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Article (Accepted Version)

Alnabulsi, Hani, Drury, John and Templeton, Anne (2018) Predicting collective behaviour at the Hajj: place, space, and the process of cooperation. *Philosophical Transactions B: Biological Sciences*, 373 (1753). pp. 1-12. ISSN 0962-8436

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Predicting collective behaviour at the Hajj: Place, space, and the process of cooperation

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Keywords: Crowds, social identity, Hajj, pilgrimage, Mecca, cooperation

Summary

Around 2 million pilgrims attend the annual Hajj to Mecca and the holy places, which are subject to dense crowding. Both architecture and psychology can be part of disaster risk reduction in relation to crowding, since both can affect the nature of collective behaviour – particularly cooperation – among pilgrims. To date, collective behaviour at the Hajj has not been systematically investigated from a psychological perspective. We examined determinants of cooperation in the Grand Mosque and plaza during the pilgrimage. A questionnaire survey of 1194 pilgrims found that the Mosque was perceived by pilgrims as one of the most crowded ritual locations. Being in the plaza (compared to the Mosque) predicted the extent of cooperation, though crowd density did not. Shared social identity with the crowd explained more of the variance than both location and density. We examined some of the process underlying cooperation. The link between shared social identity and giving support to others was stronger in the plaza than in the Mosque, and suggests the role of place and space in modulating processes of cooperation in crowds. These findings have implications for disaster risk reduction and for applications such as computer simulations of crowds in pilgrimage locations.

Introduction

The Hajj has been called the world's 'global gathering' because people from all over the world attend this annual Muslim pilgrimage to the holy places in and around Mecca [1]. Taking part in the Hajj is expected of all able-bodied and financially capable Muslims at least once in their lifetime. It involves

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participating in rituals at specified spiritual locations during a certain five-day period.¹ These requirements, combined with the ease of modern air travel, means that millions of people attend the Hajj – 1,862,909 was the official figure (not counting unofficial pilgrims) in 2016, for example [2]. Therefore, the holy places are very crowded during Hajj. Overcrowding has been linked to fatalities at the Hajj in the past. In 2006 for example, 346 pilgrims died in a crowd crush at the entrance to Jamarat Bridge [3] and at least 717 died in a crush at Mina in 2015 [4].

Architecture has been seen as part of the solution to this source of risk. The Jamarat structure was redesigned following the 2006 disaster to allow pilgrims to ‘stone the devil’ on three different floors, increasing capacity [5]. Research in psychology suggests that collective behaviour is also important in disaster risk reduction [6, 7]. Indeed, architecture and psychological processes can interact to produce forms of collective behaviour that reduce, or contribute to, risk. For example, in emergency evacuations a combination of a narrow exit and unfamiliarity with layout are among the predictors of dangerous pushing and trampling [8].

Cooperation is a crucial form of collective behaviour at the Hajj, in two ways. First, harmonious relations with others is a spiritual value which is both salient and expected at the Hajj, alongside related values such as unity and peacefulness [9]. Second, cooperation is also a practical necessity. This is particularly the case in the Grand Mosque and other very crowded locations, where failure to coordinate with others – for example pushing, not allowing others space – could lead to a crowd collapse and fatalities.

At the time of the 2012 Hajj (the focus of the present study), the Al-Masjid Al-Haram (or Grand Mosque) covered an area of 356,800 m² (88.2 acres) [10]. The Mosque contains the *Ka’aba*, a small black cube-shaped building that is the holiest site on earth to Muslims, since it is said to be built by Abraham [11]. When Muslims pray, wherever they are in the world, they turn in the direction of the Ka’aba (this is known as *Qibla*). On visits to Mecca, pilgrims circumambulate the Ka’aba seven times (*tawaf*). During Hajj, they also attend the Mosque for daily prayer, facing the Ka’aba.

The experience of seeing the Ka’aba is emotionally intense for pilgrims [12]. The communal nature of the experience is emphasized by the fact that all the pilgrims wear a simple white robe for the majority of the rituals; this serves to convey unity, equality and universality in the shared

¹ The Islamic calendar is lunar, so the date of the Hajj changes year by year in the Gregorian calendar.

submission to God. But as well as joy and harmonious behaviour, there is also competitive behaviour within the Mosque, as people strive to get close to the Ka'aba, particularly near the black stone, and some use physical force to do so (see Figure 1). Some enter the Mosque only to find their view of the Ka'aba obscured by pillars (see Figure 2). Instead, many pilgrims carry out their prayers on the plaza immediately outside (see Figure 3), where the emotional experience may be less intense, but also less variable, since expectations and competition are both lower.

Despite the importance of understanding collective behaviour at the Hajj, there has been almost no research on this topic. Understandably, most studies of the Hajj examine the public health issue of disease [e.g., 13]. Where collective behaviour is referred to, it tends to be only as a 'panic' or 'stampede' [14], despite the vast majority of Hajj rituals passing without incident.

The emphasis on negative collective behaviour in previous research on the Hajj reflects the history of crowd psychology, which has been overly preoccupied with crowd violence [15, 16]. Classical crowd psychology claimed that becoming 'submerged' in a crowd leads to a diminution of self; in this reduced psychological state, primitive aggressive drives, grounded in a 'racial unconscious' [17] or individual biology [18], would predominate, leading to uncontrolled violence. One problem for this approach is that most crowd events are peaceful. The approach notably fails to explain behaviour at ritual and ceremonial crowd events, where the act of coming together *reinforces* values and norms, rather than leading people to abandon them [19, 20].

The Hajj is an example of such a ritual crowd, and the present study is part of a wider project to examine the psychological and contextual basis of positive experiences and behaviour in crowds, based on the social identity approach [21]. The social identity approach suggests that self or identity is comprised of categorizations of self and other that vary in inclusivity in different social contexts [22, 23]. The approach has been applied to standard topics in social, organizational, and health psychology [24, 25]. It has also been used to understand the psychology of place and space across a range of crowd events. Thus a multi-method study of an overcrowded music festival found that the lack of space was uncomfortable only for those who did not share social identity with the rest of the crowd [7]. An interview study of an Orange Order parade in Northern Ireland indicated that domination of the soundscape was a way of imposing identity on the streets [26]. Research on urban riots has repeatedly shown that many of the actions of rioters against police and property reflect a common identity defined in terms of home location and a desire to eject police from that shared territory [27, 28].

The social identity approach agrees with early classical crowd psychology that emotion is a central feature of the phenomenology of many crowd events [21]. However, rather than seeing

emotion as primitive and irrational, it suggests that emotional experiences are grounded in our knowledge of our group memberships and in the relationships we have with others in our group [19]. In short, collective behaviour and emotional experience is a function not of a loss of self but of a *shared* self.

The aim of the present study was to explore some of the determinants of cooperation in the Grand Mosque and plaza during Hajj, in order to contribute to an understanding of how collective behaviour operates in these locations. By sampling a relatively matched sample of pilgrims inside and outside the Mosque, we were able to analyse the possible roles of location and crowd density in cooperative behaviour in these locations. We also sought to examine the role of shared social identity in such cooperative behaviour. Shared social identity [21] is the subjective perception that others are in the same social group as oneself, and indeed share selfhood with one. Shared social identity has been shown reliably to increase bystander helping [29]; practical and emotional social support in emergencies [30, 31]; and mundane solidarity behaviours at a (Hindu) pilgrimage [32]. In the present study, we measured shared social identity in two ways: participants' perception that others in the crowd are good Muslims (i.e., good ingroup members); and participants' identification with the crowd.

We surveyed 1194 pilgrims during the Hajj in 2012. In this paper, first we explore descriptively pilgrims' experience of crowdedness, showing that the Mosque were experienced as the most crowded ritual location. Using researchers' estimates, we then examine any differences in crowd density between the plaza and the Mosque at the time of sampling. To investigate determinants of cooperation, we examine the extent to which location (inside the Mosque or in the plaza) and crowd density each affect pilgrims' perceptions of support provided by others. To further investigate cooperation, we examine predictors of self-reported social support given. Since inside the Mosque there are enhanced expectations but also (for many people) obstructive architecture and competition for the best view of the Ka'aba, we expect that self-reported social support will be slightly lower in the Mosque than in the plaza. We also expect that shared social identity will be significantly and positively associated with giving social support. Finally, we unpack the process of cooperation using structural equation modelling. Based on the notion that others' (normative) behaviour can tell us something about their category membership [33], and that their category membership can affect our behaviour towards them [29, 30], we investigated the extent to which perceiving social support in the crowd predicts shared social identity (perceiving others as good Muslims and then identification with the crowd) and shared social identity predicts giving social support. We suggest that if space and place do shape cooperation then this process will also be affected. Specifically, the reduction in social

support given in the Mosque compared to the plaza will be accounted for by a reduction in the power of the main predictor, shared social identity.

With respect to the problem of disaster risk reduction at the annual Hajj, our approach suggests a view of collective behaviour different to the assumption that the crowd is simply a problem that planners have to work around. In this account, shared social identity in the crowd facilitates the cooperative behaviour needed in valued locations where dense crowds gather; it motivates people to be supportive; and it enables them to anticipate each other's behaviour. These processes of self-organization occur 'naturally' in many crowds, though organizers can play a role in supporting them (for example by providing information, communicating regularly, and so on). If our analysis is correct, it means there is a role for social psychology in planning for mass gatherings and crowd safety management training [7, 34], when grounded in a broader understanding of place and space in relation to the built environment..

Methods

Recruitment procedure

We surveyed 1194 pilgrims, sampling in a way stratified by the main languages of pilgrims at the Hajj: 420 (35%) were Arabic speakers, 150 (13%) were speakers of Malay, 150 (13%) of Urdu, 120 (10%) of French, 120 (10%) of Persian, 120 (10%) of Turkish, and 114 (9%) of English. Twelve research assistants, native speakers of the seven languages, were trained to recruit pilgrims with verbally administered questionnaires. The research assistants were all male, but three of them were accompanied by their wives in order to facilitate recruitment of female participants. We recruited 421 (35.7%) participants inside the Grand Mosque and 753 (64.0%) on the plaza immediately outside. Recruitment took place in three phases: 383 (32.5%) participants were surveyed in the nine-day period when people arrive in Mecca; 533 (45.2%) during Hajj rituals; and 260 (22.0%) at the farewell *tawaf* period.² (Information on the recruitment time and location of 4 participants was missing.) Each questionnaire took around 38 minutes to complete.

Measures

² The Hajj rituals last for five days, but pilgrims gather in a crowd at the Holy Mosque to take part in *tawaf* in the days beforehand and immediately afterwards.

Density: The research assistants estimated the number of people per square metre (ppm²) around each participant they recruited.

Most subjectively crowded ritual locations: Participants were asked to rank the crowdedness of five ritual locations: sa'ee (moving between the hills of Safa and Marwa in the Grand Mosque, symbolizing Hagar's search for water for her son), tawaf, Jamaraat, standing in Muzdalifah, and *nafrāh* (leaving Arafat).

Cooperation was measured in two ways: first, participants' *perceptions that others give social support* (three items, e.g. 'In my view, most pilgrims are supportive of others'; $\alpha = .78$); and second, participants' reports of *giving social support* to others on the Hajj (two items, e.g. 'I have been helpful to others'; $\alpha = .66$). Responses on these items and those below (other than demographics) were assessed on a seven-point Likert scale, ranging from 'agree strongly' to 'disagree strongly'. (See Supplementary Materials for full details of these and other items.)

Perceptions that others in the crowd are good Muslims was measured with three items (e.g. 'In my view, other people in this crowd are good Muslims'; $\alpha = 0.79$). *Identification with the crowd* was measured with three items (e.g. 'I feel a sense of togetherness with other people on the Hajj'; $\alpha = .80$).

Demographic measures taken included age, gender, level of education, previous experience of the Hajj, nationality, and language.

Acquiescence: to control for the possibility that some participants would agree with questionnaire items whatever the content, we created a measure of acquiescence by averaging scores of those items which pointed in two different directions. Full details are provided in the Supplementary Materials.

Results

The results are divided into four sections. First, we present sample characteristics. Second, we provide analysis of participants' perceptions of the most crowded locations and researchers' estimates of crowd density. Third, we examine predictors of cooperation. Finally, we present structural equation modelling of the process of cooperation across the Mosque and plaza locations.

Sample characteristics

Generally, it was difficult to persuade pilgrims to take part in the study, especially close to the Ka'aba, since they were there to worship rather than to fill in a questionnaire. Response rates were around 60% inside the Mosque and around 70% on the plaza. There were also some demographic factors noted. Thus response rates were found to decline with increasing age. Some pilgrims declined

to participate on the grounds that they were illiterate (and sometimes passed us to a relative instead). Finally, women were more likely to refuse than were men.³

The data for 18 participants were entered incorrectly by one research assistant. As there was no way subsequently of correcting these, the data from these participants were removed from the analysis. Inspection of the density data revealed that seven participants were scored at 0ppm² and three were scored at implausibly high density (12ppm² and 15ppm²). The data from these participants were also removed, leaving 1166 participants in the final dataset.

Seven hundred and fifty-two (64.5%) of the participants were male and 414 (35.5%) were female. This matches the proportion of males to females in the population attending Hajj in 2012 [35]. Seventeen participants (1.5%) were aged between 18 and 19 years old; 97 (8.3%) were aged 20 to 29; 223 (19.1%) were aged 30 to 39; 452 (38.8%) were aged 40 to 49, and 377 (32.3%) were aged 50 years and over. Sixty-six participants (5.7%) were illiterate, 193 (16.6%) were educated to 'read and write' level, 193 (16.6%) to primary school level, 236 (20.2%) to secondary school level, 393 (33.7%) to undergraduate degree level, 77 (6.6%) had Master's degrees, and 8 (0.7%) had doctorates. Three hundred and sixty-seven (31.2%) participants had been on Hajj before, whereas for 799 (68.5%) this was their first time.

The study included participants from 72 countries. The majority of pilgrims attend through arrangement with the six Hajj travel establishments, or travel agencies, which are (mostly) structured by geographical region. In most cases, the proportion in our sample from each establishment roughly corresponded with official estimates [35] for the event as a whole: Arab and Arabian Gulf countries 36.1%; America, Australia and Europe (including Turkey) 18.8%; South Asia 13.8%; South East Asia 11.7%; Iran and Tajikistan 10.4%; and non-Arab African Countries 9.2%.

Sample characteristics: Mosque vs plaza

³ It makes intuitive sense to assume that people willing to participate in a survey may be more dispositionally cooperative than others. Given that response rates correlated with age, education and gender, we compared participants in each of these on giving social support to test for demographic evidence of such a bias. See Supplementary Materials for details.

The sample from the plaza ($n = 753$) was larger than that from inside the Mosque ($n = 418$). For age and level of education the numbers sampled in each location were proportionate to these numbers, but there were significant differences for the other variables. For gender, men made up 64% of the overall sample but the proportion of men compared to women sampled within the Mosque was 59%. Pilgrims for whom this was their first Hajj made up 69% of the overall sample, but the proportion of these new people who were sampled within the Mosque was 74%. In the sample as a whole, the proportion of non-Arab African country pilgrims was 9%, but this group made up 18% of those sampled in the Mosque. In the sample as a whole, the percentage of French speakers was 9%, but the percentage of French speakers sampled inside the Mosque was 22%. (Statistics for these tests can be found in the Supplementary Materials.)

Crowdedness and density by Hajj location

For participants' ranking of the crowdedness of the five ritual locations, a repeated measures ANOVA with pairwise comparisons showed that participants evaluated tawaf as significantly more crowded than each of sa'ee ($p < .001$), nafrah (Arafat, $p < .001$), Jamaraat (i.e., stoning the devil, $p < .001$), and standing in Muzdalifah ($p < .001$) - see Table 1 for means and *SDs*. When we compared researchers' density estimates for participants surveyed inside the Grand Mosque ($M = 5.63\text{ppm}^2$, $SD = 1.47$) with those surveyed in the plaza ($M = 4.96\text{ppm}^2$, $SD = 1.85$) using regression, as expected location significantly predicted estimated density, $b = -.185$, $p < .001$. These results are in line with the expectation that the Mosque itself would be especially crowded.

Predictors of cooperation

Descriptives and correlations for all measures are presented in Table 2. The first examination of predictors of cooperation used *perceived social support* in the crowd as the dependent measure. As Table 3 shows, in the first block of the regression equation, four of the control variables were significant predictors. Participants in the 40-49 age bracket reported most, and those under 20 reported least, perceived social support. French speakers, those from Turkey, America, Australia and Europe, and those from non-Arab African countries were less likely than others to perceive social support whereas those high in acquiescence were more likely to report perceiving social support. (See Supplementary Materials for additional statistics.) The second block comprised the two 'place and space' variables: density and location, neither of which were significant predictors. The R^2 change from block 1 to block 2 was not significant, $p = .14$.

The second examination of predictors of cooperation used the measure of the participant *giving social support* to others. Table 4 shows that four of the control variables were predictive. Older participants were more likely to report giving social support than were younger participants. Male

participants were more likely to report giving social support than were female participants. Higher level of education predicted more support given. French speakers gave less support than the other language groups. Those who had been to Hajj before gave more support than those for whom it was the first time. (See Supplementary Materials for additional statistics.) When the ‘place and space’ variables were added in block 2, density was not predictive, but location was: more social support was given in the plaza than in the Mosque (though levels of social support given were high in both locations): $M_{\text{Mosque}} = 5.89$, $SD = 0.85$; $M_{\text{plaza}} = 6.19$, $SD = 0.84$). The R^2 change from block 1 to block 2 was significant, $p = .044$. When the shared social identity variables were then added in a third block, perception that others were good Muslims and identification with the crowd each positively predicted giving support (see Table 4). Importantly, the final block explained considerably more of the variance than the other two, and the R^2 change from block 2 to block 3 was significant, $p < .001$.

The process of cooperation

We used R to conduct structural equation modelling (SEM) with robust maximum likelihood on the direct and indirect pathways from perceived social support to giving social support via the perception that others are good Muslims and then identification with the crowd – see Figure 4. We included the following variables as covariates: education, language, prior experience of the Hajj, and acquiescence.⁴

We first performed confirmatory factor analysis to explore the measurement models for all participants, and then separately for participants inside the grand Mosque and on the plaza. The fit indices of the measurement model for participants in both locations were $AIC = 49147.588$, $RMSEA = .072$, $SRMR = .049$, $CFI = .891$, $\chi^2(99) = 680.691$, $p < .001$; inside the Grand Mosque, $AIC = 16759.791$, $RMSEA = .060$, $SRMR = .046$, $CFI = .908$, $\chi^2(99) = 242.939$, $p < .001$; in the plaza, $AIC = 32050.306$, $RMSEA = .090$, $SRMR = .059$, $CFI = .851$, $\chi^2(99) = 685.153$, $p < .001$. Overall, the fit indices suggest that the order of the serial mediation is a good model, and conducting separate models for the two locations provides the best measurement.

When exploring the model for participants in both locations, the fit statistics were $AIC = 51372.174$, $RMSEA = .071$, $SRMR = .047$, $CFI = .889$, $\chi^2(99) = 680.054$, $p < .001$. There was a significant direct effect, $b = .391$, $p < .001$, $z = 7.615$, but the indirect effect was non-significant, $b =$

⁴ We report results for this analysis carried out without the covariates in the Supplementary Materials.

.181, $p = .063$, $z = 1.859$. There were significant direct effects of perceived social support on the perception of others as good Muslims, $b = .354$, $p < .001$, $z = .160$, on social identification with the crowd, $b = .321$, $p < .001$, $z = 6.220$, and on giving social support, $b = .391$, $p < .001$, $z = 5.327$; and a significant direct effect of the perception of others as good Muslims on social identification with the crowd, $b = .534$, $p < .001$, $z = 4.741$. However, the direct effect of perceiving others as good Muslims on giving social support was non-significant, $b = .140$, $p = .098$, $z = 1.657$, as was the effect of social identification with the crowd on giving social support, $b = .111$, $p = .199$, $z = 1.283$. All indirect effects were non-significant: perceived social support on giving social support via social identification with the crowd, $b = .035$, $p = .90$, $z = 1.310$; perceived social support on giving social support via the perception of others as good Muslims, $b = .050$, $p = .118$, $z = 1.564$; perceived social support to giving social support via the perception of others as good Muslims and social identification with the crowd was non-significant, $b = .021$, $p = .237$, $z = 1.183$. The path model is presented in Figure 4.

Inside the Grand Mosque

The model fit for participants inside the Grand Mosque was $AIC = 18233.213$, $RMSEA = .064$, $SRMR = .048$, $CFI = .894$, $\chi^2(99) = 268.926$, $p < .001$. Most of the direct paths remained significant with the exception that the direct effect of perceiving others as good Muslims on social identification with the crowd became non-significant, $b = .224$, $p = .108$, $z = 3.629$, and all indirect pathways remained non-significant. Overall, the direct effect was significant, $b = .783$, $p < .001$, $z = 4.697$, but the indirect effect was non-significant, $b = -.188$, $p = .351$, $z = -.934$. The indirect path from perceived social support via perceptions that others are good Muslims to giving social support was non-significant, $b = -.038$, $p = .712$, $z = .369$; the indirect path from perceived social support via identification with the crowd to giving social support was non-significant, $b = -.069$, $p = .423$, $z = -.801$, and the indirect path from perceived social support to giving social support via the perception of others as good Muslims and social identification with the crowd was non-significant, $b = -.009$, $p = .601$, $z = -.523$. The path model is presented in Figure 5.

On the plaza

The model fit for participants on the plaza was $AIC = 32835.680$, $RMSEA = .082$, $SRMR = .056$, $CFI = .857$, $\chi^2(99) = 417.163$, $p < .001$. There was a significant direct effect, $b = .266$, $p < .001$, $z = 5.742$, and a significant indirect effect, $b = .311$, $p = .007$, $z = 2.699$. The indirect effect from perceived social support to giving social support via perceptions that other are good Muslims was non-significant, $b = .034$, $p = .241$, $z = 1.171$, and the indirect path from perceived social support to giving social support via the perception of others as good Muslims and social identification with the

crowd was non-significant, $b = .039$, $p = .105$, $z = 1.623$, but there was a significant indirect effect from perceived social support to giving social support via identification with the crowd, $b = .067$, $p = .033$, $z = 2.136$. The path model is presented in Figure 6.⁵

Using the criteria for model fit set out by Hu and Bentler [36], where $RMSEA < 0.06$, $SRMR < 0.08$, $CFI > 0.95$, all models demonstrate modest fit. Based on Busemeyer and Diederich [37] where the lowest AIC value indicates the best model fit, we take the model for participants inside the Grand Mosque to be better than that for those in the plaza. It also has some larger beta values. However, importantly, only the model for those on the plaza demonstrates the connection between shared social identity and giving social support. Consequently, only this model has an indirect effect from perceived support to giving social support.

Alternative models

To explore the order of the model variables, we also tested alternative models to explain giving social support. First, we tested a model from social identification with the crowd to giving social support via perceived social support and the perception of others as good Muslims, again including the covariates of education, language, prior experience of the Hajj, and acquiescence (see Figures 7 and 8). The model fit for this version of the model for participants who responded inside the Grand Mosque was $AIC = 18250.279$, $RMSEA = .067$, $SRMR = .060$, $CFI = .913$, $\chi^2(99) = 285.992$, $p < .001$, and for participants in the plaza, $AIC = 32864.698$, $RMSEA = .089$, $SRMR = .065$, $CFI = .850$, $\chi^2(99) = 681.643$, $p < .001$. Second, we tested the model with the order of the original mediator variables reversed, from perceived social support to giving social support via social identification with the crowd and the perception that others are good Muslims (see Figures 9 and 10). The model fit statistics for respondents inside the Grand Mosque were $AIC = 32835.680$, $RMSEA = .086$, $SRMR = .056$, $CFI = .857$, $\chi^2(99) = 652.626$, $p < .001$, and in the plaza, $AIC = 18233.213$, $RMSEA = .064$, $SRMR = .048$, $CFI = .894$, $\chi^2(99) = 28.926$, $p < .001$. Overall, the fit statistics for the alternative models, though better on some criteria, were comparable and not an improvement on the hypothesized model.

Discussion

⁵ See Supplementary Materials for additional analysis in which we test a version of the model without the variable 'others are good Muslims'.

According to both participants' perceptions and researchers' estimates, the Grand Mosque was the most crowded location at the Hajj. Neither location (Mosque vs plaza) nor crowd density predicted perceptions of social support (which were relatively high across the sample). Examining participants' reports of their own cooperative behaviour allowed us to look more closely at the possible psychological processes involved. Participants reported giving more social support in the plaza than in the Mosque. The shared social identity variables – seeing others as good Muslims and identification with the crowd – were the strongest predictors of this self-reported cooperation. However, it is important to note that perceptions of cooperation by others were the same across locations, and the reports of giving help (and indeed the other measures) were all high both inside and outside the Mosque.

We found evidence for a process of cooperation involving shared social identity. In the first place, seeing others' supportive behaviour predicted perceiving others as good Muslims and identifying with the crowd. In the second place, identification with the crowd predicted giving social support – at least on the plaza. Moreover, on the plaza there was a significant indirect effect from seeing others' cooperative behaviour via shared social identity (identification with the crowd) and giving social support.

There is a substantial research literature on the spreading of cooperative (or 'generous') behaviour [e.g., 38, 39]. The mechanism of 'spread' suggested by our analysis – shared social identity – is an alternative to those accounts which conceptualize it as form of 'contagion'. The 'contagion' concept implies that such behaviour spreads as a form of mimicry, or at least with little discrimination. By contrast the present account focuses on the way that others' (cooperative) behaviours tell us something about their category membership: whether they embody the values of a social category and indeed whether they are in our own group; if they are 'us', we feel more motivated to give them social support [29-31].

We suggested in the Introduction that experiences in the Mosque might be more varied than on the plaza: seeing the Ka'aba produces the most intense positive emotional experience, but there is also competition to get close, and some get inside only to find their view obscured. The present findings are consistent with the view that this 'mixed' experience is associated with less cooperative behaviour compared to being on the plaza; perhaps the more relaxed and 'homogeneous' experience of the plaza enables greater cooperation. This differences in behaviour and process between the two locations supports the overall thesis of this article that the psychological is in part a function of the spatial.

A limitation of the study is that we have no direct measures of competition or other mediating factors in the Mosque. We do know, from the analysis, that simple crowd density does not seem to differentiate behaviour in the Mosque vs the plaza. It may be possible to use the current data-set to explore further some of these questions, since it is now publicly available. However, we suggest that a different kind of study may be needed to examine the phenomenology of the Mosque experience to determine process in more detail. For example, rather than questioning pilgrims, research could take the form of an ethnography, in which the observing researcher acts as the research instrument.

Many of the questionnaire items were constructed for this survey (when no established scales were available), and for practical reasons some measures were brief. More importantly perhaps for our claims about process, this study was cross-sectional. Clearly the correlational nature of the design means that, while there is evidence for the process of cooperation specified here, other configurations of the variables are possible. For example, we know from elsewhere that shared identity enhances expectations (and hence perceptions) that others will be supportive [6, 7]; and we can infer that since giving social support is likely to encourage others to do the same, other starting points than perceived social support are possible. While the model tested here was a little better than the alternatives we looked at, other alternatives are possible. The present design decision was again due to practical constraints, for running a panel study (to allow cross-lagged analysis) presented insurmountable difficulties.

Finally, this analysis had a relatively narrow scope. There are other collective-behavioural features of the Hajj that are practically as well as theoretically important which we could have investigated. These include the preference of Shia Muslims to pray in the open at the Mosque, for example. A prediction of self-categorization theory would be that, by gathering together to pray in the open, the Shia identity might become more salient than the superordinate Muslim identity, due to both comparative and normative fit [23]. However, investigating this question must wait for a future study.

The relation between architecture and (collective) behaviour has long been noted, both generally [40] and in relation to Islamic design [41], with its characteristic feature of symmetry. Open spaces, for example, can facilitate interaction [42], and the design of the Grand Mosque and plaza offer examples where this is the case. There is also a clear association between certain architectural features and (disordered) behaviour in emergency evacuations [8]. Disasters at Hajj locations and other pilgrimages have been linked to collective behaviour [43], often with the implication that crowds at these holy sites lack the critical judgement necessary for coordinated conduct [7, 13, 43]. The present study suggests an alternative view of the relation between collective behaviour and

disaster risk reduction in crowded locations, which side-steps attempts to define rationality (versus ‘panic’) in these contexts [cf. 8]), through the use of the concept of social identity. As well as explaining disasters, we need to explain the fact that most of the time the Hajj crowd is orderly. Shared social identity in a crowd is an established predictor of cooperative and coordinated behaviour and can therefore help explain that orderliness. Space and place (for example carrying out rituals in spiritually important buildings) can serve to enhance the salience of social identities [44]. These points are relevant to the planning for mass gatherings [34], crowd safety management training [7], and in computer simulation in planning [45]. Most crowd plans and simulations assume simply that a crowd is a large number of people in the same place. The social identity concept suggests, and our findings evidence, that collective behaviour – behaving *as* a crowd, rather than simply as individuals in the same location – varies according to the context, and therefore that this should be a fundamental assumption of planning.

Conclusion

A questionnaire survey of 1194 pilgrims at the Hajj to Mecca found that pilgrims perceived the Grand Mosque as a very crowded ritual location. Pilgrims were more likely to report giving support to others in the Mosque itself than in the plaza outside; crowd density did not appear to be a factor in the explanation; shared social identity explained more of the variance than both location and density. There was also evidence of a process of cooperation: perceiving others give support predicted shared social identity which predicted giving help to others. This predictive pattern only occurred in the plaza, and suggests the role of place and space in modulating identity processes.

Acknowledgments

We thank Dr Mohammed Edrees, Dr Adnan Gutub, Dr Basim Zafar, Kristoffer Post, Michael Chant, Keita Qasom, Mohammed Diyar, Gaddafi Dorma, Ahmed Zain Al Ghazal, Abdalufa Musliman, Abraham Elias, Sherif Aziz Allah, Obaidullah Al-Nasser, Fateh Tenker, Sohail Oglu, Kalim Khan, Wessam Hassanin, and Mazen Menshawe for assistance with the planning, data collection, and data entry for this study; and the Custodian of the Two Holy Mosques Institute of Hajj Research and Centre of Research Excellence in Hajj and Omrah for logistical support throughout the project. We thank Sanjeedah Choudhury for help with table preparation, Vivian L. Vignoles for advice on the acquiescence measure, and Khalifah Alfadhli for suggestions.

Ethics

The study protocol was approved by the Ethical Committee, Custodian of the Two Holy Mosques Institute of Hajj Research, Umm Al-Qura University (Mecca) Saudi Arabia, and by the University of

Sussex, Brighton, United Kingdom in July 2012. All participants provided their written informed consent before participation.

Data Accessibility

The original SPSS data-set is available on Figshare:

https://figshare.com/articles/HAJ3317aORIGINALDATASET_sav/5406403

Authors' Contributions

HA: research design, data collection, analysis, writing, data curation. JD: supervision, research design, analysis, writing. AT: analysis, writing.

Competing Interests

We have no competing interests.'

Funding

This research was funded by a doctoral scholarship grant from the Ministry of the Interior, Kingdom of Saudi Arabia, to the first author.

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Tables

Table 1.

Location	<i>M</i>	<i>SD</i>
Tawaf	3.98	1.38
Sa'ee	2.45	1.12
Nafrah	3.04	1.29
Jamaraat	2.91	1.40
Muzdalifah	2.62	1.28

Table 2

	Mean	SD	2	3	4	5	6
1. Acquiescence	4.77	0.63	.09**	.08**	.07*	.02	.15**
2. Perceived social support	5.83	0.96		.39**	.30**	.43**	.03
3. Giving social support	6.08	0.86			.27**	.33**	-.03
4. Others are good Muslims	6.16	0.71				.52**	-.06
5. Social identification with crowd	6.05	0.78					-.10**
6. Estimated density	5.20	1.75					

** $p < .01$, * $p < .05$

Table 3 – see separate file

Table 4

	Step 1					Step 2					Step 3				
	<i>b</i>	<i>SE B</i>	β	<i>p</i>	<i>95% CIs for b</i>	<i>b</i>	<i>SE B</i>	β	<i>p</i>	<i>95% CIs for b</i>	<i>b</i>	<i>SE B</i>	β	<i>p</i>	<i>95% CIs for b</i>
Constant	5.48	.25		< .001	(4.99, 5.96)	5.46	.25		< .001	(4.97, 5.95)	3.36	.32		< .001	(2.73, 4.00)
Age group	.07	.03	.09	.004	(0.02, 0.13)	.07	.03	.08	.007	(0.02, 0.12)	.05	.03	.06	.053	(< -0.01, 0.10)
Gender	-.15	.05	-.09	.003	(-0.25, -0.05)	-.14	.05	-.08	.007	(-0.24, -0.04)	-.13	.05	-.07	.010	(-0.23, -0.03)
Education	.04	.02	.07	.018	(0.01, 0.08)	.05	.02	.08	.015	(0.01, 0.08)	.04	.02	.07	.016	(0.01, 0.08)
Language (French vs rest)	-.58	.12	-.20	< .001	(-0.81, -0.35)	-.53	.12	-.18	< .001	(-0.77, -0.30)	-.28	.12	-.09	.019	(-0.51, -0.05)
Hajj service (non-Arab African vs rest)	.01	.12	< .01	.954	(-0.22, 0.24)	.02	.12	.01	.863	(-0.21, 0.25)	-.04	.11	-.01	.731	(-0.26, 0.18)
Performed Hajj before	-.20	.05	-.11	< .001	(-0.31, -0.10)	-.20	.05	-.11	< .001	(-0.30, -0.09)	-.16	.05	-.09	.002	(-0.26, -0.06)
Acquiescence	.13	.04	.09	.001	(0.05, 0.20)	.11	.04	.08	.009	(0.03, 0.18)	.09	.04	.06	.027	(0.01, 0.16)
Estimated density (persons per metre ²)						.01	.02	.01	.685	(-0.02, 0.04)	.01	.01	.03	.327	(-0.01, 0.04)
Mosque vs plaza						.14	.06	.08	.012	(0.03, 0.25)	.13	.05	.08	.011	(0.03, 0.24)
Social identity with crowd											.25	.04	.23	< .001	(0.18, 0.32)
Good Muslims											.11	.04	.09	.007	(0.03, 0.18)

Note. $R^2 = .09$ for Step 1; $\Delta R^2 = .09$; for Step 2. $\Delta R^2 = .17$ for Step 3

Figure and table captions

Table 1. Perceived crowdedness of ritual locations (means and standard deviations).

Table 2. Means, standard deviations, and correlations

Table 3. Linear model of predictors of perceiving social support.

Table 4. Linear model of predictors of reported giving social support.

Figure 1. Crowd close to the black stone, at the Ka'aba (picture courtesy of Wessam Hassanin)

Figure 2. Al-Masjid Al-Haram, or Grand Mosque, Mecca, with Ka'aba at centre and pillars round edge.

Figure 3. Plaza outside the Grand Mosque

Figure 4. Structural equation model for both locations

Figure 5. Structural equation model for inside the Grand Mosque

Figure 6. Structural equation model for in the plaza

Figure 7. Alternative model 1: inside the Grand Mosque

Figure 8. Alternative model 1: in the plaza

Figure 9. Alternative model 2: inside the Grand Mosque

Figure 10. Alternative model 2: in the plaza