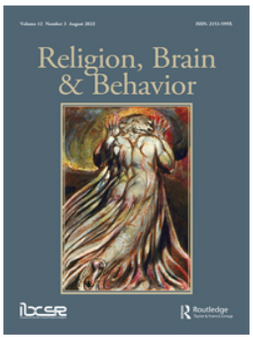

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Kiwi Diwali: a longitudinal investigation of perceived social connection following a civic religious ritual

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ABSTRACT

Religious rituals are ubiquitous. Recent research indicates they can powerfully affect social connection, increasing collective sentiments and behaviors. However, the extent to which these effects depend on religious commitment remains unclear. Here, we use longitudinal data to investigate this question in a natural ritual setting by comparing the responses of religiously committed Hindus and non-Hindus immediately after a public Diwali celebration in New Zealand, and for two weeks following. Effects of time and level of religious commitment are assessed on five targets that measure reported social connection of participants to themselves and to specific groups: "Myself," "My family and friends," "Work colleagues/university peers," "People who celebrate Diwali," and "Humanity in general." We find that participation in the civic religious ritual affects social connection of all participants, with stronger effects among religiously committed Hindus. Private religious behavior appears integral to the mechanisms underpinning the amplification of solidarity at public rituals, as we find separation in the level of reported social connection to Diwali celebrants between practicing and non-practicing Hindus. Though religious commitment leads to greater perceived social connection, this study additionally demonstrates that in a religiously diverse democracy, a civic religious ritual may foster greater democratic unions across religious differences.

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Diwali; social cognition; longitudinal; religion; religious diversity; democracy; ritual

Introduction

No society lacks collective rituals (Sosis & Alcorta, 2003). Collective rituals have been proposed to facilitate group living by aligning the emotional, motivational, and social states of participants (Hobson, 2017), and function as markers of affiliation and commitment to in-group values (Watson-Jones & Legare, 2016). The evidence indicates that features of collective ritual behaviors enhance in-group social solidarity (Mogan et al., 2017). Religious rituals, in particular, appear to promote greater cooperative sharing than non-religious rituals (Fischer et al., 2013; Sosis &

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Ruffle, 2003). The cooperative enhancement observed for collective religious rituals is consistent with longstanding speculation that religious rituals and beliefs promote social cohesion (Durkheim, 2001). Presumably, religious rituals and beliefs co-evolved as adaptations for cooperation, part of culturally selected "packages" of shared customs that bind anonymous masses across ethnic and geographic boundaries, as best exemplified by world religions (Norenzayan et al., 2016).

Previous studies of collective religious rituals have focused on settings in which participants share religious commitment. However, in many contemporary societies, rituals that were once imbued with supernatural meanings have subsequently evolved into secular practices. From the ceremonial launching of ships, to the offerings of toasts and salutations before drinking, to the swearing of oaths as a person begins political office, religious rituals have lost their once-religious frames of reference. There are hybrid cases too. Formerly religious rituals may remain religiously significant for some and not for others. Across the Christian west, for example, the Christian ritual of Christmas is widely celebrated by non-Christians and Christian affiliates (Moore, 1994; Schmidt, 1992). For many contemporary American Jews and Scandinavian Christians, religious rituals such as Passover and Easter are, above theological considerations, related to self-identification with a cultural group and its heritage and are attended by "culturally religious individuals" (Zuckerman, 2010). That is, once-religious collective rituals sometimes evolve into hybrid civic religious events populated by a mix of religious devotees and onlookers. Large-scale public Diwali celebrations in New Zealand, the focal point of this study, are a clear example. Diwali festivals reflect a transformed cultural-religious tradition that deviates from the unpublicized religious practices of local Hindu Indian communities (Johnson & Figgins, 2014). That said, community members who participate in locally dedicated religious celebrations also often participate in Diwali "mega-events" that are popular among the non-Hindu population (Johnson & Figgins, 2014). Diwali celebrations take on a dual secular-sacred nature in the New Zealand context. As these examples illustrate, there is a remarkable diversity of religious and quasi-religious ritual forms, functions, and frequencies.

We agree with scholars who claim there is theoretical utility in analysing ritual effects on social cohesion by focusing on the effects of ritual forms (Whitehouse, 2004; Whitehouse & Lanman, 2014). However, a systematic bio-cultural investigation of diverse ritual forms remains on the horizon of present inquiries in the scientific study of religion (see concluding remarks, Schjoedt, 2009). Here, we focus on religious rituals that are celebrated by both religious and non-religious participants, what we call "civic religious rituals." Despite the increasing prominence of civic religious rituals in contemporary societies, whether they affect people differently depending upon shared commitment to the faith tradition of the event remains unclear.

Here, we use longitudinal data to systematically investigate whether levels of religious commitment mediate the relationship between civic religious ritual participation and perceived social connection among a mixed group of Hindus and non-Hindus who attended the festival of Diwali hosted in New Zealand's capital city of Wellington (October 2014).

Background research

One line of investigation suggests that civic religious rituals are likely to build solidarity among both religious and non-religious participants alike. In a study investigating social identities following a religious ritual among Tamil Hindus in Mauritius, Xygalatas et al. (2013) found that both observers and performers of a high ordeal Kavadi ritual tended to identify with inclusive Mauritian identities over parochial Hindu identities following the collective religious ritual. Notably, this enlarging of social identification is consistent with laboratory research indicating rituals can amplify solidarity with people outside of the ritual group, for example, through synchronous actions (Reddish et al., 2014; Reddish et al., 2016), which have been found to enhance social bonding even in the absence of shared meaningful group identification (Mogan et al., 2017).

However, neither the Thaipusam field study nor the laboratory synchrony studies resolve how civic religious rituals might affect people who vary in commitment to religious beliefs, separate

from specific ritual effects. In the Thaipusam field study, self-identification was connected to perceived ordeal intensity, not to intrinsic differences in religiosity. In the controlled laboratory studies, Reddish et al. (2016) deliberately removed framing about shared context to better identify the specific effects of synchronized movements as an important part of collective rituals. Though civic religious rituals may enlarge solidarity among religious participants, we cannot infer from this research whether extension of solidarity in a civic religious ritual, separate from the effects of minimally ritualistic behaviors, requires that participants share religious commitment.

Another line of investigation suggests that, by contrast, civic religious rituals are unlikely to build solidarity among participants without personal connection to the ritual. Previous research indicates that familiarity with ritual performers, not merely sharing in the collective experience of a ritual, affects social responses. In a study investigating heart-rate synchrony between spectators and performers at a traditional fire-walking ritual in San Pedro, Spain, Konvalinka et al. (2011) observed a strong coupling of heart rate rhythms among spectators who had prior familiarity with firewalkers. Personal connection with at least one firewalker was essential for evoking synchronous heart rhythms. Notably, familiarity with one firewalker extended increased heart-rate synchronicity throughout the ritual event to all firewalkers, even to unfamiliar firewalkers. That is, among spectators without any prior connection to a performer at the fire-walking ritual, reliable heart-rate synchrony with firewalkers was not observed. However, this study did not directly assess social-cognitive processes, nor differences in religious commitment. We note that in the field study by Xygalatas et al. (2013) observers of the Kavadi ritual in Mauritius typically had prior connection to the ritual, either through relation to performers or through prior performance of the ritual. Taken together, these studies imply that prior connection to a religious ritual, firsthand or through social relation, modulates the enlarging effects of ritual on participant solidarity.

Following Konvalinka et al. (2011), we suspect that prior belief or behavioral commitment to a ritual's faith tradition, not unlike prior commitment of observers to performers, matters to amplifying perceived social connection at a civic religious ritual. This is consistent with findings from a laboratory study by Reddish et al. (2013) suggesting synchronous behaviors, when combined with shared goals, strongly affect levels of interpersonal trust. To the extent that religious commitments embody shared intentions and goals, the findings of this study imply that religious commitments are likely required to support greater levels of cooperation following a religious ritual. In the same vein, another field study by Fischer et al. (2013) found an association between performing a ritual associated with sacred values and more generous contributions in an economic game. Laboratory findings are broadly consistent with cross-cultural observational studies among Candomblé members in Brazil (Soler, 2012) and Israeli kibbutz members (Sosis & Ruffle, 2003) that suggest participation in collective religious activities positively affects cooperative decisions in economic games. Furthermore, Power (2018) demonstrated that this cooperative effect is reflected in tangible social relations: co-participants of collective religious rituals were more likely to have denser social network connections than non-participants among Hindu of a South Indian village. This said, although religious commitments appear key to cooperative outcomes, it is possible that perceived emotional unity in collective gatherings is enough to mediate social connection in participants. For example, in a quasi-longitudinal study of social responses following a Spanish folkloric drum march, Páez et al. (2015) found that higher perceived emotional synchrony among walkers increased perceived social belonging and perceived collective efficacy. While the above studies indicate that shared goals and emotions are key to social responses, whether responses will differ by level of religious commitment in a civic religious ritual setting remains to be addressed.

A final line of research suggests that civic religious rituals in religiously diverse contexts will differ in their effects from religious rituals performed among people with shared faith. Economists and behavioral ecologists theorize that costly religious rituals function to enhance within-group cooperation because ritual costs authenticate commitments to a religious group (Iannaccone, 1994; Irons, 1996, 2001). In support of this, Sosis and Bressler (2003) observed that during the nineteenth century, American religious communes with high entry costs were four times more likely to

outlast American secular communes. The focus of economists and behavioral ecologists on behavioral aspects of religion, however, leaves it unclear why costly religious rituals worked better than rituals that lacked religious ideologies. Bulbulia (2004a, 2004b) theorized that this is because costly religious rituals authenticate beliefs in a world where pro-sociality is supernaturally rewarding, and that evolutionary dynamics have favored religious ritual and belief systems over other systems. These theories and studies imply that sharing commitment to a faith will promote greater cooperation among believers who participate in the rituals of that faith.

In line with speculation that beliefs matter, secular rituals may have insufficient binding power because they lack connection to supernatural ideologies (Shaver et al., 2018). Shaver et al. (2018) compared trust among eleven secular groups, including male fraternities that impose costly entry rites on new members. The authors did not observe any reliable relationship between costly behaviors and trust in the secular groups. However, this study did not systematically examine the social-cognitive effects of ritual in settings where some people are committed to the supernatural ideologies that inform that ritual and others are not. We suspect that social-cognitive effects will differ by level of commitment to the supernatural ideology that informs the ritual.

To summarize, though civic religious rituals are increasingly commonplace, previous studies leave out the question of whether civic religious rituals will affect people differently. Though the cooperative effects of ritualistic behaviors have been observed to extend to people outside of an immediate ritual context, whether such extension of cooperation requires that ritual participants share a common faith remains unclear. To our knowledge, no previous study has investigated whether civic religious rituals affect participants differently depending on whether they are committed to ritual as a religious practice. The purpose of the present study is to investigate this question in the context of a natural human ecology, that of a civic Diwali celebration in Wellington, New Zealand ("Kiwi Diwali").

Research setting

Diwali is a multi-day religious ritual in Hinduism that is embedded within a set of narratives and beliefs about the triumph of light (good) over darkness (evil). The ritual is widely celebrated across global Hindu communities, focuses on gift-giving, food with family and friends, and veneration of Lakshmi, the Hindu goddess of health. In New Zealand, Diwali festivals have evolved into civic events whose participants include a mix of traditional Hindus and non-Hindus.

Approximately 10,000 people of mixed Hindu and non-Hindu background attended the Diwali Festival event in 2014. Large-scale public Diwali events typically last one day and are held on weekends (by contrast, household Diwali celebrations typically follow the lunar calendar and involve five days of celebration (Johnson & Figgins, 2014)). The Wellington Diwali celebration was structured around key theatrical reenactments, dance, and musical events centered on the Diwali story, performed by local and international artists and troupes, both amateur and professional, of varying ages and ethnic composition. Performances spanned traditional Indian and South Asian, contemporary Bollywood, and Indian-European fusion genres. The venue was packed with Indian food stalls, retail, traditional arts and crafts, and Mehndi vendors.

Alongside its cultural and religious dimensions, political figures have often featured in openings of "Kiwi Diwali" ceremonies thereby tying in aspects of New Zealand national identity into the event (Figure 1). Recognized as one of the nation's largest minorities, Hindu Indian communities are well established and form strong social networks in New Zealand, founded on the Indian diaspora in the nineteenth century and the flourishing of community centers in the mid-twentieth century (Johnson & Figgins, 2014). The community actively organizes events, public and private, to recognize and celebrate Indian religion and culture in New Zealand. Diwali celebrations, in particular, have become increasingly prominent outside of the Hindu community. Wellington Diwali is one of two Diwali "mega-events" established in 2002, with the second held in Auckland (Johnson & Figgins, 2014). In 2004, the country's prime minister Helen Clark commented, "it is wonderful to

Figure 1. Images from "Kiwi Diwali" civic religious ritual. (A) Wellington Mayor opens "Kiwi Diwali." (B) Dancers re-enact the Diwali story in which the forces of good vanquish evil. (C) A large crowd of mixed Hindu and non-Hindu backgrounds observes the dancers. (D) Outside of the theatre, there is Indian food and cultural products for sale. For Hindus who celebrate Diwali, gift-giving is a form of religious piety.

see the celebration of Diwali becoming a significant event in New Zealand's cultural calendar" ("Auckland Diwali Festival," n.d.). "Kiwi Diwali" is thus a collective celebratory ritual of both a cultural and religious minority in New Zealand that is well-recognized and shared in by a broader national community.

Although an increasingly secular country, New Zealand saw increased diversity in its religious population from 2006 to 2013, with a 39.6% increase in Hindu affiliation in that period, a decrease in Christian affiliates, and growing numbers for smaller world religions (Statistics New Zealand, 2014). It is also linguistically and ethnically diverse, home to a variety of religious and non-religious identities (Statistics New Zealand, 2014). "Kiwi Diwali" thus enables a systematic investigation of the role of religious commitment in affecting social perceptions among people who partake of a religious tradition (devout Hindus) and people who do not (civic participants), in a religiously diverse setting.

Here, we use longitudinal data to systematically investigate social responses immediately after, and following, a large-scale public "Kiwi Diwali" event, among (1) devout Hindus, (2) non-devout Hindus, and (3) those not affiliated with Hinduism, across five domains of perceived social connection. We use three levels of religious commitment to assess whether prior commitment to a common faith affected perceived social connection after the event, and if so, whether these changes endured in the weeks that follow. As we could not randomly assign attendants to ritual participation conditions and measure social connection beforehand in a natural setting, we infer ritual effects from the differences in observed affective decay over time between Hindu, religiously committed Hindu, and non-Hindu participants. If all participants expressed similar responses, we would infer that religious commitments did not play a role in amplifying perceived social connection. If Hindu-affiliated attendees expressed similar responses, whether or not they celebrated Diwali

at home, we would infer that sharing a religious identity in a culturally religious sense (as described by Zuckerman, 2010) impacts how this civic religious ritual amplifies social connection, but not level of religious commitment. The slopes of change over time in perceived social connection enable us to address the same interests in respect to the durability of ritual effects.

Our statistical models adjust for demographic factors and prior personal connection with Diwali actors. By tracking participants at the event and subsequently at four time points over two weeks, we clarify both the relative differences in perceived social connection between Hindus and non-Hindus at this civic religious ritual, as well as the rates of decay in perceived social connection for all participants in subsequent weeks.

Method

Ethics and data

Human ethics for this study was granted by a Victoria University Human Ethics Committee RM019281. All participants in this study were over the age of 18 and gave informed consent. All data collected for the study and the R script used for analysis are available under the Open Science Framework (OSF): https://osf.io/2tjcf/?view_only=ddd36d89a72c40599214fb30092d5f8e.

Recruitment

We recruited participants at the Diwali Festival celebration at Wellington TSB Arena in Wellington, New Zealand on Sunday 19 October 2014. The organizers provided us with a table on which we secured posters advertising the study. Those who indicated interest in participation were given a sheet explaining the study and the ethical review of the study. After verifying they were 18 years or older, those who agreed to participate were given an informed consent form to sign, a questionnaire, and were offered a private place at a table to complete both. Participants were then sent an online version of the survey over the following two-week period, on Wednesdays and Sundays of each week, yielding a total of five measurement points. The initial survey asked for demographic information about their age, gender, ethnicity, and religious affiliation. These questions were only asked at the first survey. Both the initial survey and each subsequent survey asked the same questions about general health, values, cohesion, mood and self-construal. By using the same questions in successive waves of the survey, we were able to assess how the event differentially affected people after adjusting for demographic factors; whether different effects tapered off over time, and if so, whether the time slope varied depending upon commitment to the Hindu faith. Three hundred and twenty-four adults participated in the first survey. Attrition resulted in a final sample of 196 participants at the end of the four waves. Breakdown of participants lost to attrition is provided in Supplement 2 Table 1. Survey questions for each measurement point are provided in Supplement 3. Table 1 presents a summary of participants and Figure 1 presents images from the "Kiwi Diwali" event.

Participants

Age. We asked the participants to state their age, "What is your age: … (years)?" The average age of the participants was 33.1 years old (SD = 12.2). The youngest participant was 18 years and the oldest was 67 years old. Five people (1.5%) did not report their age.

Gender identification. We asked participants, "What gender do you identify as? (please circle): Female / Male / Other." 196 participants reported "Female," 125 reported "Male," one reported Other, and three (9% of the sample) did not report a gender. We created a binary variable, "Male/Other" where male was coded as "1" and "Other" was coded as "0," reflecting the expected default value of the intercept in our multi-level regression models.[1]

Table 1. Summary of sample means and missingness rates for the endogenous variables in this study.

	Diwali ($n = 324$)
Age	
Mean (SD)	33.1 (12.2)
Median [Min, Max]	29.0 [18.0, 67.0]
Missing	5 (1.5%)
Gender	
Other	196 (60.5%)
Male	125 (38.6%)
Missing	3 (0.9%)
Indian	
Not Indian	247 (76.2%)
Indian	77 (23.8%)
Level Hindu Commitment	
Not Hindu	279 (86.1%)
Hindu − Celebrate Home	25 (7.7%)
Hindu + Celebrate Home	20 (6.2%)
Close to Diwali Dancer	
Not Close	276 (85.2%)
Close	39 (12.0%)
Missing	9 (2.8%)

Ethnicity. We asked participants to state whether they identified with an ethnic group, and if so, which one. 77 participants (23.8%) stated an Indian ethnic identification, and the remaining 247 participants (76.2%) were classified as not stating an Indian identification.

Religious affiliation. We asked participants, "Do you identify with a religion and/or spiritual group? Y / N." For those who identified with a religious group we asked, "If Y … Which religion/spiritual group?" A total of 178 (54.9%) participants were not religiously affiliated, 141 (43.5%) were religiously affiliated, and five (1.5%) did not respond.

Three levels of Hindu commitment. To assess levels of Hindu investment in Diwali, the key theoretical focus of this study, we asked participants to state whether they celebrated Diwali at home. We created a three-level factor variable for which the lowest level "0" indicated no Hindu affiliation, "1" indicated Hindu but does not celebrate Diwali at home, and "2" indicated Hindu and celebrates Diwali at home. 279 (86.1%) participants did not state a Hindu religious affiliation, 25 (7.7%) were Hindu but did not celebrate Diwali at home, and 20 (6.2%) were both Hindu and celebrated Diwali at home. Of the 25 participants who reported being Hindu and did not celebrate Diwali at home, 21 (84%) identified as Indian, while of the 20 participants who reported being Hindu and celebrated Diwali at home, 16 (80%) identified as Indian.

Emotional closeness to a Diwali dancer. To adjust for specific effects of personal connection with a ritual actor (which Konvalinka et al. (2011) observed to affect cooperative responses), we asked participants "Are you emotionally close to one or more members of a Diwali dance group? Y / N." Responses were coded as a two-level factor for Emotional Closeness to a ritual actor. 276 (85.2%) stated "No," 39 (12.0%) stated "Yes," and nine (2.8%) did not respond.

Outcome measures

To measure how connected the participants felt to themselves and to specific groups, we employed a shortened scale derived from a Sixfold Self-Construal Scale devised by Harb and Smith (2008): "Using the relevant scales below, please indicate how connected you feel to the following groups where 1 indicates 'not connected at all' and 7 indicates 'connected completely'." The following five targets were assessed at the Diwali event and then at four measurement intervals during the following two weeks: (1) "Myself" (2) "My family and friends" (3) "Work colleagues/university peers" (4) "People who celebrate Diwali" (5) "Humanity in general." Additionally, we asked

participants to rate their perceived connectedness to the "Indian community in Wellington," "Indian community in New Zealand," and "Global Indian community." We do not assess ethnic bonding here; however, as indicated in the data, there was overall greater identification with all three groups after Diwali suggesting the event may have fostered greater connection across ethnic categories, a topic for a different study. Table 2 provides average ratings for target responses at Diwali and the four following measurement points. Table 3 presents a correlation matrix of the outcome variables.

Multiple imputation

To handle bias arising from missing data, a potentially serious problem for longitudinal inference (Honaker & King, 2010) missing values were multiply imputed across the dataset using the Amelia package in R (Honaker et al., 2011). We imputed twenty missing data sets. Nominal variables were "CelebrateHome" (whether a participant did or did not celebrate Diwali at home), "Emotional-Close" (whether a participant was emotionally close or not to a Diwali dancer), "Male" (gender), "Eth" (ethnicity), "HinduPlusPuja" (level of Hindu commitment, refers to levels of celebrating Diwali at home).[2] The remaining indicators were imputed as continuous variables. To provide better fit, we included a third order polynomial for Time when estimating responses (Honaker et al., 2011). We assumed responses were missing at random, conditional on all indicators for which we had collected information. Twenty multiple imputed data sets were produced, and all statistical models inferred over the uncertainty were created from the multiple imputation process. Full details about our data imputation method are included in the OSF report.

Statistical models

All models were estimated in a Bayesian setting using the BRMS package in R. All twenty datasets were passed to the BRMS, enabling an efficient pooling of uncertainty arising from the multiply imputed data sets. Noninformative priors were used, and initial values were proposed to be zero. To enable effective sampling, models were sampled for 10^6 iterations, with a thin rate of 10. We assessed the main effects of Time (continuous over the five time points, with the first time point coded as 0, and subsequent intervals coded as 1–4 on a continuous scale, where each unit interval corresponds to 0.5 weeks of time), level of Hindu Commitment ("0" = not Hindu, "1" = Hindu but does not celebrate Diwali at home, "2" = Hindu and celebrates Diwali at home). We also assessed whether a participant was emotionally close to a Diwali dancer (a two-level factor: "0" = No, "1" = Yes), whether a participant ethnically identified as Indian ("0" = No, "1" = Yes), and whether a participant identified as male ("0" = No, "1" = Yes). To assess factors that might lead to a non-linear change in perceived connectedness, we assessed the interactions of Time and (1) Levels of Hindu Commitment, and (2) Emotional Closeness to a Diwali dancer. To adjust for dependencies for the multiple measurements within participants over time, we estimated a random intercept for each participant and included a random slope for Time, modeled in the random component of the model as a factor. All response variables were assumed to draw from Gaussian distributions. Overall levels of correlation in the responses were estimated in a residual covariance matrix, from which correlations in the residuals were estimated. The correlations enabled us to understand overall levels of correlation between the responses (Supplement 1.1). To clarify model fit, we used the *sjstats* package in R to compute Bayes R^2 values (reported in Table 4), which relies on the performance package in R and calculates the variances explained by the fixed effects (Gelman et al., 2019; Lüdecke, 2018).

Multicollinearity test

Multicollinearity arises in regression when two or more predictor variables are correlated, which tends to increase the standard error estimates for coefficients. To test for multicollinearity we

Table 2. Summary of sample means for the endogenous social connection variables at Diwali and at each of the four subsequent waves.

	Diwali ($n = 324$)	1 ($n = 324$)	2 ($n = 324$)	3 ($n = 324$)	4 ($n = 324$)
Connection Self					
Mean (SD)	5.91 (1.14)	5.84 (1.18)	5.60 (1.19)	5.62 (1.25)	5.66 (1.18)
Median [Min, Max]	6.00 [2.00, 7.00]	6.00 [1.00, 7.00]	6.00 [1.00, 7.00]	6.00 [2.00, 7.00]	6.00 [1.00, 7.00]
Missingness	7 (2.2%)	108 (33.3%)	132 (40.7%)	128 (39.5%)	128 (39.5%)
Connection Family/Friends					
Mean (SD)	5.64 (1.16)	5.41 (1.25)	5.30 (1.23)	5.35 (1.19)	5.37 (1.19)
Median [Min, Max]	6.00 [2.00, 7.00]	6.00 [1.00, 7.00]	5.00 [2.00, 7.00]	6.00 [2.00, 7.00]	5.00 [2.00, 7.00]
Missingness	7 (2.2%)	108 (33.3%)	132 (40.7%)	128 (39.5%)	128 (39.5%)
Connection Workers					
Mean (SD)	4.60 (1.49)	4.52 (1.49)	4.24 (1.53)	4.36 (1.53)	4.42 (1.52)
Median [Min, Max]	5.00 [1.00, 7.00]	5.00 [1.00, 7.00]	4.00 [1.00, 7.00]	5.00 [1.00, 7.00]	5.00 [1.00, 7.00]
Missingness	9 (2.8%)	108 (33.3%)	132 (40.7%)	128 (39.5%)	128 (39.5%)
Connection People Diwali					
Mean (SD)	3.90 (1.59)	3.54 (1.50)	3.47 (1.48)	3.51 (1.59)	3.52 (1.50)
Median [Min, Max]	4.00 [1.00, 7.00]	3.00 [1.00, 7.00]	3.00 [1.00, 7.00]	4.00 [1.00, 7.00]	4.00 [1.00, 7.00]
Missingness	7 (2.2%)	108 (33.3%)	132 (40.7%)	128 (39.5%)	128 (39.5%)
Connection Humanity					
Mean (SD)	5.10 (1.34)	4.75 (1.39)	4.78 (1.34)	4.60 (1.46)	4.67 (1.59)
Median [Min, Max]	5.00 [1.00, 7.00]	5.00 [1.00, 7.00]	5.00 [1.00, 7.00]	5.00 [1.00, 7.00]	5.00 [1.00, 7.00]
Missingness	8 (2.5%)	108 (33.3%)	132 (40.7%)	128 (39.5%)	128 (39.5%)

Note: Stable sample size is presented with missingness rate provided for each wave.

Table 3. Summary of the correlation of social connection variables with each other at the first measurement point (the Diwali event, $n = 324$).

Variable	*M*	*SD*	1	2	3	4
Connection Self	5.75	1.19				
Connection Family/Friends	5.44	1.20	.64** [.60, .67]			
Connection Workers	4.45	1.51	.40** [.35, .45]	.55** [.51, .59]		
Connection People Diwali	3.62	1.55	.21** [.15, .26]	.34** [.28, .39]	.44** [.39, .49]	
Connection Humanity	4.81	1.43	.34** [.29, .39]	.40** [.35, .45]	.39** [.33, .43]	.40** [.35, .45]

Notes: *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014).
* indicates $p < .05$.
** indicates $p < .01$.

performed five separate regressions using the lme4 package in R (Bates et al., 2015) and then applied the 'vif()' test using the CAR package in R (Fox & Weisberg, 2018) to test for multicollinearity. Each regression contained the same linear predictor as in the multivariate outcome model. Supplement 1.2 reports the Variance Inflation Factors (VIFs) calculated for each of the five models, and codes for the VIFs are provided in our OSF R script for reproduction purposes. The car package calculates both unweighted generalized VIFs and weighted generalized VIFs. A general rule of thumb in regression analysis is to consider VIFs over 5 indicating multicollinearity (Kumar, 1975). The highest VIF that we observe is 3.36 (unweighted) or 1.35 (weighted VIF) for the Hindu commitment indicator (HinduPlusPuja) for the 'connection with self' model. Though these values do not approach an arbitrary cut-off value of VIF > 5, we nevertheless advise caution when interpreting coefficient separation for the three-level Hindu commitment (HinduPlusPuja) indicator. The square root of a VIF indicates the magnitude increase in standard error compared to indicators that exhibit zero-correlation with other indicators in the model. Using the conservative GVIF value of 3.36, we calculate a 1.83 times magnitude increase a model with absolutely zero multicollinearity. It is possible that some of the coefficient estimates that cross zero in the present study do so because we lack good separation of our indicators. However, because multicollinearity leads to conservative estimates, we are confident that the estimates we observe to be reliable (i.e., do not cross zero) likely reflect true differences in the population parameters.

Results

Regression estimates for the statistical models are printed in Table 4 and plotted in Figure 2. A plot for the predicted slopes of Time × Hindu Commitment (the theoretical focus of this paper) on all five outcomes is given in Figure 3.

Social Connection with Diwali Celebrants. The expected level of connection with *Diwali Celebrants* at the intercept was ($b = 3.41$, 90% HPD = 3.27, 3.55). Older people tended to rate their connection higher ($b = 0.13$, 90% HPD = 0.06, 0.21). There were no reliable effects for males ($b = -0.06$, 90% HPD = −0.25, 0.13). People who were emotionally close to a Diwali dancer ($b = 0.66$, 90% HPD = 0.28, 1.03), of Indian ethnicity ($b = 0.67$, 90% HPD = 0.39, 0.95), Hindus who did not celebrate Diwali at home ($b = 0.58$, 90% HPD = 0.09, 1.09), and especially Hindus who celebrated Diwali at home ($b = 1.20$, 90% HPD = 0.68, 1.71) all expressed reliably greater connection to Diwali celebrants. Though none of the time interactions were reliable, a main effect of time ($b = -0.06$, 90%

Table 4. Posterior average location effects and 90% Highest Posterior Density intervals (Bayesian multi-level estimation).

	Connection People Diwali		Connection Fam/Fri		Connection Humanity		Connection Self		Connection Workers	
Predictors	Estimate	HPD (90%)	Estimate	HPD (90%)	Estimate	HPD (90%)	Estimate	HPD (90%)	Estimate	HPD (90%)
Intercept	3.41	3.27, 3.55	5.56	5.45, 5.67	4.84	4.70, 4.97	5.88	5.76, 5.99	4.55	4.41, 4.70
Time	−0.06	−0.10, −0.02	−0.06	−0.10, −0.03	−0.08	−0.13, −0.04	−0.08	−0.12, −0.04	−0.05	−0.10, −0.01
Hindu − Celebrate Home	0.58	0.09, 1.09	0.79	0.42, 1.16	0.85	0.39, 1.31	0.44	0.04, 0.83	0.65	0.13, 1.16
Hindu + Celebrate Home	1.20	0.68, 1.71	0.68	0.27, 1.08	0.90	0.40, 1.40	0.63	0.23, 1.04	0.61	0.07, 1.14
Emotionally Close	0.66	0.28, 1.03	0.06	−0.25, 0.37	0.12	−0.25, 0.48	−0.27	−0.60, 0.04	0.20	−0.18, 0.58
Age in Decades (C)	0.13	0.06, 0.21	0.10	0.04, 0.15	0.07	−0.01, 0.15	0.12	0.07, 0.18	0.05	−0.02, 0.13
Indian Ethnicity	0.67	0.39, 0.95	−0.30	−0.50, −0.09	0.05	−0.27, 0.32	−0.35	−0.58, −0.11	−0.07	−0.35, 0.22
Male	−0.06	−0.25, 0.13	−0.12	−0.25, 0.02	0.03	−0.17, 0.23	0.07	−0.07, 0.21	−0.31	−0.50, −0.12
Time × Hindu − Celebrate Home	−0.05	−0.21, 0.11	0.01	−0.13, 0.15	0.01	−0.15, 0.18	0.07	−0.07, 0.20	−0.04	−0.23, 0.15
Time × Hindu + Celebrate Home	−0.06	−0.22, 0.10	−0.03	−0.16, 0.11	−0.05	−0.21, 0.10	−0.00	−0.14, 0.13	0.07	−0.09, 0.22
Time × Emotionally Close	−0.07	−0.19, 0.06	0.03	−0.08, 0.15	−0.00	−0.12, 0.12	0.09	−0.01, 0.20	−0.01	−0.13, 0.13
Random Effects										
σ^2	0.07									
τ_{00}	0.66									
N_{Id}	324									
Observations	1620									
R^2 Bayes		0.423		0.374		0.395		0.323		0.410

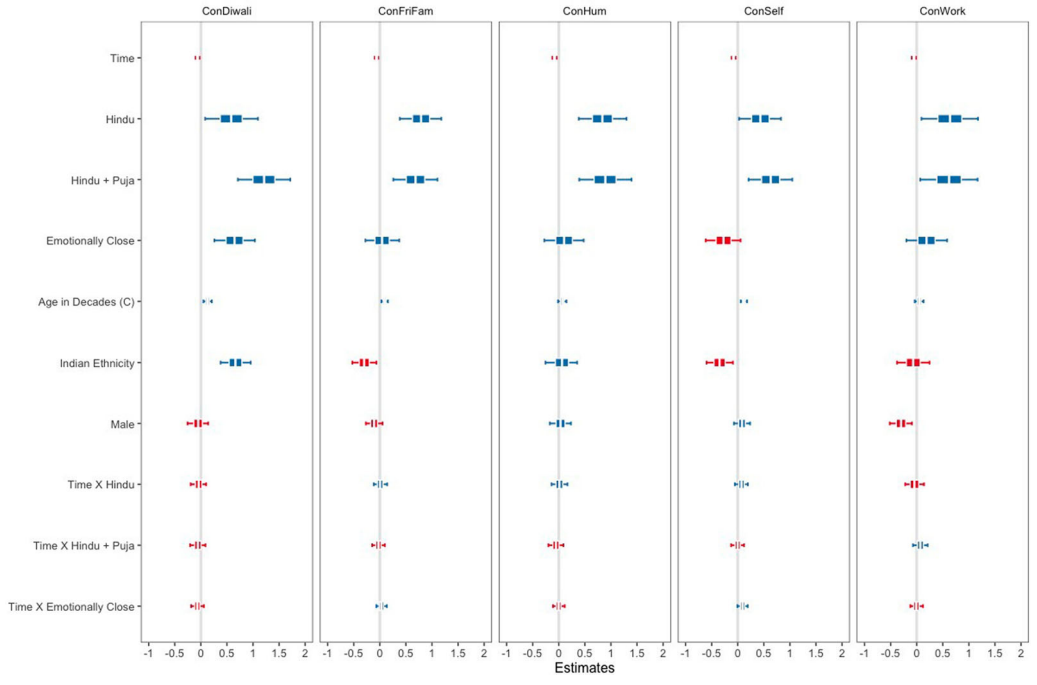

Figure 2. Coefficients plot for posterior average location effects and 90% Highest Posterior Density intervals (Bayesian multi-level estimation).

HPD = −0.10, −0.02) indicates decreasing perceived connection with Diwali celebrants following the event. This suggests that the civic religious ritual amplified social connection with Diwali co-celebrants among all celebrants, though with greater expected increases among Hindus.

Social Connection with Self. The expected level of connection with *Self* at the intercept was relatively high ($b = 5.88$, 90% HPD = 5.76, 5.99). Perceived connection with self was expected to increase with each decade of age ($b = 0.12$, 90% HPD = 0.07, 0.18). Males were not reliably different ($b = 0.07$, 90% HPD = −0.07, 0.21). There was an expected increase in perceived connection with self among Hindus who did not celebrate Diwali at home ($b = 0.44$, 90% HPD = 0.04, 0.83) and among Hindus who celebrated Diwali at home ($b = 0.63$, 90% HPD = 0.23, 1.04). We observed a main effect of time ($b = -0.08$, 90% HPD = −0.12, −0.04), indicating that perceived connection with self tended to be higher just after Diwali than at later intervals. We did not observe an interaction of time with Hindus who did not celebrate Diwali at home ($b = 0.07$, 90% HPD = −0.07, 0.20) nor with Hindus who celebrated Diwali at home ($b = -0.00$, 90% HPD = −0.14, 0.13). These results imply that the decline at later intervals was similar irrespective of the level of Hindu commitment. We find that the posterior mode for perceived connection with self was lower among those who stated that they were emotionally close to a Diwali dancer; however, the distributions crossed zero at the 90% interval, suggesting this effect is unreliable ($b = -0.27$, 90% HPD = −0.60, 0.04). However, the positive interaction observed between time and emotional closeness to a Diwali dancer is worth considering parallel to this observation, as the data hints at a rebounding of connection with self in the weeks following Diwali for this group, though this effect crossed zero at the margins ($b = 0.09$, 90% HPD = −0.01, 0.20). Coupled with the observation that participants with emotional closeness to Diwali dancers also tended to report greater perceived connection with co-celebrants, this lends some support to the findings of Konvalinka et al. (2011), that invested spectators tend to identify with focal actors at collective religious rituals. Additionally, we observe a reliably lower connection with self among people of Indian ethnicity ($b = -0.35$, 90% HPD = −0.58, −0.11), an effect

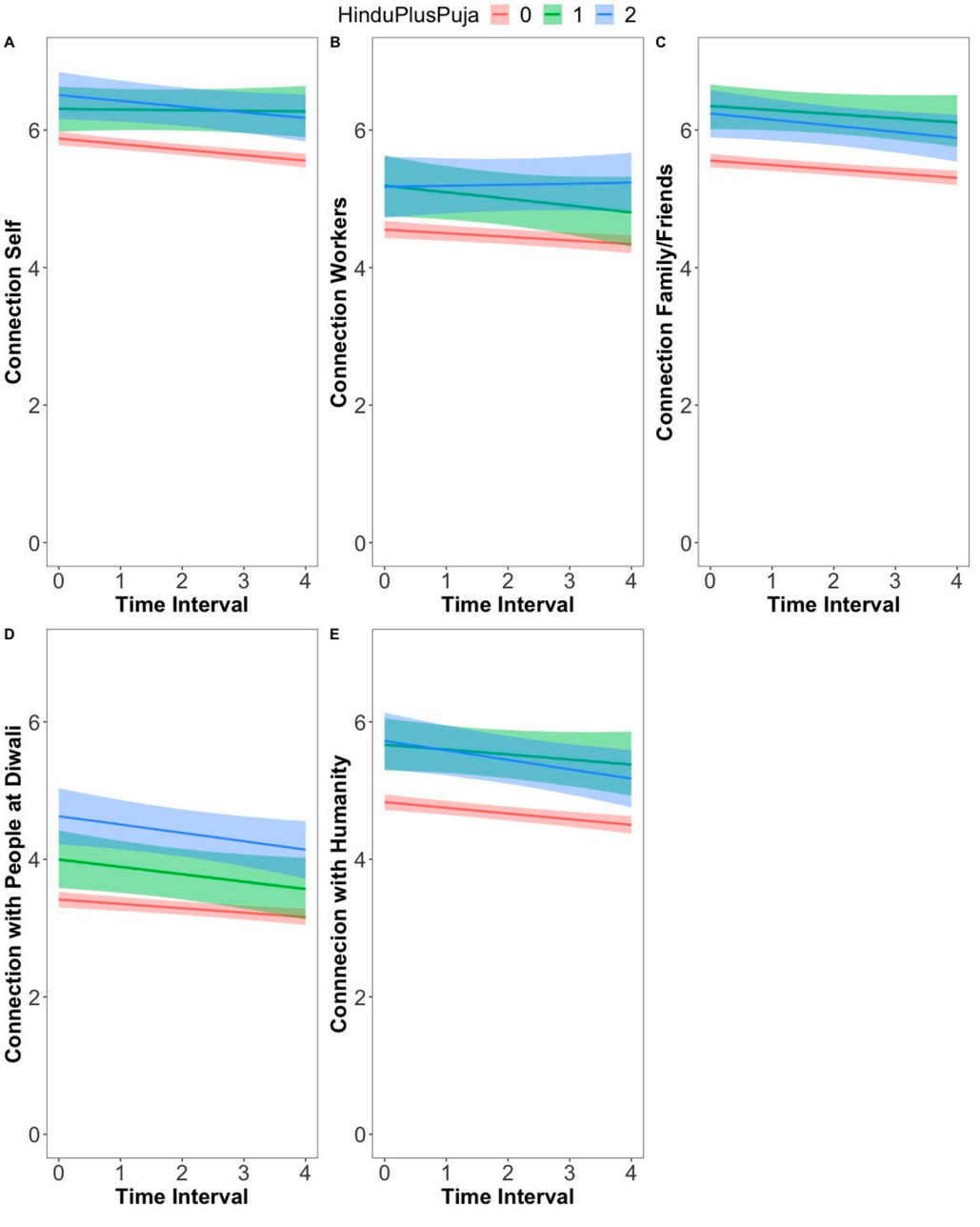

Figure 3. Predicted effects of Time × Hindu commitment reveals decay of perceived social connection across five dimensions following "Kiwi Diwali," with greater perceived social connection for Hindus.

for which we have no ready explanation. It is possible that this single item measure does not provide reliable information about participant responses, and so we advise caution when interpreting this result.

Social Connection with Friends/Family. The expected level of connection with *Friends/Family* at the intercept was ($b = 5.56$, 90% HPD = 5.45, 5.67). Perceived connection increased with each decade of age ($b = 0.10$, 90% HPD = 0.04, 0.15), and was greater for Hindus who did not celebrate Diwali at home ($b = 0.79$, 90% HPD = 0.42, 1.16), and Hindus who celebrated Diwali at home

($b = 0.68$, 90% HPD = 0.27, 1.08). After adjusting for religious identification, we find that people of Indian ethnicity expressed lower perceived connection with friends and family ($b = -0.30$, 90% HPD = −0.50, −0.09). Males also tended to express lower perceived connection but not reliably so ($b = -0.12$, 90% HPD = −0.25, 0.02). No reliable associations were observed for people who were emotionally close to a Diwali dancer ($b = 0.06$, 90% HPD = −0.25, 0.37). There was a reliable decline in perceived connection with friends and family after the Diwali event ($b = -0.06$, 90% HPD = −0.10, −0.03). We did not observe interactions between time and Hindus who did not celebrate Diwali at home ($b = 0.01$, 90% HPD = −0.13, 0.15), nor between time and Hindus who celebrated Diwali at home ($b = -0.03$, 90% HPD = −0.16, 0.11), nor between time and emotional closeness with a Diwali dancer ($b = 0.03$, 90% HPD = −0.08, 0.15). We infer that there were no reliable non-linearities in expected declines in perceived connection with friends and family as a function of Hindu commitment levels and emotional proximity to a performer at the civic religious ritual.

Social Connection with Co-workers. The expected level of connection with *Co-workers* at the intercept was ($b = 4.55$, 90% HPD = 4.41, 4.70). Males expressed reliably lower perceived connection with their co-workers ($b = -0.31$, 90% HPD = −0.50, −0.12). Hindus who did not celebrate Diwali at home ($b = 0.65$, 90% HPD = 0.13, 1.16) and Hindus who celebrated Diwali at home ($b = 0.61$, 90% HPD = 0.07, 1.14) expressed greater perceived connection with co-workers. After adjusting for religious effects, people of Indian ethnicity were not reliably different from those who did not state Indian identification ($b = -0.07$, 90% HPD = −0.35, 0.22). None of the time interactions were reliable; however, the main effect of time ($b = -0.05$, 90% HPD = −0.10, −0.01) indicates that perceived social connection with co-workers declined across all participants in the weeks following the Diwali event. This finding implies that the Diwali celebration fostered greater connection with co-workers, with more pronounced effects for Hindus, regardless of whether they celebrated Diwali at home.

Social Connection with Humanity. The expected level of perceived connection with *Humanity* at the intercept was ($b = 4.84$, 90% HPD = 4.70, 4.97). There was a much greater increase in perceived connection among both Hindus who did not celebrate Diwali at home ($b = 0.85$, 90% HPD = 0.39, 1.31) and Hindus who celebrated Diwali at home ($b = 0.90$, 90% HPD = 0.40, 1.40). People of Indian ethnicity were not reliably different from those who did not state Indian identification ($b = 0.05$, 90% HPD = −0.27, 0.32). There were no reliable differences in connection with humanity associated with age ($b = 0.07$, 90% HPD = −0.01, 0.15), male gender ($b = 0.03$, 90% HPD = −0.17, 0.23), or for people who were emotionally close to a Diwali dancer ($b = 0.12$, 90% HPD = −0.25, 0.48). Though none of the time interactions were reliable, we again observed a main effect of time ($b = -0.08$, 90% HPD = −0.13, −0.04), implying a general decline in perceived connection with Humanity for all participants following the event. We infer from these results that the civic religious ritual tended to intensify perceived social connection with Humanity for those who attended the event, with greater expected increases for Hindus.

Discussion

Previous studies have found that religious rituals foster social solidarity. However, it is possible that this effect relies upon shared religious faith and level of religious commitment. Here, we present the first quantitative longitudinal investigation of social connection following a civic religious ritual. Specifically, we measured the effects of civic religious ritual attendance on five domains of perceived social connection of religiously committed and non-committed participants, and assessed rates of decay for these effects over a two-week period.

For the purpose of understanding perceived social connection immediately after and following a civic religious ritual, we recruited participants who generally chose to attend the Diwali celebration, with minimal control over selection criteria. About 10,000 people attended the event. Because we could only assess the demographic characteristics of participants in our study, it is unclear whether

we sampled with bias from the larger population of ritual attendees. While in laboratory conditions this would, correctly, be considered a weakness in experimental design, we note that this does not owe to oversight; it reflects the limitations of conducting an ecologically valid study. We caution that adopting an ecologically valid approach resulted in only 39 Indian participants in the full sample after attrition, and the attrition of the sample in combination with our multiple imputation strategy will have attenuated all effects. This may have compromised our study's power to detect effects that would be identifiable in a larger sample, and coefficients we identify as unreliable may have been muted by the process of multiple imputation. Nevertheless, we are confident in the signals that our method detects, which, also make sense in light of previous theory. We next clarify the interest of our results in detail.

We observe that Hindu participants had reliably greater perceived social connection across all five self-construal categories than non-Hindu participants. Furthermore, we infer that the heightened perceived social connection we observed among Hindus was the result of religious, rather than of ethnic differences, from the effect of Hindu faith on perceived social connection after adjusting for Indian identification. Put differently, the overall lower social bonding predicted by Indian ethnicity counts against the alternative explanation that effects were not the result of the ritual, but instead reflect the response style of people of Indian ethnicity. Instead, non-Hindu Indians were likely to score lower in perceived social connection than Hindu Indians and non-Hindus. We note that the special amplification of social connection among those who are Hindu affiliated is consistent with findings that prosocial outcomes are predicted by the performance of rituals perceived to be sacred (Fischer et al., 2013), and ritualized activities framed by shared goals (Reddish et al., 2013), to the extent shared goals can be identified with sharing religious commitments.

That social connection was reliably higher for Hindus than non-Hindus in a civic-religious setting is not altogether mysterious. Diwali, an introduced and recontextualized sacred ritual in the public and private spheres, plays a dual role for Hindus in the New Zealand context. Large-scale annual "Kiwi Diwali" festivals are public, civic religious spaces for mass consumption of Indian culture and promotion of social harmony in a multi-cultural and multi-religious setting (Booth, 2015; Johnson & Figgins, 2014). By comparison, local community-oriented Diwali celebrations are private, and often sacred, spaces that reinforce in-group identity tied to heritage and collective memory (Booth, 2015; Johnson & Figgins, 2014). New Zealand's Hindu community actively organizes cultural and religious events among a local network of individuals and organizations, and while community members may participate in both large-scale public festivals as well as community-oriented religious celebrations, individuals outside of the community mostly attend the former (Johnson & Figgins, 2014). Speculating, amplified social connection for Hindus in general tapped into shared identity and broader community commitment. This would be consistent with Power (2018) who found co-participants at collective religious rituals were more likely to have cooperative social ties.

Given our sample size, we did not expect to find reliable differences among Hindus who celebrated Diwali at home and Hindus who did not, except where ritual effects were especially powerful. Collective religious rituals appear to promote greater cooperative responses from participants committed to religious activities (Power, 2018; Soler, 2012), but cooperative outcomes may hinge on collective ritual attendance over private religious activities (Sosis & Ruffle, 2003). For example, Sosis and Ruffle (2003) showed that among religious Israeli kibbutzim, males with frequent synagogue attendance were more cooperative than both males who attended less, and religious females, who pursue domestically oriented or private ritual obligations and are not required to attend collective rituals. This does not, however, elucidate whether private religious rituals might amplify social connection at collective rituals for those who participate in both; the relationship between private and public ritual behavior remains to be addressed (Watson-Jones & Legare, 2016). We observed such differences for Hindus who celebrated Diwali at home in their perceived connection with others at the Diwali event. This finding is consistent with the observation of Konvalinka et al. (2011) that the level of investment in a fire-walking ritual predicts the level of one's physiological

response to the ritual experiences of others. Our observation extends this finding by suggesting separation in perceived social connection to Diwali participants between levels of Hindu commitment to Diwali (Table 4). We find that religious behavior, and not merely familiarity with ritual participants or shared experience, amplifies social connection within a circle of ritual attendance. Private religious behaviors would therefore appear to be integral to the mechanisms by which public rituals affect solidarity.

We believe this observation is broadly consistent with Durkheim's (2001) speculation that individuals who reinforce their religious commitments through acts of worship strengthen what binds them to the social group. Along similar lines, Berger (1971) suggested that private religious rites function as personal reassurance of an individual's conviction in, and plausibility of, their community beliefs. Taking this into account, our observation, although modest, may contribute to the explanation for why cultural evolution has conserved religious ritual forms that combine both private and public behaviors for cooperative outcomes.

We acknowledge that private religious behavior may represent an affirmation of personal identity or compliance with group norms. However, consistent with costly signaling theories, we suggest that investment of time and energy into religious activities in unobserved and unenforceable conditions hinges on religious conviction, which adjusts the cost-benefit evaluation of performing a ritual dedicated to the supernatural. On this note we would take private religious practice as affirmation of personal religious commitment, in line with Berger (1971).

In terms of the remaining domains of perceived social connection, we find that "Kiwi Diwali" caused perceived connection with self to be reliably higher among Hindus, both among those who celebrated Diwali at home (0.63 higher than baseline) and among those who did not (0.44 points higher than baseline). Interestingly, this pattern trended in the opposite direction, and was reduced among those who had an emotional connection to a Diwali dancer (−0.27 points below baseline). Moreover, the diminished perceived connection with self as reported among spectators invested in Diwali actors tended to rebound in subsequent weeks, at a rate of 0.09 points per week. Speculating, it is possible that the civic Diwali ritual caused a diminished connection with self among those who were emotionally close to dancers, in other words, a shift from an ego-centric identity towards connection with other civic religious ritual participants amongst those who are emotionally close to Diwali dancers. This would be consistent with findings of Konvalinka et al. (2011) showing that "two hearts beat as one" among spectators invested in the performers of a ritual. Notably, the theory of ritual transformation has a long tradition. On describing the significance of positive religious ceremonies, Durkheim (2001) writes, "The individual soul is regenerated … by immersing itself once more in the wellspring of its life; subsequently, it feels stronger, more in control of itself … " (p. 259). While the bulk of probability accords with a theory of transformation by blurring the sense of self, this trend crosses zero at the 90% HPD interval. We suggest the jury is still out on proximate spectator self-diminishment.

Further, we find that "Kiwi Diwali" caused slightly greater perceived connection to friends and family, and that this effect is somewhat stronger for Hindus, regardless of whether Diwali was celebrated at home. The effect found for co-workers was similar. We suggest that while many people in religiously diverse societies might consider civic religious events such as Diwali to be leisure activities, enhanced social bonding extends to the workplace, at least for a time following the ritual. It is important not to exaggerate the magnitude of this response, which, as indicated in our coefficient plot, is small. However, that the response is reliable hints at the power of civic religious rituals such as Diwali, and potentially other cultural-religious activities, to enhance workplace relations in multicultural settings; a matter for future investigations.

Finally, we observe that perceived connection with all of Humanity was higher for all participants following Diwali. This observation is consistent with Xygalatas et al.'s (2013) finding that public religious rituals enlarge social connections across religious boundaries. However, much greater amplification of perceived connection to Humanity among Hindus implies that religious commitments may affect how rituals increase social connection.

As we are interested in identifying the effects of a naturally occurring ritual, participants could not be randomly assigned to ritual participation conditions and measured in advance of the ritual. For this reason, we could not establish baselines for perceived social connection prior to the event. Nevertheless, tracking participants in the weeks following the ritual enabled us to obtain slopes for affective decay. In all cases we find an effect of time on perceived social connection, indicating a general decline in perceived social connection that is consistent with a model in which attending "Kiwi Diwali" promoted social connection, but only temporarily, and that in the following two-week period the social connection effect produced by attendance gradually faded. Absent such a model, it would be difficult to explain the relatively lower, and steadily declining social connection, where it occurred. For example, our follow-up measurements occurred both mid-week and on weekends, suggesting that outcomes were not artifacts of weekend or weekday influences. However, because we cannot entirely rule out secondary causes, we advise caution when generalizing from the observations reported here.

Looking ahead, these findings may have applied benefits for policy makers interested in unifying people across cultural divides. Though religiously committed Hindus showed stronger responses following this civic religious ritual, sharing a common faith was not necessary to express a degree of elevated perceived social connection following the ritual. That these effects extended to communities outside the ritual, such as co-workers, family, and friends, suggests a broader scope for effects beyond this ritual.

We hope our investigation of a civic religious ritual contributes to ongoing efforts in the cultural evolutionary study of religion to clarify the functions of social activities that do not clearly sit to one or another side of a folk intuitive conception of religion. As recent commentators notice, as traditional religious communities experience decline across the developed West, new forms of spirituality and community are taking their place, about which systematic inquiries are lacking (Wilson et al., 2014). Here we demonstrate that in a mostly peaceful, and religiously diverse democracy, the civic religious ritual of Diwali elicits greater democratic unions within and between traditional religious associations. We hope the present study illustrates how a toolkit of cultural evolutionary methods and theories may help to systematically clarify how these new ritual forms affect us.

Ethics approval: Human ethics for this study was granted by a Victoria University Human Ethics Committee RM019281.

Consent: All participants in this study were over the age of 18 and gave informed consent.

Contributors statement: JB did the analysis. JB and SP did the figures. JB and SP wrote the manuscript with input from RF, JS, and all authors.

Notes

1. We agree with researchers who point out that the category "Other" may have ethical implications, and we regret any implication that people who do not fit this category are outsiders (Fraser, 2018). We advocate open-ended gender identification measures.
2. On the basis of input from our Hindu Indian collaborators, we treated "Celebrating Diwali" and "Practicing Puja" as interchangeable terms. We realize that Puja is not a ritual specific to Diwali and celebrating Diwali at home might be more involved than Puja. Further clarification of terminology is provided in Supplement 3.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

We have made available all data collected and R scripts used for the study on the Open Science Framework: https://osf.io/2tjcf/?view_only=ddd36d89a72c40599214fb30092d5f8e.

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