

Published in final edited form as:

*Psychol Music*. 2016 November ; 44(6): 1255–1273. doi:10.1177/0305735616636208.

## Singing together or apart: The effect of competitive and cooperative singing on social bonding within and between sub-groups of a university Fraternity

**Eiluned Pearce,**

University of Oxford, UK

**Jacques Launay,**

University of Oxford, UK

**Max van Duijn,**

Leiden University, The Netherlands

**Anna Rotkirch,**

Population Research Institute, Väestöliitto, Finland

**Tamas David-Barrett,** and

University of Oxford, UK

**Robin I M Dunbar**

University of Oxford, UK

### Abstract

Singing together seems to facilitate social bonding, but it is unclear whether this is true in all contexts. Here we examine the social bonding outcomes of naturalistic singing behaviour in a European university Fraternity composed of exclusive ‘Cliques’: recognised sub-groups of 5-20 friends who adopt a special name and identity. Singing occurs frequently in this Fraternity, both ‘competitively’ (contests between Cliques) and ‘cooperatively’ (multiple Cliques singing together). Both situations were re-created experimentally in order to explore how competitive and cooperative singing affects feelings of closeness towards others. Participants were assigned to teams of four and were asked to sing together with another team either from the same Clique or from a different Clique. Participants ( $N=88$ ) felt significantly closer to teams from different Cliques after singing with them compared to before, regardless of whether they cooperated with (singing loudly together) or competed against (trying to sing louder than) the other team. In contrast, participants reported reduced closeness with other teams from their own Clique after competing with them. These results indicate that group singing can increase closeness to less

---

**Corresponding Author:** Eiluned Pearce, University of Oxford, Department of Experimental Psychology, 9 South Parks Road, Oxford OX1 3UD, UK, eiluned.pearce@psy.ox.ac.uk.

#### Ethical approval

Ethics approval for this study was provided by the Central University Research Ethics Committee (CUREC) of the University of Oxford (reference: MSD-IDREC-C1-2014-130)

#### Data access

The data are available from <http://ora.ox.ac.uk/> (DOI 10.5287/bodleian:ht24wj50x).

familiar individuals regardless of whether they share a common motivation, but that singing competitively may reduce closeness within a very tight-knit group.

## Keywords

Group dynamics; singing; social cohesion; emotional closeness; Fraternity; affect

---

## Musical bonding?

The universal nature of musical activities such as singing and dancing and the common features shared cross-culturally (Savage, Brown, Sakai, & Currie, 2015) have led to the proposal that these behaviours are evolutionary adaptations for facilitating group cohesion (Dunbar, 2012; Huron, 2003; Tarr, Launay, & Dunbar, 2014). Certainly, listening to music with family or peers has been shown to increase feelings of social unity (Boer & Abubakar, 2014) and involvement in music-making is associated with a greater improvement in social affirmation compared to other activities such as language and craft classes, yoga and book clubs (Creech, Hallam, Varvarigou, McQueen, & Gaunt, 2013; Hallam, Creech, Varvarigou, McQueen, & Gaunt, 2013). In addition, shared music preferences are thought to create social bonds because they act as cues to shared values and thus increase interpersonal attraction (Boer et al., 2011; Launay & Dunbar, 2015). As well as being associated with creating social connections, group music sessions have been found to positively impact on empathy (understanding and sharing in another's emotions) in 8-11 year-old children (Rabinowitch, Cross, & Burnard, 2013), suggesting that musical engagement can promote the development of the social cognitive abilities underlying the capacity to connect with social partners.

The creation of music by a group of individuals requires coordination and synchrony, behaviours that have been shown to increase interpersonal closeness and motivate positive social behaviour (Cirelli, Einarson, & Trainor, 2014; Kirschner & Tomasello, 2010; Kokal, Engel, Kirschner, & Keysers, 2011; Launay, Dean, & Bailes, 2013, 2014; Lumsden, Miles, & Macrae, 2014; Reddish, Bulbulia, & Fischer, 2013; Reddish, Fischer, & Bulbulia, 2013; Valdesolo, Ouyang, & DeSteno, 2010; Wiltermuth & Heath, 2009). Moreover, moving in synchrony not only increases affiliative tendencies, but is perceived by others to demonstrate higher levels of rapport and unity between co-performers (Lakens & Stel, 2011; Miles, Nind, & Macrae, 2009). The fact that synchrony is used as a cue for cohesion suggests that such coordinated activity is related to the creation and maintenance of strong social ties.

Although much of the work on synchrony has focused on limb movement, any behaviours that involve synchrony and coordination might be expected to have a similar bonding effect. For instance, as a musical behaviour that involves coordination of timing and pitch as well as synchronous breathing, singing is a likely candidate as a social bonding mechanism (Dunbar, 2012; Vickhoff et al., 2013). In support of this, qualitative evidence indicates that choirs and singing groups can create an accepting environment in which to develop interpersonal connections (Clift, Hancox, Staricoff, & Whitmore, 2008; Clift & Hancox, 2001; Grindley, Astbury, Sharples, & Aguirre, 2011; Joseph & Southcott, 2014), and cause a

general improvement in mood in this social setting (Clift & Hancox, 2001; Clift & Morrison, 2011; Kreutz, 2014). Active singing yields significantly greater increases in positive affect compared to comparison activities such as passive listening or having dyadic conversations (Kreutz, 2014; Kreutz et al., 2003). The consequence of this shared uplift in mood might be an increase in the likelihood that individuals interact positively with each other to coordinate future activities effectively (Huron, 2003). In addition, developmental research demonstrates that singing ability is positively related to a child's sense of social inclusion (Welch, Himonides, Saunders, Papageorgi, & Sarazin, 2014), and singing activities have purportedly helped female prisoners to develop key interpersonal skills (Silber, 2005).

Moreover, directly comparing groups before and after singing has found a significant increase in self-reported feelings of connectivity and inclusion with fellow singers in both small groups of familiar individuals and larger groups of less familiar individuals (Weinstein, Launay, Pearce, Dunbar, & Stewart, 2015). Singing is also associated with the release of two neuropeptides known to be associated with social behaviour: oxytocin (Grape, Sandgren, Hansson, Ericson, & Theorell, 2002; Kreutz, 2014) and  $\beta$ -endorphin (Dunbar, Kaskatis, MacDonald, & Barra, 2012; Dunbar, 2010; Machin & Dunbar, 2011). Overall, there is increasing evidence that singing together can promote feelings of closeness between members of a group and therefore helps create intragroup cohesion (Pearce, Launay, & Dunbar, 2015).

However, singing not only occurs cooperatively within a unified group. It may also be used to deter or scare other groups, as illustrated by song duels and 'challenge singing' (Brenneis & Padarath, 1975; Joám Evans Pim, 2013). Given the recognisable social bonding outcomes of singing outlined above, coupled with the well-documented effect of intergroup competition in increasing in-group cohesion, performance and creativity (Baer, Leenders, Oldham, & Vadera, 2010; Bornstein et al., 1994; Tauer & Harackiewicz, 2004), the social bonding effects of competitive singing activities is an interesting area of musical engagement that has so far been neglected. In this paper we compare effects of both cooperative and competitive singing on bonding within and between groups, using data from a university Fraternity.

## The Fraternity context

The data we present were collected as part of the Fraternity Friendship Study, a longitudinal study of group formation conducted in a large (currently ~1700 members) student organisation ('Fraternity') in a major European university city. In this city there are several such Fraternities, some of which are more than 50 years old. About a fifth of the total student population at this university, both male and female, choose to join a Fraternity. The Fraternity studied here has 300-400 new members every year (approximately 60 percent female). In the summer, before the academic year begins, the whole group of novices is split into two 'camps' of 150-200 students and each go to a location 'in the woods' where they spend a few days getting to know each other, playing games and sports, and learning the Fraternity's history, rules, and songs.

In the weeks that follow, the new intake commit themselves to coming to the Fraternity house at least 1-2 times a week, for further bonding activities (such as games, sports, and singing) and in order to form what we will henceforth refer to as 'Cliques', the basic social units around which much of Fraternity life is organised. It should be noted that although we use this broad term here in order to maintain the anonymity of the Fraternity in question, this type of formal social unit is referred to by a specific name within the Fraternity itself. The 300-400 new members split themselves into around 15-30 such Cliques, each comprising 5-20 members of the same sex, whose membership is distinct and, once formed, fixed. Cliques generally meet together at least one evening a week, during which they usually cook a meal together and visit the Fraternity house where they mingle with other Cliques. Each Clique forms a real and enduring group identity as well as, according to sources from the Fraternity, lifelong dyadic friendship bonds between at least some Clique members.

Cliques adopt a unique name that is officially registered in the Fraternity records, and may also have informal markers that distinguish them from the members of other Cliques, such as a logo, certain colours and clothing, songs, and a website. They may compete with each other for popularity status in all kinds of 'informal charts', assessing attributes such as attendance rates at Fraternity-wide activities and bar nights, as well as through spontaneous, good-humoured mock fights, along with singing and dancing contests. All of these behaviours demonstrate the maintenance of strong social boundaries between members of the same Clique (in-group: 'us') versus those of other Cliques (out-groups: 'them') within the Fraternity. Overall, members of the Fraternity are habituated and confident group singers with a repertoire of familiar songs, shared either just between Clique members or, more generally, between all Fraternity members. In this study we experimentally reproduce singing contests and collaborations between Cliques to examine the social bonding implications of these behaviours within and between these sub-groups.

The good-humoured mock fights between Cliques take place in the central meeting place of the Fraternity when the members of many different Cliques are present at the same time. Often, these mock fights are accompanied by (or follow up on) spontaneously emerging singing contests, in which a Clique sings its own identity songs as loudly as possible in order to 'challenge' other Cliques, who may respond with the same behaviour. This is the context in which the kind of singing that we have termed 'competitive' in this study takes place. Given the social divisions imposed by the Fraternity structure, we might expect that the competitions observed between Cliques enhances in-group bonding (Bornstein & Erev, 1994; Puurtinen & Mappes, 2009) and emphasises differentiation between the different Cliques (Brewer, 1979), thus decreasing closeness between the Cliques.

Singing within the Fraternity is not always competitive. At other times, a general Fraternity song may spontaneously arise in the meeting room, inciting all Fraternity members present to sing this shared song together. This is the natural context for the phenomenon we have termed 'cooperative' singing here. Such collaborative singing between Cliques might be expected to refocus attention on the shared superordinate category of Fraternity membership as a basis for an individual's social identity (Wenzel, Mummendey, & Waldzus, 2007). As is typical of the nested hierarchical structure of human social organisation (Hamilton, Milne, Walker, Burger, & Brown, 2007; Zhou, Sornette, Hill, & Dunbar, 2005), Cliques within the

Fraternity share membership of a higher, more encompassing social layer, and shared songs can act as reminders of this (Collinson, 2009; Launay & Dunbar, 2015). For instance, the language used and the concepts depicted in lyrics, as well as the use of typical musical phrasing, could potentially refocus awareness away from Clique disparities and towards a shared superordinate category (Gaertner, Mann, Murrell, & Dovidio, 1989; Tajfel, Billig, Bundy, & Flament, 1971; Tajfel & Turner, 1986; Wenzel et al., 2007). Since shared attitudes and contact in a cooperative setting supports positive intergroup relations, we expect shared motivation to lead to increased closeness between teams from different Cliques (Brown & Abrams, 1986; Hewstone, Rubin, & Willis, 2002; Pettigrew & Tropp, 2006; Slavin & Cooper, 1999; Wenzel et al., 2007). Consequently, the inter-Clique singing contests are expected to decrease, and the inter-Clique singing collaborations to increase, feelings of social closeness between the different Cliques of the same Fraternity. In other words, singing may facilitate social bonding at both the level of the Clique or at the level of the Fraternity more generally (that is, between Cliques), depending on whether the inter-Clique singing interaction is motivated by disparate or shared goals. The aim of this study was to test this proposal.

## Research questions

By applying a semi-naturalistic experimental design, we seek to understand the social bonding consequences of a real-world phenomenon: inter-Clique singing contests and collaborations within a university Fraternity. To do so, participants were assigned to teams of four members from their own Clique. Subsequently, two teams from different Cliques were asked to sing loudly together cooperatively, or to compete against each other to sing the loudest. Participants were asked to rate their closeness to their own team (comprising members of the same Clique as the participant) and the other team (from a different Clique to the participant) before and after singing with them. This manipulation allows elucidation of the effect of cooperative and competitive singing on social bonding within Cliques (measured as closeness to the own team) and between Cliques (measured as closeness to the other team) who share an overarching common identity of Fraternity membership. We also explore what might happen in terms of feelings of social closeness if the observed singing contests or collaborations occurred not between teams from different Cliques, but between teams from the same Clique. Since these Cliques were already very well bonded to each other, we expected little change in response to short bouts of competitive or cooperative singing and therefore treat the latter condition as a comparative baseline.

## Hypotheses

We hypothesise that (1) competitive singing between teams from different Cliques increases closeness towards the own team (comprising members of the same Clique as the participant), (2) competitive singing between teams from different Cliques decreases closeness between the teams, and (3) cooperative singing between teams from different Cliques increases closeness between the teams. We also test the null hypothesis that feelings of closeness would not change between teams from the same Clique after competitive or cooperative singing interactions. In addition, we test whether closeness to teams from a different Clique reaches the same level of closeness, after singing together, as that felt

towards teams from the participant's own Clique. Since group singing has been associated with elevated positive affect, we also investigate the influence of competitive and cooperative singing on affect.

## Methods

### Participants

Participants were 96 members of a social club ('Fraternity') at a major European university, typically aged 18-25 (this sample: *range* = 19-23 years,  $M = 20.83$ ,  $SD = 0.834$ ). Of the 55 participants for whom more detailed demographic data were available, 95% were white Dutch, and 79% came from a middle or upper middle class background (based on their father's occupation). Participants were compensated with vouchers worth ~3 euros for ~20 minutes of their time.

### Tasks and materials

**Connectivity scales**—We used two scales to measure participants' feelings of closeness with (i) their 'own team' of four and (ii) the 'other team' of four before and after the study tasks. These were a modified version of the validated pictorial Inclusion of Other in Self (IOS) scale (Aron, Aron, & Smollan, 1992) and a verbal item that asked participants 'At the moment how connected do you feel to your own/the other group of four?' Both items used a Likert-type 7-point scale (1 = low, 7 = high). The visual scale is identical to the one used by Aron et al (Aron, Aron, & Smollan, 1992), except that the overlapping circles were labelled 'self' and 'group' rather than 'self' and 'other'. In an extensive analysis, Gächter, Starmer, & Tufano (2015) found that the IOS is strongly correlated with other measures of social closeness. For the verbal scale, 1 was anchored as 'not at all' and 7 as 'extremely', via the sequence of 'very slightly', 'a little', 'moderately', 'quite a bit' and 'very much'. Since there was a strong correlation between the baseline measures on the two scales ( $r = 0.8-0.9$ ) we took the mean of scores on both scales together as our 'social connectedness' score, and we use the term 'closeness' to describe the combined index here.

**Affect scale**—We used the Positive and Negative Affect Schedule (PANAS) (Mackinnon et al., 1999) to assess affect.

**Wall-sit exercise (manipulation check)**—This task, which involved participants holding a position as if sitting on an invisible chair with their backs against a wall for as long as possible (Harrison & El Mouden, 2011; Harrison, Sciberras, & James, 2011; Madsen et al., 2007), was intended to provide a manipulation check that the cooperative and competitive singing task influenced shared intentions: teams in the competitive singing condition were expected to be more motivated to compete against the other team in order to win a team prize in the wall-sit task as well and therefore were expected to hold the position for longer, compared to those in the cooperative singing condition. The two teams of four undertook this task on opposite walls, facing each other. The experimenters measured the time each participant held the position using lap timers.



## Design and procedure

**Conditions**—The study used a two-by-two condition design (Figure 1), giving four conditions: (1) competitive singing with members of a different Clique, (2) cooperative singing with members of a different Clique, (3) competitive singing with members of the same Clique, and (4) cooperative singing with members of the same Clique.

**Procedure**—Participants took part in this study in teams of four ('own team'). Each team of four was paired with another team of four ('other team') so that eight participants (the 'experimental group') were tested at a time: Figure 1. In half of the trials (6/12) the two teams were of different sexes or were mixed sex, and in a further five trials both teams were female. One team comprised Fraternity Board members only, not a real-life Clique, and was removed from the analysis. Of the remaining 23 own teams, 18 own teams (78%) entirely comprised members of the same Clique. In the remaining 5 own teams (22%) only 3 members of the same Clique were available and these teams included one member from a different Clique.

**Baseline and post-task questionnaires**—All questions were translated into the national language of the university by a native speaker and included the PANAS, IOS and connectivity scales towards both the own team (defined to participants as the row of four in which they were initially seated) and the other team (the row of four opposite them). These questionnaires were completed before and after the singing and wall-sit exercise tasks.

**Singing task**—After completing the baseline questionnaire, participants were positioned in their teams of four around two microphone-stands with decibel meters attached. In the competitive condition the two groups of four were positioned so that they faced each other in two lines, whereas in the cooperative condition they were equally spaced around a circle, with tape markings on the floor ensuring standardised positions. The mean distances between individuals in the same group of four were approximately equal in all conditions (~1 meter). Participants were asked to sing four songs well known to them as Fraternity members in their particular cohort (but not specific to any Clique), in a given order, without pausing between songs. The total singing period averaged 6 minutes per testing session.

In order to maximise motivation we measured the noise level using the decibel meters and participants were either asked to sing together as a group of eight and told that the loudest out of all the experimental groups participating in the study would receive a prize (cooperative condition) or told that they were competing to be louder than the other team of four and that the loudest out of all the teams participating in the study would receive a prize (competitive condition). The loudest team(s) received a prize at a special event following the experiment. The outcome of the competition was thus not revealed until several days after the experiments took place.

## Calculated variables and statistical analysis

Changes in the PANAS and social closeness scores were calculated by subtracting the baseline score from the score after singing. In order to take account of the fact that individual participants were nested within experimental groups of eight and are thus not

independent data-points, we conducted multi-level models (equivalent to a nested ANOVA) for all analyses, with ‘experimental group’ as an overarching level 2 factor and singing condition (competitive or cooperative) and/or Clique condition (within- or between-Clique, depending on whether the two teams were from the same or different Cliques) condition as level 1 independent factors predicting the dependent variable. Repeated-measure analyses (before versus after comparisons) included ‘individual participant’ as an additional intermediate nested layer and before/after as an additional independent factor (producing three layers, from top down: the ‘experimental group’, ‘individual participant’ and the independent factors predicting the dependent variable).

Five participants were excluded from the study because they were members of the Board that runs the Fraternity and were not in the same in-take year as the rest of the participants, who were entering their second year at the time of the study. Three of the remaining participants provided only partial questionnaire responses, so for the questionnaire responses  $N = 88$  (63 female, missing sex data for 3 participants). Four different participants who held the wall-sit position for more than 350 seconds (more than 4 SDs from the mean) were removed from the dataset as outliers for the time comparisons, giving  $N = 87$  (64 female, missing sex data for 3 participants) for this analysis. The number of participants, teams and trials (corresponding to the number of experimental groups of 8) for each condition are summarised in Table 1.

Neither the sex of individual participants nor the sex-composition of the two teams showed statistically significant effects in any of the social bonding or affect models and did not change the relationships between the other variables. Similarly, taking into account whether the own team comprised three or four members from the same Clique made no difference to the results. Consequently, for the sake of brevity we do not include sex or own team composition as variables in the models presented here.

## Results

### Manipulation check

Participants in the competitive singing condition held the wall-sit exercise for significantly longer ( $M = 132.07$ ,  $SD = 76.147$ ,  $N = 54$ ) than those in the cooperative condition ( $M = 104.21$ ,  $SD = 47.034$ ,  $N = 38$ ):  $t_{10.62} = 2.396$ ,  $p = 0.036$ : Figure 2. This relationship remained ( $t_{9.205} = 2.476$ ,  $p = 0.035$ ) even when Clique condition was included as a factor in the model. This implies that our singing manipulation was successful in motivating participants to genuinely compete with other teams after singing competitively against them. Clique condition did not show a statistically significant main ( $p = 0.87$ ) or interaction effect ( $p = 0.31$ ) on the time held.

### Overall social bonding model

When both the singing condition and Clique condition, as well as the interaction between them, were included together in a model, closeness towards the other team was significantly greater after singing compared to beforehand ( $t_{87} = 2.992$ ,  $p = 0.004$ ) and closeness was significantly greater where both teams were from the same Clique as opposed to being from



different Cliques ( $t_8 = 3.102$ ,  $p = 0.014$ ). Singing condition ( $p = 0.898$ ) and the interaction between singing condition and Clique condition ( $p = 0.944$ ) were not significant in this model. Consequently, only the before/after comparison and the composition of the other team (Clique condition) showed main effects. To unpack these results we test our specific hypotheses below.

**Hypothesis 1: competitive singing between teams from different Cliques increases closeness towards the ‘own team’ comprising members of the same Clique as the participant**

Singing competitively against a team from a different Clique significantly increased feelings of closeness towards members of the own team ( $t_{34} = 2.712$ ,  $p = 0.01$ ), Figure 3 & Table 2, supporting Hypothesis 1.

**Hypothesis 2: competitive singing between teams from different Cliques decreases closeness between the teams**

Singing competitively against a team from a different Clique also significantly increased feelings of closeness towards the other team ( $t_{34} = 4.769$ ,  $p < 0.0001$ ), suggesting increased closeness between Cliques: Figure 3 & Table 2. This result is opposite to that predicted and consequently Hypothesis 2 is not supported.

**Hypothesis 3: cooperative singing between teams from different Cliques increases closeness between the teams**

If the other team comprised members of a different Clique to the own team, feelings of closeness towards the other team were significantly higher after singing cooperatively with them compared to beforehand ( $t_{22} = 2.126$ ,  $p = 0.045$ ): Figure 3. Hypothesis 3 is therefore supported.

**Other results**

**Closeness towards other teams from the same Clique (within-Clique condition)**—When the other team comprised members of the same Clique as the own team, there was no change in closeness towards the other team in the cooperative singing condition ( $t_{13} = 1.336$ ,  $p = 0.205$ ), but there was a significant decrease in closeness towards the other team in the competitive singing condition ( $t_{15} = -2.255$ ,  $p = 0.04$ ): Figure 3, Table 2. However, both before and after singing participants reported feeling significantly greater closeness towards other teams from the same Clique compared to other teams from a different Clique (before singing:  $t_{10,25} = 6.042$ ,  $p = 0.0001$ , after singing:  $t_{10,25} = 4.005$ ,  $p = 0.002$ ): Table 2. The null hypothesis that within-Clique closeness would not change could not be rejected for the cooperative condition, but was rejected in the competitive condition, in which closeness between teams from the same Clique actually decreased. Despite this, closeness between teams remained significantly higher if they came from the same Clique rather than different Cliques.

**Closeness to own team**—Feelings of closeness towards members of the participants’ own team were significantly higher at the end of the study compared to before ( $t_{87} = 4.534$ ,

$p < 0.0001$ , Table 1), regardless of whether they sang competitively or cooperatively with another team (no independent effect:  $p = 0.707$ ) or whether the other team comprised members of the same or a different Clique or not (no independent effect:  $p = 0.730$ , interaction:  $p = 0.916$ ).

**Change in affect (Figure 4)**—Positive affect significantly increased after singing ( $M = 2.96$ ,  $SD = 0.646$ ,  $N = 91$ ) compared to before ( $M = 2.75$ ,  $SD = 0.642$ ,  $N = 91$ ):  $t_{90} = 2.924$ ,  $p = 0.004$ . This result remained unchanged when singing condition ( $p = 0.979$ ), Clique condition ( $p = 0.669$ ) and the interaction between the two ( $p = 0.878$ ) were taken into account. Negative affect was also significantly higher after singing ( $M = 1.60$ ,  $SD = 0.625$ ,  $N = 91$ ) compared to before ( $M = 1.47$ ,  $SD = 0.590$ ,  $N = 91$ ):  $t_{90} = 2.175$ ,  $p = 0.032$ . Similarly to positive affect, this result remained unchanged when singing condition ( $p = 0.141$ ), the Clique condition ( $p = 0.856$ ) and the interaction between the two ( $p = 0.697$ ) were taken into account.

## Discussion

### Overall results

Participants felt significantly closer to the members of other pre-existing Cliques after singing with them compared to beforehand, regardless of whether they competed or cooperated. This supports the hypothesis that cooperative singing can overcome social boundaries by connecting the members of different groups together (Hypothesis 3), at least when the groups share some common identity, in this case Fraternity membership. However, contrary to our hypothesis that competitive singing would decrease inter-Clique closeness (Hypothesis 2), the results demonstrate the opposite effect. The finding that both competitive and cooperative singing had similar positive consequences for feelings of closeness towards out-group members of other Cliques suggests that a shared motivation is not necessary for an intergroup bonding effect, perhaps reflecting the strength of the superordinate Fraternity category in shaping individual identity in this case. Participants also felt significantly closer to members of their Clique after singing if they sang as part of the same team (thus supporting Hypothesis 1), but not if they competed as members of different teams. Only in the cooperative singing condition did reported closeness towards members of the same Clique remain the same before and after singing, as predicted.

### Competition, cooperation and closeness between friendship groups

Participants who sang synchronously with people from a different Clique reported feeling closer to them afterwards, even if they competed against them. That we were able to pick up a significant change after just six minutes of singing suggests that the effect is both strong and rapid, and thus likely to be stronger still after a more prolonged singing session of the length one might expect in casual everyday events that involve communal singing. It is noteworthy that these results suggest that a shared motivation is not necessary in order for singing to promote intergroup bonding, which appears to be in conflict with at least one previous result which demonstrated that sharing motivation can have a significant effect on subsequent social bonding (Reddish, Bulbulia, et al., 2013). This discrepancy might be explained by the lack of immediate feedback in the current study regarding achievement of

the goals that were given, and provides further support that shared motivation might not have a social bonding effect unless it leads to shared experience of success (Launay et al., 2013; Wolf, Launay, & Dunbar, 2015).

The lack of a difference between the effects of competitive and cooperative singing leaves open the question of the mechanism by which singing can lead to intergroup bonding. One possibility is that the immediate motivation may have been overridden in this case by the increased salience of a shared social identity through the singing of Fraternity songs in the competitive as well as cooperative scenario. Alternatively, the physical act of synchronous singing may stimulate affiliative behaviour regardless of context (although with very familiar individuals the difference might be modest). For example, previous work indicates that the affiliative behaviour due to performing synchronous movement in a group may be generalised towards non-performing as well as co-performing individuals and groups (Reddish, Bulbulia, et al., 2013). This suggests that social synchronous movement might create a general positivity towards others in general, rather than being directed towards 'in-group' members only. This is in agreement with the findings of the present study, which suggest that singing leads to an increase in positive affect irrespective of team composition or whether motivation is shared. Thus, singing may heighten positive mood regardless of context and this synchronisation of mood may facilitate further coordination (Huron, 2003). One way to test between these psychological (identity salience) versus physiological (synchrony and coordination of affect) explanations would be to investigate the effect of different nested levels of shared identity (for instance, university affiliation, nationality, and so on) on the outcomes of intergroup singing.

A third possibility is that the bonding mechanism for less familiar individuals differs depending on whether or not there is a shared motivation: for instance, a shared motivation may activate the same processes as *intragroup* bonding, whereas increased intergroup closeness after competitive singing might result from the need to pay particular attention to the less familiar competitors. Since the combination of intragroup cooperation and intergroup competition has been shown to increase individual motivation and performance (Tauer & Harackiewicz, 2004), such intra-Fraternity competition might actually inspire stronger affiliation to the Fraternity as a whole as the Fraternity becomes positively associated with feelings of success, purpose and well-being (Ryan & Deci, 2001). For instance, through acting as a signal of coalition quality, music-making might pave the way for intergroup cooperation by allowing less familiar individuals in different groups to demonstrate their willingness and ability to work as a team, as well as to assess each other as potential collaborative partners while advertising similar attitudes (Boer et al., 2011; Brown & Abrams, 1986; Hagen & Bryant, 2003; Launay & Dunbar, 2015). In any case, it is clear that intra-Fraternity contests do not lead to Fraternity fragmentation and, regardless of the mechanism, these findings do not support the hypothesis that cooperation is necessary for intergroup bonding through synchronous singing, at least in the context of a shared superordinate category.

## Singing to break the ice between groups

The increase in closeness towards teams from a different Clique after singing found here echoes previous findings that singing together can increase feelings of closeness to relative strangers within a large choir that meets infrequently (Weinstein et al., 2015). It appears as though singing with less familiar individuals has an 'icebreaker effect', bringing people closer together whilst by-passing the need for prior social interaction over an extended period (Pearce et al., 2015). The creation of social solidarity suggested here might depend upon the creation of shared and automatic emotional responses that pave the way for action in unison (Huron, 2003) and this may be reflected in the increase in positive affect found here and previously (Kreutz, Bongard, Rohrman, Hodapp, & Grebe, 2004). Synchronous singing appears to create positive emotions that might indicate release of neuropeptides such as oxytocin and  $\beta$ -endorphin (Dunbar et al., 2012; Grape et al., 2002; Kreutz, 2014). These likely induce singers to feel warmly and positively predisposed towards others in the vicinity without the need to know anything about them (Pearce et al., 2015). However, the current findings suggest that singing does not make individuals feel as close to out-group members of different Cliques as they feel towards members of their own Clique in-group, probably because more intense emotional relationships require a prolonged social history. Singing shared Fraternity songs therefore blurs the boundary between Cliques but does not remove them completely. Rather, singing may act as a basic group-cohesion device that is sufficient for certain collective activities where individuals need to work together but do not necessarily need to know each other personally.

These findings provide us with some insights into the possible role of music in the evolution of human sociality. Human social organisation generally consists of a series of nested groupings that fission into smaller units and fuse into larger ones (Grove, Pearce, & Dunbar, 2012; Hamilton et al., 2007; Zhou et al., 2005). Consequently, individuals need ways of creating bonds not only with their immediate social circle of close family and friends (their 'in-group'), but also with the less familiar individuals comprising other social groups with whom they periodically come into contact and with whom they temporarily form a single encompassing social unit. Connections between different 'in-groups' can form a wider network of 'weak ties' that provide access to mating partners, independent sources of information, and help beyond the social core (Granovetter, 1973; Pearce, Shuttleworth, Grove, & Layton, 2014; Pearce, 2014; Roberts, Dunbar, Pollet, & Kuppens, 2009; Wiessner, 1983). Creating and maintaining social relationships requires a certain degree of sustained personal contact that is normally very time consuming (e.g. Miritello et al., 2013; Roberts et al., 2009; Roberts & Dunbar, 2011a, 2011b; Sutcliffe, Dunbar, Binder, & Arrow, 2011), but in the context of intergroup encounters individuals are unlikely to have time to personally connect with each member of the other group. Consequently, intergroup bonding requires a way of fast-forwarding the process of forming relationships so that members of the different groups feel closer to each other without the usual time-consuming processes of 'getting to know' each other. The present findings suggest that singing may be one way of doing this, although more work is required to corroborate this in contexts where the different groups are more socially distant, for example drawn from different universities or countries. Nonetheless, the use of cross-cultural music education in Northern Ireland and Spain to bring together disparate communities and the success of the West-Eastern Divan orchestra,

which was primarily started to facilitate contact between young Palestinian and Israeli musicians, implies that music can help foster intergroup bonding (Almau, 2005; Etherington, 2007; Odena, 2009; Washington & Beecher, 2010).

### Competition within friendship groups

In contrast to the between-Clique results, when the two teams were from the same Clique there was no significant change in closeness when motivation was shared (cooperative singing), perhaps because closeness had already reached a ceiling. However, when members of the same Clique competed, the average closeness towards them decreased. This adverse effect of competition might arise because emotional relationships with closer friends incorporate a more cognitive element that emerges through a protracted history of interaction and accumulated personal knowledge. In a competitive situation, the cognitive element might override the automatic 'feel good' emotional response to synchronous singing when a close friend fails to act as cooperatively as expected. Overall, therefore, these results suggest that although singing can create social bonds, in certain circumstances competitive singing may start to weaken social ties.

### Limitations and future directions

Due to the nature of this semi-naturalistic study, we were unable to control for the previous interaction history between the members of different friendship groups. Nonetheless, average feelings of closeness towards other teams from a different Clique did not differ between the singing conditions at baseline.

In terms of future work, it would be useful to test subgroups from a variety of different social categories. For example, would members of the same university but a different Fraternity feel closer to out-group members after singing with them, regardless of whether they shared a motivation? Would the same be true of members of different ethnic groups that shared a nationality? It would also be informative to test whether singing less familiar, rather than shared, songs has the same effect. This would help test whether it is the act of singing *per se* that has the intergroup bonding effect, or whether bonding arises from the increased salience of a shared identity brought about by singing mutually-known songs.

Although our findings indicate that after a short one-off singing session, closeness to out-group members does not reach the same levels as that felt towards the in-group, a productive avenue for future research would be to test whether an out-group member can become an in-group member just through synchronous singing. If so, it would be interesting to run a longitudinal study to discover how long this would take and how frequent the musical interactions would have to be to achieve this, perhaps by following newly-formed inter-community choirs.

### Conclusion

Overall, our findings support the idea that singing can lead to an increase in social closeness towards members of another group, but, contrary to our expectations, both competitive and cooperative singing had this effect. This similar effect irrespective of motivation could be due to the lack of immediate feedback about success, because teams sang in synchrony with

each other or because the singing of Fraternity songs evoked a sense of shared identity. Whatever the mechanism, we argue that intergroup bonding regardless of motivation is the result of the ‘ice-breaker’ effect of singing with less familiar individuals, with whom a positive connection is created without the need for a protracted phase of mutual assessment. In combination with the findings of previous studies, the results presented here imply that although singing might create sub-structuring within groups, the overwhelming function of singing seems to be to create more cohesive social units. Perhaps singing initially evolved to bond social groups and was subsequently co-opted for signalling group identity to create and sustain social boundaries between those groups.

## Acknowledgements

The authors would like to thank the Fraternity Board for making this research possible, the Fraternity members who participated and Rafael Wlodarski, Cole Robertson, James Carney, and Bronwyn Tarr from the Social & Neuroscience Research Group, University of Oxford, for feedback on this research and logistical help with running the study.

## Funding

EP, JL, TDB and RD are supported by an Advanced Investigator grant (295663) from the European Research Council awarded to RD. The Friendship Fraternity Study is supported by the Linked Lives project (266898), Academy of Finland, directed by AR.

## References

- Almau A. Music is why we come to school. *Improving Schools*. 2005; 8(2):193–197. DOI: 10.1177/1365480205057707
- Aron A, Aron EN, Smollan D. Inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology*. 1992; 63(4):596–612. DOI: 10.1037/0022-3514.63.4.596
- Baer M, Leenders RTAJ, Oldham GR, Vadera AK. Win or lose the battle for creativity: The power and perils of intergroup competition. *Academy of Management Journal*. 2010; 53(4):827–845.
- Boer D, Abubakar A. Music listening in families and peer groups: benefits for young people’s social cohesion and emotional well-being across four cultures. *Frontiers in Psychology*. 2014; 5:392. doi: 10.3389/fpsyg.2014.00392 [PubMed: 24847296]
- Boer D, Fischer R, Strack M, Bond MH, Lo E, Lam J. How shared preferences in music create bonds between people: Values as the missing link. *Personality and Social Psychology Bulletin*. 2011; 37(9):1159–1171. [PubMed: 21543650]
- Bornstein G, Erev I, Gary B, Ido E, Bornstein G, Erev I. The enhancing effect of intergroup competition on group performance. *International Journal of Conflict Management*. 1994; 5(3):271–283. DOI: 10.1108/eb022747
- Brenneis D, Padarath R. “About those scoundrels I’ll let everyone know”: Challenge singing in a Fiji Indian community. *The Journal of American Folklore*. 1975; 88(349):283–291. CR – Copyright © 1975 American Folkl. DOI: 10.2307/538888
- Brown R, Abrams D. The effects of intergroup similarity and goal interdependence on intergroup attitudes and task performance. *Journal of Experimental Social Psychology*. 1986; 22(1):78–92. DOI: 10.1016/0022-1031(86)90041-7
- Cirelli LK, Einarson KM, Trainor LJ. Interpersonal synchrony increases prosocial behavior in infants. *Developmental Science*. 2014; 17(6):1003–1011. DOI: 10.1111/desc.12193 [PubMed: 25513669]
- Clift S, Hancox G. The perceived benefits of singing: Findings from preliminary surveys of a university college choral society. *Journal of the Royal Society for the Promotion of Health*. 2001; 121:248–256. [PubMed: 11811096]

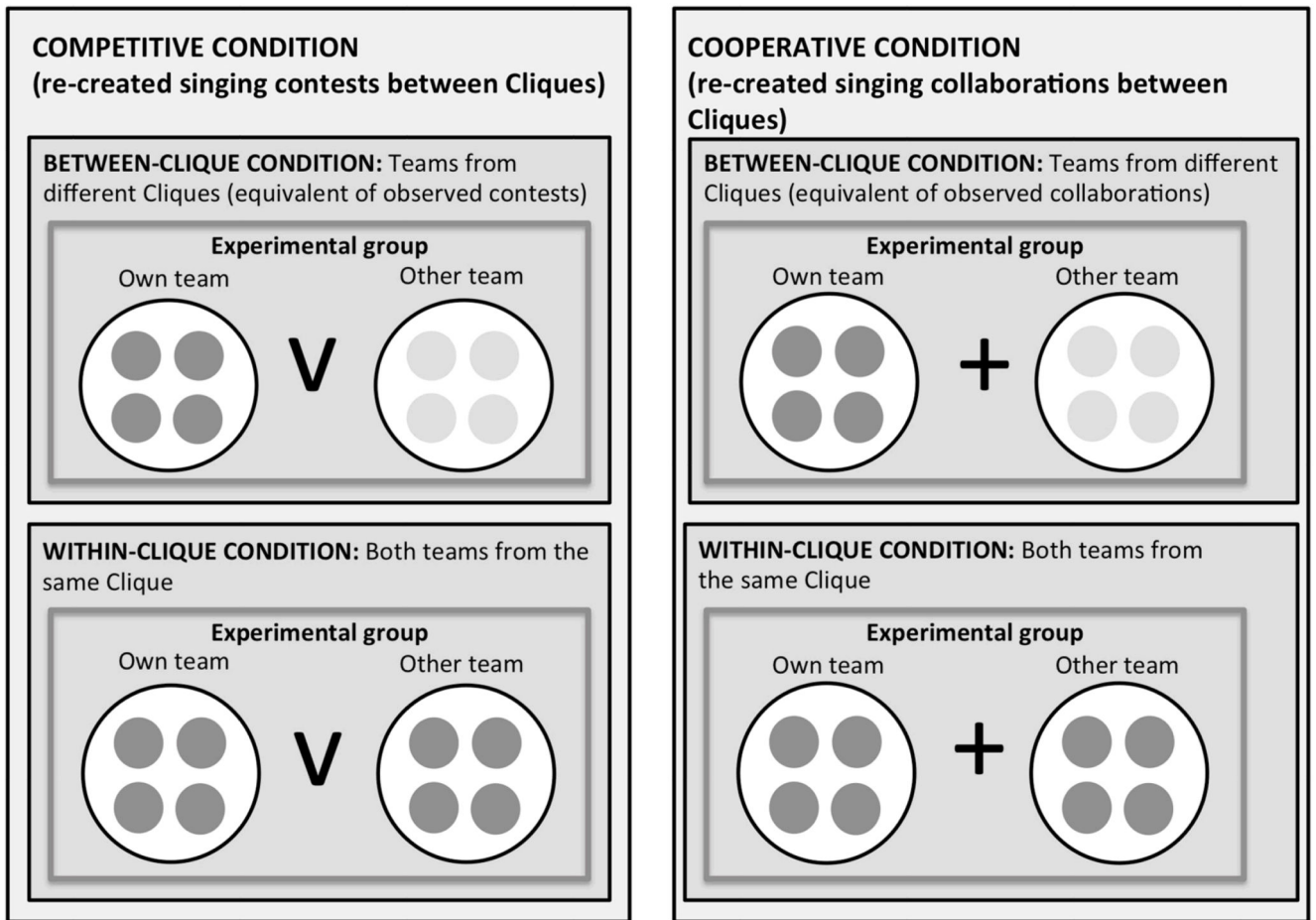


- Clift, S.; Hancox, G.; Staricoff, R.; Whitmore, C. Singing and health: Summary of a systematic mapping: a review of non-clinical research (Vol. null). Canterbury Christchurch University, UK: Sidney De Haan Research Centre for Arts and Health; 2008.
- Clift S, Morrison I. Group singing fosters mental health and wellbeing: Findings from the East Kent “singing for health” network project. *Mental Health & Social Inclusion*. 2011; 15(2):88–97. DOI: 10.1108/20428301111140930
- Collinson I. “Singing songs, making places, creating selves:” Football songs & fan identity at Sydney FC. *Transforming Cultures eJournal*. 2009; 4(1)
- Creech A, Hallam S, Varvarigou M, McQueen H, Gaunt H. Active music making: A route to enhanced subjective well-being among older people. *Perspectives in Public Health*. 2013; 133(1):36–43. DOI: 10.1177/1757913912466950 [PubMed: 23308006]
- Dunbar RIM. The social role of touch in humans and primates: Behavioural function and neurobiological mechanisms. *Neuroscience & Biobehavioral Reviews*. 2010; 34(2):260–268. DOI: 10.1016/j.neubiorev.2008.07.001 [PubMed: 18662717]
- Dunbar, RIM. On the evolution of song and dance. *Music, Language, & Human Evolution*. Bannan, N., editor. Oxford, UK: Oxford University Press; 2012. p. 201–214.
- Dunbar RIM, Kaskatis K, MacDonald I, Barra V. Performance of music elevates pain threshold and positive affect. *Evolutionary Psychology*. 2012; 10(4):688–702. [PubMed: 23089077]
- Etherington B. Instrumentalising musical ethics: Edward Said and the West-Eastern Divan orchestra. *Australasian Music Research*. 2007; 7
- Gächter S, Starmer C, Tufano F. Measuring the Closeness of Relationships: A Comprehensive Evaluation of the “Inclusion of the Other in the Self” Scale. *PLoS ONE*. 2015; 10(6):e0129478.doi: 10.1371/journal.pone.0129478 [PubMed: 26068873]
- Gaertner SL, Mann J, Murrell A, Dovidio JF. Reducing intergroup bias: The benefits of recategorization. *Journal of Personality and Social Psychology*. 1989; 57(2):239–249. DOI: 10.1037/0022-3514.57.2.239
- Granovetter MS. The strength of weak ties. *American Journal of Sociology*. 1973; 78(6):1360–1380. DOI: 10.2307/2776392
- Grape C, Sandgren M, Hansson L-O, Ericson M, Theorell T. Does singing promote well-being?: An empirical study of professional and amateur singers during a singing lesson. *Integrative Physiological and Behavioral Science*. 2002; 38(1):65–74. DOI: 10.1007/bf02734261
- Grindley H, Astbury J, Sharples J, Aguirre C. Benefits of group singing for community mental health and wellbeing. Survey & literature review. 2011 Victorian Health Promotion Foundation.
- Grove M, Pearce E, Dunbar RIM. Fission-fusion and the evolution of hominin social systems. *Journal of Human Evolution*. 2012; 62(2):191–200. [PubMed: 22197359]
- Hagen E, Bryant G. Music and dance as a coalition signaling system. *Human Nature*. 2003; 14(1):21–51. DOI: 10.1007/s12110-003-1015-z [PubMed: 26189987]
- Hallam S, Creech A, Varvarigou M, McQueen H, Gaunt H. Does active engagement in community music support the well-being of older people? *Arts & Health*. 2013; 6(2):1–16. DOI: 10.1080/17533015.2013.809369
- Hamilton MJ, Milne BT, Walker RS, Burger O, Brown JH. The complex structure of hunter-gatherer social networks. *Proceedings of the Royal Society B: Biological Sciences*. 2007; 274(1622):2195–2203. [PubMed: 17609186]
- Harrison F, El Mouden C. Exploring the effects of working for endowments on behaviour in standard economic games. *PLoS ONE*. 2011; 6(11):e27623.doi: 10.1371/journal.pone.0027623 [PubMed: 22110696]
- Harrison F, Sciberras J, James R. Strength of social tie predicts cooperative investment in a human social network. *PLoS ONE*. 2011; 6(3):e18338.doi: 10.1371/journal.pone.0018338 [PubMed: 21479173]
- Hewstone M, Rubin M, Willis H. Intergroup bias. *Annual Review of Psychology*. 2002; 53(1):575–604. DOI: 10.1146/annurev.psych.53.100901.135109
- Huron D. Is music an evolutionary adaptation? *Annals of the New York Academy of Sciences*. 2003; 930(1):57–75. DOI: 10.1111/j.1749-6632.2001.tb05724.x

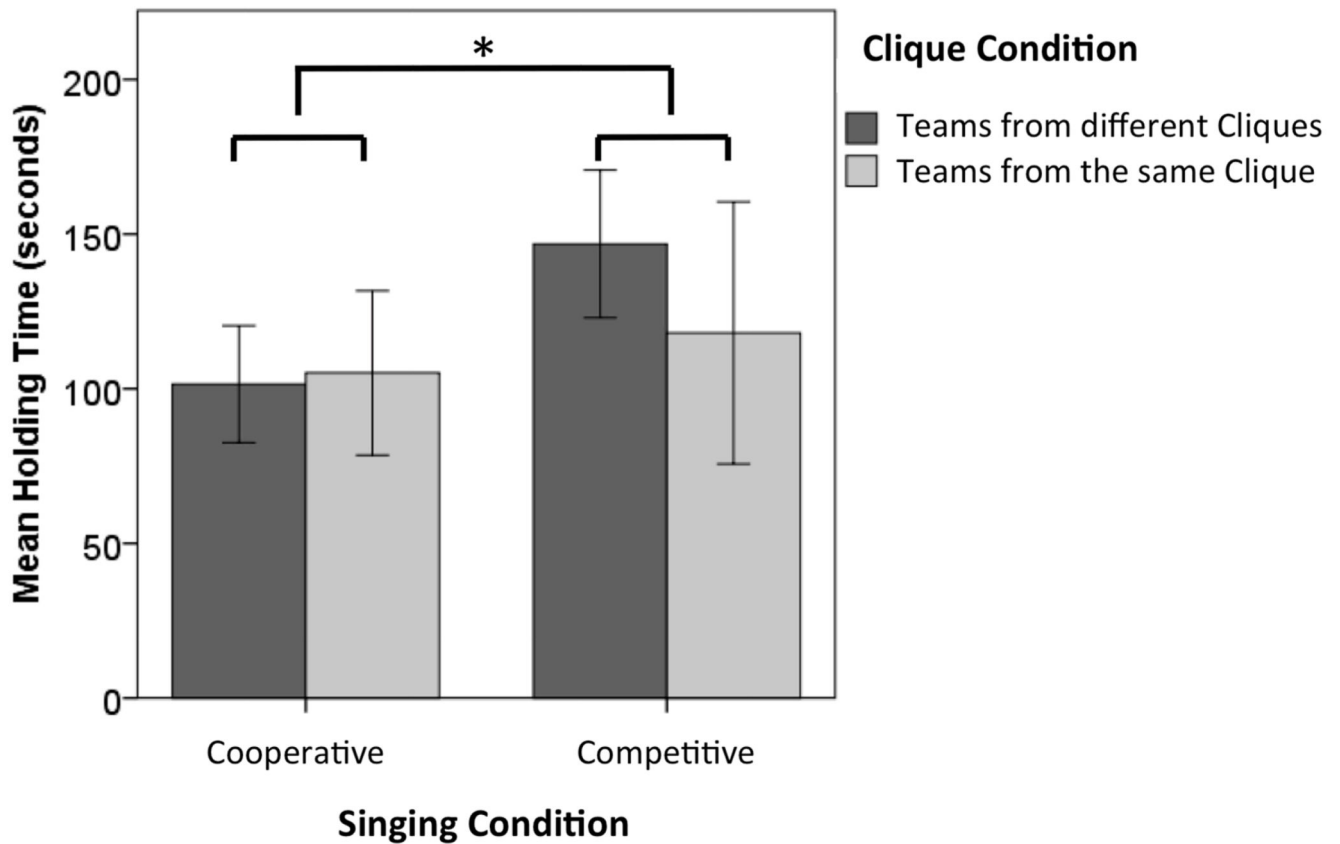
- Evans Pim, Joám. Man the singer: Song duels as an aggression restraint mechanism for nonkilling conflict management. War, peace, and human nature: The convergence of evolutionary and cultural views. Fry, Douglas P., editor. New York: Oxford University Press; 2013. p. 514-539.
- Joseph D, Southcott J. Singing and companionship in the Hawthorn University of the Third-Age Choir, Australia. *International Journal of Lifelong Education*. 2014; :1–14. DOI: 10.1080/02601370.2014.991951
- Kirschner S, Tomasello M. Joint music making promotes prosocial behavior in 4-year-old children. *Evolution and Human Behavior*. 2010; 31(5):354–364. DOI: 10.1016/j.evolhumbehav.2010.04.004
- Kokal I, Engel A, Kirschner S, Keysers C. Synchronized Drumming Enhances Activity in the Caudate and Facilitates Prosocial Commitment - If the Rhythm Comes Easily. *PLoS ONE*. 2011; 6(11):e27272.doi: 10.1371/journal.pone.0027272 [PubMed: 22110623]
- Kreutz G. Does singing facilitate social bonding? *Music & Medicine*. 2014; 6(2)
- Kreutz, G.; Bongard, S.; Rohrmann, S.; Grebe, D.; Bastian, HG.; Hodapp, V. Does singing provide health benefits?; In *Proceedings of the 5th Triennial ESCOM Conference*; Hanover University of Music and Drama, Germany. 2003.
- Kreutz G, Bongard S, Rohrmann S, Hodapp V, Grebe D. Effects of choir singing or listening on Secretary Immunoglobulin A, Cortisol, and emotional state. *Journal of Behavioral Medicine*. 2004; 27(6):623–635. DOI: 10.1007/s10865-004-0006-9 [PubMed: 15669447]
- Lakens D, Stel M. If they move in sync, they must feel in sync: Movement synchrony leads to attributions of rapport and entitativity. *Social Cognition*. 2011; 29(1):1–14. DOI: 10.1521/soco.2011.29.1.1
- Launay J, Dean RT, Bailes F. Synchronization can influence trust following virtual interaction. *Experimental Psychology*. 2013; 60(1):53–63. DOI: 10.1027/1618-3169/a000173 [PubMed: 22935329]
- Launay J, Dean RT, Bailes F. Synchronising movements with the sounds of virtual partner enhances partner likeability. *Cognitive Processing*. 2014; 15(4):491–501. DOI: 10.1007/s10339-014-0618-0 [PubMed: 24805849]
- Launay J, Dunbar RIM. Playing with strangers: Which shared traits attract us most to new people? *PLoS ONE*. 2015; 10(6):e0129688.doi: 10.1371/journal.pone.0129688 [PubMed: 26053921]
- Lumsden J, Miles LK, Macrae CN. Sync or sink? Interpersonal synchrony impacts self-esteem. *Frontiers in Psychology*. 2014; 5doi: 10.3389/fpsyg.2014.01064
- Machin AJ, Dunbar RIM. The brain opioid theory of social attachment: A review of the evidence. *Behaviour*. 2011; 148:985–1025.
- Mackinnon A, Jorm AF, Christensen H, Korten AE, Jacomb PA, Rodgers B. A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality and Individual Differences*. 1999; 27(3):405–416. DOI: 10.1016/S0191-8869(98)00251-7
- Madsen EA, Tunney RJ, Fieldman G, Plotkin HC, Dunbar RIM, Richardson JM, McFarland D. Kinship and altruism: A cross-cultural experimental study. *British Journal of Psychology*. 2007; 98(Pt 2):339–359. DOI: 10.1348/000712606x129213 [PubMed: 17456276]
- Miles LK, Nind LK, Macrae CN. The rhythm of rapport: Interpersonal synchrony and social perception. *Journal of Experimental Social Psychology*. 2009; 45(3):585–589. DOI: 10.1016/j.jesp.2009.02.002
- Miritello G, Moro E, Lara R, LMartinez-Lopez R, Belchamber J, Roberts S, Dunbar RIM. Time as a limited resource: Communication Strategy in Mobile Phone Networks. *Social Networks*. 2013; 35(1):89–95.
- Odena O. Practitioners' views on cross-community music education projects in Northern Ireland: Alienation, socio-economic factors and educational potential. *British Educational Research Journal*. 2009; 36(1):83–105. DOI: 10.1080/01411920902878909
- Pearce E. Modelling mechanisms of social network maintenance in hunter–gatherers. *Journal of Archaeological Science*. 2014; 50:403–413. DOI: 10.1016/j.jas.2014.08.004 [PubMed: 25214706]
- Pearce E, Launay J, Dunbar RIM. The ice-breaker effect: Singing mediates fast social bonding. *Royal Society Open Science*. 2015; 2:150221.doi: 10.1098/rsos.150221 [PubMed: 26587241]

- Pearce, E.; Shuttleworth, A.; Grove, M.; Layton, R. The costs of being a high latitude hominin. The Lucy project: Benchmark papers. Dunbar, RIM.; Gamble, C.; Gowlett, J., editors. Oxford: Oxford University Press; 2014. p. 356-379.
- Pettigrew TF, Tropp LR. A meta-analytic test of intergroup contact theory. *Journal of Personality and Social Psychology*. 2006; 90(5):751–783. DOI: 10.1037/0022-3514.90.5.751 [PubMed: 16737372]
- Rabinowitch T-CC, Cross I, Burnard P. Long-term musical group interaction has a positive influence on empathy in children. *Psychology of Music*. 2013; 41(4):484–498.
- Reddish P, Bulbulia J, Fischer R. Does synchrony promote generalized prosociality? *Religion, Brain & Behavior*. 2013; 4(1):3–19. DOI: 10.1080/2153599X.2013.764545
- Reddish P, Fischer R, Bulbulia J. Let's dance together: Synchrony, shared intentionality and cooperation. *PLoS ONE*. 2013; 8(8):e71182. [PubMed: 23951106]
- Roberts S, Dunbar RIM. Communication in social networks: Effects of kinship, network size, and emotional closeness. *Personal Relationships*. 2011a; 18(3):439–452. DOI: 10.1111/j.1475-6811.2010.01310.x
- Roberts S, Dunbar RIM. The costs of family and friends: An 18-month longitudinal study of relationship maintenance and decay. *Evolution and Human Behavior*. 2011b; 32(3):186–197. DOI: 10.1016/j.evolhumbehav.2010.08.005
- Roberts S, Dunbar RIM, Pollet TV, Kuppens T. Exploring variation in active network size: Constraints and ego characteristics. *Social Networks*. 2009; 31(2):138–146. DOI: 10.1016/j.socnet.2008.12.002
- Ryan RM, Deci EL. On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology*. 2001; 52(1):141–166. DOI: 10.1146/annurev.psych.52.1.141
- Savage PE, Brown S, Sakai E, Currie TE. Statistical universals reveal the structures and functions of human music. 2015; (27):1–6. DOI: 10.1073/pnas.1414495112
- Silber L. Bars behind bars: The impact of a women's prison choir on social harmony. *Music Education Research*. 2005; 7(2):251–271. DOI: 10.1080/14613800500169811
- Slavin, Re; Cooper, R. Improving intergroup relations: Lessons learned from cooperative learning programs. *Journal of Social Issues*. 1999; 55(4):647–663. DOI: 10.1111/0022-4537.00140
- Sutcliffe A, Dunbar RIM, Binder J, Arrow H. Relationships and the social brain: Integrating psychological and evolutionary perspectives. *British Journal of Psychology*. 2011; 103:149–168. DOI: 10.1111/j.2044-8295.2011.02061.x [PubMed: 22506741]
- Tajfel H, Billig MG, Bundy RP, Flament C. Social categorization and intergroup behaviour. *European Journal of Social Psychology*. 1971; 1(2):149–178. DOI: 10.1002/ejsp.2420010202
- Tajfel, H.; Turner, JC. The social identity theory of intergroup behaviour. *Psychology of intergroup relations* (2nd ed.). Worchel, S.; Austin, AG., editors. Chicago: Nelson-Hall; 1986. p. 7-24.
- Tarr B, Launay J, Dunbar RIM. Music and social bonding: “Self-other” merging and neurohormonal mechanisms. *Frontiers in Psychology*. 2014; 5:1–10. DOI: 10.3389/fpsyg.2014.01096 [PubMed: 24474945]
- Tauer JM, Harackiewicz JM. The effects of cooperation and competition on intrinsic motivation and performance. *Journal of Personality and Social Psychology*. 2004; 86(6):849–861. DOI: 10.1037/0022-3514.86.6.849 [PubMed: 15149259]
- Valdesolo P, Ouyang J, DeSteno D. The rhythm of joint action: Synchrony promotes cooperative ability. *Journal of Experimental Social Psychology*. 2010; 46(4):693–695. DOI: 10.1016/j.jesp.2010.03.004
- Vickhoff B, Malmgren H, Åström R, Nyberg G, Engvall M, Snygg J, Jörnsten R. Music structure determines heart rate variability of singers. *Frontiers in Psychology*. 2013; 4doi: 10.3389/fpsyg.2013.00334
- Washington DM, Beecher DG. Music as social medicine: Two perspectives on the West-Eastern Divan orchestra. *New Directions for Youth Development*. 2010; 2010(125):127–140. DOI: 10.1002/yd.343 [PubMed: 20391623]
- Weinstein D, Launay J, Pearce E, Dunbar RIM, Stewart L. Singing and social bonding: Changes in connectivity and pain threshold as a function of group size. *Evolution & Human Behaviour*. 2015; doi: 10.1016/j.evolhumbehav.2015.10.002

- Welch GF, Himonides E, Saunders J, Papageorgi I, Sarazin M. Singing and social inclusion. *Frontiers in Psychology*. 2014; 5doi: 10.3389/fpsyg.2014.00803
- Wenzel M, Mummendey A, Waldzus S. Superordinate identities and intergroup conflict: The ingroup projection model. *European Review of Social Psychology*. 2007; 18(1):331–372. DOI: 10.1080/10463280701728302
- Wiessner P. Style and Social Information in Kalahari San Projectile Points. *American Antiquity*. 1983; 48(2):253–276.
- Wiltermuth SS, Heath C. Synchrony and cooperation. *Psychological Science*. 2009; 20(1):1–5. DOI: 10.1111/j.1467-9280.2008.02253.x [PubMed: 19152536]
- Wolf W, Launay J, Dunbar RIM. Joint attention, shared motivation and social bonding. *British Journal of Psychology*. 2015; doi: 10.1111/bjop.12144
- Zhou WX, Sornette D, Hill RA, Dunbar RIM. Discrete hierarchical organization of social group sizes. *Proceedings of the Royal Society B: Biological Sciences*. 2005; 272(1561):439–444. [PubMed: 15734699]



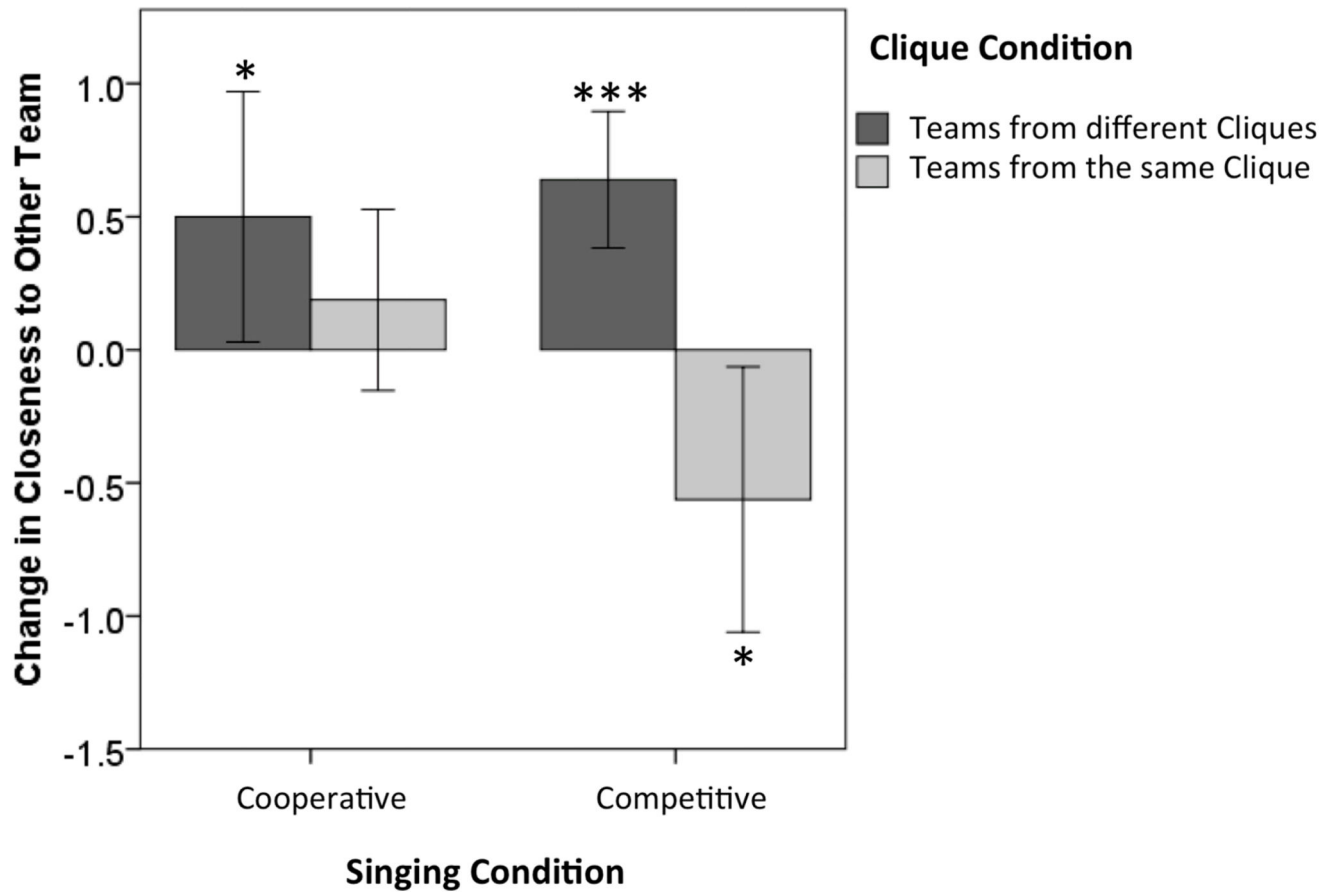
**Figure 1.**  
The study set up, showing the four conditions and how they relate to ethnographic singing behaviour in the Fraternity.



**Figure 2.**

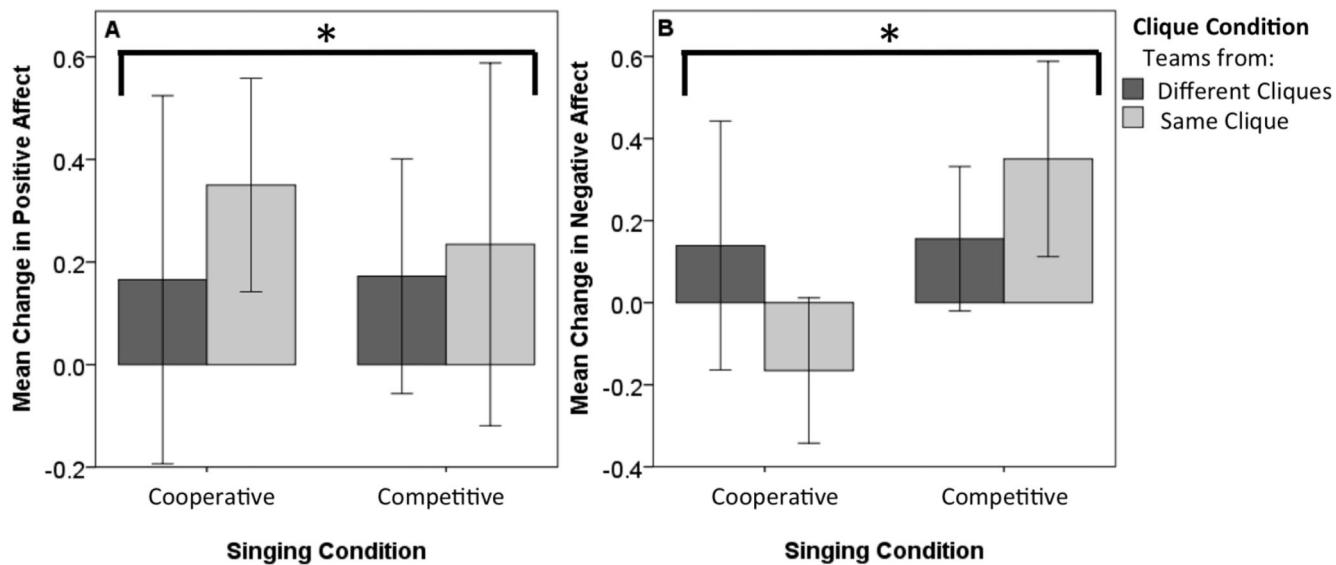
The mean holding time for the wall-sit exercise in the competitive and cooperative singing conditions, split by Clique condition (teams from the same or different Cliques),  $N=87$ . Error bars show  $\pm 2$  standard errors. Fraternity board members and outliers who held the position for more than 350 seconds are excluded. Any significant differences between conditions are indicated as \*  $p < 0.05$ , \*\*  $p < 0.001$ , \*\*\*  $p < 0.0001$ .





**Figure 3.**

The change in reported closeness with the other team in the competitive and cooperative singing conditions, split by Clique condition (teams from the same or different Cliques),  $N=88$ . Error bars show  $\pm 2$  standard errors. Fraternity board members are excluded. Any significant differences from zero are indicated as \*  $p < 0.05$ , \*\*  $p < 0.001$ , \*\*\*  $p < 0.0001$ .



**Figure 4.**

The change in reported positive (A) and negative (B) affect in the competitive and cooperative singing conditions, split by Clique condition (teams from the same or different Cliques),  $N=91$ . Error bars show  $\pm 2$  standard errors. Fraternity board members are excluded. Any significant differences from zero are indicated as \*  $p < 0.05$ , \*\*  $p < 0.001$ , \*\*\*  $p < 0.0001$ .

**Table 1.**

Sample sizes for the different conditions for the questionnaire and wall-sit data, giving the number of individual participants (Ps), the number of four-person teams and the number of trials (experimental groups of eight).

Composition of other team	Singing condition	Questionnaire		Wall-sit	
		Number of Ps	Number of teams (trials)	Number of Ps	Number of teams (trials)
Same Clique (within-Clique condition)	Cooperative	14	4 (2)	16	4 (2)
	Competitive	16	4 (2)	16	4 (2)
Different Cliques (between-Clique condition)	Cooperative	23	6 (3)	21	6 (3)
	Competitive	35	9 (5) *	34	9 (5) *
TOTAL		88	23 (12)	87	23 (12)

\* One team of four in this condition was comprised of Board members only.

**Table 2.**

Descriptive statistics for the self-reported closeness felt towards members of the participants' own team and the other team in the different conditions, before and after singing. Standard deviations for the means are given in parentheses.

Composition of other team	Singing condition	Mean closeness to own team (SD)		Mean closeness to other team (SD)	
		Before	After	Before	After
Same Clique (within-Clique condition)	Cooperative (N= 14)	5.25 (1.66)	5.57 (1.19)	4.61 (1.52)	4.86 (1.11)
	Competitive (N= 16)	5.38 (0.81)	5.81 (0.98)	5.16 (0.72)	4.59 (1.19)
Different Cliques (between-Clique condition)	Cooperative (N= 23)	5.41 (1.35)	5.70 (1.30)	2.33 (1.60)	2.83 (1.77)
	Competitive (N= 35)	5.51 (1.35)	5.84 (1.29)	2.30 (1.03)	2.93 (1.13)