The Biosocial Basis of Collective Effervescence: An Experimental Anthropological Study of a Fire-Walking Ritual

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ABSTRACT

Collective rituals have long been assumed to play a role in increasing social assimilation and forging emotional bonds between group members. Émile Durkheim described a feeling of belonging and emotional alignment produced by ritual participation, which he called “collective effervescence.” Although this notion has informed generations of anthropologists, it has been notoriously difficult to quantify, while little is known about the physiological mechanisms underlying this effect. In a recent field study, we used physiological measurements alongside traditional...
ethnographic methods to operationalize and quantify this notion. I discuss the implications of these findings and the use of laboratory methods in field research.

**Keywords:** effervescence; experimental anthropology; fieldwork; fire-walking; laboratory; Spain.

If one wished to compile an encyclopaedia of maladaptive behaviours of our species, an obvious place to start would be an ethnographic catalogue of the world’s rituals. Piercing and scarring of the skin, mutilation of the genitalia, walking on fire, flagellation...the list is inexhaustible. There seems to be no form of torture that has not been used in a ritual context, and indeed very often voluntarily. Ritual behaviour in general, characterized as it is by stereotypy, rigidity, powerful commitments and manifest costs as well as functional opaqueness and dubious payoffs (Sørensen, 2007), is a puzzling yet universal aspect of human behaviour. This cost problem is particularly evident in certain high-arousal rituals, which entail extraordinary risks but equally uncertain benefits. As evolutionary theorists of religion have noted, such costly behaviours should not have been so widespread unless they also involved some direct or indirect benefits (Atran and Henrich, 2010; Bulbulia, 2010; Norenzayan and Shariff, 2008; Sosis, 2003).

Indeed, social theorists have long observed that the collective performance of highly arousing rituals may have beneficial effects for the community, by means of fostering social assimilation (Turner, 1967), enhancing prosocial behaviour (Rappaport, 1979; Sosis and Ruffle, 2003), and reinforcing social solidarity and group cohesion (Radcliffe-Brown, 1952; Robertson Smith, 1889; Whitehouse, 2004). Thus, rituals may become vehicles for social organization and transformation by contributing to the formation of strong emotional bonds between group members (Dunbar, 2006; Dunbar and Lycett, 2005). Most famously, Émile Durkheim described a state which he called “collective effervescence,” a feeling of belonging and assimilation produced by participation in collective rituals:

> The very act of congregating is an exceptionally powerful stimulant. Once the individuals are gathered together, a sort of electricity is generated from their closeness and quickly launches them to an extraordinary height of exaltation... Probably because a collective emotion cannot be expressed collectively without some order that permits harmony and unison of movement, these gestures and cries tend to fall into rhythm and regularity (1912/1995: 216–18).

In other words, rituals bring people together. But how can we define and/or measure this “togetherness”? This conjecture has been supported by anecdotal and ethnographic evidence (e.g. Gluckman, 1963), but the bio-somatic effects of effervescence have not been investigated, while the mechanisms that drive these effects remain unclear. Although there is probably a variety of such mediating

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mechanisms, one way collective rituals (at least those involving high levels of arousal) might bring about this feeling of assimilation is through the alignment of emotional states and the concomitant empathic responses produced. Previous research has shown that engaging in synchronous motor activity can lead to increased social rapport and cooperation (Bernieri, 1998; Cohen et al., 2010; Hove and Risen, 2009; Isabella et al., 1989; Miles et al., 2009; Valdesolo and DeSteno, 2011; van Baaren et al., 2004; Wiltermuth and Heath, 2009). This indicates that rituals involving the synchronous performance of bodily actions can lead to emotional alignment, which can in turn increase group bonding and solidarity. On the other hand, neurological evidence offers grounds for assuming that the collective performance of rituals might have similar results even in the absence of any coordinated motor activity (de Vignemont and Singer, 2006; Jackson, 2006; Singer and Lamm, 2009). In a recent study (Konvalinka et al., 2011), my colleagues and I investigated the physiological effects of the collective performance of a highly arousing fire-walking ritual which did not involve motor synchrony, by looking into levels of synchronized arousal between performers and spectators of the event. This article aims to situate the results of that study into their ethnographic context and to discuss the advantages and limitations of combining experimental and ethnographic methods.

**Setting**

The study took place in San Pedro Manrique, a rural village in the Spanish province of Soria, situated 275 km Northeast of the capital city of Madrid. The village is home to approximately 600 inhabitants, whose livelihoods predominately relate to farming (herding, agriculture, and work at the local pork factory). The fire-walking ritual takes place annually every June, as part of the festival of San Juan. This festival lasts for eight days and incorporates both religious and secular themes. Religious celebrations include Eucharists, processions, and venerations of the statues of the Virgin Mary and San Pedro (the patron saint of the village), while secular festivities include concerts and dances, communal meals, horse races, public speeches, and other events (for more see Caro Baroja, 1950; Ruiz Vega, 1985; San Baldomero Ucar, 1998). Three adolescent girls called mónidas are selected before the festival to act as focal figures at both religious and secular functions. The historical origins of this ritual character remain obscure but probably arose independently of the fire-walking ceremony.¹ The most important and celebrated event of the festival is the fire-walking ritual. While the precise

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¹ For more information and some conjectures on the origins of the mónidas, see Corťés (1969).
origins of this ritual also remain unclear, evidence of its performance can already be found in the earliest town records, dating to the middle of the nineteenth century. Spanish ethnologists have often argued that this ritual dates back to prehistoric times; notwithstanding, evidence for this claim is entirely lacking (Iñigues y Ortiz, 1924).

The fire-walk is performed on the night of 23 June, at the height of the summer solstice, exactly at midnight. An amphitheatre (el recinto), used exclusively for this ritual, has been built on the outskirts of the village to accommodate an influx of spectators. Its rows have a capacity of up to 3,000 people, nearly five times the number of the local inhabitants, and are always fully packed during the fire-walk. On the amphitheatre’s central stage, heavy black scorch prints perennially mark the spot where fire-walking is performed. The fire is built from more than two tons of oak wood, which produces a particularly high temperature that can be felt dozens of metres from the fire’s boundary. The fire burns for three to four hours before being reduced to a carpet of glowing red coals about seven metres long, two metres wide, and about 20 cm deep. Using a pyrometer, we recorded surface temperatures from the coal bed at 677 degrees Celsius (1250 degrees Fahrenheit) a few minutes before the walk.

As the coal bed is prepared, the fire-walkers, led by the móndidas, begin their procession at the village church. Accompanied by music and a large crowd, the group parades through the Town Hall Square before filing up a short hill to the ritual theatre. The walkers enter a cleared space at the foot of the theatre while the tiers are brimming with spectators. After dancing for several minutes in a circle around the glowing fire, they assemble and decide the order in which they traverse the fire. They then remove their shoes and take their place on the ground, nervously awaiting their turn. Each performer is summoned to the walk by the dramatic sound of a single dissonant trumpet burst. They cross the fire bare-footed, most of them (especially the men) carrying a person on their back. The three móndidas are the first to be carried across the fire, usually by members of their family. Then follow the remaining fire-walkers, each one typically carrying a spouse, relative, or friend. Once a walker-passenger pair crosses the fire, their beloved ones rush over to embrace them and celebrate their feat (Figure 1).

Although some performers believe that the Virgin Mary protects them from getting burned, there is no explicit religious meaning attached to this ritual. Nonetheless, the fire-walk does seem to have a sacred character for San Pedrans, having tremendous salience in people’s individual lives and playing a central part in their autobiographical narratives. Performers commonly report feelings of pride, duty, and achievement related to their participation. These reports were also consistent with more systematic self-reported ratings. When I asked some of
the fire-walkers to rate the importance of this ritual in their personal lives on a scale from 1 to 10, the mean-rated importance provided was 8.14 (n = 14, SD = 1.10). Similarly high importance was reported in people’s unprompted statements during these interviews:

c) **Interviewer:** How important is fire-walking to you?
**Fire-walker:** Very, very much.
**I:** How important would you rate it on this scale, from...
**F:** (interrupting) The maximum.
**I:** How important would you rate fire-walking on a scale from 1 to 10?
**F:** Extremely important. Out of 10 ... if you marked 20 on your scale, you’d be right!

d) There will be a day when I am too old to cross the fire. When that day comes, I will not go up [to the recinto]. Because if I am there and I cannot fire-walk, I will jump from the bell tower.

In addition to this personal salience, the fire-walk is also fundamental to the community’s collective identity. This ritual is clearly the most important event of the year for the entire village, which visibly revolves around it for many weeks or even months, through the preparations preceding it or the discussions following it. People consistently describe this tradition as an inextricable part of their collective identity. Time and again, I was told that “San Pedro would never be San Pedro without the fire-walk,” and was asserted that this ritual will continue to be performed.
for as long as San Pedro exists. As one fire-walker explained, “This is our tradition; it’s our identity; it’s part of who we are. If you ask any local what makes them a San Pedran, they will refer to our festivals and our rituals, our traditions.”

The importance of this ritual to the local community is also visibly manifest throughout the event. The village is replete with flags and other markers of identity (Figure 2), and everyone dresses up for the occasion; the day of the fire-walk is a holiday for all; public speeches delivered by town officials, alluring to tradition and identity, cause waves of excitement; the three mòndidas recite poems that belaud the bravery of the fire-walkers and their pride in being part of the fiestas as the locals shed tears of emotion; similarly, as soon as the fire-walkers complete their feat, their friends and relatives rush to hug and congratulate them with eyes full of tears (Figure 3). Overall, this ritual seems to generate a collective feeling of togetherness, similar to what has been observed in many other highly arousing rituals, reminiscent of the Durkheimian notion of “effervescence.”

Our study was aimed at examining the biological markers of this presumed effervescence, which we operationalized the alignment of physiological states. Our hypothesis was that the ritual would produce synchronous arousal, despite the absence of synchronous movement. Furthermore, we wished to investigate the social underpinnings of this alleged phenomenon, as they might presumably be evidenced by differences between levels of social proximity.
Methodology

This study was part of a long-term ethnographic investigation of this tradition, which extended approximately between two years before and two years after the study. This enabled me to gain access to the local community, conduct extensive interviews with over 80 subjects, recruit participants for the quantitative study and design the latter around the local ecology rather than simply “parachuting” it into the field (Astuti, 2007). The fire-walking ritual was opportune for testing our hypothesis because it seemed to involve very high levels of arousal and — importantly—because fire-walkers were not performing their ordeals in parallel (simultaneously) but serially (one after the other), and any effects of synchronous arousal could be disentangled from motor synchrony.

For this study, we recruited 38 participants: 12 fire-walkers, 9 local spectators who were either relatives or friends of at least one fire-walker, and 17 visiting spectators, who were not related to any of the locals and were recruited on-site. Local participants were recruited through the lead ethnographer by simply enlisting all available volunteers, due to the small size of the community. Visiting participants were recruited by local assistants at random as they were entering the venue. Written approval for the study was provided by the Town Council and each participant signed an informed consent form.
We operationalized arousal based on autonomic activity, using the Polar Team System, a heart-rate measurement system made up of an interface unit and a set of transmitter belts worn around the chest. The specific equipment was chosen as a reliable, practical, and unobtrusive measure. The belts were worn under the clothes and were entirely invisible to the observer, and so those who were not wearing this equipment themselves were not able to notice anything out of the ordinary. The belts were synchronized in time via the interface unit with a computer as well as with five high-definition video cameras, which allowed us to assess arousal at each specific stage of the ritual.

We conducted baseline measurements at a relaxed state prior to the ritual. On the day of the ritual, participants wore the monitors for approximately three hours, which included the procession before the event, the fire-walk itself (27 minutes in length), and approximately 30 minutes after the event. The observed effects of the ritual on heart rate might be confounded by factors over which we had no control, such as alcohol intake, lifestyle, or variance in health and age. However, since our main interest in these measurements was in fluctuations in individual heart rates, within the time frame of the ceremony, such potential confounds do not pose a significant threat to the results.

Structured and unstructured interviews were obtained by all participants before and after the study, while further qualitative material was gathered by the lead ethnographer in the years preceding and following this experiment. Detailed kinship and friendship charts were created based on interviews with all participants to provide a measure of social proximity.

**Results**

The heart-rate measurements showed that all performers had an extremely strong physiological response to the fire-walk. Without exception, the moment of the walk provided the peak heart rate throughout the measurements, which was much higher than dancing or briskly climbing the hill prior to the walk. Absolute maximum heart rates during the fire-walk ranged between 165 and 193 bpm ($M = 178.90$, $SD = 8.81$) and for 66% of participants exceeded the conventional safe maximal heart rate ($HR_{max}$) (Londeree and Moeschberger, 1982; Robergs and Landwehr, 2002).

Interestingly, these measurements sharply contradicted the subjective ratings that participants provided after the ritual. In these reports, all fire-walkers but one rated their state of arousal as being lower during the fire-walk compared to any other part of the ritual, and even the baseline. In fact, in my daily interactions with
the participants, several of them repeatedly challenged me to bet on the accuracy of their predictions and were later rather surprised to discover the discrepancy at the debriefing sessions (Xygalatas et al., 2013).

A qualitative analysis of the linear data suggested that there was a common pattern of arousal for all fire-walkers, with each person’s own walk providing the highest peak and a distinctive arrangement around the structure of the ritual, irrespective of bodily movement. A similar pattern was observed in the data obtained from related spectators, with the highest peaks provided for the walks of their beloved ones despite the absence of any significant movement. Such synchrony was lacking in the data of unrelated spectators, although their motor activity was the same as that of related spectators (all spectators were seated throughout the event) (Figure 4).

In order to quantify these effects and evaluate dynamical properties of physiological arousal, a Recurrence Quantification Analysis (RQA) was performed on individual participants’ data, using four metrics (%DETerminism, MAXLine, Entropy, Laminarity). A 3x2 mixed-model multivariate analysis of variance (MANOVA) was employed to compare the baselines with the entire 30-minute duration of the fire-walk for all three groups, with the group as a between-subject variable. The analysis confirmed that heart rhythms were arranged around the structure of the ritual for fire-walkers and related spectators but not for unrelated observers, whose plots showed a drift texture with no evidence of transitions around the ritual. There was a significant main effect of the group [F(8,64) = 2.75, p < 0.011] for all four metrics and significant interaction for all measures except entropy [F(8,64) = 3.869, p < 0.001], although only a marginal effect of the source epoch (p = 0.077). Post hoc Bonferroni correction tests showed no significant difference between fire-walkers and related spectators in all metrics except stability, but a significant difference between fire-walkers and non-related observers in all metrics.

To examine inter-personal effects, a Cross-Recurrence Quantification Analysis (CRQA) with the same metrics was performed on three types of between-group pairs: (a) fire-walkers and closely related spectators (family and close friends), (b) fire-walkers and marginally related spectators (mere acquaintances from within the village), and (c) fire-walkers and unrelated spectators (outsiders who had no prior connection to the village). A MANOVA with relatedness as the between-subjects variable showed a main effect of relatedness in all metrics [F(8,24) = 3.508, p < 0.008] and a main effect of the ritual [F(4,12) = 9.473, p < 0.001] but only a marginal interaction (p = 0.079). Post hoc Bonferroni correction tests showed more synchrony between related and marginally related pairs than between pairs of unrelated participants (for more see Konvalinka et al., 2011).
Discussion and Conclusions

Our measurements showed that participation in the fire-walking ritual produced extremely high levels of arousal. The observed heart-rate response during fire-walking supports our assumption that this event indeed activates a strong physiological response for the practitioners. While arousal has been assumed for such rituals, our study provides the first demonstration of physiological arousal using an implicit biomarker for a personally significant event. Interestingly, subjective ratings sharply contrasted this result, as participants reported minimal arousal during the fire-walk. In another publication (Xygalatas et al., 2013), we conjectured that this subjective perception of low arousal might be directly related to the observed disruption of memories for the event. In any case, this finding indicates the subtlety of the ritual’s effects, as the extremely elevated levels of arousal were not perceivable (or at least remembered) by the subjects.

Moreover, our results revealed shared heart-rate dynamics in the absence of motor synchrony. It has been proposed that synchronized action in rituals fosters
group assimilation and solidarity between members (Ehrenreich, 2006; Haidt et al., 2008; McNeill, 1995), and experimental studies have showed that performing an action in synchrony leads to increased inter-personal rapport and prosocial behaviour (Fischer-Lokou et al., 2011; van Baaren et al., 2004; Wiltermuth and Heath, 2009). Our findings show that ritual ordeals can bring about the alignment of affective and physiological states even without synchronized action. Given that many or perhaps most rituals do not seem to involve any overt motion synchrony, these findings suggest that a mechanism similar to Durkheim’s “collective effervescence” could be operating during the performance of collective rituals and may indeed be more widespread than has previously been assumed.

Importantly, this study was the first to demonstrate the role of social proximity in shared autonomic activity between actors and related observers, a social effect that is amplified by the ritual structure itself. This social modulation extends across the entire duration of the ritual and is not simply confined in individual fire-walks, thus revealing subtle patterns of synchrony and not a mere biological, “automatic” mirroring of affective states, as the same experience has predictably differential effects depending on group affiliation. Indeed, Durkheim himself well understood that effervescence is fundamentally communal, not merely generating emotions but precisely bringing “those who share them into more intimate and more dynamic relationship.”

Our study demonstrated the effects of ritual participation on shared arousal. Thus, these findings have important implications in terms of uncovering some of the mechanisms by which highly arousing collective rituals might build solidarity as well as in terms of the extent of this phenomenon. Notably, however, it did not directly establish a link between this shared arousal and group cohesion in a measurable way, a link which needs to be empirically investigated. Nonetheless, the participants’ recurrent reports of such increased cohesion provide some anecdotal evidence in that direction. Just a few examples of such statements are: “When you go up there, everyone is your brother”; “Even if someone is your enemy, when you’re there, he is your comrade, your brother”; and, “The next day, you see another fire-walker in the street, and you know you’ve been through this together, you’ve bonded, you have a different relationship to this person.” Such pronouncements were as consistently present in reports obtained from the locals as they were absent from those of outsiders, which of course is not a surprising finding. Even though there is no formal justification for the performance of the fire-walk, San Pedrans are continuously reminded of its importance through an abundance of symbolic representations (such as the fire-walker depicted on the town’s coat of arms), narratives, and public events that provide implicit or explicit references to the link between this ritual and the local community’s sense
of belonging. Thus, what to the outsider spectator might seem like a folkloric curiosity or entertainment (exciting though it may be), becomes to the local participants an event of the outmost sacredness, over which tears of pride are shed, an intricate cultural significance that is amplified by the ritual event.

Due to this intricacy, it is difficult to study such large-scale, high arousal rituals in a tightly controlled way, and all but impossible to do so in a laboratory setting, where the event is stripped out of its most meaningful aspects. Rather than taking such an eminently cultural phenomenon out of its natural environment and moving it into a sterilized laboratory setting, it is often more fruitful to take laboratory methods and equipment into the relevant environment by moving them into the field and combining them with context-aware ethnographic methods.

Unavoidably, this combination of ethnographic and experimental methods imposed severe challenges on the study. For example, it was not possible to select a random sample of local participants according to standard parameters, for example, health, age, and gender. Generally, all available participants who volunteered were recruited, simply because the small potential sample did not afford meaningful selection criteria. Notably, some of the participants were experienced fire-walkers whereas others were walking for the first time (mean experience was 13.2 years, ranging from 1 to 21 years, $SD +/−10.3$). Moreover, because participants felt the ritual event to be of sacred importance to them, we exerted strong care to minimize the intrusiveness of our tests. These limitations reflect constraints intrinsic to field experimentation.

On the other hand, our methods allowed us to maintain the crucial virtue of realism. As opposed to laboratory studies, field experimental studies offer hope of increased ecological validity, given that cognition naturally occurs in social and cultural settings which may exhibit designs that offload cognitive tasks to the environments of interaction (Bulbulia, 2008; Vogeley and Roepstorff, 2009). Regarding ritual behaviour in particular, a naturalistic design is often the only viable option, as collective rituals tend to hold strong personal importance for participants, which cannot be replicated in controlled settings. Furthermore, conducting previous ethnographic fieldwork in the village allowed us to gain a sense of the overall cultural milieu and to get to know our participants personally, which greatly enhanced their willingness to participate in the study. Anyone who has done ethnographic fieldwork will surely recognize the importance of anthropological work to field experiments such as this, for which it is often impossible to recruit participants without substantial prior interaction.

It is important to stress that field experiments are not proposed as a golden standard for studying ritual or doing anthropology. Participant observation and laboratory experiments are firmly established paradigms in studying behaviour,
and for good reasons, as they offer distinctive insights into human nature; nonetheless, an experimental anthropology may often selectively combine benefits from each one of those paradigms when the topic under inquiry allows or necessitates it. Moreover, this methodology does not purport to offer superior or all-encompassing answers —on the contrary, it can often productively generate more questions. For example, what is the extent and the limits of biological and cultural mechanisms involved in shared arousal? How might these results differ if non-related outsiders actually performed the ritual? What is the phenomenological experience of a fire-walker who reports being completely calm and yet has a heart rate of 200 bpm? These are questions that call for further investigation and interpretation.

This article offers an example of ways in which experimental research and anthropological studies can be mutually supporting paradigms. Methods developed in the laboratory bring new levels of insight when applied in the field. Field studies, in turn, can offer context-sensitive evidence, enabling researchers to better understand cultural and social dependencies absent from the laboratory but also to test the external validity of laboratory findings. Finally, the results of such field studies need to be tested for internal validity in more controlled laboratory settings. Thus, laboratory and field methods may be profitably integrated to bring light to questions neither approach can answer alone.

References


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