, & Chartrand, 2003; Miles et al., 2010; Ramseyer & Tschacher, 2008; Sadler, Ethier, Gunn, Duong, & Woody, 2009; van Baaren et al., 2009). The present article complements these findings by providing a preliminary glimpse into how conflict impacts interpersonal dynamics. We have endeavoured to imbue the experimental design with a high degree of external validity by employing naïve dyads in largely self-structured conversations about strongly held beliefs and personal opinions. Given how little attention conflict has received in this area, the present study has attempted to provide a bird's-eye view of how convergence functions in naturalistic argument.

The present study aimed to answer three major questions. First, we extended previous findings of bodily synchrony in naturalistic contexts (Paxton & Dale, 2013; Schmidt et al., 2012)—*in-phase* changes in overall body movements between participants[4]—to argumentative situations, although the argumentative context significantly decreased the amount of bodily synchrony within the dyad. In answer to our second and third questions, we found virtually no relationship between affect and bodily synchrony nor any interactions with conversation type. It should be noted that we also explored raw PANAS scores, the relationship between conversation type and raw and change PANAS scores, partner-based analyses of PANAS scores, and other analyses. In general, affect may have been too coarsely measured to achieve any significant relationship with bodily synchrony. We can therefore conclude that conversation type may drive aspects of discourse without necessarily invoking or being mediated by strong affective fluctuations. Future work may better tap into affective influences through continuous coding methods (e.g., Sadler et al., 2009; see Future Directions section).

Some of these results were unexpected in light of previous research linking increased liking to increased synchrony (e.g., Hove & Risen, 2009). We expected that increases in positive affect would predict increases in interpersonal synchrony and that increases in negative affect would predict the opposite. Neither was a significant predictor in any model. As noted above, this may be an issue of power, given that there was only one data point for affect per person per conversation.

However, previous work (Miles et al., 2010) found no effect of affect on interpersonal synchrony

[4]An anonymous reviewer suggested that there may be interesting differences at the level of specific behaviours (e.g., Chartrand & Bargh; Lakin et al., 2003; van Baaren et al., 2009). The connection between synchrony of overall body movement and specific behaviours may also be an interesting avenue of future research on this corpus.

during interactive tasks with asymmetric social elements. Indeed, despite numerous differences between our paradigm and theirs, we found the same general result: Neither affect valence related to bodily synchrony. They also used a version of the PANAS as their affective measure, supporting our suspicion that the PANAS may be too coarse or too low in power to detect meaningful impacts of affect on synchrony.

Future directions

Although we counterbalanced the order of the affiliative and argumentative prompts, supplementary analyses[5] suggested that conversation order may impact patterns of interaction. To test this, we created a fully specified linear mixed-effects model predicting *r* with order and conversation type (with dyad and participant as random intercepts). While conversation type conformed to patterns reported in the Results section, order alone did not reach significance, but its interaction with conversation type trended toward significance.[6] Interestingly, the interaction revealed that, during argument, affiliative-first dyads exhibited *lower* levels of interpersonal synchrony than argumentative-first dyads. Synchrony in behaviour may thus be signalling differences in flexibility to new conditions depending on how dyads initiated their transient relationship: While levels of synchrony during affiliation were similar across all dyads, participants who began their interaction on a positive note appeared to have had difficulty adjusting to the new conversational context, despite their rapport. We intend to further explore these relations in future work.

While reviewing the argumentative conversations, we have begun to see patterns in the participants' responses to conflict, including a stereotypical debate-like pattern (with a consistent question–answer–rebuttal structure) and a "geographical survey" pattern (using the conversation to map out exact boundaries of agreement and disagreement). This suggests that there may be different styles of arguing or responses to arguments. Although these observations are merely anecdotal, attempts to quantitatively distinguish among possible response classes may be worthwhile to researchers at basic and applied levels. We imagine that the investigation of styles of responses to arguments, along with their characteristic components, may lead to new insights about conflict and conflict resolution.

The two directions mentioned above—exploring the temporal structure of interaction quality and identifying styles of arguing—may support the idea of dyad-level variability in interaction. Parallel to the idea of individual variability, there may be significant variability in dyads' responses to any given situation. Put differently, two sources of individual differences (the conversation partners) interact to produce an outcome that may not be a simple function of their respective conversation styles, creating a kind of "individual difference" at the dyadic level. For instance, while most dyads' behavioural synchrony decreased during argument, a small number of dyads showed *higher* levels of synchrony during their argumentative conversation (see Figure 3). Future research aimed at exploring the "gestalt" of the dyad may reveal emergent properties of the interaction, with characteristics as diverse as its composite individuals' characteristics.

In addition to behavioural convergence, researchers have investigated questions of *affective* convergence or synchrony—or how individuals' emotional states change together over time (e.g., Sadler et al., 2009). While we did not find that changes in self-reported affect significantly influenced behavioural synchrony, we would like to investigate how different conversational contexts impact moment-to-moment affective synchrony. By gathering data on numerous communication channels, we hope to contribute to the ongoing investigation into the functions and causes of these phenomena.

Conclusion

How does conflict impact interpersonal synchrony? The study presented here demonstrates that

[5]We thank our anonymous reviewers for suggesting these analyses.

[6]Results of model: conversation type, $\beta = -.52$ ($p < .005$); order, $\beta = .31$ ($p < .27$); interaction, $\beta = .55$ ($p < .09$).

conflict disrupts the "hum" of bodily synchrony that takes place between two individuals. Surprisingly, negative affect neither drives nor mediates this relationship, suggesting that the context itself causes these effects. In general, the intuitive prediction regarding argument is supported in our data: Dyads engaged in argument experience a sort of breakdown in interpersonal relations. In an exchange rooted in conflict, individuals' low-level behavioural variables appear to be significantly impacted by that discourse—so much so that the hum of synchrony is gone altogether.

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