Sexual Segregation in Human Conversations

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Summary

Human conversation groups have a characteristic size limit at around four individuals. Although mixed-sex social groups can be significantly larger than this, census data on casual social groups suggest that there is a fractal pattern of fission in conversations when social group size is a multiple of this value. This study suggests that, as social group size increases beyond four, there is a tendency for sexual segregation to occur resulting in an increasing frequency of single-sex conversational subgroups. It is not clear why conversations fragment in this way, but a likely explanation is that sex differences in conversational style result in women (in particular) preferring to join all-female conversations when a social group is large enough to allow this.

Key words: Conversation group size, sexual segregation, sex differences, conversational style

Introduction

Language has, without question, been the single most important evolutionary innovation that characterises modern humans. Its syntactical structure lends itself to a variety of forms of information exchange, ranging from instruction (Tomasello 2008) to joking (Gervais & Wilson 2005), but its central function probably remains that of servicing social relationships (Dunbar 2009; Redhead & Dunbar 2013). Aside from the special case of 'lectures' (where specific rules of who can speak when are universal), natural conversations seem to have an upper limit at around four individuals (Dunbar et al. 1995; Waller et al. 2011; Dezecache & Dunbar 2012). This limit is even maintained in fictional drama, with Shakespeare and modern film dramas maintaining a consistent rule of only having four speaking parts in most scenes (Stiller et al. 2004; Krems & Dunbar 2013). It is not clear why this should be so, although a number of hypotheses have been suggested, including the exponential reduction in turn-taking opportunities as the number of participants increases (Dunbar et al. 1995), increasing difficulty of monitoring the prosodic and visual cues that are so important for interpreting speech (Leavitt &Mueller 1955; Argyle et al. 1968) and the difficulty of discriminating speech sounds once the conversation circle becomes too large (Cohen 1971).

The fact that conversation groups seem to naturally fragment as they increase in size raises the question as to whether the subgroups that emerge consist of a random assortment of the group as a whole, or whether the group splits along social or demographic divisions. One obvious basis for division would be in terms of sex, given that the two genders have very different social styles. Sociolinguists describe women's conversations as being more collaborative, with a great deal of 'co-construction' or 'polyphonic talk' (several individuals speaking at the same time, usually saying exactly the same words or phrase as listeners anticipate what the speaker is about to say), a lot of backchannel commentary (vocal and

verbal comments on the speaker's utterances such as *uh-huh*, *yes!* or *hmmm*) and a more supportive ambience, whereas men's conversations are described as more competitive (little backchannel or overlap, and a more combative style) (Coates 1993, 1994,1997). Men typically find women's tendency to co-construct and overlap rude, and women commonly find men's more combative style unfriendly, and this might well be sufficient to cause segregation. In mixed-sex dyads, women tend to adjust their speaking style to that of men, whereas the reverse is less often the case (Grainger & Dunbar 2009), and this might impose stresses on women that would favour finding more congenial conversation partners when the opportunity arises (except, presumably, in the special case of developing romantic relationships).

The processes of group formation may themselves be important in this context. The dynamic aspects of group formation, and the two sexes' predispositions to be attracted to groups of different size or composition, may significantly influence both the size of groups and the extent to which they become substructured. In monkeys, apes and feral goats, for example, males are attracted to join groups of females, with a group's attractiveness being a simple function of the number of females it contains (Dunbar et al. 1990; Dunbar 2000). On the other hand, the increasingly disruptive behaviour of males as their numbers increase and they begin to compete with each other may, at least in ungulates, result in females leaving the group to avoid harassment (Ruckstahl & Neuhaus 2002; Calhim et al. 2006); the result may be an optimal group size that trades off the benefits and costs that females incur from grouping. However, in a species like humans where females are more proactive in mate choice (Palchykov et al. 2012; Machin & Dunbar 2013), the reverse pattern might be expected, with females being increasingly attracted to groups of males as their size increases and groups become more like mating leks (Dunbar et al. 1997).

To explore these questions, a large number of casual social groups were sampled in natural social contexts. These data were used to examine the size and gender composition of both complete social groups and the conversations they contained. Although it was not possible to observe the dynamic process of conversation fragmentation in this study, nonetheless we can infer quite a lot about this process from analyses of the patterns in these kinds of data.

Methods

A total of 292 casual social groups were sampled in a variety of contexts in several locations in the north of England and in Oxford, mainly in city centres. In all, 1201 adults (651 females; mean estimated age 40 years, range 18-80) were sampled. The venues included large social receptions/events (38 groups), cafes/restaurants (26), bars/pubs (127), public parks (50) and shopping centres (malls) (51). Locations were sought that contained large numbers of social groups. On arrival at a location, all social groups were censussed as rapidly as possible to ensure no movement between conservations/groups. All sampling was carried out by RD and two graduate research assistants, with samples distributed across all hours of the day between 10.00-22.00 hrs.

A social group was defined as a set of people who were obviously associating with each other (standing or sitting together), and a conversation group was defined as a set of individuals who were engaged (as listeners) with the same speaker (Dunbar et al. 1995; Dezecache & Dunbar 2012). The normal rules of human conversation dictate that there is only a single speaker who holds the floor at any one moment. For each social group encountered, the following were noted: total number of people in the social group (social group size), number and approximate decadal age class of adult males and females, and the size and composition of individual conversations within the social group (the conversation

group size). Children (including teenagers) were not included. Mean number of adults per social group was 4.11 (range 2-13), and the mean size of conversation groups was 2.75 (range 2-6). No group larger than 6 people consisted of a single conversation. Of the 1201 adults sampled, 130 (69 females) were "solitary" (i.e. were quite clearly members of a social group, but at the time of the census ere not involved in a conversation). On average, there were 1.7 conversations per social group (range 1-6), indicating that conversations were not constrained by the layout of the environment. Indeed, half the groups were sampled in open environments (parks, public places) where their spatial movements were unrestricted. Neither the size of social groups (mean sizes: 4.3±1.6 vs 3.9±1.6; $F_{1,290}$ = 3.80, p=0.052) nor the size of conversation groups (mean sizes: 2.7±1.1 vs 2.8±1.0; $F_{1,290}$ = 0.06, p=0.815) differed between indoor and outdoor locations.

Ethical approval for the study was given by the University of Liverpool human research ethics committee.

Results

Fig. 1 gives the distribution of social group sizes for single sex and mixed-sex social groups. Mean group sizes were 3.61 for male-only groups (N=33), 3.51 for female-only groups (N=46) and 4.32 for mixed-sex groups (N=213), with mixed-sex groups having an average of 2.02 males and 2.30 females. Only mixed-sex groups ever contained more than six individuals, and the frequencies of such groups were quite small (just 6.5% of all groups). Fig. 2 plots the number of separate conversations against social group size for mixed-sex and the combined single sex social groups. Broadly speaking, irrespective of gender composition, a social group typically constitutes a single conversation up to groups of size four, after which the number of conversations rises in a series of steps at what appears to be multiples of groups of size of four. Fig. 3 plots mean conversation group size against social group size for

single sex and mixed-sex groups, confirming previous findings (Dunbar et al. 1995; Waller et al. 2011; Dezecache & Dunbar 2012) that there seems to be an upper limit on conversation group size at four individuals, at the same time demonstrating that this is true independently of both group size and composition and sample location.

Fig. 4 plots the mean percentages of males and females that were in single-sex conversations for each size of social group. Overall, the larger the group, the more males there are in male-only conversations and the more females there are in female-only conversations (pooling separate correlations for each sex: χ^2=18.752, df=4, p=0.0009), with some suggestion of a "broken stick" pattern with an inflection point at a group size of 4-5. Although the relationship is much stronger for males (r_s=0.243, p=0.0015 1-tailed testing a directional hypothesis) than it is for females (r_s=0.123, p=0.067 1-tailed), it seems that both sexes increasingly gravitate towards single-sex conversation groups as social group size increases. The borderline significance for the females is due mainly to the fact that they are more likely to be in mixed-sex conversations in very large social groups.

The difference between the two sexes presumably reflects the fact that they have somewhat different patterns in the way they decide to join and leave mixed-sex groups. As a first step in exploring this, Fig. 5 plots the mean gender composition of mixed-sex groups as a function of their size. The two distributions increase more or less in parallel as a linear function of social group size (males: $F_{1,204}$= 145.9, standardized β=0.646, r^2=0.417, p<0.0001; females: $F_{1,204}$= 285.1, standardized β=0.783, r^2=0.581, p<0.0001). Neither small nor large social groups seem to be differentially attractive to either sex. However, this does not mean that mixed-sex conversations increase in size proportionately with group size: as indicated by Fig. 6, the size of mixed-sex conversations asymptotes at just below two members of each sex. Only for very large social groups of 10+ individuals is it the case that most of the males and females will be in the same conversation group (and the sample size is

very small in this case). This suggests that larger groups probably form for specific social purposes or under particular circumstances, but their rarity suggests that they quickly dissipate as the constituent conversations into which they fragment cause them to break up and drift apart.

Fig. 7 provides further insight into the dynamics of this process. It plots the proportion of all females in a group who were in a mixed-sex conversation against the proportion of all males who were in a mixed-sex conversation (no matter how many such conversations were active within the social group). The best fit to the raw data is a cubic regression ($F_{3,128}$=136.4, r^2=0.762, p<<0.0001). The proportion of females in mixed conversations initially rises very steeply compared to the proportion of males. This suggests that females may be targeting a small number of males to create a mixed-sex conversation, and that this very quickly draws in other females. This then attracts other males to switch from all-male conversations to the mixed-sex conversation. However, once this happens, it results in a precipitate collapse in the females' interest and they leave to join all-female conversations. However, if more males continue to gravitate into the mixed-sex conversation, the females will inexorably be drawn back in once more than half the males in the social group are in the same mixed sex conversation.

Discussion

The main findings reported here are (1) that social groups are increasingly likely to fragment in conversational subgroups as they increase in size and (2) that, when they do so, these conversational subgroups are increasingly likely to become sexually segregated. In addition, the data confirm earlier findings that there is a natural limit to the size of conversation groups at around four individuals (Dunbar et al. 1995; Dezecache & Dunbar 2012). While there is a tendency for smaller social groups to be single sex and larger ones to

be mixed-sex, once group size exceeds four there is an increasing tendency for single sex conversations to become more common. These results are not a consequence of the locations at which the data were collected. We endeavoured to sample a wide variety of locations where natural social groups occur so as to avoid location-specific biases; indeed, it was clear that neither social group size nor conversation size differed significantly between the two major categories of location (indoor environments where movement might have been constrained by tables at which people sat vs outdoor locations where people could move about more freely).

There was some suggestion that very large conversations form because one sex is differentially attracted to join conversational groups that contain members of the other sex, but there is a striking sex difference in the patterns involved. Small mixed-sex conversations seem to develop because women are attracted to join them, but once more than about a quarter of the males in the social group become involved, women seem to withdraw from mixed-sex conversations (Fig. 7). Men, however, continue to be attracted to mixed-sex conversations. Only once more than about half the men in the group are in mixed-sex conversations will women rejoin. This suggests that women generally prefer to be in conversations with smaller numbers of males – unless most of the males in the social group are in the same conversation.

Fragmentation of social groups occurs frequently among mammals, and sexual segregation, in particular, has been a major topic of interest in research on medium and large ungulates (Main et al. 1996; Ruckstuhl & Neuhaus 2000, 2002; Bowyer & Kie 2004). Among the hypotheses that have been proposed for sexual segregation in ungulates have been sex differences in dietary needs, activity patterns or risk aversion with respect to predators, as well as social avoidance (usually of males by females with vulnerable young-at-heel). Although a difference in activity scheduling is probably the single most important

206 determinant of segregation in ungulates (Conradt 1998; Calhim et al. 2006; Dunbar & Shi
207 2008), there is some evidence to suggest that the social avoidance of overly-boisterous males
208 may be secondarily important in some cases (Calhim et al. 2006).

209 Most of these exogenous ecological explanations (predation risk, habitat and diet
210 preferences, foraging patterns) are unlikely to be relevant to human conversations, suggesting
211 that endogenous issues associated with social preferences are a more plausible explanation.
212 Of these, the most likely possibility is that women find the typical male conversational style
213 too confrontational and disconcerting (Coates 1993), and so are more likely to withdraw into
214 single-sex conversations when there are too many males in the conversation. This is only
215 likely to occur when the social group is large enough to allow two separate conversations to
216 emerge. Dunbar et al. (1995) noted that women increasingly became listeners rather than
217 speakers as the size of mixed-sex conversations increases. However, when most of the males
218 in a social group are part of the same mixed-sex conversation, women may be forced to
219 accept this as a cost rather than remaining in single-sex conversations.

220 It is possible that sex differences in preferred conversation topics might be responsible
221 for women's switch into single sex conversations once too many men are present in a
222 conversation. Although the relative frequency of different conversation topics is broadly
223 similar between the two sexes, one striking sex difference has been noted, namely a tendency
224 for men (but not women) to talk more about technical or work-related matters in mixed-sex
225 (but not single sex) conversations (Dunbar et al. 1997). To test between these two
226 possibilities (sex differences in conversational or social style versus sex differences in
227 conversation topics) would require a more detailed study of these behaviours with respect to
228 group size and composition.

229 The data from this study do not allow us to determine why there is a natural limit of
230 four for conversations. Indeed, it is still not clear why conversations fragment so readily at

around this size, and do so fractally as social group size increases. The fact that even single sex conversations exhibit this pattern (Fig. 2) suggests that it has nothing to do with the social forces that drive sexual segregation. Instead, it is likely to have something to do with limits on the processes of communication once the conversation circle gets too large, and hence reflects either difficulty in speech detectability or reduced opportunities for turn-taking. If turn-taking is the issue, the upper limit on conversation size at four suggests that people become dissatisfied if they are given less than about 20-25% of the conversation time (allowing for the possibility that this figure might be higher for extraverts and lower for introverts, as well as differ between the sexes).

There is some experimental evidence to suggest that people feel more engaged in the conversational process when conversation group size is small. Studies of juries have suggested that the conventional size of 12 members results in some members contributing little (and sometimes nothing at all) to the discussion (Kessler 1973; Sanders 1997). Waller et al. (2011) reported that, when subjects in a decision-making group of 12 (a ‘mock jury’) were divided into three subgroups of four, they felt that they had made more of a contribution to the group decision (and felt less inhibition about contributing) than subjects who did the experiment as a single group of 12, even though both groups came to exactly the same conclusion (verdict). While this provides promising prima facie evidence for this explanation, more detailed studies that follow conversations in real time are needed to show that individuals whose conversation share dropped below 20-25% were the most likely to break away and form a new conversation.

An alternative possibility is that focus (attention) may be an issue: it may be that it just becomes difficult to attend to more than four individuals at once in a group so as to coordinate one’s speaking behaviour with everyone. This might relate to mentalising abilities, since mentalising (or mindreading) may be crucial to being able to maintain the flow of

conversation by simultaneously integrating the perspectives and mindstates of the various members of the conversation group. Normal adult humans can typically cope with just five orders of intentionality (Kindermann et al. 1997; Stiller & Dunbar 2007; Powell et al. 2010), limiting them to handling just four others' mindstates in addition to their own. If the conversation involves the discussion of the behaviour, intentions or mindstate of someone not present (as it may often do in natural conversations), there will be a limit of four on the number of people that can maintain a coordinated conservation.

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Legends to Figures

Fig. 1. Distribution of social group sizes for male only (N=33), female only (N=46) and mixed-sex (N=213) groups.

Fig. 2. Mean (± 1 se) number of conversations in social groups of different size for single sex (open symbols, both sexes combined: N=79) and mixed-sex (solid symbols: N=213) conversations.

Fig. 3. Mean (± 1se) conversation group size as a function of social group size for single sex (open symbols, both sexes combined: N=79) and mixed-sex conversations (solid symbols: N=213). Note that sample sizes for groups ≥10 are very small (see Fig. 1).

Fig. 4. Mean percentage of all males (solid symbols) and all females (open symbols) in each mixed-sex social group that are in single sex conversations, as a function of social group size. N=213 mixed-sex conversations. Note that sample sizes for groups ≥10 are very small.

Fig. 5. Mean total number of males (solid symbols) and females (open symbols) in mixed-sex conversations, as a function of social group size. N=213 mixed-sex conversations.

Fig. 6. Mean number of males (solid symbols) and females (open symbols) in mixed-sex conversations, as a function of social group size. N=213 mixed-sex conversations.

Fig. 7. Mean (± 1 se) proportion of females in mixed-sex conversations plotted against mean proportion of males in mixed-sex conversations. The plotted variable is the proportion of all males/females in each social group. N=213 mixed-sex social groups.

366 **Figure 1**

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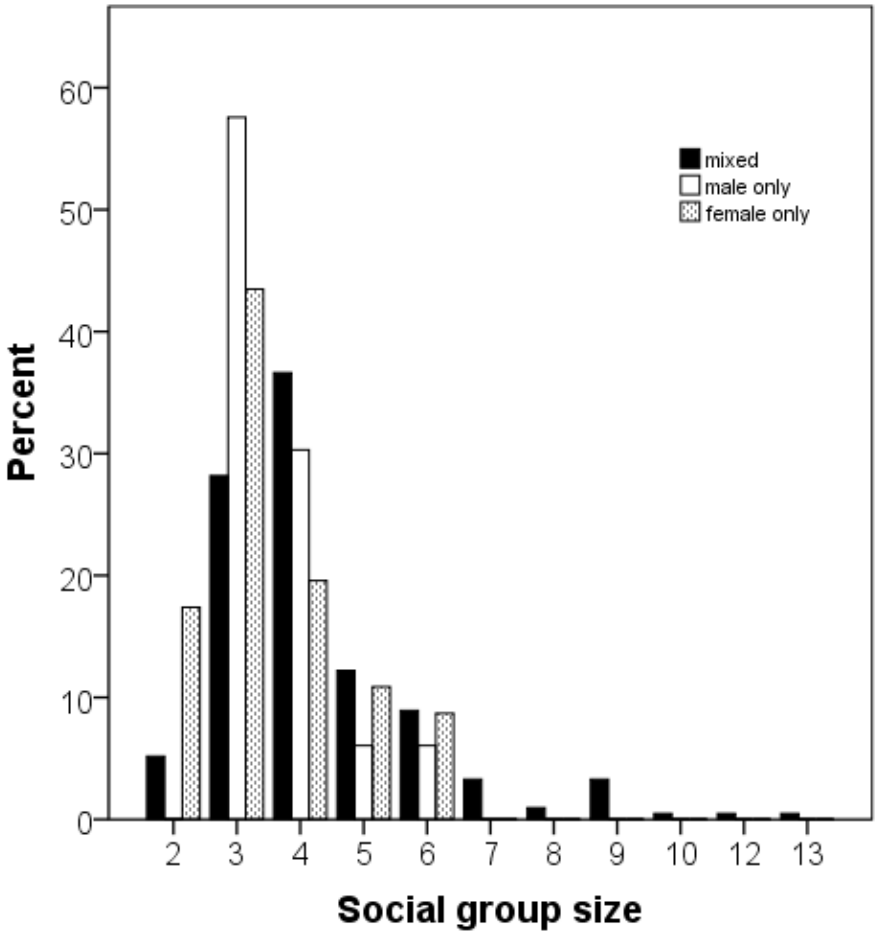

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370 **Figure 2**

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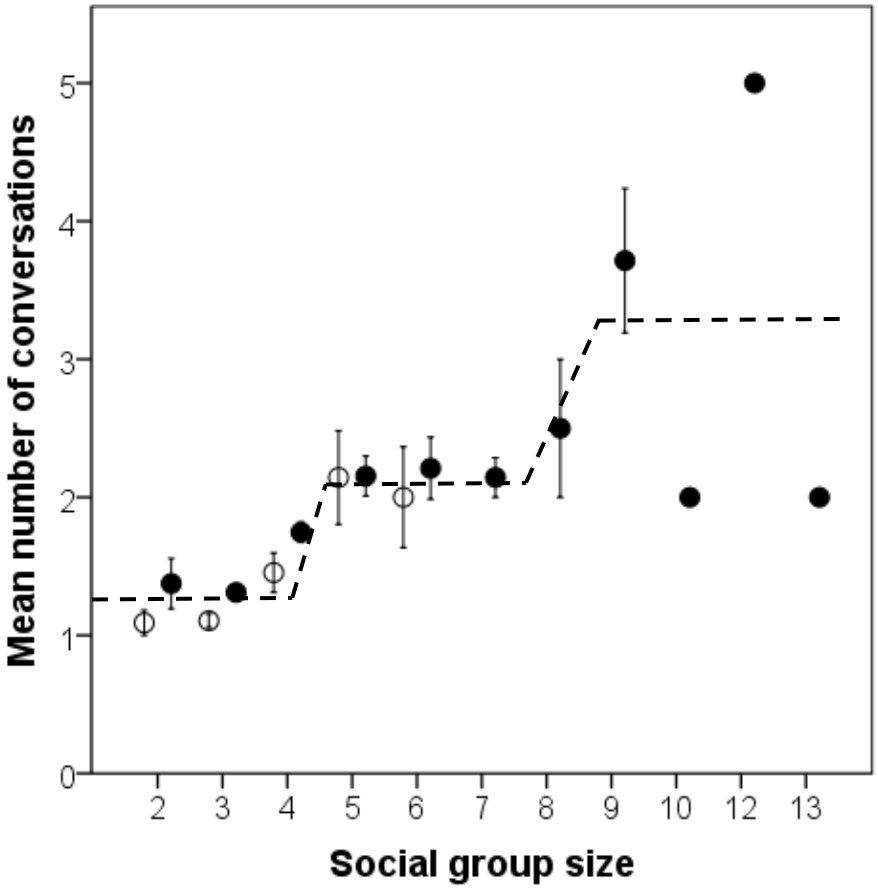

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374 **Figure 3**

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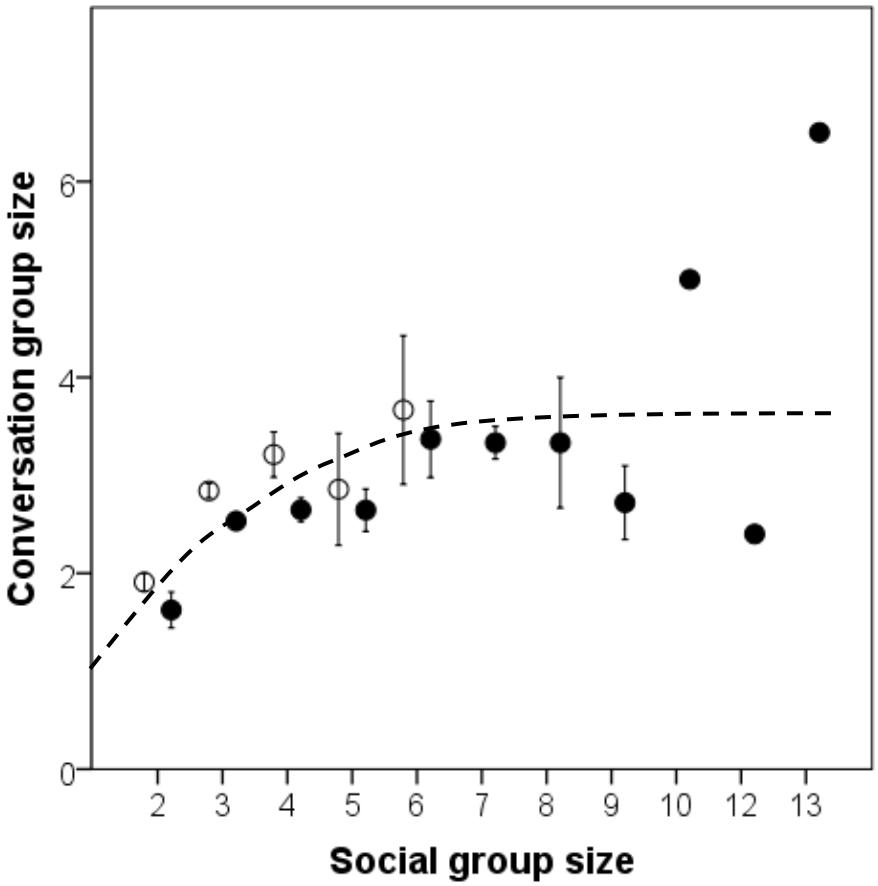

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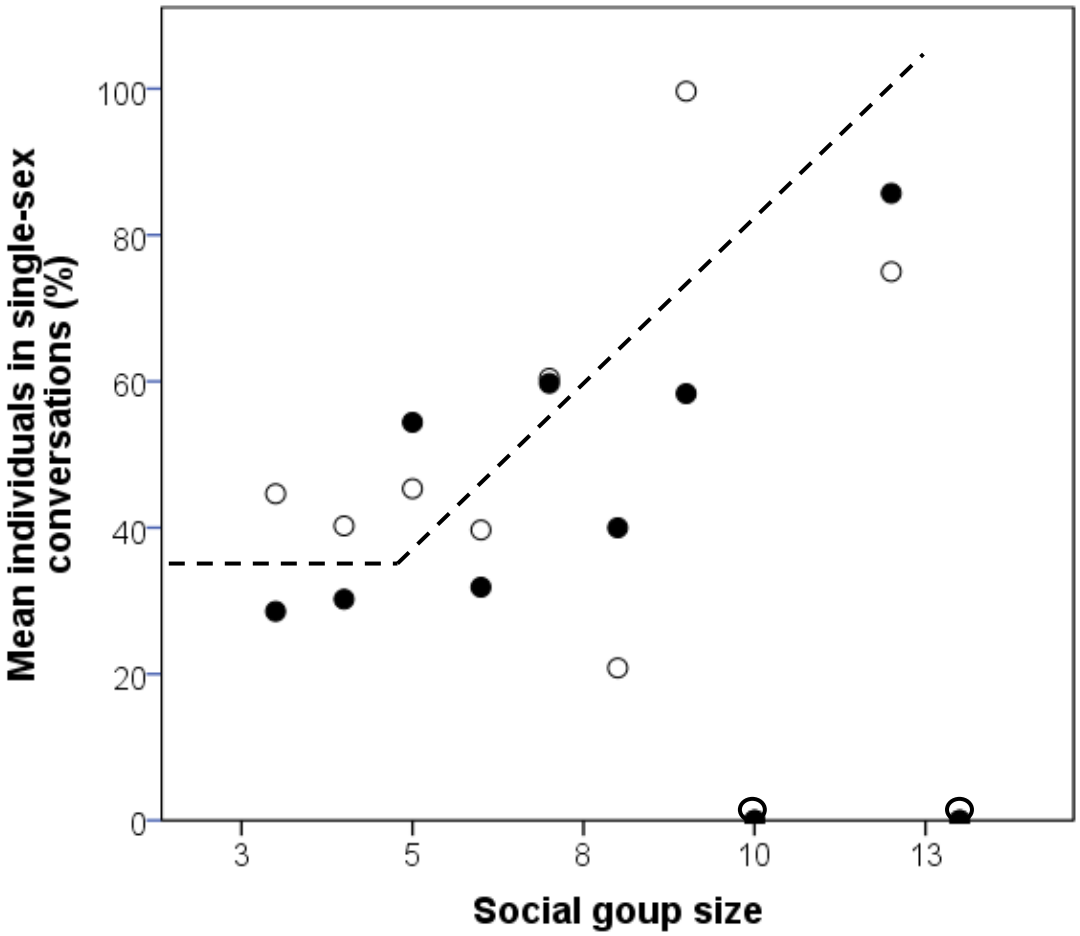
Figure 4


Mean individuals in single-sex conversations (%)
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3
5
8
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13
Social goup size

382 **Figure 5**

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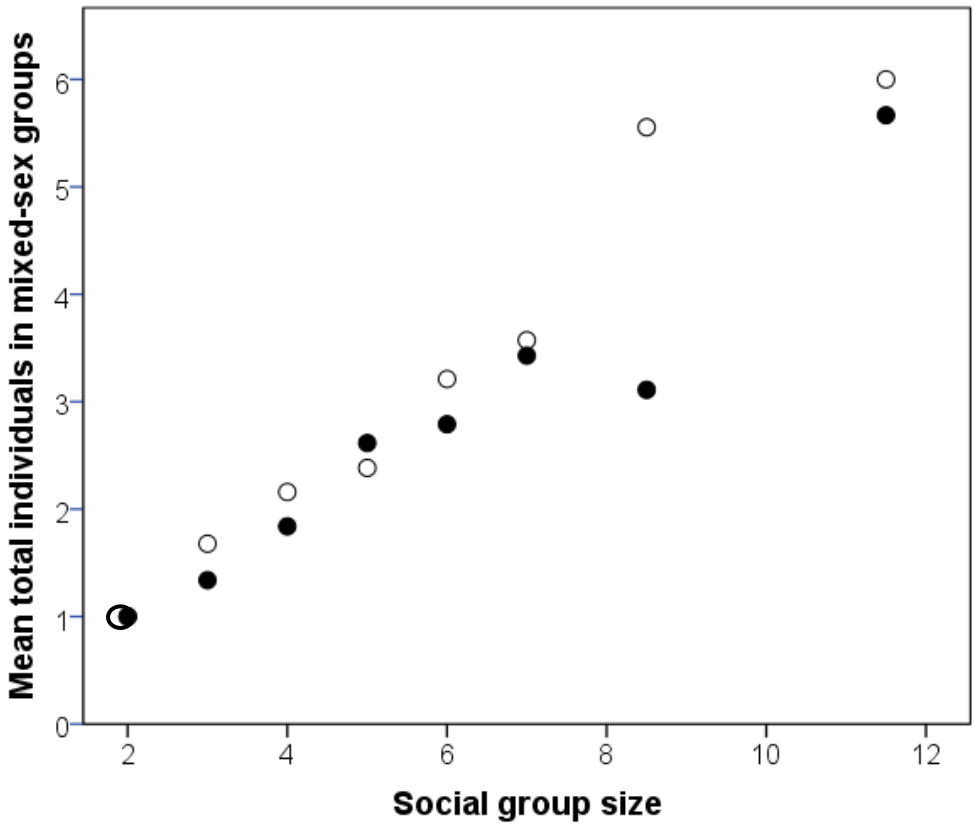

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386 **Figure 6**

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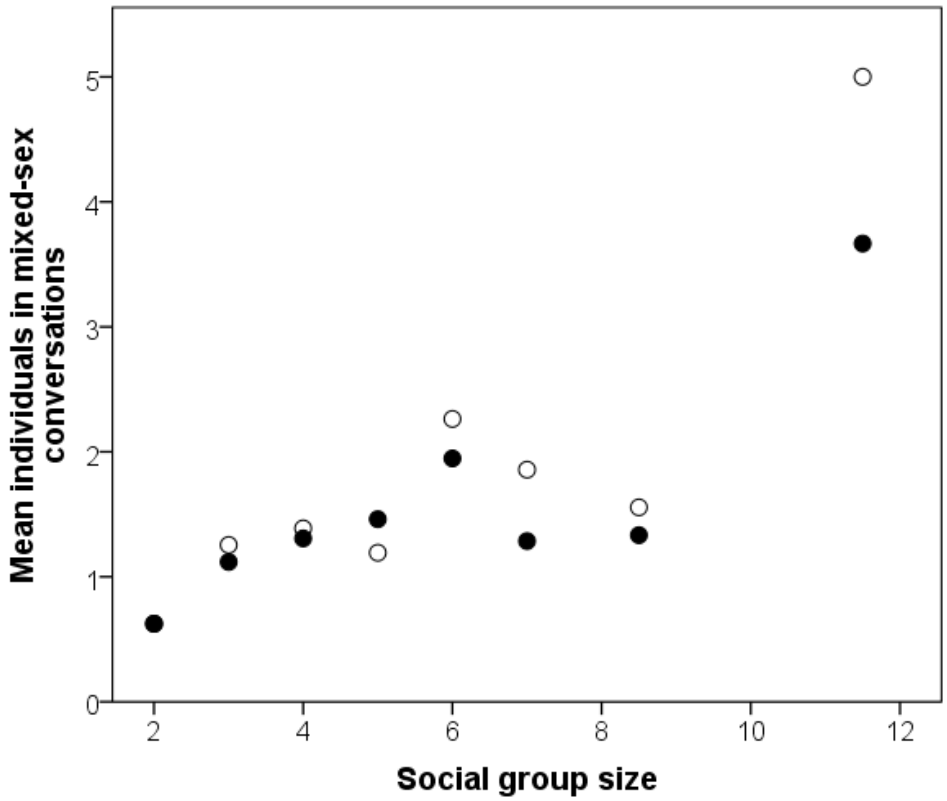

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390 **Figure 7**

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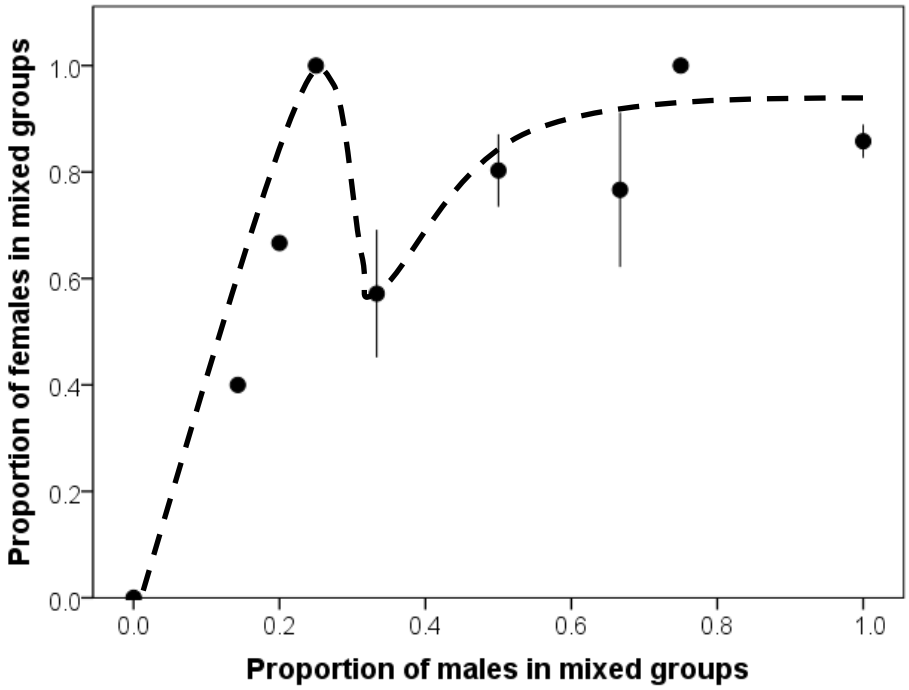

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