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Original Article

Convergence of speech rate in conversation predicts cooperation

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ABSTRACT

During conversation, interlocutors coordinate their behavior on many levels. Two distinct forms of behavioral coordination have been empirically linked with affiliation and cooperation during or following face-to-face interaction: *behavior matching* and *interpersonal synchrony*. Only the latter form constitutes behavioral entrainment involving a coupling between independent oscillators. We present the first study of the association between spontaneously occurring behavioral coordination and post-interaction economic game play. Triads of same-sexed strangers conversed for 10 min, after which each participant played an unannounced one-shot prisoner's dilemma (PD) toward each co-participant. When dyads had higher language style matching scores (LSM: Gonzales, A.L., Hancock, J.T., & Pennebaker, J.W. (2010). Language style matching as a predictor of social dynamics in small groups. Communication Research, 31, 3–19), the individuals evaluated each other more positively, but they were no more likely to cooperate in the PD. However, when dyads' speech rates (mean syllable duration) converged more strongly from the beginning to the end of the conversation, they were more likely to cooperate in the PD, despite no effect on interpersonal evaluations. Speech rate convergence, a form of rhythmic entrainment, could benefit interlocutors by mutually reducing cognitive processing during interaction. We suggest that spontaneous, temporally based behavioral coordination might facilitate prosocial behavior when the joint cooperative effort is itself perceived as a form of coordination.

1. Introduction

Conversational interaction is fundamental to human communication, and involves the dynamic interplay of many complex phenomena. While engaged in conversation, interlocutors communicate with their bodies, voices, and language. Research across many disciplines has documented a variety of ways that conversationalists coordinate their actions in the service of mutually beneficial interaction. How people talk together in real time is closely tied to broader interactive goals, which themselves are products of adaptations for navigating the social world.

Two distinct forms of behavioral coordination have been empirically linked with affiliation and cooperation during or following face-to-face interaction (Bernieri & Rosenthal, 1991; Hove & Risen, 2009). The first, *behavior matching*, involves individual *B* copying a behavior of individual *A*, but with neither a particular temporal relation to *A*'s action, nor any implication that *A* responds in any specific fashion to *B*'s copying action. A substantial body of research has established that people unconsciously mimic their interaction partners' postures, gestures, and mannerisms (Lakin, Jefferis, Cheng, & Chartrand, 2003), and language use patterns (Niederhoffer & Pennebaker, 2002), and that such mimicry is related to subsequent affiliative behavior. Among a large number of similar findings, people spontaneously mimic an experimental confederate's gestures and report greater liking for a confederate who mimics them (Chartrand & Bargh, 1999), and leave larger tips for a waitress who mimics them (van Baaren, Holland, Steenaert, & van Knippenberg, 2003). Researchers using the automated Linguistic Inquiry and Word Count algorithm (Pennebaker, Francis, & Booth, 2001, Pennebaker, Booth, & Francis, 2007) have found that similarity in relative usage frequency of common function word categories (e.g. prepositions, conjunctions) predicts successful hostage negotiations (Taylor & Thomas, 2008), task group cohesiveness (Gonzales, Hancock, & Pennebaker, 2010), and the formation and persistence of romantic relationships (Ireland et al., 2011). Coordinated language use and behavior may facilitate mutual understanding (Pickering & Garrod, 2004). Ireland and Pennebaker (2010; see also Meyer & Bock, 1999) argued that function words such as pronouns and articles (unlike content words) are "inherently social," because their comprehension typically depends, not just on the conventions of a speech community, but also on shared frames of reference actively established among interlocutors. For example, every English speaker knows the meaning of *garden*, but the particular garden referred to by *the garden* will be apparent to a listener only when she shares the same immediate frame of reference as the speaker. For this reason, according to Ireland and Pennebaker (2010), pairwise similarity in frequency of function word use is associated with greater affiliation or cooperation.

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A second form of behavioral coordination is *interpersonal synchrony*, which typically involves entrainment—a temporal coupling between independent oscillators that enter into some type of phase relationship. Prime examples of this are turn-taking in conversation (Wilson & Wilson, 2005) and playing music with an isochronous beat (Bispham, 2006). In Wilson and Wilson's (2005) model of conversational turn-taking, speech rate entrainment occurs via speakers' syllabic production, which operates interpersonally as a medium for entraining neural oscillators among interlocutors. This facilitates conversational coordination and allows for inter-turn transitions marked by minimal gap and minimal overlap (Stivers et al., 2009). Perceptions of timing in music and speech can affect subsequent productions in these respective domains (Jungers, Palmer, & Speer, 2002), and speech rate convergence has been linked to interpersonal judgments (e.g. ratings of competence: Street, 1984).

Talk is just one form of social interaction in which people are sensitive to entrainment. Studies have shown that singing together can increase cooperation in a prisoner's dilemma game (Anshel & Kipper, 1988) and a public goods game (Wiltermuth & Heath, 2009), though the effect can be sensitive to experimental conditions (e.g. Kurzban, 2001). Children who sang and danced together were more likely to assist one another in a later playground incident (Kirschner & Tomasello, 2010). Synchronous tapping, but not asynchronous tapping, generated higher affiliation ratings, but only when the synchrony was with another person, and not just experienced (i.e., tapping to a metronome) (Hove & Risen, 2009). Synchronized training in competitive rowers resulted in increased endorphin release (Cohen, Ejsmond-Frey, Knight, & Dunbar, 2010), suggesting a proximate mechanism motivating this kind of behavioral coordination. Behavioral entrainment is highly detectable, and can impact people's perceptions of the affiliation between the synchronizers. Hagen and Bryant (2003) showed that better temporal coordination in a music performance positively affected third party judgments of coalition quality between the musicians. While social entrainment may have evolved in many species from the simpler adaptive ability to entrain one's behavior to rhythmic information in the physical environment (Phillips-Silver, Aktipis, & Bryant, 2010), human interpersonal synchrony is moderated by many social factors and interacts in complex ways with group membership and the dynamics of alliance formation (Miles, Griffiths, Richardson, & Macrae, 2009; Miles, Lumsden, Richardson, & Macrae, 2011).

Laughter is another interactive phenomenon that can involve behavioral coordination and may be associated with cooperative behavior. Research has shown that people who have known each other longer tend to laugh together more (Smoski & Bachorowski, 2003a; Bryant, 2012) and familiarity between conversationalists is perceptible in the co-laughter itself (Bryant, 2012). Lynch (2011) found that people with greater similarity in implicit preferences laugh together more, suggesting an association with social cohesion. Gervais and Wilson (2005) argued that laughter functions as a medium for mirthful emotional contagion that recruits partners into resource-building social play. Accordingly, comparative work has demonstrated that chimpanzees use laugh-like vocalizations to manage playful social interactions, and that antiphonal laugh sequences lengthen play time (Davila-Ross, Allcock, Thomas, & Bard, 2011). Other scholars have suggested a variety of communicative functions for coordinated laughter that relate to cooperation (Owren & Bachorowski, 2003; Mehu & Dunbar, 2008), bonding (Dezecache & Dunbar, 2012; Platow et al., 2005) and social assortment (Flamson, Bryant, & Barrett, 2011).

The adaptive significance of these various phenomena remains a matter of debate. Simple mimicry in nonhuman social animals has obvious adaptive advantages (e.g. treating conspecifics' fear responses as reliable cues of imminent danger), and is presumably the phylogenetic source of more elaborate forms of behavioral coordination (Lakin et al., 2003). However, why these should serve as "social glue" is unclear. A number of nonhuman animal species exhibit inter-individual temporal coordination (Hall & Magrath, 2007), but the functions of these displays often remain unknown. Phillips-Silver et al. (2010) argue that even in cognitively simple species, collective social entrainment can amplify social signals in adaptive ways (e.g. courtship choruses; Greenfield, 1994). In human collective action, social entrainment may be necessary to accomplish work activities that require behavioral coordination. Recent work has shown that engaging in synchronized action facilitates success in later joint activity. For example, people who rocked synchronously in chairs, compared to controls that rocked asynchronously, were better able to subsequently coordinate their action on a collaborative task (Valdesolo, Ouyang, & DeSteno, 2010). This suggests that synchronizing action may calibrate expectations about others' behavior, and help coordinate action in other domains.

In this study, we examined whether distinct kinds of vocal and verbal convergence in naturalistic social interactions predicted cooperation in a one-shot prisoner's dilemma (PD). In a PD, an actor chooses whether to cooperate or defect toward a recipient. The actor gains the largest payoff when he defects while the recipient cooperates; the second largest when both cooperate; the third largest when both defect; and the lowest when the actor cooperates while the recipient defects. From a strictly monetary perspective, defection is always the best decision in a one-shot PD. However, a sizeable proportion of educated American, European, and Japanese participants treat one-shot PDs as assurance games, gaining the most psychological utility from mutual cooperation (Hayashi, Ostrom, Walker, & Yamagishi, 1999; Kiyonari, Tanida, & Yamagishi, 2000; Fehr & Camerer, 2007), and therefore cooperating if, and only if, they expect their partner to cooperate. This suggests that social preferences transform the PD into a coordination game (specifically, a Stag Hunt—Van Huyck, Battalio, & Beil, 1990) in which one coordinated outcome (mutual cooperation) yields higher payoffs to both players than the other coordinated outcome (mutual defection).

To assess whether different types of naturally occurring behavioral coordination facilitate cooperation-as-coordination, we measured behavior among strangers in open-ended conversation prior to their playing an unannounced one-shot simultaneous PD. We examined dyadic convergence in three vocal characteristics: (1) fundamental frequency (F_0); (2) variation in F_0, and (3) speech rate (mean syllable duration). We also calculated several measures of coordinated laughter and laughter/speech coordination. Finally, we calculated each dyad's language style matching score (LSM: Gonzales et al., 2010). We also examined the relationships between convergence and coordination in these diverse channels. Based on the empirical literature reviewed above, we expected that greater behavioral convergence would raise expectations of cooperative coordination, and that therefore dyads showing greater (1) vocal convergence, (2) coordinated laughter and (3) verbal convergence (higher LSM score) would be more likely to cooperate in the PD. We also elicited ratings of co-participants' *warmth* and *competence*, and predicted that these person perception variables would mediate the relationship between the convergence/coordination variables and PD decisions. This is the first study to examine whether spontaneous (as distinct from experimentally induced) behavioral coordination is associated with post-interaction behavior in an incentivized social dilemma.

The analyses presented here build on our previous report of findings regarding the determinants of our conversation participants' PD decisions (Gervais, Kline, Ludmer, George, & Manson, 2013). In a multivariate model, we found two main effects: people were more likely to cooperate (1) if they grew up in a wealthier zip code and (2) toward more facially attractive co-participants. We also found two interaction effects with subclinical primary psychopathy (callous affect, interpersonal manipulation) as measured by a self-report instrument: people who scored higher on primary psychopathy were less likely to cooperate toward co-participants (1) who interrupted them more frequently during the pregame conversation, and (2) with