Verbal Synchrony in Large Groups

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Abstract

Metronomes, cells, neurons, fireflies, and human beings all fall into synchrony with each other, given the opportunity. Synchrony between people appears to generate social cohesion by increasing liking and feelings of togetherness. But the function of dancing, chanting and singing is not just to produce warm, affiliative feelings, anthropologists have speculated, but also to improve group action. The group that chants and dances together hunts well together. Direct evidence for this is sparse, as research so far has mainly focused on studies of pairs, the effects of bodily movement, and measured cooperation and affiliative decisions. In contrast, in our experiment, large groups of people were studied, the synchrony of their verbal behaviour alone was manipulated, and in addition to affiliation, we measured their performance on a memory task and on a group action task, playing a video game together. Our evidence suggests that the effects of synchrony are stable across modalities, and can be generalized to larger groups.

Keywords: synchrony, action coordination, affiliation, groups, cooperation, joint action

Introduction

Most of us will have experienced the spontaneous synchronisation of steps when walking next to another person, audiences clapping in time with each other, demonstrators chanting together with one voice, or will have listened to the sound of crickets in perfect harmony. Synchrony can be found at every scale in the natural world. For example, cardiac cells fire in synchrony and fireflies flash in unison (Strogatz, 2003; Cabeza, Rubido, Kahan, & Marti, 2010); metronomes start to synchronise if put on a freely moving base (Pantaleone, 2002); neurons synchronise their activity to allow for coherent percepts and actions (Singer, 1993); and human beings coordinate their postural sway during conversation (Shockley, Richardson D.C., & Dale, 2009), and their movements during a pendulum swinging task, or while rocking in a chair when visually coupled (Richardson, Marsh, & Schmidt, 2005). This suggests that there is a compelling drive for systems to self-organise in synchrony.

Anthropologists and historians have argued for a long time that 'keeping together in time' induces emotional bonding among human groups with significant consequences for interaction and cooperation (McNeill, 1995). Marching, dancing, singing, or playing music together and in unison has been part of human rituals across all cultures in the world (McNeill, 1995; Codrons, Bernardi, Vandoni, & Bernardi, 2014) and the idea has been put forward that coordinating our actions with others is fundamental and the basis for social connectedness (Marsh, Richardson, & Schmidt, 2009).

Empirical evidence supports the idea that coordinated action can function as 'social glue' that binds people together and equips them with the ability to cooperate (Valdesolo, Ouyang, & DeSteno, 2010). Observing synchronous movement for example increases perceived rapport and interpersonal connectedness between people (Miles, Nind, & Macrae, 2009; Lakens & Stel, 2011); exposure to synchronous stimulation enhances the degree of self-other merging (Paladino, Mazzurega, Pavani, & Schubert, 2010); and active engagement in synchronised physical and verbal activities boosts actual liking and cooperation (Hove & Risen, 2009; Wiltermuth & Heath, 2009; Reddish, Fischer, & Bulbulia, 2013).

Most experimental demonstrations of coordinated behaviour focus on pairs of participants, or more commonly, a participant and a confederate who has been instructed to mimic body motions. Nevertheless, it is not hard to see that synchronous action often happens between many more than just two or a handful of people. For example, large numbers of soldiers have been marching in step with one another for thousands of years (McNeill, 1995).

The impressive breadth and variety of studies investigating behavioural coordination masks the fact that there are several fundamental questions about the phenomena, which are currently unanswered. How do the effects of coordination scale up from pairs of people to small and then large groups? Does it matter which aspect of behaviour is coordinated – speech, posture or gesture – in order to produce particular psychological effects? Are the benefits of coordination restricted to social judgements – attitudes and opinions about other people – or does it also affect social action and cognition – the ability of people to perform a dynamic task together?

We decided to focus on chanting, or joint speech, since it can be observed in every human culture, and as a means of storing and passing on information, it predates the written word (Cummins, 2013). It has been speculated that when a group sings or chants together, this will help to increase group affiliation and improve the group's coordination (McNeill, 1995), and so we measured its effects on action coordination, affiliation and cognition.

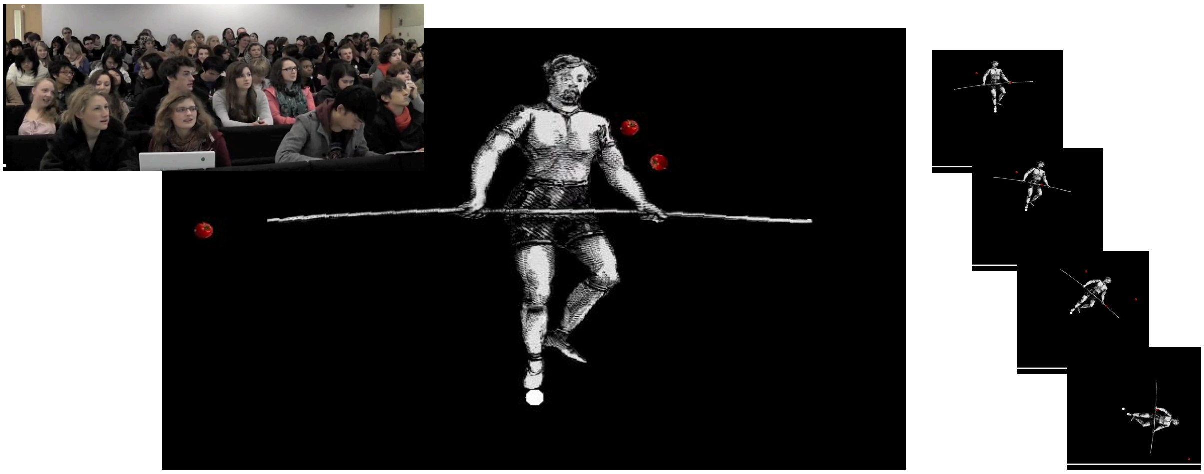

Figure 1. The tightrope game (taken from Richardson, et al., 2011)

The majority of empirical measures of behavioural coordination are concerned with the positive feelings that an individual will have towards the person or group with whom they are coordinating. The effects are measured by ratings and judgements the individual makes about the joint performance or likeability of an interaction partner or group, the degree of similarity and closeness they feel towards them, or by decisions the individual makes about sharing resources or opting to cooperate with the group even if that means to personally sacrifice.

In addition to social outcomes, it is possible that behavioural coordination leads directly to changes in cognition and action. Discussions about the evolution of behavioural coordination often focus less on the advantages of liking and positive feelings in a group, and more on the adaptive value of being able to act as a coherent group, planning and executing a hunt, for example. Performance benefits from behavioural coordination are rarely studied, however. Although it makes perfect sense to believe that there is a synchrony-action link, there appears to be hardly any empirical evidence for the idea that moving together in time improves future action coordination (but see Valdesolo et al., 2010).

Furthermore, even though there is some evidence that hand and arm movements performed in synchrony enhanced participant's memories for an interaction partner's utterances and facial appearance (Macrae, Duffy, Miles, & Lawrence, 2008), and decreased the typically observed memory advantage for self-related in comparison to other related information (Miles, Nind, Henderson, & Macrae, 2010), the benefits of synchronised activity on memory are not well-established, yet. More specifically, the possible benefits of collective speech on memory seem to have been overlooked entirely. This is interesting since collective speech is employed in educational settings in which remembering the spoken word is important such as in schools or churches. On top of that, one could speculate that national anthems, songs sung at sport events, or slogans shouted during demonstrations are remembered not only because people are exposed to them frequently, or because they are memorable, but also because they are almost exclusively associated with collective vocalisation.

In our experiment, groups of twenty to thirty participants either read a list of words out loud together or individually. Reading single words in unison is quite different to the coordinated, spontaneous joint speech that one finds during demonstrations or at a football game. However, it is a first approximation, and allowed a close comparison with an asynchronous speech condition in which people did not read the same words at the same time, but started at different places in the list of words that they were provided with.

After reading for around two minutes, participants played a group video game in which they used audience response handsets to jointly control a tightrope walker and keep him upright (Richardson, Dale, Rogers, & Ireland, 2011). Following the game, participants were asked to recall as many words as possible from the list, and rate their feelings towards their group. Our hypotheses were that those in the synchronised reading condition would perform better as a group in the action task, they would remember more words from the list, and have increased feelings of group affiliation.

Methods

Participants

215 participants from the undergraduates psychology programme at University College London participated in exchange for course credit. The participants were run in 8 groups of between 23 and 34 people.

Apparatus and design: the tightrope game

Each participant was given a *Turning Technologies* audience response handset. Their button presses were sent to a USB receiver plugged into a Macbook. These responses were sent to the tightrope game, developed by *Delosis.* The

Macbook was connected to a projector, which displayed the game on a large screen that everyone could see.

In the game, participants saw a man holding a pole, balancing on a rope (Figure 1). Each time one of the participants pressed either 1 or 3 on their handset, it sent a very small nudge to the tightrope walker, sending him to the left or right. The size of individual nudges depended on the number of people playing, such that the strength of all nudges added together would be the same across games with different numbers of people. The movements of the tightrope walker were governed by a physics engine that accounted for the size and position of the figure and the pole, as well as their momentum. A game ended when the tightrope walker fell off the rope, or participants successfully kept him upright for 30 seconds.

The game was made harder by introducing random noise in the form of tomatoes. They were fired from the sides of the screen at random and knocked the tightrope walker to the left or right. The frequency of these missiles was varied to change the difficulty of the game.

We quantified the success of each game in terms of its duration and the tightrope walkers average deviation from the vertical. This allowed us to investigate participants' perception and evaluation of their own actions under different levels of difficulty, and develop models of how they performed the task and responded to each other. For more description of the game and typical participant performance, see Richardson, et al., 2011.

Procedure

Participants were randomly allocated to groups, and each group was assigned to a synchronous (sync) or asynchronous (async) speech condition. At the start of the session, participants were given a list of 54 words, split into three columns. They were told to read them out loud, completing 2 cycles of the entire list. In the sync condition, participants were instructed to start at the top of the page with the first word and read the words together. In the async condition, participants were told to start at the top of the first, second, or third column, and participants sat adjacent to each other always started in different places. They were told to read out the words at their own preferred speed.

Participants then played the tightrope game. They were allowed a practice session with no tomatoes being fired as we explained how they could control the tightrope walker. Then they played five games with monotonically increasing rates of tomatoes being fired at them. If the tightrope walker fell off before 30 seconds, the game was restarted, until participants were able to complete a total of 30 seconds.

After playing the game, participants were then asked to fill in a worksheet. In 60 seconds they wrote down as many of the words as they could remember from the list that they had read out previously. Then they responded on a 7 point Likert scale from 'strongly disagree' to 'strongly agree' to the following statements, designed to assess participants' positive feelings towards their group, i.e. group affiliation:

a) During the video game I felt that my group performed well.
b) I enjoyed playing the video game together with my group.
c) During the video game I experienced a feeling of togetherness with my fellow group members.
d) I felt that my group acted like a team while we were playing the video game.

Results and Discussion

We analysed participants' responses in the tightrope game, the memory test and their ratings of group affiliation, comparing participants in the synchronous with the asynchronous speech condition.

Tightrope game

We used two levels of analysis to understand performance on the tightrope game. Firstly, since the participants in each group were working together, controlling a single tightrope walker, we analysed the data with each group as a 'participant', and the different games as trials. The goal of the game was to keep the tightrope walker as upright as possible upright for at least 30 seconds. For the large majority of the games, participants were successful at achieving this target duration, and so to discriminate between games our dependent variable was the average *vertical distance,* the angle between the tightrope walker and the vertical, either tilting to the right or the left. We computed the average vertical distance across all games and groups, for different levels of game difficulty and plotted them in figure 2A. Lower numbers on this measure indicate a greater success at the task.

To test for differences between conditions, we used generalised logistic mixed effects models for the average vertical distances in each game. There were fixed effects for speech condition and game difficulty level. We specified random effects for the group with random intercepts. This full model was compared to a reduced model that did not include effects for speech condition. We found that the speech condition did not directly affect the average vertical angle (($\chi 2(1)= 0.7372$, $p=0.39$). Using the same technique, we found that there was a significant effect of the difficulty level (($\chi 2(2)= 9.49$, $p=0.009$), and an interaction between condition and difficulty level that was not significant, but perhaps marginally so (($\chi 2(2)= 4.32$, $p=0.11$). A similar pattern of significance was found deriving p values using Satterthwaite's approximation for degrees of freedom.

Secondly, we analysed the behaviour of individual participants. For each participant, in each game, we calculated the average vertical distance of the tightrope walker from the vertical each time they made a button response. Figure 2B shows the distribution of average click distances for the two speech conditions. As before, we used generalized logistic mixed effects models to account for fixed effects of difficulty level and speech condition, as well as random effects from individuals being in different groups.

By comparing full and reduced models, we again found a significant effect of the difficulty level ((χ2(2)= 356, p<.0001), and a significant effect of the interaction between condition and difficulty level ((χ2(1)= 101.91, p<0.0001). Here, the effect of speech condition on its own was also significant ((χ2(1)= 2.7311 , p=0.098).

In summary, there is evidence that reading out the list of words together had an effect on participants' behaviour in a task of group coordination. There was an interaction with difficultly levels, such that the difference between speech conditions appeared to be greater in more difficult games. The evidence was weaker for this conclusion when the results were modelled at the level of games and groups, but stronger at the level of an individual's responses.

Word memory

We scored each participant by the number of words that they correctly recalled minus the number that they incorrectly recalled. The distribution of scores between the synchronous and asynchronous speech conditions is plotted in Figure 2C. A t-test between the means of these distributions showed that the participants who read out their words in synchrony with each other correctly recalled more words (t (213)= 2.2039, p=0.029).

Affiliation scores

Participants' ratings of the four affiliation statements were averaged. The distribution of these scores in the two conditions are plotted in Figure 2D. The mean of the four ratings for participants in the synchrony condition (M=8.0, SD=0.9) was higher than the mean in the asynchrony condition (M=7.2, SD=1.0). Since the participants were rating their groups, we needed to take account of the effect of being in different groups, and used generalized linear models following our analysis of the tightrope game. Our model had a fixed effect of condition, and a random effect of group. Comparing this to a simplified model that just accounted for group effects, we found that speaking together for a few minutes, later affected how group members felt about each other ((χ2(1)= 7.0367, p=0.008). Moreover, when the ratings for each question were analysed separately in the same way, all four showed a similar pattern of being significantly higher in the synchronous condition. Chanting together in synchrony seems to have similar effects to moving together in synchrony; people have more positive feelings towards their group after engaging in collective speech.

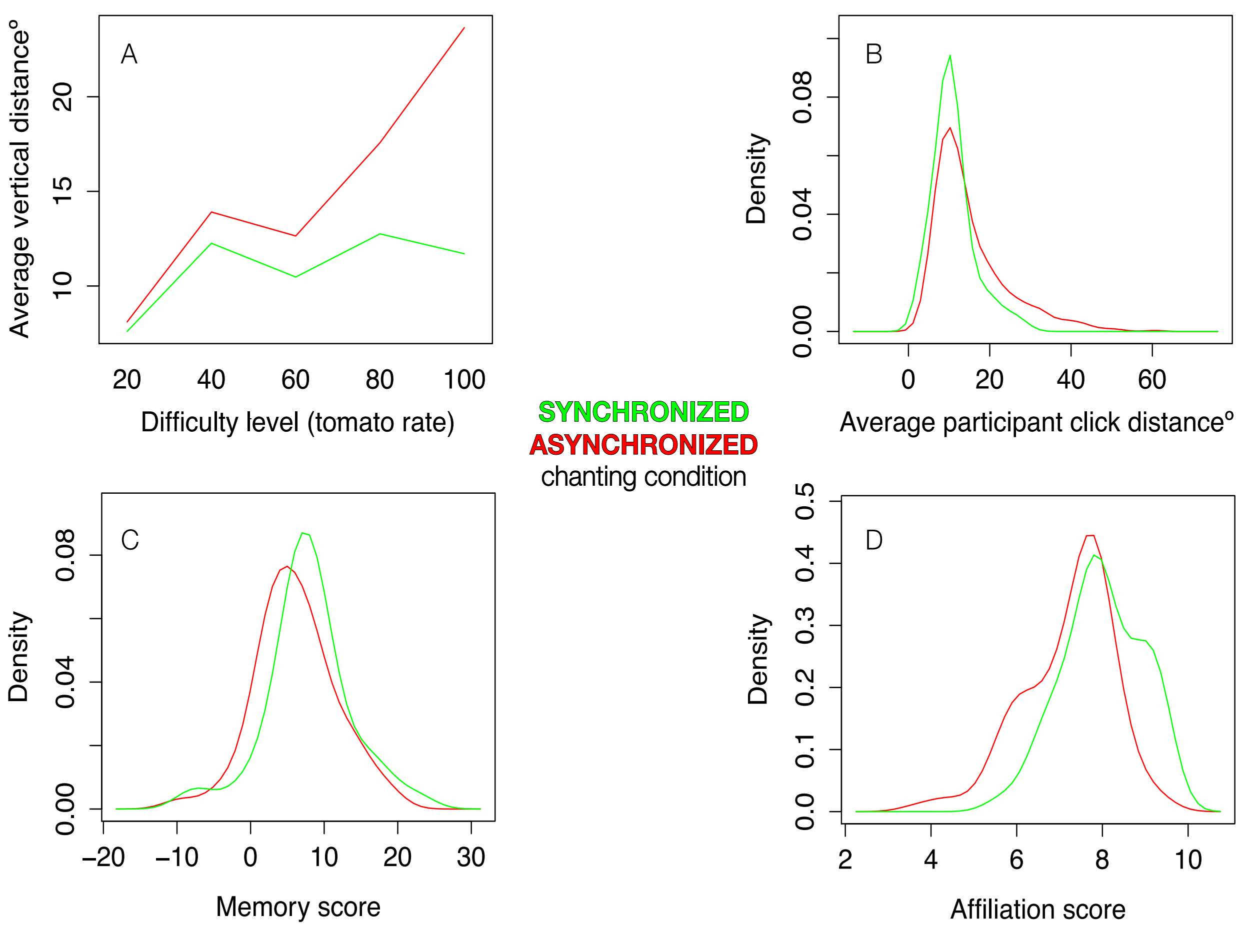

Figure 2. (A) Average angle of tightrope walker across games (B) Average angle at which participants' clicked (C) Memory score (D) Affiliation score

General Discussion

With our experiment we wanted to expand on already existing synchrony and behavioural coordination literature in three ways. First, we wanted to see if the affiliative effects generally reported scale up to larger groups. We found that members of large groups indeed seemed to feel closer to each other after they had chanted together in synchrony. The finding that behavioural synchrony can lead to interpersonal liking and rapport seems to therefore hold true also for much larger groups than previously found.

Second, we wanted to investigate if verbal synchrony alone is sufficient to induce the effects of behavioural coordination generally observed. Since our groups did not move together, but sat still during the chanting exercise, we are confident that verbal synchrony alone is enough to induce significant changes in participants. Individuals' ratings of their groups, their affiliation, and their performance increased in the synchronous condition. Of course, from this study we are unable to identify exactly which aspect of synchronous speech was responsible for changing participants' behaviour. It could be that chanting increases affiliation, and thereby improves group performance. Or perhaps chanting is in itself a pleasant activity, and so increases motivation, mood and attention to the tasks at hand. Conversely, speaking out of time with each other might be aversive, demotivating or simply more difficult, and as a consequence of differences in task performance, feelings of group affiliation change. In future work we hope to separate the different potential effects of chanting and to investigate their causal connections.

Third, we were curious to see if synchronous behaviour would also affect action and cognition in addition to the social effects often observed. A diverse set of researchers have come to the realisation that perception, action and cognition cannot be fully understood by investigating single individuals (e.g., Barsalou, Breazeal & Smith, 2007; Robbins, & Aydede, 2008; Sebanz, Bekkering & Knoblich, 2006). Studies of situated cognition show that cognition 'in the wild' is intimately linked not only to representations of the external world, but also to the cognitive processes of others. For example, Hutchins (1995) observed the ways in which navy navigators would distribute cognitive processes between themselves by using external tools and representations, such as maps and notations. Knoblich and Jordan (2003) gave a detailed analysis of the way that two people coordinate their actions: To be successful, participants had to anticipate both the movements of the objects in the game and the actions of their partner. More recently, experimental methods are starting to reveal the cognitive mechanisms involved in the joint activity of two people engaged in parallel tasks (Sebanz et al., 2006), talking to each other (Richardson, Dale & Kirkham, 2007), or just silently looking at pictures, changing their gaze patterns because of the knowledge that someone each other is looking at the same thing (Richardson, et al, 2012).

We wanted to find empirical evidence for the hypothesis that there is a synchrony-action link, that group members who have previously synchronized with one another will be better coordinated in a subsequent task. Our evidence supports this idea. Groups overall seem to do better on more coordination tasks after their members have engaged in synchronous behaviour, at least at the harder levels of task difficulty. In future experiments we will tease apart how difficulty level interacts with group synchrony to produce differing group performance. In this study, however, not only did we find a synchrony-action link, but also a synchrony-cognition link: Participants who had chanted words collectively, rather than reading them out loud by themselves, remembered more of these words at the end of the experiment. As with the affiliation findings, this study does not provide insights into the mechanisms driving the memory effect. Although synchrony was found to improve memory performance, the results give no answer as to why this might be the case. To clearly attribute the effects found to synchrony and to understand in which ways it affects memory, will be the task of future studies.

Behavioural coordination is often portrayed as something that binds people together, a type of 'social glue', which evokes positive and pro-social feelings towards interaction partners. However, there is more to coordinated joint action than hugs. For example while synchrony, like mimicry (Chartrand & Bargh, 1999) often increases rapport and cooperation, sometimes it has quite different results. In two studies, Wiltermuth showed that synchrony can lead to aggression and destructive obedience (2012a; 2012b). People who had just bonded with one another through synchronous action were more likely to comply with each other's requests, even if those entailed to engage in aggressive behaviour towards others, such as administering a noise blast to another group of participants, or killing sow bugs at a leader's request (Wiltermuth, 2012a; 2012b). These studies support the idea that physical synchrony cannot only lead to pro-social, but also to anti-social and destructive behaviour. There seems to be a dark side to the phenomenon, and verbal synchrony seems to have comparable effects. Spectators at a football game who had engaged in collective chanting during the game reported higher levels of aggression than those who had not chanted (Bensimon & Bodner, 2011).

Anthropologists and historians have long argued that acting together in time influences group cohesion and group action. Large groups of people engaged in collective speech act better together, display improved cognitive functions and like each other more. Though we have explored the scope of behavioural coordination in this way, there is one significant question about the directionality of these effects we cannot answer with our findings. Does synchrony increase group affiliation and thereby improve cognition and action, or does synchrony increase group performance and this improvement increase the attraction of the group?

References

Barsalou, L., Breazeal, C., & Smith, L. (2007). Cognition as coordinated non-cognition. *Cognitive Processing, 8 (2),* 79–91.

Bensimon, M. & Bodner, E. (2011). Playing With Fire: The Impact of Football Game Chanting on Level of Aggression. *Journal of Applied Social Psychology, 41 (10),* 2421-2433.

Cabeza, C., Rubido, N., Kahan, S., & Marti, A.C. (2010). Synchronization of fireflies using a model of light controlled oscillators. International Conference on Chaos and Nonlinear Dynamics at the National Institute for Space Research, Brazil.

Chartrand, T.L. & Bargh, J.A. (1999). The Chameleon Effect: The Perception-Behavior Link and Social Interaction. *Journal of Personality and Social Psychology, 76 (6),* 893-910.

Codrons, E. Bernardi, N.F, Vandoni, M., & Bernardi, L. (2014). Spontaneous Group Synchronization of Movements and Respiratory Rhythms. *PLOS ONE, 9 (9),* 1-10.

Cummins, F. (2013). Towards an enactive account of action: Speaking and joint speaking as exemplary domains. *Adaptive Behavior, 13 (3),* 178–186.

Hove, M.J. & Risen, J.L. (2009). It's all in the timing: Interpersonal synchrony increases affiliation. *Social Cognition, 27 (6),* 949-960.

Hutchins, F. (1995). *Cognition in the Wild.* Cambridge, Massachusetts: The MIT Press.

Knoblich, G. & Jordan, J.S. (2003). Action coordination in groups and individuals: Learning anticipatory control. *Journal of Experimental Psychology Learning Memory and Cognition, 29 (5),* 1006-1016.

Lakens, D. & Stel, M. (2011). If They Move in Sync, They Must Feel in Sync: Movement Synchrony Leads to Attributions of Rapport and Entitativity. *Social Cognition, 29 (1),* 1-14.

Macrae, C.N., Duffy, O.K., Miles, K.M., & Lawrence, J. (2008). A case of hand waving: Action synchrony and person perception. *Cognition, 109,* 152-156.

Marsh, K.L., Richardson, M.J., & Schmidt, R.C. (2009). Social Connection Through Joint Action and Interpersonal Coordination. *Topics in Cognitive Science, 1,* 320-339.

McNeill, W.H. (1995). *Keeping Together in Time: Dance and Drill in Human History.* Cambridge, Massachusetts: Harvard University Press.

Miles, L.K., Nind, L.K., Henderson, Z., & Macrae, C.N. (2010). Moving memories: Behavioral synchrony and memory for self and others. *Journal of Experimental Social Psychology, 46,* 457-460.

Miles, L.K., Nind, L.K., & Macrae, C.N. (2009). The rhythm of rapport: Interpersonal synchrony and social perception. *Journal of Experimental Social Psychology, 45,* 585-589.

Paladino, M.P., Mazzurega, M., Pavani, F., & Schubert, T.W. (2010). Synchronous Multisensory Stimulation Blurs Self-Other Boundaries. *Psychological Science, 21 (9),* 1202-1207.

Pantaleone, J. (2002). Synchronization of Metronomes. *American Journal of Physics, 70 (10),* 992-1000.

Reddish, P., Fischer, R., & Bulbulia, J. (2013). Let's Dance Together: Synchrony, Shared Intentionality and Cooperation. *PLOS ONE, 8 (8),* 1-13.

Richardson, D.C., Dale, R., & Kirkham, N.Z. (2007). The Art of Conversation Is Coordination: Common Ground and the Coupling of Eye Movements During Dialogue, *Psychological Science, 18 (5),* 407-413.

Richardson, D.C., Dale, R., Rogers, J., & Ireland J. (2011). How do 100 people walk a tightrope together? An experiment in large scale joint action. In L. Carlson, C. Hölscher, & T. Shipley (Eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*, Austin, TX: Cognitive Science Society.

Richardson, M.J., Marsh, K.L., & Schmidt, R.C. (2005). Effects of Visual and Verbal Interaction on Unintentional Interpersonal Coordination. *Journal of Experimental Psychology: Human Perception and Performance, 31 (1),* 62-79.

Richardson, D.C., Street, C.N.H., Tan, J.Y.M., Kirkham, N.Z., Hoover, M.A., & Ghane Cavanaugh, A. (2012). Joint perception: gaze and social context. *Frontiers in Human Neuroscience*, *6*.

Robbins, P., Aydede, M. (Eds.). (2008). *The Cambridge handbook of situated cognition.* Cambridge: Cambridge University Press.

Sebanz, N., Bekkering, H., & Knoblich, G. (2006). Joint action: bodies and minds moving together. *Trends in Cognitive Sciences, 10 (2),* 70-76.

Shockley, K., Richardson, D.C., & Dale, R. (2009). Conversation and Coordinative Structures. *Topics in Cognitive Science*, *1* (2), 305–319.

Singer, W. (1993). Synchronization of cortical activity and its putative role in information processing and learning. *Annual Review of Physiology, 55,* 349-74.

Strogatz, S. (2003). *Sync. The emerging science of spontaneous order.* London: Penguin Books.

Valdesolo, P., Ouyang, J., & DeSteno, D. (2010). The rhythm of joint action: Synchrony promotes cooperative ability. *Journal of Experimental Social Psychology, 46,* 693-695.

Wiltermuth, S.S. (2012a). Synchronous activity boosts compliance with requests to aggress. *Journal of Experimental Social Psychology, 48,* 453-456.

Wiltermuth, S.S. (2012b). Synchrony and destructive obedience. *Social Influence, 7 (2),* 78-89.

Wiltermuth, S.S. & Heath, C. (2009). Synchrony and Cooperation. *Psychological Science, 20 (1),* 1-5.