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Running Head: Interpersonal Synchrony

# The Rhythm of Rapport:

# Interpersonal Synchrony and Social Perception

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**Abstract**

The temporal coordination of behavior during dyadic interactions is a foundation for effective social exchange with synchronized actions enhancing perceptions of rapport and interpersonal connectedness. What has yet to be established, however, are the precise characteristics of behavioral coordination that give rise to such effects. Informed by a dynamical systems approach, the current investigation considered whether judgments of rapport are influenced by the mode of interpersonal synchrony. In two experiments, participants rated the degree of rapport manifest by a simulated pair of walkers exhibiting various configurations of synchronized strides. The results revealed that the highest levels of rapport were associated with the most stable forms of interpersonal coordination (i.e., in-phase and anti-phase synchrony), regardless of whether coordination between the walkers was conveyed via the presentation of visual (Expt. 1a) or auditory (Expt. 1b) cues. These findings underscore the importance of interpersonal coordination to core aspects of social perception.

**The Rhythm of Rapport:**

**Interpersonal Synchrony and Social Perception**

"When two things keep happening simultaneously for an extended period of time, the synchrony is probably not an accident." (Strogatz, 2003, p. 2).

Performing actions that are similar to, and coordinated with, those of an interaction partner elicits feelings of connectedness and interpersonal rapport (Bernieri, 1988; Bernieri, Davis, Rosenthal, & Knee, 1994; Cappella, 1997; Chartrand & Bargh, 1999; Lakin & Chatrand, 2003; Tickle-Degnen & Rosenthal, 1990). This relationship between coordinated behavior and social perception has been demonstrated in a variety of settings (e.g., parent-child bonding, intimate relationships, teacher-student interactions – see Isabella, Belsky & van Eye, 1989; Julien, Brault, Chartrand & Bégin, 2000; LaFrance, 1979), such that the temporal organization of action is acknowledged to be a critical determinant of successful social exchange.

To date, the social implications of behavioral coordination have been documented following both the mimicry of discrete bodily movements (e.g., foot shaking, face touching – see Chartrand & Bargh, 1999; van Baaren, Maddux, Chartrand, de Bouter, & van Knippenberg, 2003) and the synchronization of more continuous sequences of action (e.g., postural movements, facial expressions, gestures – see Bernieri, 1988; Cappella, 1997). Research in this domain has been driven by two primary objectives. First, to establish the emergence of mimicry by aggregating instances of to-be-imitated behavior (e.g., face touching) during social interactions (e.g., Chartrand & Bargh, 1999). Second, to examine the relationship between coordinated behavior and perceptions of social connectedness (e.g., Bernieri et al., 1994). While this work has repeatedly demonstrated a positive association between coordination and rapport (see Chartrand, Maddux & Lakin, 2005), it has not yet considered whether variations in the dynamics of synchronized actions modulate the nature of this relationship (Semin & Cacioppo, 2008). That is, does the manner in which behavior is coordinated impact social perception?

Related work in the areas of dynamical systems and human movement science may inform this issue. Dynamical approaches to interpersonal coordination (see Schmidt & Richardson, 2008) consider the nature and degree of synchrony between two (or more) coupled oscillators, such as the recurrent movements of interacting individuals (e.g., the limb movements of two people walking side-by-side). This research has provided valuable evidence for spontaneous and unintentional behavioural entrainment across a range of activities, including walking (e.g., van Ulzen, Lamoth, Daffertshofer, Semin & Beek, 2008; Zivotofsky & Hausdorff, 2007), limb movements (e.g., Issartel, Marin & Cadopi, 2007; Schmidt, Carello & Turvey, 1990), postural sway (e.g., Shockley, Santana & Fowler, 2003), the swinging of handheld pendulums (e.g., Richardson, Marsh & Schmidt, 2005), and the motion of rocking chairs (e.g., Richardson, Marsh, Isenhower, Goodman & Schmidt, 2007).

Of relevance to the current inquiry, when the movements of individuals (i.e., coupled oscillators) become entrained, two dominant modes of synchrony emerge (Haken, Kelso & Bunz, 1985; Schmidt & Richardson, 2008): *in-phase* coordination (i.e., a 0° relative phase relationship,[1] whereby the actions of each individual are at equivalent points of the movement cycle); and *anti-phase* coordination (i.e., a 180° relative phase relationship, whereby each individual's actions are at opposite points of the movement cycle). While the actions of interacting individuals routinely move through the various intermediary stages of the relative phase relationship, over time they typically settle in a state of in-phase or anti-phase coordination (Schmidt et al., 1990). This effect arises because in-phase and anti-phase coordination reflect the globally stable attractor states for coupled oscillators (Haken et al., 1985), and indeed interpersonal coordination (Schmidt et al., 1990).

Thus, when individuals coordinate or synchronize their actions, two pertinent observations can be made. First, social-cognitive research has revealed that aspects of the interaction – notably judgments of social connectedness and rapport – are enhanced when behavior is coordinated (e.g., Bernieri, 1988; Chartrand & Bargh, 1999). Second, work from a dynamical systems perspective has

[1] In-phase coordination can also be defined as a 360° relative phase relationship.

shown that two modes of interpersonal coordination predominate, in-phase and anti-phase synchrony (Haken et al., 1985; Schmidt & Richardson, 2008). The integration of these related yet disparate literatures gives rise to an interesting question. Does the mode of interpersonal coordination impact people's evaluations of a dyadic interaction? To explore this issue, we assessed the level of rapport associated with a simulated pair of walkers displaying different modes of behavioral synchrony. Coordination mode was manipulated by varying the relative phase relationship between the strides of the walkers and the phase-relevant information was conveyed to participants either visually (Expt. 1a) or auditorily (Expt. 1b).

## Method

*Participants*

Sixty-six participants (31 females) ranging in age from 18-36 years took part in the research in exchange for course credit or £5. Thirty-six participants (19 females) completed Experiment 1a and 30 participants (12 females) completed Experiment 1b.

*Stimulus Materials*

*Experiment 1a (Visual Synchrony)*: A simple 2-dimensional video animation of a walking figure was created by combining, in sequence, 11 static images of a stick figure at equally spaced degrees of stride length, ranging from full stride to feet together and back again to full stride. Target videos were constructed by duplicating the figure so it appeared that two stick characters were walking side-by-side. The phase relationship between the strides of the figures was varied by shifting the starting point in the animation sequence of one figure relative to the other. A separate video was created for each of the combinations of the starting positions of the one figure relative to the other (i.e., ranging from both figures starting at 'full stride,' to one starting at 'full stride' and the other at 'feet together,' back to both starting at 'full stride') resulting in 22 video clips. These clips represented regularly spaced increments in the relative phase relationship between the two figures' strides ranging from 0° to 360°. The duration of each clip was 10 seconds and comprised 15 repetitions of the stride sequence for the two figures.

*Experiment 1b (Auditory Synchrony)*: A stereo audio recording was made of the footsteps of an adult male walking in hard-soled shoes on a firm surface at a comfortable pace (i.e., average inter-stride interval of 650 ms). To create the impression of two individuals walking together (i.e., two sets of footsteps), one channel of the recording was time-shifted to create a delay between channels in terms of the onset of each step. The relative phase relationship between the footsteps was manipulated by varying the amount of delay (50 – 600 ms, in 50 ms increments) for each channel giving a total of 24 audio clips. As for the video stimuli, these clips represented regularly spaced increments in the relative phase relationship between the two sets of footsteps ranging from 0° to 360°. The clips comprised 19 footsteps in each channel and ranged in duration from 11.4 – 12 seconds.

*Procedure*

Participants were invited to take part in a study concerning perceptions of walking styles and were tested individually. Following their random assignment to one of the tasks, participants were informed that they would be making ratings of interpersonal rapport from either video (i.e., Expt. 1a) or audio recordings (i.e., Expt. 1b). Participants in Expt. 1a were told that they would be viewing stick figures that represented the movements of two interacting individuals. Participants in Expt. 1b were instructed that they would be listening to audio recordings of the footsteps of two individuals walking side-by-side. Following each video or audio clip, participants gave their ratings of rapport on a 9-point rating scale (anchored, 1 = no rapport at all; 9 = a high level of rapport). The video/audio clips were presented in a unique random order for each participant. Upon completion of the tasks, participants were debriefed and dismissed.

**Results**

To preserve the structure of the phase manipulations, for the purpose of analysis the data sets were ordered linearly according to the relative phase relationship between walkers' strides/footsteps. Thus, the first and last levels of the phase manipulation corresponded to in-phase coordination (i.e., a 0°/360° relative phase relationship). The intermediate levels of the phase manipulation corresponded to an incremental linear transition of the phase relationship, such that the middle values represented anti-phase coordination (i.e., a 180° relative phase relationship).

*Experiment 1a (Video Walkers)*

Mean ratings of rapport (see Figure 1, top panel) were subjected to a single factor (Relative Phase Level: 1-22) repeated measures analysis of variance (ANOVA). This yielded a significant effect on participants' ratings [$F(21, 735) = 52.76$, $p < .001$, $p_{rep} > 0.99$, $\eta_p^2 = 0.60$]. Within-participants contrast tests were employed to examine this effect more closely. These revealed that the pattern of change in ratings of rapport fit a quartic[2] function [$F(1, 35) = 209.49$, $p < 0.0001$, $p_{rep} > 0.99$, $\eta_p^2 = 0.86$]. Participants perceived the level of interpersonal rapport to be highest when stride patterns reflected either in-phase or anti-phase coordination, and lowest at the mid-points of the transitions between in-phase and anti-phase movements (i.e., around 90° and 270° relative phase).

*Experiment 1b (Audio Walkers)*

As in Expt. 1a, mean ratings of rapport (see Figure 1, bottom panel) were submitted to a single factor (Relative Phase Level: 1-24) repeated measures ANOVA. This yielded a significant effect on participants' ratings [$F(23, 667) = 22.10$, $p < 0.001$, $p_{rep} > 0.99$, $\eta_p^2 = 0.43$]. Within-participants contrast tests revealed that the effect of the phase manipulation on ratings of rapport fit

[2] Quartic (or biquadratic) functions indicate three points of inflection (i.e., changes of direction) in a curve fitted to the data as can be seen in the 'W' shaped curves in both panels of Figure 1.

a quartic[2] function [$F$ (1, 29) = 118.53, $p < 0.0001$, $p_{rep} > 0.99$, $\eta_p^2 = 0.80$]. Replicating the video walkers, interpersonal rapport was highest when footsteps conveyed in-phase or anti-phase coordination. Again, the mid-points of the transitions between in-phase and anti-phase coordination (i.e., 90°and 270° relative phase) were perceived to reflect the lowest levels of rapport.

## Discussion

A relationship between behavioral coordination and interpersonal connectedness has been revealed in previous research. For the most part, this work has operationalized coordination very broadly, either in terms of mimicry (e.g., Chartrand & Bargh, 1999; van Baaren et al., 2003) or synchrony (e.g., Bernieri et al., 1994; Capella, 1997) during dyadic interactions. As a result, little consideration has been given to the precise nature of the coordination observed and how this may impact the perceived quality of social exchanges. Addressing this issue, we explored whether the characteristics of coordinated action, specifically the mode of interpersonal synchrony modulates third-party judgments of rapport. The results were revealing. Across two experiments, in-phase and anti-phase synchrony were consistently judged to reflect the highest levels of interpersonal rapport. Moreover, transitions between in-phase and anti-phase synchrony were accompanied by strikingly consistent gradations in perceived rapport, such that when the relative phase relationship was arranged linearly (i.e., from 0° to 360°) ratings of rapport revealed a strong curvilinear (i.e., quartic) pattern (see Figure 1). Importantly, perceiver's ratings of rapport were lowest when relative phase approximated 90° and 270° (i.e., the points most distant from in-phase and anti-phase), states which represent potentially unstable modes of coordination. This relationship was evident when phase-relevant information was presented visually (Expt. 1a) or auditorily (Expt. 1b), thereby demonstrating the generality of the observed effect.

This association between the relative phase of coordination and rapport corresponds with the stability of in-phase and anti-phase synchrony and the relative instability of other modes of coordination within natural self-organizing systems (Haken et al., 1985; Strogatz, 2003). It would appear that stability in the dynamics of an interpersonal coupling creates the appearance of a social connection or synergy between interacting individuals (Marsh, Richardson, Baron, & Schmidt, 2006) which, in turn, enhances judgments of rapport. That is, stable coordination generates a spatio-temporal context (i.e., common ground) that can be used to judge the qualitative aspects of social interaction. In this respect, deviations in critical aspects of the relative phase relationship (e.g., remaining coordinated but in unstable modes) are sufficient to disrupt interactional synergy and undermine perceptions of rapport. What this suggests is that perceivers' naïve theories regarding the quality of interpersonal interactions appear to correspond almost exactly with the dynamical properties that support and constrain the entrainment of coupled oscillators within real-world physical systems (Haken et al., 1985; Strogatz, 2003).

The current findings demonstrate that the manner in which behavior is coordinated is an important determinant of the perception of interpersonal connectedness. However, although the simulated dyads we employed provide a means to isolate synchronous movement from other potentially confounding variables (e.g., sex, emotion, social status), it remains to be seen whether our findings are applicable to the perception of actual, real-world interactions. While previous research has shown that perceptions of psychological attributes based on low-level kinematic information are consistent regardless of whether the movements are represented as videos of actual individuals or as animations of nonhuman entities (e.g., Morewedge, Preston & Wegner, 2007), it is likely that a host of social and contextual factors (e.g., goals, motives, target characteristics, task setting) play a significant role in shaping people's judgments. One useful task for future research will be to explore this issue. In addition, work should also consider whether qualitative variations in the synchronicity of behavior influence judgments of rapport when the perceiver is a member of the social unit in question. Given that third-party perceptions of rapport are closely aligned with interactants' reports of the occurrence of rapport (e.g., Bernieri, Gillis, Davis & Grahe, 1996; Cappella, 1997), it is probable that first-person experiences of interpersonal connectedness during an interaction will also be influenced by the nature of behavioral coordination.

Of additional theoretical importance is the extent to which the beneficial effects of behavioral synchrony extend to the more cognitive aspects of social interaction. Aside from providing a foundation for enhanced rapport and effective social exchange (Semin, 2007; Wilson & Knoblich, 2005), we suspect that interpersonal synchrony may afford other cognitive advantages to interacting individuals. Wilson and Knoblich (2005), for example, have suggested that coordinated action provides a basis for *perceptual emulation*, a process through which self-perception can inform the understanding of other social agents and facilitate observational learning when self/other actions overlap. Supporting this claim, behavioral coordination has been shown to facilitate action planning and anticipatory control when individuals perform a joint tracking task (Knoblich & Jordan, 2003). Additionally, Wilson (2001) has proposed that coordinating one's actions with another may facilitate what she termed *information flow*, the dynamics of knowledge transmission during a social exchange. Through savings in working memory, coordinated behavior may enable attentional resources to be directed toward conspecifics, thereby enhancing the person-perception process. Recent findings provide preliminary support for this viewpoint. In a task designed to tap the incidental acquisition of person knowledge during a social exchange, Macrae, Duffy, Miles and Lawrence (2008) demonstrated that memory for an interaction partner's appearance and utterances were enhanced following instances of synchronized action. Thus, moving in perfect harmony not only facilitates the processes vital to the foundations of effective interaction, so too it modulates core aspects of person perception and understanding.

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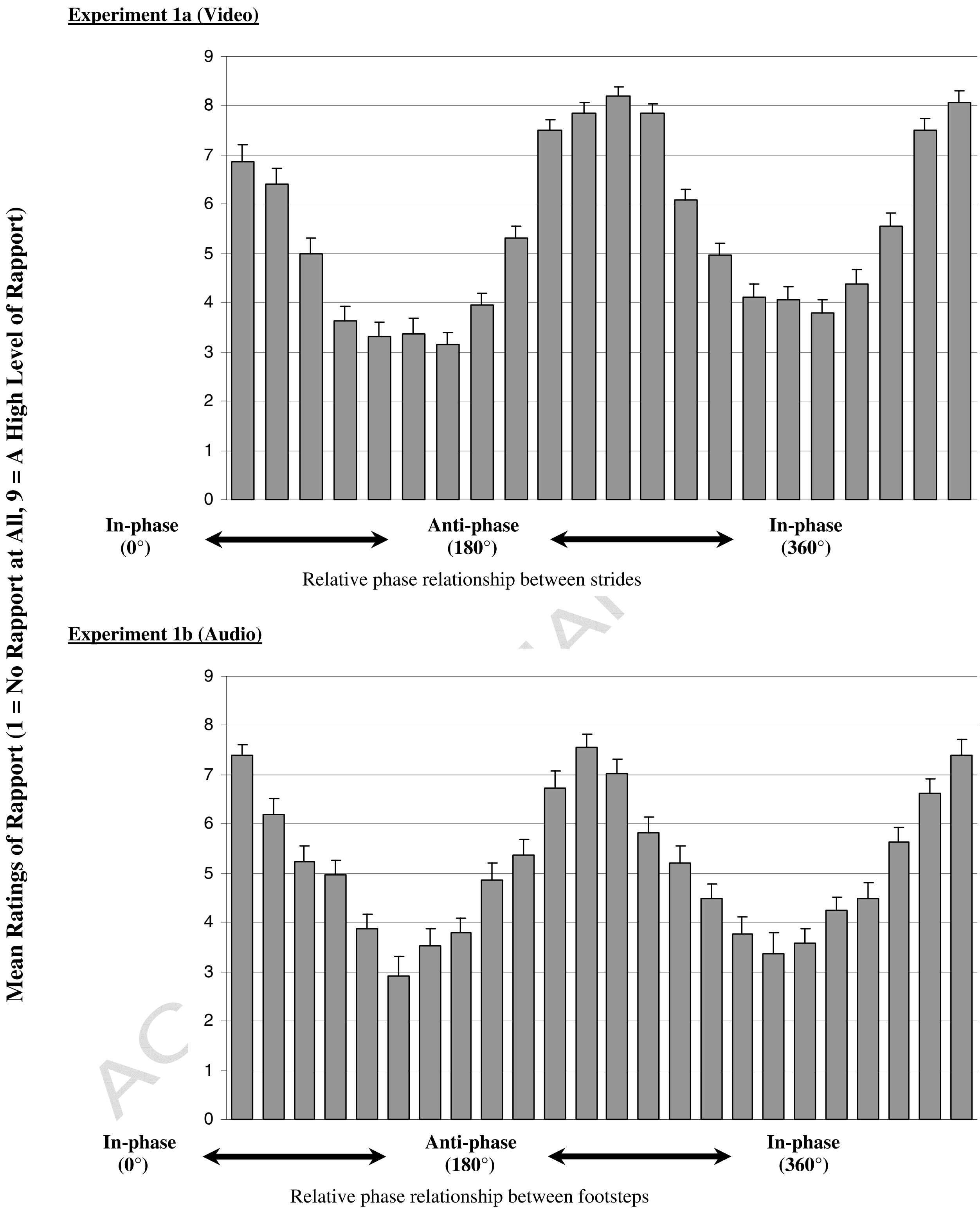


*Figure 1:*
Mean ratings of rapport as a function of relative phase for E1a (top panel) and E1b (bottom panel). Error bars indicate 1 standard error of the mean.