Joint attention, shared goals, and social bonding

Article *in* British Journal of Psychology · August 2015

DOI: 10.1111/bjop.12144 · Source: PubMed

3 authors:

Wouter Wolf
Duke University

Jacques Launay
University of Oxford

Robin Dunbar
University of Oxford

British Journal of Psychology (2015)

The British Psychological Society
www.wileyonlinelibrary.com

Joint attention, shared goals, and social bonding

Wouter Wolf*, Jacques Launay and Robin I. M. Dunbar
Department of Experimental Psychology, University of Oxford, UK

There has recently been interest in the ways in which coordinated movements encourage coactors to feel socially closer to one another, but this has generally overlooked the importance of necessary precursors to this joint action. Here we target two low-level behaviours involved in social coordination that may mediate a relationship between joint actions and social bonding, namely joint attention and shared goals. Participants engaged in a simple reaction time task while sitting next to a partner performing the same task. In a joint attention condition, both participants attended to stimuli presented on the same half of a computer screen, while in a control condition, they attended to opposite sides of the computer screen. Shared goals were manipulated by giving participants the instruction to keep below a threshold score for both individual response times and accuracy (individual goal), or their joint mean response time and accuracy (i.e., averaging their mean response time and accuracy with that of their partner: shared goal). Attending to the same side of the screen led to higher ratings on a composite social bonding index directed towards a partner, while shared goals did not cause any effects on partner ratings. Joint attention was sufficient to encourage social closeness with an interaction partner, which suggests that any activities which encourage attending to the same point in space could have some influence on how connected coactors feel about one another.

Humans are intensely social, and it is likely that we use a broad spectrum of behaviours to create and maintain social relationships with those around us. While bonding on a small scale is relatively easily achieved across many primate species using grooming and in humans with gossip (Dunbar, 2004; Lehmann, Korstjens, & Dunbar, 2007), it is harder for large human groups to reach the social closeness required to experience a sense of community. To solve this problem, humans have developed a number of social behaviours that facilitate bonding on a larger scale (e.g., making music together, dancing), tapping into a variety of low-level processes that influence social closeness. In this study, we examine the social bonding properties of two low-level cognitive processes which are inherent prerequisites for engaging in large-scale social bonding behaviours, namely joint attention and shared goals.

Large-scale social bonding through joint action

Behaviours such as music-making, dance, and marching appear to serve no functional purpose, but are often involved in rituals and religion, and have social bonding effects for those people engaged in them (e.g., Dunbar, Kaskatis, MacDonald, & Barra, 2011; McNeill, 1995). This has led to the suggestion that these coordinated physical activities may be

*Correspondence should be addressed to Wouter Wolf, Department of Experimental Psychology, Tinbergen Building, University of Oxford, Oxford OX1 3UD, UK (email: wouter.wolf@gmail.com).

DOI:10.1111/bjop.12144

specifically developed technologies that help keep communities closely bonded (Cross, 2001; Dunbar, 2012; Tarr, Launay, & Dunbar, 2014). For example, previous research into this effect has focused on the possibility that synchronizing movements with those of others during these activities might have important consequences for trust (Launay, Dean, & Bailes, 2013; Wiltermuth & Heath, 2009), positive social evaluation (Hove & Risen, 2009; Launay, Dean, & Bailes, 2014; Tunçgenç, Cohen, & Fawcett, 2015; Valdesolo & DeSteno, 2011), and prosocial behaviour (Cirelli, Einarson, & Trainor, 2014; Kokal, Engel, Kirschner, & Keysers, 2011; Valdesolo, Ouyang, & DeSteno, 2010).

However, the mechanisms through which coordinated social behaviours influence social bonding remain underexplored. It has been observed that there are many different features of joint action that might have this influence (e.g., shared success: Launay *et al.*, 2013; shared intentionality: Reddish, Fischer, & Bulbulia, 2013; making predictions about another person: Sebanz & Knoblich, 2009), yet previous experiments have sometimes conflated these elements making it impossible to evaluate their relative importance. Social facilitation research has demonstrated that sitting next to another person and performing a similar task can have beneficial effects on performance compared with acting alone, or when performing a different task from that person (Böckler, Knoblich, & Sebanz, 2011, 2012; Tsai, Kuo, Jing, Hung, & Tzeng, 2006), suggesting that relatively subtle social experiences can influence behaviour. Social facilitation effects can be influenced by judgments made about an interaction partner (e.g., Hommel, Colzato, & van den Wildenberg, 2009), and it is likely that engaging in a task at the same time as another person might reciprocally influence the social evaluation of that person. These demonstrations of the interplay between low-level cognitive processes and social evaluation warrant a closer examination of the processes inherent to coordinated joint action, and an exploration of their individual contribution to the social bonding function of large-scale joint action-based activities.

In this study we examine the social bonding effect of two of such processes. First, to coordinate movements with another person in most natural settings, the minimum requirement is to both attend to the same external source and react to this source. This joint attention process is inherently social in nature and plays a major part in the establishment of the first interactive relationships in childhood (Tomasello, 1995; Tomasello & Carpenter, 2007). Therefore, this process might play a major part in establishing social bonds through joint action-based social activities. Second, when engaging in joint action-based activities, individuals must share the goal of executing this specific joint action in order for social coordination to be achieved. As sharing a goal has been associated with the formation of social bonds (e.g., Tomasello, Carpenter, Call, Behne, & Moll, 2005; Tomasello & Rakoczy, 2003), this might also play a major part in the establishing social bonds through joint action-based activities. In summary, as joint attention and shared goals can both influence partner evaluation (e.g., Bayliss *et al.*, 2013; Reddish *et al.*, 2013), it is important to test the limits of these effects, and whether the interaction between the two could have social consequences similar to those demonstrated for joint action in general.

Joint attention and social bonding

Joint attention has been well studied with a view to understanding the developmental process of social learning (Butterworth & Cochran, 1980; Carpenter & Nagell, 1998; Mundy & Gomes, 1998). To learn behaviour from a parent, children must be capable of attending to the same point in space and this becomes one of the first forms of social interaction that develops (Tomasello, 1995; Tomasello & Carpenter, 2007). Attending to the same space is thus a very basic building block for social learning and might therefore be expected to enhance social relationships between adults who are engaged in such an activity.

Throughout life, there is a very strong automatic tendency to follow the gaze of other people (Ricciardelli, Bricolo, Aglioti, & Chelazzi, 2002; Xu, Zhang, & Geng, 2011), and this shared gaze is linked to positive evaluation of objects (Bayliss, Paul, Cannon, & Tipper, 2006), and positive evaluation of the person with whom gaze is shared (Bayliss *et al.*, 2013). Gaze therefore continues to be an important social cue into adulthood, and it is likely that any shared attention to an external object could have similar effects. Importantly, evidence suggests that attending to the gaze of another person is influenced by top-down beliefs about the agent involved (e.g., if they are perceived to be receiving visual information: Teufel, Alexis, Clayton, & Davis, 2010; or perceived to be a computer rather than a human: Wiese, Wykowska, Zwickel, & Müller, 2012; Wykowska, Wiese, Prosser, & Müller, 2014). This suggests that awareness of the gaze of another person engages social cognitive processes rather than gaze following having only a bottom-up influence driven by external stimuli.

Despite the interest in sharing attention and social cognition, the minimum conditions for joint attention are not widely agreed upon. While joint attention has been described as merely two or more individuals coordinating attention towards a third object (e.g., Bakeman & Adamson, 1984), some communication channel between the two individuals is a requirement for this attention to be described as 'joint' (e.g., Carpenter & Call, 2013). Practically, there is likely to be a continuum between attending to the same object without any knowledge that the experience is shared and true joint attention, with a relatively arbitrary distinction drawn between the two. Placing that distinction at the point where people are clearly attending to one another is a relatively 'safe' definition of joint attention, but it is possible that there are some social effects of joint attention that are overlooked if this definition is strictly adhered to.

Here we are interested in how findings from joint attention paradigms might be replicated when there is no direct information about the location of another person's gaze, and people can only infer that someone else is attending to the same spatial location. A variety of studies have investigated the cognitive consequences of attending to the same object and found that sharing an attentional focus with other individuals causes more elaborate processing of the jointly attended object, increased memory of that object, and increased relevance attribution of that object (Eskenazi, Doerrfeld, Logan, Knoblich, & Sebanz, 2013; He, Lever, & Humphreys, 2011; Shteynberg, 2010; Shteynberg & Galinsky, 2011). Yet, the social consequences of sharing an attentional focus have remained largely unstudied. The only research so far that has looked at the social component of individuals attending the same space concerned emotional amplification towards an object caused when the object was attended to by several individuals at once (Shteynberg, Hirsh, Galinsky, & Knight, 2014). It is therefore still unclear how much joint attention is required to instigate some sense of social closeness to an interaction partner.

Sharing goals and social bonding

Sharing the same goals as another person is intuitively likely to be associated with some positivity felt towards that person (Tomasello *et al.*, 2005; e.g., Tomasello & Rakoczy, 2003). In real instances of joint action, people who are interacting with one another often have a shared goal, for example, when working a two-handed wood saw. However, in experimental settings, there has been no consistency about whether participants are instructed to follow some arbitrary goal unrelated to that of the person moving in time with them (Hove & Risen, 2009), given a shared goal with a partner (Wiltermuth & Heath, 2009), or the specific goal to coordinate with a partner (e.g., Miles, Nind, Henderson, & Macrae, 2010). Without a specific manipulation of the goals that are shared, and the experience of success that may occur as a consequence, it is unclear to what extent this might influence the social closeness experienced in experiments of this type.

It is well now established that having shared, or superordinate, goals decrease social stereotyping and thereby intergroup conflict (Sherif, 1958). However, decreased intergroup conflict does not necessarily imply increased social bonding. More recent research has demonstrated that shared goals can influence social bonding (Reddish *et al.*, 2013), but in this experiment participants were explicitly told to work together, rather than being given the instruction to achieve a shared objective. This might have influenced the way that they attended to one another. In contrast, the current instructions were intended to give a minimal level of shared goal and did not include any mechanism by which participants could identify their degree of shared success.

Hypotheses

Here we are interested in the effects of attending to the same space (a low level of joint attention) and sharing goals with an interaction partner and make the following two predictions:

> *Hypothesis 1*: Joint attention during a joint action task will encourage social closeness between strangers.
>
> *Hypothesis 2*: Having a common goal in a joint action task will encourage social closeness between strangers.

By manipulating joint attention and shared goals separately in an experimental setting, we can test whether they have independent effects on social behaviour or interact with one another, but there are no principled, *a priori* hypotheses as to how these two might interact (i.e., they could act independently or additively).

Methods

Participants and design

The experiment used a two (joint attention vs. disjoint attention; within subjects) by two (shared goal vs. individual goal; between subjects) design. Sixty-four participants, divided up into sixteen same sex groups of four, participated in exchange for financial compensation (£7.50). The order of the within-subjects factor (joint attention) and the between-subjects condition (shared goals) was counterbalanced over each of the four groups. One participant did not follow the experimental instructions and was removed from data analysis. The final sample therefore included 63 participants (20 males, mean age = 23.14, *SD* = 4.3).

Procedure

Upon their arrival, participants were asked whether or not they knew or were otherwise familiar with any of the other participants, after which they read the participant information sheet and signed the informed consent form. Furthermore, participants were specifically told that it was crucial for the experiment that they would not talk or otherwise communicate with one another. During the remainder of the experiment, the experimenters remained in the room to ensure that these instructions were followed through. Next, participants were seated at their individual computer, received instructions, and engaged in several practice trials of the cognitive task. After all four participants had finished the introductory phase, each was paired up with one of the other participants, and each of these pairs was seated behind a computer screen to engage in the first of two experimental task sessions. After the first session, participants were led back to their individual computer to give feedback on the response task session they had just completed.

Next, each participant was paired up with another member of the group of four, engaged in another experimental cognitive task session, and completed a second round of feedback. At the end of the second feedback round, participants completed the final measurements, including questions about their demographics, and were thanked, paid, and debriefed. For a schematic overview of the procedure, see Figure 1.

Cognitive task

Participants were told to respond to a letter (font size 28, i.e., 9.9 mm) that briefly appeared on the screen by pressing a button on a mouse (practice trials) or response box (experimental trials). They were instructed to press the yellow (left) button whenever the stimulus letter was a consonant (K, R, T) and the blue (right) button whenever the stimulus was a vowel (A, E, U). Each trial consisted of a sequence including an empty screen (500 ms), a fixation point (1500 ms), target stimulus (150 ms), and another empty screen (3,000 ms) (for a schematic overview of the cognitive task, see Figure 2).

Throughout the task, the screen was divided up into two sections, separated by a vertical black bar in the middle of the screen. Before the start of every block, participants were presented with their initials on the side of the screen they should attend to. These initials remained visible throughout the remainder of the trial. During the task, all parts of the trial sequence appeared simultaneously on both sides of the screen. In order for the visual fields not to overlap, and the stimuli not to interfere with one another, the distance between letters and fixation points (and in the disjoint attention condition, the initials) were set to 650 pixels (i.e., 34 cm). The presentation of the consonants versus vowels was counterbalanced across the trials (both in the practice and the experimental phase), meaning that the distribution of consonants and vowels participants had to respond to was 50-50 and that whenever the stimulus letter was a consonant, there was a 50% chance that the stimulus on the other side was also a consonant (and vice versa).

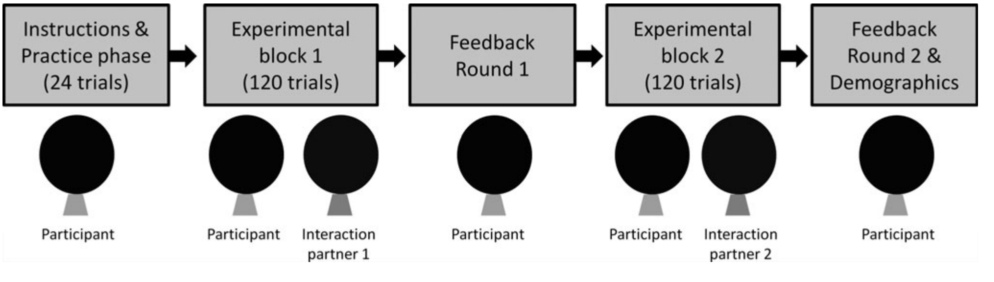

Figure 1. Schematic overview experimental procedure.

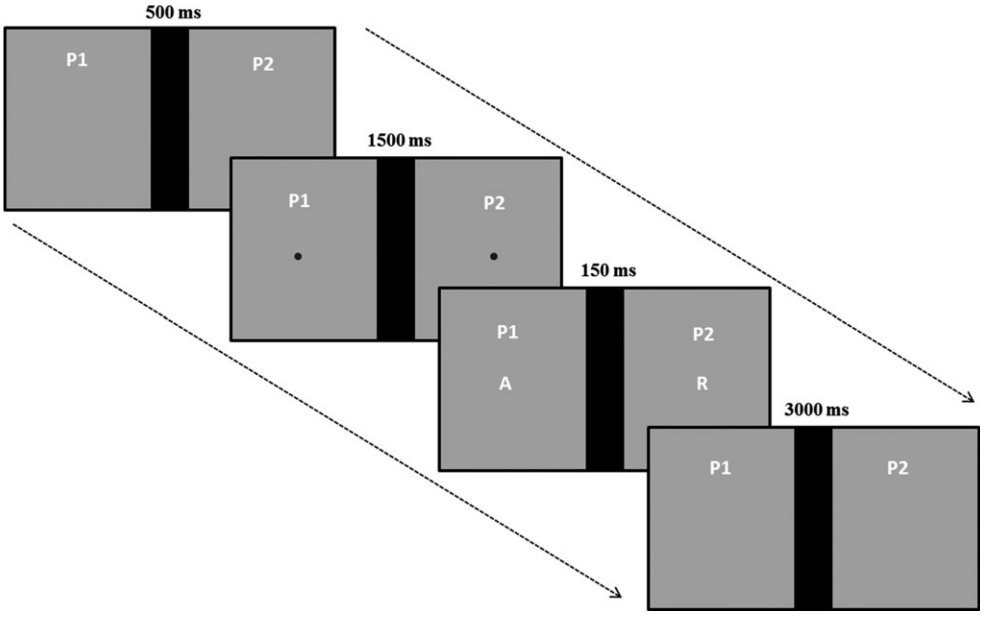

Figure 2. Schematic overview cognitive task.

Individual practice phase. After receiving the task instructions, participants completed 2 blocks of 12 practice trials of the cognitive task (stimulus placement in all decision tasks was counterbalanced across the blocks) to familiarize themselves with the task. During the individual practice phase, participants responded by clicking the right or left mouse button, which had yellow and blue stickers corresponding to the placement on the response boxes used in experimental trials. After each practice trial, participants received feedback on whether or not they had pressed the correct button and their response time. Before each block, they were presented with a screen which contained their initials in order to show them which part of the screen they had to respond to. Also the words, 'other participant initials', were presented on the screen to indicate that during the experimental session, the initials of the other participants would be displayed on either the same or a different hemifield.

Experimental session. During every experimental session, participants completed 1 practice block of 24 trials to adjust to the response boxes, followed by 4 blocks of 24 response time task trials in which their response times were recorded. Before the start of every block, participants were presented with a summary of the instructions for 15 s, followed by a screen which only contained their initials, showing them which side of the screen they would have to respond to during the next block. To prevent additional effects of (un)successful goal attainment, participants received no feedback on their performance during the experimental sessions.

Manipulations

Joint attention. To induce the experience of joint or disjoint attention, we manipulated the focus of the participants' visual field by cueing them to either the same or different parts of the screen. Whenever participants engaged in a joint attention session, their initials were presented on the same side of the screen as the initials of the other participant, thus indicating they had to respond to the same stimuli. As such, the visual fields of the participants were overlapping during the cognitive task. In the disjoint attention session, the initials of the participants were displayed on different hemifields, indicating that they had to respond to different stimuli, causing the visual fields of the participants to be different. As the side to which participants had to respond was counterbalanced within the experimental sessions (across blocks), the visual field of participants in the disjoint attention crossed in 50% of the blocks. Each participant engaged in one joint attention session, and one disjoint attention session, the order of which was counterbalanced across groups. During the individual practice phase, participants completed both a joint attention and disjoint attention block.

Shared goals. At the end of the instructions (i.e., after the practice trials), participants in the individual goal condition were told that they should aim to achieve a maximum target response time of 300 ms and a response accuracy of at least 95%. In the shared goal condition, participants were told that their response times and accuracy scores would be averaged with those of the participant sitting next to them and that their joint goal was to get an average response time of 300 ms and an average accuracy score of 95%. To keep the manipulation salient, these instructions were reiterated on the summary screen shown before the start of each block. Furthermore, to prevent between-participant competitiveness, participants in the shared goal condition were told that their individual scores would only be compared with the target score and not to the scores of their fellow participants. Finally, to prevent effects caused by (perceived) task performance, participants only received feedback on their performance after the experiment was finished.

Dependent measures

Social bonding. To measure social bonding, we designed a social bonding scale (Cronbach's $\alpha = .86$, suggesting high scale reliability) which consisted of eight different questions that were answered on a 100-point Likert scale. We asked participants 'How much did do you like the other participant?' (0 = not at all, 100 = a lot), 'To what extent do you think the other participant is liked by others?' (0 = not at all, 100 = a lot), 'How positively do you feel about the other participant?' (0 = very negatively, 100 is very positively), 'How much do you trust the other participant?' (0 = not at all, 100 = very much), 'To what extent did you connect with the other participant?' (0 = not at all, 100 = very much), 'If you had to do a similar task again, how would you feel about doing it once more with this specific participant?' (0 = I'd prefer doing it with someone else, 100 = I'd prefer doing it with the same person), 'To what extent did you feel cooperative towards the participant sitting next to you?'(0 = not at all, 100 = very cooperative), and finally the *Inclusion of the Other in the Self* scale (IOS; Aron, Aron, & Smollan, 1992).

During each feedback round, the social bonding questions were presented in the midst of hypothesis-irrelevant questions concerning the task they had just completed (see Supplementary Materials Data S1).

Response times. During the task, we recorded the response times of the participants in milliseconds using a Cedrus (RB-530) response box.

Attractiveness. Physical attractiveness might be an important confound in social bonding. We therefore measured the extent to which participants were physically attracted to the other participant at the end of the experiment by asking them 'To what extent did you feel physically attracted to the participant in the first[/second task]?' (0 = very unattracted, 100 = very attracted).

Competitiveness. The experimental instructions in the individual goal clearly indicated that the task was not competitive. However, to make sure that participants had internalized this part of the instruction at the end of the experiment, we asked them 'During the first[/second] task, to what extent did you feel competitive towards the participant sitting next to you?' (0 = not at all, 100 = very competitive).

Analysis

Bayesian mixed model ANOVA

To simultaneously estimate the effect of joint attention, shared goals, and their interaction, we used a Bayesian mixed model ANOVA, a model similar to other Bayesian sum-to-zero ANOVA models (Kruschke, 2010), but specifically designed to accommodate one within-subjects factor and one between-subjects factor. We adopted the model SplitPlotJags.R (Kruschke, 2012 model in Supplementary Material Data S2).

This model uses a Gaussian likelihood to estimate several parameters that are relevant for estimating the differences between the cells within the mixed model design. As the skewness and kurtosis of all our dependent variables was between -1 and 1, we considered a Gaussian distribution to be suitable for analysing the data. The model first uses the data to estimate the posterior distribution of the sample mean. It then estimates the posterior distribution of the mean deflections of the cell means relative to the estimated sample mean of a dependent variable. To do so, it estimates (1a) the mean of each between-subjects factor group to subsequently estimate (1b) the mean difference in the between-subjects factor groups, and (2a) the difference score between the within-subjects factor data points for each participant separately to subsequently estimate (2b) the participant's average difference score based on the within-subjects factor, and finally (3) the quadratic trends across groups in order to examine the extent to which the effect of one factor varies as a function of the other. The model uses hierarchical prior distributions, with the priors of the groups being mildly informed normal priors, and the precision of these priors estimated from the data using standard gamma priors (both of which are considered appropriate for using zero-sum ANOVA models based on normal likelihoods; Kruschke, 2010).

The contrasts we were interested in were (1) the estimated difference score of the two joint attention cells versus the two disjoint attention cells (i.e., the main effect of joint attention); (2) the estimated difference score of the two shared goal cells versus the two individual goal cells (i.e., the main effect of shared goal); and (3) the difference scores of the quadratic trends across groups in order to examine the extent to which these contrasts vary as a function of the other factor (i.e., the interaction effect). We interpret the contrasts (i.e., the main and interaction effects of joint attention and shared goal) as credible where the 95% high-density interval (HDI) of the estimated mean difference score of a contrast did not overlap with zero.

For each dependent variable, we ran ten Monte Carlo Markov Chains (MCMC) of 500,000 steps, in which we burned in the first 2,000 steps and thinned the chains by only saving every fifth step. All the chains properly converged.

Results

Social bonding

The posterior distribution of the estimated bonding scale contrast scores showed a credible main effect of joint attention. That is, the Bayesian credible interval of the contrast comparing the attention condition cells did not overlap with zero (95% HDI: −5.99, −.59; see Figure 3a). The estimated mean bonding score of participants was therefore between .6 and 6 points higher when rating their joint attention task partner ($M = 49.5$, $SD = 12.4$) compared with their disjoint attention task partner ($M = 46.2$, $SD = 11.0$). As the bonding composite score had a scale of 0 to 100, an estimated .6 to 6 point difference between the joint and disjoint attention condition can be interpreted as small, which is not surprising given the subtlety of the attention manipulation. We interpret this effect as support for our hypothesis concerning the facilitative role of joint attention in social bonding. However, we did not find a credible main effect for the shared goals contrast. The Bayesian credible interval of the contrast comparing the goal condition cells overlapped with zero (95% HDI: −2.86, 2.53, see Figure 3b; joint goal $M = 48.0$, $SD = 11.6$; individual goal $M = 47.8$, $SD = 9.28$). We therefore concluded that shared goals, as manipulated in this experiment, did not have an effect on social bonding. Finally, we did not find a credible interaction effect. As the Bayesian credible interval of the quadratic contrast overlapped with zero (95% HDI: −3.88, 1.27), we concluded that the difference in the joint attention contrast did not vary as a function of the shared goals factor (or vice versa).

Attractiveness

To ensure that the effect of joint attention on social bonding was not caused by random differences in attractiveness between the cells, we looked at the posterior distribution of the difference scores in attractiveness ratings between the different cells of the design. We found no credible difference in perceived attractiveness in participants that were rating their joint attention partner versus participants rating their disjoint attention factor (95% HDI: −5.38, 8.59; joint attention $M = 26.8$, $SD = 25.2$; disjoint attention $M = 29.3$, $SD = 29.4$).

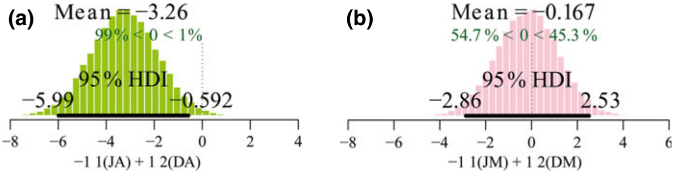

Figure 3. Posterior distribution of the joint attention contrast (a; Disjoint attention–Joint attention) and the shared motivation contrast (b; Individual motivation–Shared motivation) on the bonding composite scale.

Furthermore, we did not find a credible difference in perceived attractiveness between the joint versus individual motivation cells (95% HDI: −2.78, 0.48; joint goal $M = 31.7$, $SD = 21.6$; individual goal $M = 24.5$, $SD = 24.2$), nor a credible interaction contrast (95% HDI: −26.2, 14.4). We therefore concluded that our results concerning the effect of joint attention on social bonding were not driven by a randomly unequal distribution of participant physical attractiveness across the joint attention versus disjoint attention cells.

Response times

We also examined whether our manipulations had any behavioural effects by examining the participant response times. We first removed all the trials with response times under 100 ms and over 1,500 ms from the analysis. We then calculated the average response times per participant and excluded every trial in which the response time was more than 3 standard deviations removed from the participant's mean response time within that experimental session.

The posterior distribution of the response time contrasts showed no credible main effect of the joint attention contrast (95% HDI: −7.54, 8.92 ms; see Figure 4a; joint attention $M = 226$, $SD = 49.0$; disjoint attention $M = 227$, $SD = 47.2$). However, we did find a credible main effect contrast of the shared goal factor (95% HDI: −19.3, −2.56 ms; see Figure 4b). Participants in the shared goal condition ($M = 232$, $SD = 46.9$) were on average between 2.56 ms and 19.3 ms slower than participants in the individual goal condition ($M = 221$, $SD = 43.2$). Finally, we found no credible interaction contrast (95% HDI: −3.12, 12.9 ms).

Congruency and crossing attentional fields

To ensure that the response time effects were not an artefact of the set-up of the cognitive tasks, we first checked for flanker effects by comparing trials in which incongruent stimuli were displayed (i.e., a consonant on one side of the screen and a vowel on the other side of the screen). We found no difference between response times in incongruent trials ($M = 227$, $SD = 45.1$) compared to congruent trials ($M = 226$, $SD = 45.9$), nor an interaction between congruency and either of the two experimental conditions (all HDIs overlapped with zero).

Next, we looked at whether in the disjoint attention condition participants' response time differed in trials in which their visual field crossed that of the other participant relative to trials in which their visual field did not cross. Again, we found no credible difference in response times between trials in which participants' field crossed ($M = 227$, $SD = 45.96$) compared to trials in which participants' visual did not cross ($M = 227$, $SD = 50.3$), nor an interaction with the joint goal condition (all HDIs overlapped with zero).

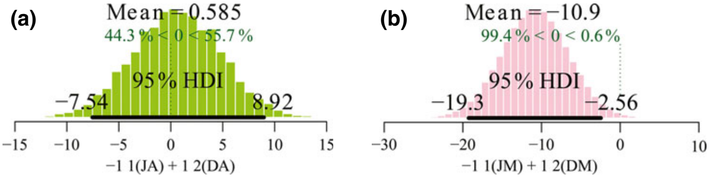

Figure 4. Posterior distribution of the joint attention contrast (a; Disjoint attention–Joint attention) and the shared motivation contrast (b; Individual motivation–Shared motivation) on the response times.

Competitiveness

Even though participants in the individual goal condition were specifically told that their individual target goal was not a competitive one relative to the other participant, we wanted to ensure that the effect of the joint versus individual goal condition on response times was not driven by competitiveness. We therefore examined the posterior distribution of the difference scores in competitiveness. We found neither a credible contrast based on the attention factor (95% HDI: −6.65, 5.60; joint attention M = 46.1, SD = 29.6; disjoint attention M = 46.7, SD = 29.3), nor a credible contrast based on the goal factor (95% HDI: −7.44, 4.48; joint goal M = 45.70, SD = 27,5; individual goal M = 47.0, SD = 26,5), nor a credible interaction contrast (95% HDI: −3.67, 7.55). We therefore concluded that the effect of joint versus disjoint attention on the response times was not due to participants in the disjoint attention condition being more competitive than participants in the joint attention condition.

Discussion

This experiment demonstrates that sharing an attentional focus during an irrelevant cognitive task can increase subsequent perceptions of social bondedness with an interaction partner. The manipulation of joint goals used in the current experiment did not have any influence on social bonding, however. These results imply that relatively low-level constituent parts of coordinated social behaviours can have consequences for bonding experienced between people.

Joint attention

As the purpose of the experiment was to identify the minimal conditions under which the experience of joint attention would increase perceptions of social bonding, we ensured that the social dynamics between participants were highly constrained. Participants were specifically instructed not to talk or otherwise communicate with each other, thus limiting the potential social feedback during the task. It is therefore significant to find even a small, yet consistent effect of joint attention on social bonding (c.f., Carpenter & Call, 2013; Shteynberg *et al.*, 2014). This demonstrates that the experience of sharing an attentional field with another individual increases perceptions of bondedness with this individual even when the degree to which this experience is actually shared cannot be verified through social feedback.

This research thus provides a starting point from which the additive (or interactive) effects of experiencing joint attention and receiving feedback on that experience can be studied. This would ultimately allow us to gain more insight into the social dynamics of a variety of other social bonding activities in which joint attention seems to play a key role, such as watching a movie or listening to music together. Activities such as watching a television in the presence of another person are generally not seen as social activities (e.g., Chorianopoulos & Lekakos, 2008), but the current results suggest that people may in fact experience social bonding while jointly attending to a stimulus of this kind, even without discussing the material being watched. This is an interesting and novel proposition and could be further experimentally explored both with visual stimuli (e.g., television programs) and auditory stimuli (e.g., music).

Furthermore, the present research contributes to the growing body of literature investigating the complex interaction between low-level cognitive processes and higher order social cognition, showing that the awareness of the attention patterns of others influences the subsequent cognitive appraisal of an interaction (partner). The question remains on what level this social bonding effect occurs. One potential explanation is that joint attention elicits a social categorization heuristic, similar to a minimal-group paradigm effect in which individuals with whom one shares an attentional focus are perceived to be in one's group, whereas individuals whose attention is disjoint from one's attentional focus are categorized as non-ingroup or outgroup (e.g., Tajfel, Billig, Bundy, & Flament, 1971). An alternative explanation involving higher order cognitive processes is that the awareness of sharing an attentional field with an interaction partner induces additional higher order social cognitive processes such as mentalizing, which could facilitate the formation of social attributions to an unknown individual, increasing perceptions of social closeness.

An explanation following a similar line of thought but on a different processing level is that relative to disjoint attention, joint attention induces a stronger intentional stance (Wykowska *et al.*, 2014). In this case, individuals do not engage in higher order mentalizing processing per se, but adopt a pair of social 'goggles' through which their attention is drawn towards social information and through which information is more readily interpreted as social information (i.e., pre-processing it for social interpretation). If this were the mechanism through which joint attention facilitates social bonding, the question remains whether this effect occurs due to the information about the interaction being processed in a more social context (i.e., it being socially pre-processed, potentially facilitating attributions of closeness), or due to the attentional stance causing one's attention to be more sensitive to social information, thereby increasing peripheral social information processing about the interaction partner (causing dyadic bonding), or even to social stimuli in general (which would suggest that engaging in joint attention would be effective in large-scale group bonding even if individuals do not focus their attention on one another). As such, the present research provides a starting point for an additional line of research in the growing field examining the social cognitive mechanics underlying joint action (Böckler *et al.*, 2012; Tsai, Knoblich, & Sebanz, 2011).

Shared goals

Contrary to our expectations and previous research on similar phenomena (e.g., Reddish *et al.*, 2013), the shared goal condition did not yield an independent effect on social bonding. One possible explanation is low statistical power in the current sample. As the shared goal condition was a between-subjects factor in the mixed model design, this contrast ended up with considerably less power than the joint attention contrasts. However, when examining the posterior distribution of the shared goal contrast, this seems unlikely: the probability distribution of the estimated difference score is almost perfectly situated around zero, and reducing the width of the HDI would still not yield a credible difference. Instead, the posterior distribution suggests that the means of the shared versus individual goal cells are not different, implying that shared goals as manipulated in the current experiment did not have a facilitative role in social bonding. A second potential explanation is that our shared goal manipulation was not salient or relevant enough to be internalized by the participants. However, this also seems unlikely, as the shared goal manipulation did yield a behavioural effect in terms of response times. This implies that the shared goal manipulation was to some degree internalized by the participants, but did not result in higher levels of perceived closeness to the interaction partner.

A third theoretical explanation for identifying no effect of shared goals on social bonding is that perhaps joint success is more important in social bonding than shared goals. During the experiment, participants did not receive feedback on their (joint) performance until the experiment was finished. Experience of success has previously been shown to play an important role in the social bonding effects of synchronization (Launay *et al.*, 2013), and previous experiments that have manipulated shared goals allowed people to experience shared success through observation of one another's actions (Reddish *et al.*, 2013). Cognitively, it seems likely that sharing success with another person (i.e., experiencing positive feedback together) would have important implications for social relationships because it would encourage seeking out that positive reinforcement in future. While shared goals might be expected to have some effects on social bonding in groups of people who have chosen to work together, it is possible that they have less effect when the goals are provided by a third party with whom individuals have no relationship (e.g., an experimenter). Further experiments could independently manipulate instructed and uninstructed goals as well as the role of task feedback (i.e., success, failure or no feedback) to further elucidate the current result.

Joint action and social bonding

In general, this research demonstrates that studying the low-level implicit processes inherent to joint action is vital in understanding the social bonding mechanics of large-scale social bonding activities. It is possible that social bonding in joint action is merely the product of a series of repeated low-level implicit social bonding processes required to attain behavioural coordination. While each of these might have very minor effects on how close we feel to people with whom we engage, the combination of many different processes can eventually allow a significant additive development of social bonds. This would, for example, explain why behavioural synchrony is a form of coordination that is highly effective in evoking these implicit social bonding dynamics: the high level of precision required for synchrony provides very accurate cues from which the social dynamics within a group of individuals can be inferred.

Although experiments aimed at isolating the effect of the constituent psychological processes of joint action as a social bonding mechanism using minimal paradigms can be very informative, in the real world all these mechanisms are necessary prerequisites to achieve joint action. Therefore, future research should also be directed at studying the social processes of joint action in a more ecologically valid manner.

Nevertheless, the present research shows that studying the constituent components of joint action can provide fruitful insights into the dynamics of social coordination in general. As such, it is a stepping stone from which we can slowly start to understand the underlying mechanisms of joint action and its function as a large-scale social bonding mechanism. In a broader perspective, it provides us with tentative answers about the how and why of humans' large-scale social bonding activities such as making music and dancing, namely that such activities, even seemingly asocial ones like attending a television screen together, might in fact be providing a very subtle social bonding effect due to the inherent low-level cognitive processes they invoke.

Acknowledgements

This work was funded in part by a Cultuurfondsbeurs of the Dutch Prins Bernhard Cultuurfonds and European Research Council Grant No. 295663.

References

Aron, A., Aron, E., & Smollan, D. (1992). Inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology*, *63*, 596–612. doi:10.1037/0022-3514.63.4.596

Bakeman, R., & Adamson, L. (1984). Coordinating attention to people and objects in mother-infant and peer-infant interaction. *Child Development*, *55*, 1278–1289. doi:10.2307/1129997

Bayliss, A. P., Murphy, E., Naughtin, C. K., Kritikos, A., Schilbach, L., & Becker, S. I. (2013). "Gaze leading": Initiating simulated joint attention influences eye movements and choice behavior. *Journal of Experimental Psychology: General*, *142*, 76–92. doi:10.1037/a0029286

Bayliss, A. P., Paul, M. A., Cannon, P. R., & Tipper, S. P. (2006). Gaze cuing and affective judgments of objects: I like what you look at. *Psychonomic Bulletin & Review*, *13*, 1061–1066. doi:10.3758/BF03213926

Böckler, A., Knoblich, G., & Sebanz, N. (2011). Giving a helping hand: Effects of joint attention on mental rotation of body parts. *Experimental Brain Research*, *211*, 531–545. doi:10.1007/s00221-011-2625-z

Böckler, A., Knoblich, G., & Sebanz, N. (2012). Effects of a coactor's focus of attention on task performance. *Journal of Experimental Psychology: Human Perception and Performance*, *38*, 1404–1415. doi:10.1037/a0027523

Butterworth, G., & Cochran, E. (1980). Towards a mechanism of joint visual attention in human infancy. *International Journal of Behavioral Development*, *3*, 253–272. doi:10.1177/016502548000300303

Carpenter, M., & Call, J. (2013). How joint is the joint attention of apes and human infants. In J. Metcalfe & H. S. Terrace (Eds.), *Agency and joint attention* (pp. 49–61). New York: Oxford University Press.

Carpenter, M., & Nagell, K. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, *63*(4), 1–6. doi:10.2307/1166214

Chorianopoulos, K., & Lekakos, G. (2008). Introduction to social TV: Enhancing the shared experience with interactive TV. *International Journal of Human-Computer Interaction*, *24*, 113–120. doi:10.1080/10447310701821574

Cirelli, L. K., Einarson, K. M., & Trainor, L. J. (2014). Interpersonal synchrony increases prosocial behavior in infants. *Developmental Science*, *17*, 1003–1011. doi:10.1111/desc.12193

Cross, I. (2001). Music, cognition, culture, and evolution. *Annals of the New York Academy of Sciences*, *930*, 28–42. doi:10.1111/j.1749-6632.2001.tb05723.x

Dunbar, R. I. M. (2004). Gossip in evolutionary perspective. *Review of General Psychology*, *8*, 100–110. doi:10.1037/1089-2680.8.2.100

Dunbar, R. I. M. (2012). On the evolutionary function of song and dance. In N. Bannan (Ed.), *Music, language, and human evolution* (pp. 201–214). Oxford, UK: Oxford University Press.

Dunbar, R. I. M., Kaskatis, K., MacDonald, I. F., & Barra, V. (2011). Performance of music (but not passive listening) elevates pain threshold and positive affect. *Evolutionary Psychology*, *10*(4), 688–702.

Eskenazi, T., Doerrfeld, A., Logan, G. D., Knoblich, G., & Sebanz, N. (2013). Your words are my words: Effects of acting together on encoding. *Quarterly Journal of Experimental Psychology*, *66*, 1026–1034. doi:10.1080/17470218.2012.725058

He, X., Lever, A. G., & Humphreys, G. W. (2011). Interpersonal memory-based guidance of attention is reduced for ingroup members. *Experimental Brain Research*, *211*, 429–438. doi:10.1007/s00221-011-2698-8

Hommel, B., Colzato, L., & van den Wildenberg, W. (2009). How social are task representations? *Psychological Science*, *20*, 794–798. doi:10.1111/j.1467-9280.2009.02367.x

Hove, M., & Risen, J. (2009). It's all in the timing: Interpersonal synchrony increases affiliation. *Social Cognition*, *27*, 949–960. doi:10.1521/soco.2009.27.6.949

Kokal, I., Engel, A., Kirschner, S., & Keysers, C. (2011). Synchronized drumming enhances activity in the caudate and facilitates prosocial commitment-if the rhythm comes easy. *PLoS ONE*, *6*, e2727. doi:10.1371/journal.pone.0027272

Kruschke, J. K. (2010). *Doing Bayesian data analysis: A tutorial with R and BUGS*. Burlington, MA: Academic Press.

Kruschke, J. K. (2012). *Split-plot design in JAGS: Revised version*. Retrieved from http://doingbayesiandataanalysis.blogspot.nl/2012/05/split-plot-design-in-jags-revised.html

Launay, J., Dean, R., & Bailes, F. (2013). Synchronization can influence trust following virtual interaction. *Experimental Psychology*, *60*, 53–63. doi:10.1027/1618-3169/a000173

Launay, J., Dean, R. T., & Bailes, F. (2014). Do you like who you play with? Synchronising movement with the sounds of virtual others can influence affiliative behaviour. *Cognitive Processing*. doi:10.1007/s10339-014-0618-0

Lehmann, J., Korstjens, A. H., & Dunbar, R. I. M. (2007). Group size, grooming and social cohesion in primates. *Animal Behaviour*, *74*, 1617–1629. doi:10.1016/j.anbehav.2006.10.025

McNeill, W. H. (1995). *Keeping together in time*. Cambridge, MA: 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. doi:10.1016/j.jesp.2009.12.006

Mundy, P., & Gomes, A. (1998). Individual differences in joint attention skill development in the second year. *Infant Behavior and Development*, *21*, 469–482. doi:10.1016/S0163-6383(98)90020-0

Reddish, P., Fischer, R., & Bulbulia, J. (2013). Let's dance together: Synchrony, shared intentionality and cooperation. *PLoS ONE*, *8*, e71182. doi:10.1371/journal.pone.0071182

Ricciardelli, P., Bricolo, E., Aglioti, S., & Chelazzi, L. (2002). My eyes want to look where your eyes are looking: Exploring the tendency to imitate another individual's gaze. *NeuroReport*, *13*, 2259–2264. doi:10.1097/01.wnr.0000044227

Sebanz, N., & Knoblich, G. (2009). Prediction in joint action: What, when, and where. *Topics in Cognitive Science*, *1*, 353–367. doi:10.1111/j.1756-8765.2009.01024.x

Sherif, M. (1958). Superordinate goals in the reduction of intergroup conflict. *The American Journal of Sociology*, *63*, 349–356. doi:10.1086/222258

Shteynberg, G. (2010). A silent emergence of culture: The social tuning effect. *Journal of Personality and Social Psychology*, *99*, 683–689. doi:10.1037/a0019573

Shteynberg, G., & Galinsky, A. D. (2011). Implicit coordination: Sharing goals with similar others intensifies goal pursuit. *Journal of Experimental Social Psychology*, *47*, 1291–1294. doi:10.1016/j.jesp.2011.04.012

Shteynberg, G., Hirsh, J. B., Galinsky, A. D., & Knight, A. P. (2014). Shared attention increases mood infusion. *Journal of Experimental Psychology: General*, *143*, 123–130. doi:10.1037/a0031549

Tajfel, H., Billig, M. G., Bundy, R. P., & Flament, C. (1971). Social categorization and intergroup behaviour. *European Journal of Social Psychology*, *1*, 149–178. doi:10.1002/ejsp.2420010202

Tarr, B., Launay, J., & Dunbar, R. I. M. (2014). Music and social bonding: "self-other" merging and neurohormonal mechanisms. *Frontiers in Psychology*, *5*, 1–10. doi:10.3389/fpsyg.2014.01096

Teufel, C., Alexis, D., Clayton, N., & Davis, G. (2010). Mental-state attribution drives rapid, reflexive gaze following. *Attention, Perception, & Psychophysics*, *72*, 695–705. doi:10.3758/APP.72.3.695

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103–130). New York: Lawrence Erlbaum.

Tomasello, M., & Carpenter, M. (2007). Shared intentionality. *Developmental Science*, *10*, 121–125. doi:10.1111/j.1467-7687.2007.00573.x

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences*, *28*, 675–735. doi:10.1017/S0140525X05000129

Tomasello, M., & Rakoczy, H. (2003). What makes human cognition unique? From individual to shared to collective intentionality. *Mind & Language*, *18*, 121–147. doi:10.1111/1468-0017.00217

Tsai, J. C. C., Knoblich, G., & Sebanz, N. (2011). On the inclusion of externally controlled actions in action planning. *Journal of Experimental Psychology: Human Perception and Performance*, *37*, 1407–1419. doi:10.1037/a0024672

Tsai, J. C. C., Kuo, W. J., Jing, J. T., Hung, D. L., & Tzeng, O. J. L. (2006). A common coding framework in self-other interaction: Evidence from joint action task. *Experimental Brain Research*, *175*, 353–362. doi:10.1007/S00221-006-0557-9

Tunçgenç, B., Cohen, E. E. A., & Fawcett, C. (2015). Rock with me: The role of action synchrony in infants' social and non-social choices. *Child Development*, *86*, 976–984. doi:10.1111/cdev.12354

Valdesolo, P., & DeSteno, D. (2011). Synchrony and the social tuning of compassion. *Emotion*, *11*, 262–266. doi:10.1037/a0021302

Valdesolo, P., Ouyang, J., & DeSteno, D. (2010). The rhythm of joint action: Synchrony promotes cooperative ability. *Journal of Experimental Social Psychology*, *46*(4), 693–695. doi:10.1016/j.jesp.2010.03.004

Wiese, E., Wykowska, A., Zwickel, J., & Müller, H. J. (2012). I see what you mean: How attentional selection is shaped by ascribing intentions to others. *PLoS ONE*, *7*, e45391. doi:10.1371/journal.pone.0045391

Wiltermuth, S. S., & Heath, C. (2009). Synchrony and cooperation. *Psychological Science*, *20*, 453–456. doi:10.1111/J.1467-9280.2008.02253.X

Wykowska, A., Wiese, E., Prosser, A., & Müller, H. J. (2014). Beliefs about the minds of others influence how we process sensory information. *PLoS ONE*, *9*, e94339. doi:10.1371/journal.pone.0094339

Xu, S., Zhang, S., & Geng, H. (2011). Gaze-induced joint attention persists under high perceptual load and does not depend on awareness. *Vision Research*, *51*, 2048–2056. doi:10.1016/j.visres.2011.07.023

Received 9 December 2014; revised version received 25 June 2015

Supporting Information

The following supporting information may be found in the online edition of the article:

Data S1. Filler questions during feedback round.
Data S2. The model syntax for the Bayesian Mixed model ANOVA.