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Traveling Groups Stick Together: How Collective Directional Movement Influences Social Cohesion

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Abstract

We tested the hypothesis that the social act of moving through space with others—collective directional movement—is associated with greater levels of group cohesion compared to static activities. We asked participants to imagine participating in activities as part of a same-sex group and found that imagining going on a journey is associated with higher levels of expected cohesion compared to imagining attending a meeting (Study 1) or an event (Study 2). Study 3 replicates the main effect using different manipulations and finds that it persists regardless of whether the imagined group were friends or strangers. Two further studies employed real-world tasks and show that the effect is not a consequence of goal ascription (Study 4) or synchrony/exertion (Study 5). We argue that the link between this activity and cohesion is a consequence of its ubiquity in social ecologies and the interdependence and shared common fate of those engaged in it.

Keywords

group cohesion, travel psychology, behavioral synchrony, collective movements, directional movement

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Understanding how groups of individuals become cohesive units has been a focus of social psychologists for some time (see, e.g., Greer, 2012; Hogg, 1992). Cohesiveness can be defined as "the resultant of all forces acting on all the members to remain in the group" (Festinger, 1950, p. 274), and some of the things that have previously been shown to be linked to group cohesion include identifying with the group itself and with members of the group (Swann, Gomez, Jetten, Whitehouse, & Bastian, 2012; Van Vugt & Hart, 2004), shared humor between group members (Curry & Dunbar, 2013; Gervais & Sloan Wilson, 2005), and nonconscious mimicry of other group members' actions (Lakin, Jeffries, Cheng, & Chartrand, 2003). Collaborative activity offers adaptive benefits that would not be achievable through individual effort (Kameda, Vugt, & Tindale, 2015), but in order for collaborations to be successful, the individuals involved must necessarily be cohesive to some extent. For this to happen, members must experience prosocial sentiments toward each other and calibrate their behavior with respect to the group's activities accordingly. Given that collaborative activities are dynamic and heterogeneous, one would therefore expect that the degree of prosocial sentiment that individual group members experience (and thus the degree to which the group can be said to be cohesive) would be highly sensitive to contextual factors including relevant features of the group itself, the activity that the group is engaged in, and the context in which the group operates (see Kameda & Tindale, 2006, for similar arguments). In one study, Mitkidis, Sørensen, Nielbo, Andersen, and Lienard (2013) asked groups of strangers to collaborate on a block-building task and found that groups who shared knowledge of the goal that they were trying to achieve were subsequently more generous to each other in an anonymous economic game compared to groups who performed exactly the same building task but did not know in

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advance what their final goal was. From an evolutionary point of view this makes sense: Feeling positive toward those whom you know share your goals (and behaving in accordance with these sentiments) will bring adaptive benefits by making your goals more likely to be achieved, and so we might expect selection pressures to have favored psychological systems that enable this by adjusting prosocial sentiment upward in the appropriate context.

In this article, we aim to further extend our understanding of what factors influence group cohesion by identifying an adaptive activity that could reasonably be considered to have been a recurrent and ubiquitous feature of ancestral social environments, such that it became a "target" for selection processes, eventually resulting in the emergence of regulatory systems to facilitate it (see Tooby, Cosmides, Sell, Lieberman, & Sznycer, 2008, for a discussion of how such regulatory systems might operate; see Barrett, 2015, on how invariants in the social environment can drive selection). Such activities are probably rare and difficult to identify, but we propose one that we believe merits attention: *traveling with others*. We suggest that this behavior, which might alternatively be called *collective directional movement* (CDM), is a social behavior characterized by the feelings of cohesion experienced by those engaged in it.

What we are calling CDM is simply the social act of leaving one place and moving to another, from A to B. Whenever an organism moves from one place to another, for whatever reason, it is taking some kind of calculated risk (see Higginson & Ruxton, 2015, for a discussion on this from a foraging perspective). Almost all journeys will involve unknown factors to some extent, so if an organism is currently safe and its prime concern is to remain safe, then the most sensible thing for it to do is to stay where it is. Most mobile organisms, however, will eventually be motivated to move (Wilkinson, 2016), which means facing all of the potential dangers and uncertainties that go along with getting from one place to the next. Natural selection has provided many strategies for managing such risks, one of which is to have conspecifics whose interests overlap with your own make the journey with you; there is safety in numbers. It is not uncommon for organisms to organize themselves to collectively move in the same direction for mutual benefit (see Boinski & Garber, 2000, for an overview) and such behavior is observed in both invertebrates (e.g., insects and earthworms; Bonabeau, Theraulaz, Deneubourg, Aron, & Camazine, 1997; Zirbes, Deneubourg, Brostaux, & Haubruge, 2010) and vertebrates (e.g., primates and sheep; Fichtel, Pyritz, & Kappeler, 2011; Ramseyer, Boissy, Dumont, & Thierry, 2009). On a larger scale, several species of land mammal famously migrate in large groups, often covering hundreds of miles as they do so (see, e.g., Avgar, Street, & Fryxell, 2014) while many species of bird behave similarly (Berthold, 2001). Indeed, large-scale migratory behavior has been traced back to dinosaur species, demonstrating how pervasive such behaviors are likely to have been over deep time (see Fricke, Hencecroth, & Hoerner, 2011).

Understanding the nature of such collective behavior has been a recent focus of research and much progress has been made in discovering the decision processes and other causal factors that govern how and why groups of animals coordinate themselves to collectively move through space (e.g., Couzin, 2008; Couzin, Krause, Franks, & Levin, 2005; Petit & Bon, 2010; Pyritz, Fichtel, & Kappeler, 2010; Rands, 2010; Strandburg-Peshkin, Farine, Couzin, & Crofoot, 2015). For example, Strandburg-Peshkin, Farine, Couzin, and Crofoot (2015) report that the decisions of groups of wild baboons to move collectively are not due to the influence of dominant individuals and are instead the consequence of a more egalitarian process linked to the cohesion of the group. Similarly, Couzin, Krause, Franks, and Levin (2005) present a model showing how group movement decisions might be influenced by group members holding relevant information, reporting, for example, that larger groups require a smaller proportion of informed individuals to guide the group's decision to collectively move.

One thing that CDM activities have in common is that, for each individual in the group, it pays to be "on the same side" as those with whom they are traveling, even if there are other contexts or social situations in which it might pay to act differently. Given that the act of moving from one place to another involves inherent uncertainty, members of a group undertaking this behavior are necessarily interdependent to an extent that they would not be in a static situation (assuming that all other relevant factors are equal). Indeed, one might argue that members of groups engaging in CDM share an acute "common fate" during the course of their journey, a concept that has long been linked to cohesiveness (see Campbell, 1958).

Generally, then, we argue that CDM is an adaptive social behavior and we suggest that at least some of the mental mechanisms associated with it act by increasing levels of cohesion between those engaged in it. We suggest that this is the result of selection pressures acting on such mechanisms due to the adaptive benefits that CDM offers (e.g., mutual protection) in conjunction with the specific features of the activity itself (e.g., interdependence between group members during an activity involving potential risks and uncertainties).

A similar logic can be applied specifically to human groups. Every day across the world humans join with other humans and physically move together through their shared environments, for a multitude of reasons. Travel companions can act as useful collaborators on mutually beneficial projects that might be linked to the journey in some way, and many human journeys are undertaken primarily as collaborations for mutual benefit. Many hunting/gathering activities, for example, involve small groups traveling away from the relative safety of their home base toward their shared goal (see Kelly, 2007), and on a much larger scale, one might argue that a migratory tendency exists in our species and may have contributed significantly to our evolution (Garcea, 2016).

Moving together as part of a group has previously been found to have psychological effects on humans. For example, Gallup, Chong, Kacelnik, Krebs, and Couzin (2014) demonstrated that pedestrians respond differently to potentially negative social cues when walking alone compared to when walking as part of a group. This arguably relates to the common fate that group members share when moving together (see Ward, Herbert-Read, Sumpter, & Krause, 2011, for a similar finding in shoals of fish). Gallup et al. (2014) suggest that their finding might be explained as a consequence of "group affiliation" influencing how people monitor their environment for threats.

But where does this feeling of affiliation come from? Do traveling groups already have preexisting bonds that support them during their journey, or does the journey itself help foster cohesion? In the current article, we focus on the latter suggestion.

CDM in humans is usually (but not necessarily) a collaborative activity. Keeping any collaborative group cohesive for the duration of its collaboration is essential given the link between cohesion and performance (Evans & Dion, 1991; Mullen & Copper, 1994), but keeping a *traveling* group cohesive seems to demand something extra given the additional level of interdependence that this activity entails. CDM permeates human social life, so in addition to the general arguments outlined above for considering it as an adaptive behavior in the wider biological world, we further suggest that human cooperative activity can essentially be classified into two distinct kinds: (1) the kind in which the goal could be achieved in the same location that the group was formed (or at some other specified location at which the collaborators independently convene) and (2) the kind in which the goal could only be achieved (or could be achieved most optimally) if the group travels together toward it. It is our assertion that there is a substantive difference between these two broad classes of activity in terms of the cohesion associated with engaging in them and that this can be empirically examined.[1]

In the psychological literature, the research that is most relevant to this question is that concerning the effects of behavioral synchrony on social cognitive function (see, e.g., Hove & Risen, 2009; Lakens, 2010; Launay, Dean, & Bailes, 2013, 2014; Macrae, Duffy, Miles, & Lawrence, 2008; Valdesolo & Desteno, 2011; Wiltermuth & Heath, 2009). Wiltermuth and Heath, for example (Study 1), had an experimenter lead participants on a walk around a campus, with groups walking either in or out of synchrony with each other, and found that groups who walked in synchrony subsequently showed more cooperative tendencies toward group members compared to those who walked out-of-step. These authors attribute this specifically to the bonding effects of synchronous action, but it is also possible that the directional nature of the activity contributed to the effect. This is potentially important given that, as argued above, CDM is likely to have had a long evolutionary history and could arguably be considered as an early example of collective action between individual organisms.

The hypothesis that we test in the current studies, therefore, is that traveling with others from one location to another is associated with elevated group cohesion compared to activities that are static in nature. Our first three studies test this by asking participants to imagine being part of a same-sex group engaging in either CDM or static activities. Studies 4 and 5 involved participants actually engaging in CDM/static activities as part of a same-sex group. We chose to limit group membership to same-sex groups because previous research has found that cohesion in groups undertaking a walking task is reduced when the group consists of both males and females compared to when the group consists of only males or only females (see Shapcott, Carron, Burke, Bradshaw, & Estabrooks, 2006; also see General Discussion section). Given that our primary hypothesis concerns the effects of CDM, we decided not to include factors relating to group composition that might potentially interact with our measure of cohesion.

Study 1

We predicted the following: When asked to imagine engaging in a social scenario, participants will report higher levels of imagined group cohesion when the scenario involves CDM compared to when it does not.

Method

For each study described in this article, an application for ethical approval was submitted via the host institution's review process. After being assessed and deemed ethical, the application was signed-off by the relevant authority and permission for data collection was granted.

Prior to all experiments, participants were invited to read an information sheet describing their rights as participants, the nature of the research, and the procedure that they would go through should they consent to participation. After this, they were presented with a separate paper consent form to sign.

Fifty-nine participants (mean age 21; 13 male, 46 female) took part. A mixed design was employed, with the primary hypothesis being tested in a repeated-measures design and a between-groups component to test for possible order effects.

Participants were asked to imagine taking part in two social scenarios, only one of which involved CDM. After each scenario, they rated how much group cohesion they would expect to experience as a result of taking part in the imagined activity using a 10-item measure, responses to which were on a 7-point Likert-type scale. The items were chosen on the basis that they reflected some aspect of group cohesion. They asked about trust between group members, the closeness of the relationship between group members, levels of bonding, shared humor, camaraderie, friendship, rapport, cooperation, enjoyment of group membership, and likelihood of collaborating in the future[2] (see Supplementary Materials).

The scenarios were in the following format (italicized components appropriate to condition): *We would like you to imagine that you are part of a small group of people who are traveling on an important journey/attending an important meeting together in a remote part of the country. The journey/meeting will last for 3 days. During the journey/meeting, you will have no contact with anyone else except the members of your group. All members of the group are the same sex as you. Please take a moment to think about what this experience would be like.*

Table 1. Cohesion Scores and Statistical Comparisons for Study 1.

	Mean Cohesion [95% CI]		
Condition	Overall (Repeated Measures)	Seen First (Between Groups)	Seen Second (Between Groups)
Journey meeting	4.51 [4.27, 4.75]	4.63 [4.31, 4.94]	4.38 [4.00, 4.76]
	3.75 [3.53, 3.96]	3.97 [3.68, 4.26]	3.54 [3.20, 3.88]
t Test (one-tailed)	$t_{54} = 4.54$, $p < .001$	$t_{53} = 3.12$, $p = .002$	$t_{53} = 3.41$, $p < .001$
Effect size (original units)	0.75 [0.42, 1.08]	0.65 [0.26, 1.06]	0.84 [0.36, 1.32]
Cohen's *d*	.62	.85	.92

The order in which the scenarios were presented was counterbalanced. Participants were instructed to try to get a clear picture in their heads of what it might be like to be a part of the group engaging in the activity described and to think about the social dynamics of the group during the imagined activity. They were allowed to do this at their own pace with the instruction that they should only proceed once they had felt they had achieved this. Although we did not measure how long people spent engaging with the scenarios, there did not seem to be noticeable variance in how long people spent thinking about them. There was also a short engagement check designed to ensure that participants had engaged with the scenarios appropriately.[3] It took approximately 20 min for participants to complete all of the tasks.

Results

Two participants were removed from the analysis on the basis of their responses to the engagement check. One of these was due to elaboration beyond the given scenario when asked to recount what the scenario involved. The other was removed because of she or he provided a commentary on their emotions instead of a summary of the scenario that they were asked to imagine.

The cohesion instrument demonstrated good reliability (Cronbach's $\alpha = .89$). After initial data analysis, a further two participants were removed for having a mean cohesion rating that was an outlier in one of the conditions (for the remainder of this article, outliers are defined as being those scores that are two or more standard deviations away from the mean).

For the analyses, 95% confidence intervals (in square brackets) and effect sizes will be reported alongside means and traditional *p* values. Cohen's *d* values were calculated using the average of each mean's individual standard deviation. When Cohen's *d* was calculated for related data, the correlation between the means was used to correct for dependence using Morris and DeShon's (2002) equation 8.

A 2 × 2 mixed analysis of variance (ANOVA) revealed a significant main effect of condition: $F(1, 53) = 21.59, p < .001$. No main effect was found for the order of testing: $F(1, 53) = 0.32, p = .572$. A significant interaction was observed between condition and order: $F(1, 53) = 4.41$, $p = .041$. Further analyses revealed that the source of this interaction was due to a larger effect in the predicted direction when the CDM condition was completed second compared to when it was seen first. Descriptive statistics and simple-effects analyses are presented in Table 1.

The results suggest that the effect does not depend on participants comparing the two scenarios (and so is not dependent on a repeated-measures design). Although the results support the hypothesis, the nature of the control scenario was not ideal. Study 2 was conducted with the intention of replicating the effect using a different control condition.

Study 2

Study 2 aimed to replicate the results of Study 1 while addressing one obvious methodological issue. The non-CDM control condition in the previous study asked participants to imagine attending a "meeting." This may have resulted in responses to this condition being influenced by a stereotypically negative view of meetings and their association with work. The current study used a more neutral term to denote the control scenario.

Method

Forty-one participants took part (mean age 22; 7 male, 34 female). The same design, materials, and procedure were used as described in the previous study, with one difference: The static (non-CDM) condition was reworded to replace the word "meeting" with the word "event."

Results

Five participants were excluded from the analysis. One of these was because the participant failed to provide any responses to the second scenario, while four were excluded due to providing insufficient descriptions of the scenario in the engagement check (in all of these cases, participants failed to make a distinction between the two scenarios, stating that they both involved traveling). One outlier was also removed. The measure of cohesion was reliable: Cronbach's $\alpha = .76$.

When participants imagined taking part in a "journey," the mean cohesion was 5.14 [4.90, 5.38]; when they imagined taking part in an "event," the mean cohesion was 4.81 [4.51, 5.11]. Effect size in original units is 0.33 [−0.01, 0.67], Cohen's $d = .34$.

A 2 × 2 mixed ANOVA confirmed this main effect of condition: $F(1, 33) = 4.39, p = .044$. No main effect was found for the order in which the scenarios were seen: $F(1, 33) = 0.36$,

p = .55, and there was no significant interaction between condition and order: $F(1, 33) = 3.43$, p = .07.

Discussion for Studies 1 and 2

The results from our initial experiments suggest that "going on a journey" is associated with greater levels of expected cohesion compared to either "attending a meeting" or "attending an event." This does not seem to be due to the experimental design. Our main hypothesis is supported but questions remain. The effect sizes in Study 2 are smaller than in Study 1. This raises the possibility that the effect is an artifact of the way we manipulated the independent variable. Additionally, it could be argued that people are just more likely to think of friends and/or family when imagining going on a journey compared to attending a meeting or an event. Study 3 was conducted to further explore these questions.

Study 3

For Study 3, we manipulated the social relationship between the participants and their imagined group by explicitly stating whether they were to imagine undertaking the described activity with friends or with strangers. Additionally, we used a new way of presenting the manipulation of interest. Finally, along with the cohesion instrument, we also included a measure that asked participants to rate how much they imagined each cohesion construct (e.g., trust in group members) changing during the course of the described activity.

Method

Ninety-four participants took part (mean age 21; 22 male, 72 female). A mixed design was employed. Participants were asked to imagine taking part in two social activities, one involving CDM and one not; one involving friends and one involving strangers. These factors were fully counterbalanced across the sample as was the order of presentation. The scenarios were as follows (italicized components were appropriate to condition): *We would like you to imagine that you are part of a small group of friends/strangers who will be spending the next three days traveling/living together. All members of the group are the same sex as you. Please take a moment to think about what it what this experience would be like.*

The same 10-item cohesion instrument used in the previous studies was used. Additionally, after each cohesion item, we also asked participants to rate the level of change in that construct over the duration of the imagined activity. This was measured on a scale that ranged from −4 (*significantly decreased*) to +4 (*significantly increased*). We also asked participants to tell us how many members constituted their imagined groups and used new engagement-check questions (see Supplementary Materials).

Results

Eleven participants were removed from the analysis. Six of these were because in the engagement check they mentioned an activity involving CDM (e.g., going for walks/hikes) when asked to describe how they imagined the static condition. Three participants did not distinguish between the scenarios, one participant did not complete the second condition, and one participant did not complete the engagement questions. Three outliers were also removed from the cohesion analysis. There was no difference between how many other people were imagined to be in traveling groups compared to static groups (mean group sizes: 3.23 and 3.27, respectively). Again, the cohesion instrument demonstrated good reliability (Cronbach's $\alpha = .96$).

For the cohesion measure, 2 × 2 mixed ANOVA revealed a significant main effect for the imagined activity: $F(1, 78) = 19.38$, $p < .001$ and a significant interaction: $F(1, 78) = 251.02$, $p < .001$. The nature of this interaction can be seen in Figure 1. All simple-effects analyses were statistically significant. The effect size in original units for the overall difference between the CDM condition and the static condition is 0.82 [0.23, 1.41], Cohen's $d = .31$. When participants imagined participating with friends, the effect size in original units is 0.61 [0.24, 0.98], Cohen's $d = .77$. When participants imagined participating with strangers, the effect size in original units is 0.68 [0.19, 1.17], Cohen's $d = .61$.

Responses on the cohesion-change items were summed to give a single measure of change. Six outliers were removed from this analysis. A 2 × 2 mixed ANOVA revealed a main effect for imagined activity: $F(1, 75) = 7.45$, $p = .008$ and a significant interaction effect: $F(1, 75) = 14.65$, $p < .001$. The nature of the interaction is shown in Figure 2.

Comparisons theoretically relevant to the current hypotheses are presented in Table 2.

Discussion for Study 3

Using a new manipulation of the independent variable, the results of Study 3 further support our main hypothesis. Imagined cohesiveness was higher when the social situation implied CDM (traveling together) compared to when it did not (living together), and this was true whether the imagined travel companions were friends or strangers.

The results from the cohesion-change measure suggest that people expect the act of traveling to have a larger causal effect on the cohesiveness of their imagined group compared to the static condition. Although the data suggest that this effect may apply to friends more than it does to strangers, it should be noted that the cohesion-change scores for the two strangers' conditions were higher than the scores in the corresponding friends conditions. Although comparing friends and strangers was not a primary hypothesis of the current study, we conducted post hoc tests on these data and confirmed that cohesion change between strangers was significantly larger than that found between friends, for both CDM and static conditions (travel: $t_{75} = 2.09$, $p = .04$; living: $t_{75} = 2.31$, $p = .024$,

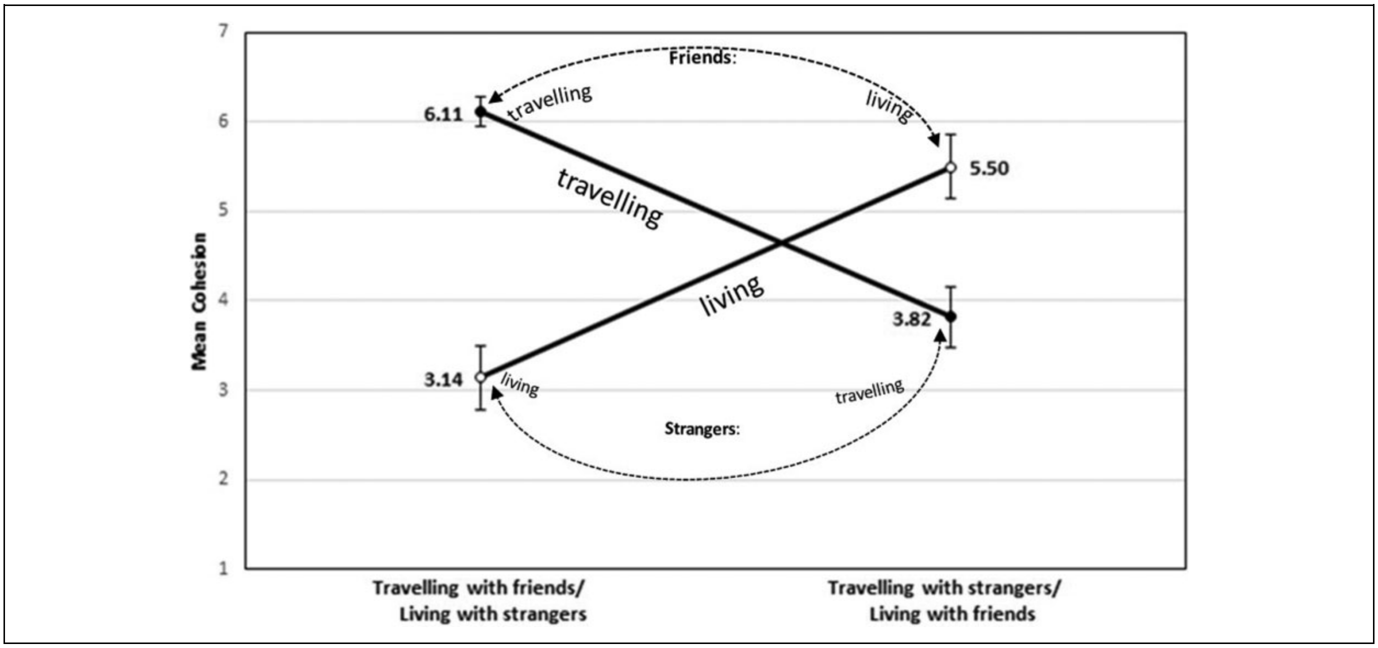

Figure 1. Interaction between mean cohesion scores across conditions. Error bars represent 95% confidence intervals.

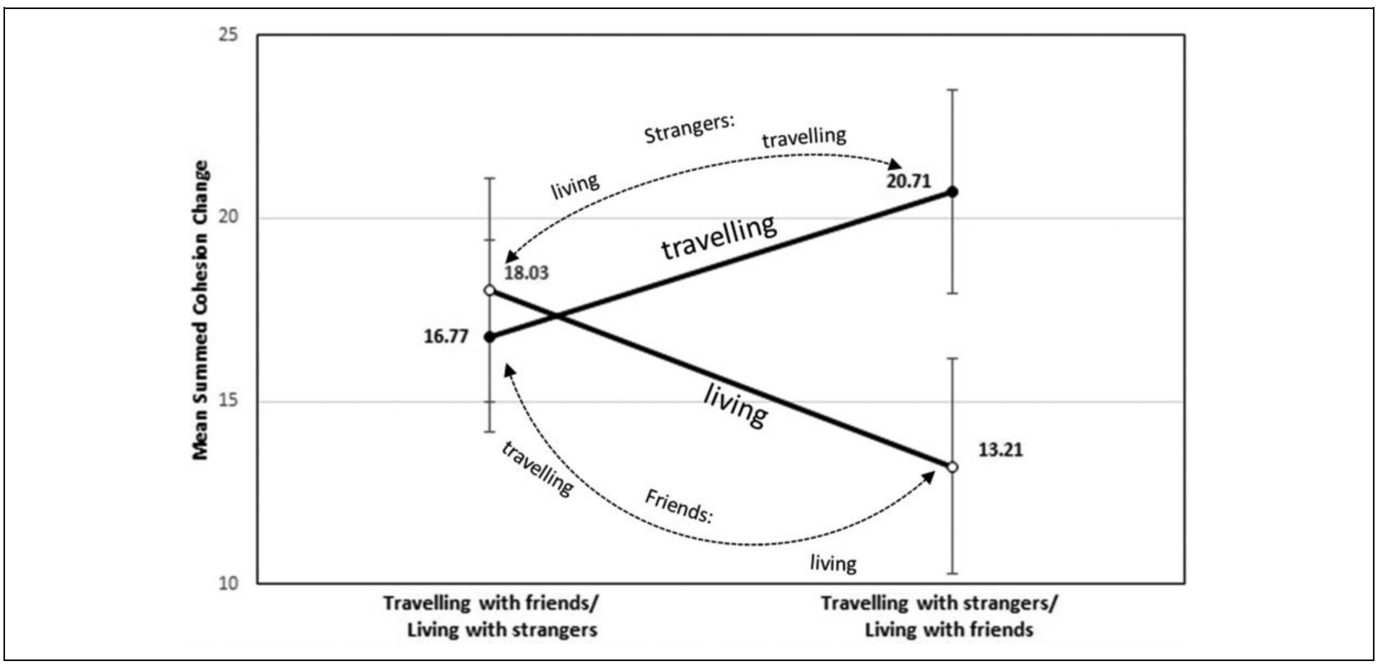

Figure 2. Interaction between mean cohesion-change scores across conditions. Error bars represent 95% confidence intervals.

two-tailed tests). This is unsurprising, given that engaging in an activity with a group of strangers requires cohesion to be established from zero if the activity is to be successful, whereas for groups of friends, the prior relationships already exist, meaning that we might expect lower change scores in the "friends" condition. The seemingly larger effect in this condition appears to be a consequence of the way in which prior relationship interacts with the imagined activities. When relationships are already established, imagining living together could arguably evoke expectations of conflict which would explain the depreciated cohesion-change scores in the friends/living condition. In contrast, the strangers/traveling condition is likely influenced by both the manipulation of interest (CDM) and the fact that establishing a successful collaborative group of strangers requires a change in cohesion from zero upward. This manifests as the interaction displayed in Figure 2, in which it can be

Table 2. Mean Summed Change Scores [and 95% Confidence Intervals] Along With Effect Sizes and *t*-Test Results.

	Summed Change Scores [95% CI]		
Condition	Overall (Repeated Measures)	Friends (Between Groups)	Strangers (Between Groups)
Living together (static)	15.65 [13.51, 17.79]	13.21 [10.27, 16.15]	18.03 [14.99, 21.06]
Traveling together (CDM)	18.71 [16.80, 20.63]	16.77 [14.15, 19.39]	20.71 [17.93, 23.49]
Effect Size (original units)	3.06 [0.24, 5.88]	3.56 [−0.25, 7.37]	2.68 [−1.30, 6.66]
t Test (one-tailed)	$t_{76} = 2.47$, $p = .008$	$t_{75} = 1.83$, $p = .036$	$t_{75} = 1.32$, $p = .10$
Cohen's *d*	.28	.42	.30

Note. CDM = collective directional movement.

seen that the differential between the two scenarios in the TravelingStrangers/LivingFriends version was larger than that observed in the TravelingFriends/LivingStrangers version.

Despite this interaction suggesting that participants imagined the dynamics of groups of friends to be different to those of groups of strangers, there is still the possibility that the effects observed are a consequence of the way in which participants imagined the groups that they were asked to think about. Even though we made the distinction between friends and strangers, it is still possible that participants simply imagined more positive companions in the CDM conditions than in the static conditions.

In order to establish a causal effect of CDM, our final two studies aimed to address these issues by asking strangers to undertake tasks that either involved CDM or did not and then measuring how cohesive they felt. These studies were conducted with the aim to test the hypothesis under "real-world" conditions while also addressing two issues of control. Study 4 was designed to hold the group's ultimate goal constant (cf. Mitkidis, Sørensen, Nielbo, Andersen, & Lienard, 2013) while manipulating the manner by which the goal is achieved (CDM in one condition; static in the other). Study 5 was designed to control for behavioral synchrony (e.g., Hove & Risen, 2009) by including a control condition in which participants acted in synchrony but did not engage in CDM.

Study 4

We asked groups of strangers to collaborate on a task, the completion of which required the group to use a map and a set of directions to identify the location of a target object. In this way, the goal for each group was held constant. They used these directions to either travel together toward the target location (the CDM condition) or follow the route to the target location on the map without leaving the testing room (the static condition). After completing the task, we measured their cohesiveness and asked them to take part in a one-shot economic game with an anonymous member of their group.

Method

Fifty-six participants took part (mean age 21; 28 male, 28 female) in 14 same-sex groups of 4 (7 groups per condition). We used a modified version of the cohesion measure consisting of 8 items framed as being in relation to the prospect of the group undertaking an unspecified new task in the near future (see Supplementary Material). One item was removed because it asked about trust and we didn't want to prime this concept in advance of the economic game. Another item was omitted as it asked about future group activities. As the questions were framed in terms of a near-future activity, this question was deemed moot. Three questions were added that related to task engagement: "How easy/enjoyable/entertaining did you find the task?" (1 = *not at all*, 7 = *very*). A map of the university campus was created and is reproduced below (Figure 3). A booklet was provided that consisted of 10 directions that led from the starting point on the map to the target location. These directions were interspersed with orienting questions that asked the group to identify landmarks along the route.

The public goods game is widely used in behavioral economics (see, e.g., Ostrom & Walker, 2003). The version that we used was a one-shot anonymous version of the game (see Mitkidis et al., 2013). It is considered to be a measure of trust between players. We measured both the actual investments of each participant and how much they expected their anonymous partner would invest.

Sessions were conducted by four people (S.W., A.D., and two others who were blind to the hypothesis, M.M. and E.B.). Steps were taken to ensure that participants were strangers and they were met individually so as to avoid any CDM from meeting point to testing room prior to participation. After being allocated to a condition and introduced to the task, groups followed the directions provided in conjunction with the map in an effort to identify the location of the target object. In one condition, the groups did this without leaving the lab (reporting their responses to an experimenter located in the corridor outside the lab). In the CDM, condition groups followed the same directions but actually traveled together toward the target location (recording their responses on paper as they went along) and then came back to the lab once they had found the target object. In both conditions, it was left up to the group to decide who recorded (CDM condition) or reported (static condition) responses to the orienting questions. Because of potential disparities in the time taken to complete the respective tasks, the experimenters were instructed to delay their feedback to groups in the static condition if the group appeared to be close to completing the task in under 10 min (10 min was the time that it took most groups to complete the CDM version of the task).

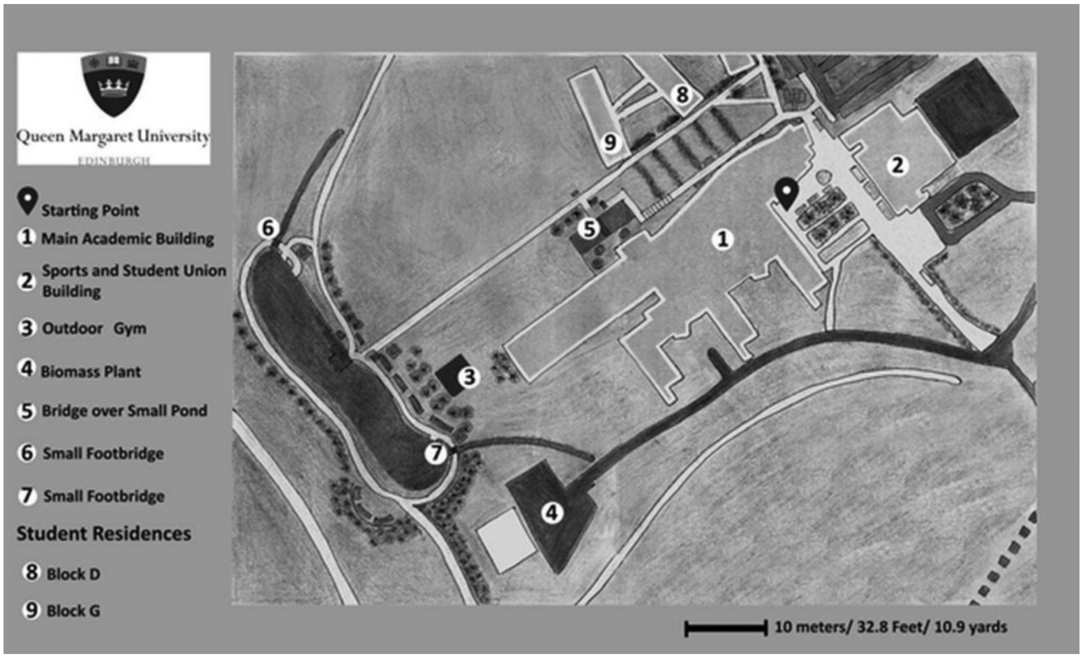

Figure 3. Map of campus provided to participants in Study 4.

This involved having the experimenter at the door of the lab receive the group's responses and then "check" their answers with the second experimenter who was located at the end of the corridor before providing feedback to the group. Doing this allowed the experimenters to delay any static groups who seemed to be completing the task quickly and ensured that the task took approximately 10 min to complete.

On completion of the task, participants were separated and the cohesion measure and public goods game were administered. The public goods game was explained in the response booklet with graphics and examples (see Supplementary Materials). Participants had to complete a short series of "training" investments in which they were presented with a series of incomplete examples and had to complete the missing values. This ensured that participants understood the economic game. Participants who could not correctly complete at least 50% of these were excluded from any analysis involving the economic game.

Results

The 8-item version of the cohesion measure displayed good reliability: Cronbach's $\alpha = .86$.

Because of the hierarchical nature of the design (individual participants grouped into units of four), there is a possibility of dependence in the data. One way to address this would be to run the analysis at the level of the group, but the consequence of doing this is a loss in statistical power ($N = 7$ per condition). To determine whether dependence was an issue, the data were subjected to a multilevel analysis, with individual participants considered as the first level and group as the second level. If dependence is present, the second-level model (describing variance attributable to group membership) should differ from the first-level model (describing variance attributable to individuals). For all three dependent measures (cohesion, investment, and expected investment), this analysis revealed that the group level contributed negligible variance to the basic model and the change statistics were identical for the single-level and group-level models.[4] Given this finding, and due to the increase in statistical power resulting from the loss of a degree of freedom, we therefore proceeded with analysis at the individual level.

After the removal of outliers, cohesion scores were $M_{\mathrm{CDM}} = 4.45$ [4.14, 4.76]; $M_{\mathrm{static}} = 3.93$ [3.65, 4.21]. Effect size in original units is 0.52 [0.12, 0.92], Cohen's $d = .70$: $t_{52} = 2.57$, $p = .007$, one-tailed.

For the public goods game, participants were excluded from the analysis if their score was an outlier on the respective measure or if they failed to achieve 50% correct in the training task ($n = 12$). Two further participants did not attempt the training task and one participant withdrew from the study during the economic game.

For the actual amount invested: $M_{\mathrm{CDM}} = 4.18$ [3.57, 4.79]; $M_{\mathrm{static}} = 3.93$ [3.43, 4.44]; effect size in original units: 0.25 [−0.49, 0.99], $t_{38} = 0.65$, $p = .26$ (one-tailed), Cohen's $d = .21$.

For the expected investment from partner: $M_{\mathrm{CDM}} = 3.97$ [3.38, 4.56]; $M_{\mathrm{static}} = 3.35$ [2.88, 3.12]; effect size in original units: 0.62 [−0.08, 1.32]; $t_{38} = 1.75$, $p = .044$ (one-tailed), Cohen's $d = .55$.

Table 3 displays correlations between measures in both CDM and static conditions. Cases were excluded if they were outliers on the primary cohesion measure or on either of the measures being correlated. For correlations involving the

Table 3. Correlations Between Measures Across Both Conditions in Study 4.

		Investment	Expected Investment	Task Ease	Task Enjoyment	Task Entertainment
CDM						
Cohesion	Pearson's *r*	.062	.352	.271	.248	.155
	p (two-tailed)	.814	.166	.171	.221	.441
	n	17	17	27	26	27
Investment	Pearson's *r*		.918*	.179	−.229	.069
	p (two-tailed)		<.001	.492	.394	.800
	n		16	17	16	16
Expected investment	Pearson's *r*			.464	−.144	−.027
	p (two-tailed)			.060	.596	.921
	n			17	16	16
Task ease	Pearson's *r*				−.115	−.194
	p (two-tailed)				.583	.342
	n				25	26
Task enjoyment	Pearson's *r*					.511*
	p (two-tailed)					.008
	n					26
Static						
Cohesion	Pearson's *r*	−.134	−.289	.571*	.518*	.094
	p (two-tailed)	.551	.192	.003	.010	.655
	n	22	22	25	24	25
Investment	Pearson's *r*		.668*	.253	−.121	.145
	p (two-tailed)		.001	.269	.600	.532
	n		22	21	21	21
Expected investment	Pearson's *r*			.038	−.001	.076
	p (two-tailed)			.870	.995	.745
	n			21	21	21
Task ease	Pearson's *r*				.295	−.008
	p (two-tailed)				.171	.972
	n				23	24
Task enjoyment	Pearson's *r*					.669*
	p (two-tailed)					< .001
	n					24

Note. Starred coefficients are statistically significant. CDM = collective directional movement.

Table 4. Mean Responses, Effect Sizes, and Comparisons Between Conditions for Engagement Questions.

Condition	How Easy Was the Task?	How Enjoyable Was the Task?	How Entertaining Was the Task?
CDM	6.56 [6.28, 6.83]	5.27 [4.88, 5.66]	4.93 [4.49, 5.36]
Static	5.80 [5.48, 6.11]	5.50 [5.17, 5.83]	5.24 [4.81, 5.67]
Effect Size (original units)	0.76 [0.36, 1.16]	0.23 [−0.25, 0.71]	0.31 [−0.28, 0.90]
t Test (two-tailed)	$t_{50} = 3.73$, $p < .001$	$t_{48} = 0.93$, $p = .359$	$t_{50} = 1.05$, $p = .300$
Cohen's *d*	1.04	0.26	0.29

Note. Tests on these dependent variables were two-tailed as we had no theoretical reason to make predictions in one direction. CDM = collective directional movement.

measures relating to the economic game, participants who did not pass the training task were also excluded.

Table 4 shows comparisons between conditions on each of the engagement measures. Cases were excluded if they were outliers on the main cohesion measure or on the measure being compared across conditions.

Discussion for Study 4

The primary hypothesis for Study 4 was supported: Individuals in groups that achieved the goal by collectively moving toward it expressed stronger feelings of cohesion toward group members compared to participants in groups that achieved the goal without leaving the lab. However, we found no difference in how much participants were willing to invest with an anonymous partner in an economic game. This was somewhat surprising, given that Mitkidis et al. (2013) found an effect using the same economic game and also because of the encouraging results from our cohesion instrument. Although we found no significant difference between conditions in actual economic behavior, when participants were asked to indicate how much they expected their partner to invest, we found that those in the

CDM condition expected to receive significantly more than those in the static condition, although scores for expected investments were lower than the scores for actual investments over both conditions. Additionally, the correlational analysis revealed strong correlations between actual investment and expected investment over both conditions, with scores in the CDM condition showing the stronger association. In an attempt to understand this pattern of results, we went back to Mitkidis et al. (2013). These authors also report strong correlations between actual and expected investments over their two conditions and they also report lower rates of expected investment than actual investment. Both of their dependent variables (actual and expected investment) appeared sensitive to the experimental manipulation, whereas in the current experiment, actual investment was not. We suggest that this might be a consequence of the currencies used, such that the current data reflect a measure approaching "ceiling." Mitkidis et al. (2013) used Danish Krone and report that the minimum amount paid was 75DKK and the maximum 175DKK. We used Pound Sterling and although we told participants they could invest anything they want, inspection of the data reveals that all participants invested multiples of 0.50 (minimum = £1.50, maximum = £5), meaning our investment scale was substantially narrower than that used by Mitkidis et al. Furthermore, inspection of the investment data reveals that, of 41 valid investments, 21 of them were the maximum amount allowed (£5). We thus suggest that, while the expectation data were sensitive enough to detect a difference between treatments, the investment data approached ceiling, explaining our unexpected finding.

The correlational analyses reveal unsurprising associations between task enjoyment and how entertaining the task was across both conditions. There are also significant correlations between cohesion and both ease and enjoyment and between the measures of ease and enjoyment, but only in the static condition. This may be a consequence of the delaying tactics that were deployed by the experimenters in the static condition to prevent groups completing the task in a time that was not comparable to the CDM condition. Such experiences may have given some groups in the static condition the impression that their task was especially difficult. This suggestion is supported by the comparisons of the three engagement questions (Table 4), which revealed that only the measure of task easiness was significantly different between the CDM and static conditions.

Although our primary hypothesis was confirmed, we do acknowledge the methodological limitations of Study 4. There were procedural differences between the two experimental conditions and it is possible that these differences could account for the results. Another alternative explanation is that the observed effects might be a consequence of the physical exertion or movement synchrony inherent in the CDM task, rather than CDM itself (see Tarr, Launay, & Dunbar, 2016). While Study 4 established that the effect of CDM on cohesion is present when the goal is held constant, our final study was conducted to further establish the effect and to address some of the outstanding questions about it.

Study 5

Pairs of strangers were recruited for a study on "social dynamics and light exercise." The CDM condition involved pairs following a path around a campus building and returning to the starting point. The static condition involved pairs marching on-the-spot next to each other at the starting location.

Method

Ninety-six participants (mean age = 24; 48 male, 48 female) took part in male/male or female/female pairs with the stipulation that they were strangers to each other. There was an equal balance of male and female pairs across conditions. Half of the pairs took part in the CDM condition and half in the static condition. Cohesion was measured using the cohesion instrument (which framed questions in the same terms used in Study 4) and cohesion-change instrument (see Study 3) along with questions concerning task engagement measured on a 7-point Likert-type scale.

On arrival, participants were met separately and taken to an outdoor gym area where they were pseudo-randomly allocated to a condition (CDM or static). We should note that this study was conducted at a time of year when the outdoor gym was not being used and in a location that, due to the weather, was not generally busy with people. The allocation procedure allowed us to ensure that the times taken by groups in each condition were strictly matched across the sample. Once the activity concluded, participants were separated, reminded that their responses were confidential, and asked to complete the cohesion measures.

Results

Scale reliability was again high (Cronbach's $\alpha = .93$). Scores for each pair were averaged and the analysis proceeds at this level. Three outliers on the cohesion measure were removed. Pairs who walked around the path showed a higher level of reported cohesion compared to pairs who marched on the spot: $M_{\text{CDM}} = 4.68$ [4.44, 4.91]; $M_{\text{static}} = 4.37$ [4.10, 4.63]. The effect size in original units is 0.31 [−0.02, 0.64]; Cohen's $d = .55$; $t_{43} = 1.84$, $p = .036$, one-tailed.

For the cohesion-change measure, scores from each member of the pair were summed. Two outliers were removed. Pairs in the CDM condition reported that their cohesion increased more during the task compared to pairs in the marching condition: $M_{\text{CDM}} = 36.26$ [32.43, 40.09]; $M_{\text{static}} = 28.65$ [23.72, 33.58]. Effect size in original units is 7.61 [1.71, 13.51]; Cohen's $d = .75$; $t_{44} = 2.53$, $p = .008$, one tailed.

Correlations between measures can be found in Table 5. Cases were excluded if they were outliers on either of the main dependent variables or the engagement measure being correlated.

Analyses of engagement questions can be found in Table 6. For these comparisons, we excluded cases that were outliers on

Table 5. Correlations Between Measures Across Both Conditions in Study 5.

		Cohesion Change	Task Ease	Task Enjoyment	Task Entertainment	Time Talking
CDM						
Cohesion	Pearson's *r*	.392	−.147	.308	.330	.162
	p (two-tailed)	.071	.514	.163	.134	.496
	n	22	22	22	22	20
Cohesion change	Pearson's *r*		−.243	.349	.464*	.062
	p (two-tailed)		.277	.111	.030	.794
	n		22	22	22	20
Task ease	Pearson's *r*			−.091	−.304	−.231
	p (two-tailed)			.688	.170	.328
	n			22	22	20
Task enjoyment	Pearson's *r*				.817*	.376
	p (two-tailed)				<.001	.102
	n				22	20
Task entertainment	Pearson's *r*					.449*
	p (two-tailed)					.047
	n					20
Static						
Cohesion	Pearson's *r*	.687*	.132	.306	.601*	.512*
	p (two-tailed)	<.001	.602	.202	.005	.018
	n	22	18	19	20	21
Cohesion change	Pearson's *r*		.105	.455*	.589*	.406
	p (two-tailed)		.678	.050	.006	.068
	n		18	19	20	21
Task ease	Pearson's *r*			.567*	.414	.526*
	p (two-tailed)			.022	.111	.030
	n			16	16	17
Task enjoyment	Pearson's *r*				.656*	.515*
	p (two-tailed)				.003	.029
	n				18	18
Task entertainment	Pearson's *r*					.587*
	p (two-tailed)					.008
	n					19

Note. Starred coefficients are statistically significant. CDM = collective directional movement.

Table 6. Scores, Effect Sizes, and *t*-Test Results for the Task Engagement Questions.

Condition	How Easy Was the Task?	How Enjoyable Was the Task?	How Entertaining Was the Task?	How Much of the Task Was Spent Talking to Each Other?
CDM	6.84 [6.74, 6.95]	6.14 [5.87, 6.40]	5.64 [5.19, 6.08]	6.93 [6.81, 7.04]
Static	6.83 [6.69, 6.98]	5.32 [4.83, 5.80]	4.90 [4.49, 5.31]	6.64 [6.48, 6.81]
Effect Size (original units)	0.01 [−0.16, 0.18]	0.82 [0.31, 1.33]	0.74 [0.17, 1.31]	0.28 [0.10, 0.48]
t Test (two-tailed)	$t_{38} = .09$, $p = .929$	$t_{39} = 3.23$, $p = .003$	$t_{40} = 2.52$, $p = .016$	$t_{39} = 2.93$, $p = .006$
Cohen's *d*	0.04	1.03	0.79	0.97

Note. Reported *p* values are two-tailed as no directional hypotheses were made. CDM = collective directional movement.

either of the cohesion measures or the engagement measure being compared across conditions.

Discussion for Study 5

Once again, our primary hypothesis was confirmed. Pairs of strangers who engaged in CDM were significantly more cohesive compared to pairs who engaged in synchronized on-the-spot marching. The cohesion-change measure followed the same pattern, with pairs who engaged in CDM reporting experiencing significantly greater change in the cohesion constructs during their activity compared to pairs in the control condition. These results suggest that CDM has a stronger influence on group dynamics than simple behavioral synchrony, although we also accept that this study also has limitations and we discuss these below.

As in the previous study, correlation patterns differed across conditions. As was found in Study 4, the main measure of cohesion did not correlate with any of the engagement measures in the CDM condition, but in the static condition, cohesion was found to significantly correlate with how entertaining the task was and how much of the task was spent talking to each other.

The cohesion-change measure was found to correlate with entertainment in the CDM condition and both entertainment and enjoyment in the static condition. Task ease and time spent talking to each other showed no correlation with cohesion change in either condition.

In the static condition, there were significant correlations between task ease and enjoyment/entertainment/time spent talking. Enjoyment was significantly correlated with both entertainment and time spent talking and entertainment was significantly correlated with time spent talking. Only one of these correlations (task enjoyment/entertainment) was found to be significant in the CDM condition.

When the engagement questions were compared across conditions (Table 6), all of the measures with the exception of task ease were found to be significantly higher in the CDM condition. This is notable because in the previous study task, ease was the only engagement measure that was found to be different between the conditions and was correlated with cohesion only in the static condition. The data from Study 5 replicate the effect of CDM on cohesion and demonstrate that the effect is not due to differences in how easy the respective activities are, casting doubt on any interpretation of Study 4 that appealed to the ease of the tasks. Study 5 also found that the CDM condition was rated as being more entertaining and enjoyable, with participants in this condition also talking more to each other than in the static condition. Despite higher ratings, these engagement measures were not significantly correlated with cohesion in the CDM condition, whereas entertainment ratings and time spent talking were significantly correlated with cohesion in the static condition. Taken together, these results suggest that, where mediating factors relating to task engagement have an influence on cohesion, they appear to be more influential in the static condition than in the CDM condition. It seems that the effect of CDM on cohesion is not entirely due to the way participants engage with the task. If this was true, task engagement measures would show similar correlations with cohesion measures across both conditions, which they do not. That participants engaging in CDM still report elevated cohesion compared to the static condition suggests an additional influence that was not present in the static condition. We suggest that this influence is the act of directional movement.

It is worth noting the differences between the tasks used, as this could provide insight into the observed results. For example, the task used in Study 4 had a problem-solving component to it and a clear final goal, whereas the task used in Study 5 had no obvious goal. Furthermore, the nature of the static activity in the current study may have been unusual for participants, and so the data from the static condition may be tracking the idiosyncrasies of this particular control condition in a similar way to how the control condition in Study 4 ostensibly reflected the nature of the task/procedure. An alternative control activity might have been bidirectional movement, but this would have sacrificed the behavioral synchrony that Study 5 aimed to incorporate. Despite the differences between tasks, we are encouraged by the consistency of the effect that CDM tasks appear to have on measures of cohesion.

General Discussion

Over five experiments, we found consistent evidence that engaging in (or imagining engaging in) the general class of social behaviors that we have labeled CDM is associated with higher levels of cohesion compared to control conditions. Before we discuss any theoretical implications, it is important to address alternative explanations for our results. In our previous discussion of the theoretical justification for the current studies, we stated more than once that we might expect CDM to inhere greater cohesion between those engaged in it compared to static activities *all other relevant factors being equal*. That is, if we could hold all the other factors that might influence cohesion constant, we would still expect CDM activities to be associated with increased cohesion due to the nature of the activity itself. It is, of course, impossible to hold all the other relevant factors constant. One might argue that implementing control conditions in the current studies is particularly difficult because it is not entirely clear what features a “static” control condition should have (or not have). We strived to control for different things in our studies, but it is still possible that there exist unidentified confounding factors that can explain our results. For example, in Study 4, the static groups stayed in one room and the CDM groups left the building. These are two different social experiences that could influence the groups in each condition in different ways. Similarly, in Study 5, the static group engaged in an unusual activity in a public place (marching on the spot), which itself could have influenced their responses compared to the CDM pairs, who simply walked on a path. In practical terms, there is probably no perfect experiment that can test the current hypothesis without sacrificing some element of control, but we do believe that support for our hypothesis is strengthened by the consistent effects found using a number of different experimental procedures, and we argue that our data justify CDM being considered by the scientific community as an important social activity.

Assuming that the general effect is valid, what can we say about it? The results of the first three studies tell us that people expect to experience more cohesion when engaging in CDM activities compared to static activities and that this is generally true regardless of whether the imagined travel companions are friends or strangers (Study 3). Studies 4 and 5 suggest that it is the CDM itself that is the causal factor and that the effect is not due to goal ascription (Study 4; although ease of goal acquisition may be a factor) or behavioral synchrony (Study 5). In terms of potential mechanisms, we would be surprised if there wasn’t a motivational component to the phenomenon. Although the first studies could not establish causality, the results did suggest that people at least found the CDM activities to be more agreeable and, presumably, more attractive as activities. The task engagement data from the final study suggest that engaging in CDM is particularly enjoyable and encourages more social interaction (i.e., talking). Anecdotally, humans frequently engage in CDM for a variety of different reasons, whether for recreation or for convenience. In many people's day-to-day lives, it is something that they do without much thought. Others use CDM as a leisure activity and spend considerable time and money on it. All of this suggests the existence of motivational mechanisms that provide the necessary pushes-and-pulls for CDM to exist as part of our behavioral repertoire. This raises other questions concerning how such mechanisms might interact with other relevant contextual factors. For example, what effect might manipulating intragroup dynamics have on groups engaging in CDM compared to other activities? We chose to limit the composition of the groups we asked our participants to engage with by making them all-male or all-female (see Shapcott et al., 2006, for justification). Obviously, many real-world groups will be mixed, and so future work might attempt to uncover how group composition interacts with other relevant factors, such as the demands of the task or the goals of the group. The literature on this question is equivocal. Contrary to Shapcott, Carron, Burke, Bradshaw, and Estabrooks (2006), Lee and Far (2004) asked groups of students to undertake two in-class (i.e., static) projects and found that groups consisting of only males or only females were less cohesive than mixed groups (see also Marshall & Heslin, 1975). It's clear that both the task and the context matter a great deal for group cohesion. Given the ubiquity of CDM, we would be surprised if the reported effect on group cohesion does not hold for mixed groups, although we also expect complex interactions when the nature of the task is taken into consideration. Characterizing such interactions should be a focus for future work.

One factor worth considering is the environment in which the CDM occurs. As previously noted, Gallup et al. (2014) found that pedestrians respond differently to certain social cues when they are part of a group compared to when they are moving alone, suggesting that individuals in moving groups have different information priorities. We have argued that groups engaging in CDM share a common fate, and so understanding how environments and/or goals that vary in threat or uncertainty influence cohesion and other psychological measures would be an interesting extension to the current work.

An additional consideration is the importance of the *choice* to engage in CDM and how it affects subsequent group dynamics. Humans often find themselves traveling in the same direction with others that they have not explicitly chosen to be with (e.g., on public transport). Do people in these situations experience similar affinity for their travel companions compared to individuals who have made an explicit decision to undertake CDM with their group? In the literature on collective movement on animals, choice is one of a number of contributing factors that researchers have studied (see, e.g., King & Sueur, 2011). Insights from this literature can inform future research on CDM in humans and might include questions concerning social parameters such as the size of the group and the hierarchical dynamics of the individuals who make up the group (see Couzin et al., 2005; Strandburg-Peshkin et al., 2015): physiological parameters such as energetic costs (Steudel, 2000) or environmental parameters such as threat (Boinski, Treves, & Chapman, 2000). An advantage of looking to the comparative literature is that it can provide us with clues as to which relevant factors might interact to influence feelings of prosocial sentiment, which, as discussed previously, are necessary for keeping codependent groups together but which are not easily measured in nonhumans.

Cohesion between humans has traditionally been studied by investigating how fluctuating features of the current social environment influence group dynamics (see, e.g., Forsyth, 2010). We adopted an alternative approach by attempting to identify a behavior that could reasonably be described as having been a recurrent and invariant feature of ancestral social environments such that it became a target for selection processes (see Barrett, 2015; Tooby et al., 2008). As argued previously, for many biological organisms, CDM is a behavior that has adaptive utility. It is widespread in the biological world and almost ubiquitous in human societies. Despite this, it has received very little attention from experimental psychologists. The research described in the current article addresses this.

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Supplemental Material

Supplemental material for this article is available online

Notes

1. We acknowledge that there are many different kinds of collaborative group and that "group" is left somewhat undefined in our treatment. Tooby, Cosmides, and Price (2006) provide a useful discussion of these issues, but for our current purposes, we will proceed under the assumption that any effect of collective directional movement (CDM) on cohesion is relative to all the other causal factors that influence a group's success (including the "kind" of group that it is). Thus, if we imagine all of these other factors held constant (admittedly impossible in reality), we would expect to see CDM activities result in more cohesion between participants compared to static activities.
2. In addition to these 10 questions, 2 further questions were included that were what might be described as "anti-cohesion" items, asking about competitiveness and hostility. However, reliability analyses on this short 2-item measure in the current experiment suggested

that this was not a reliable anti-cohesion measure and so data relating to this are not reported.

3. In addition to the cohesion measure, participants were asked to make personality judgments about one member of their imagined group. As the current article is primarily concerned with cohesion, these results are not reported.
4. It was surprising to find a variance estimate so close to zero and we were initially skeptical. However, this finding was confirmed on three different software packages and after a full inspection of the raw data. There really was negligible group-level variance in this data.

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