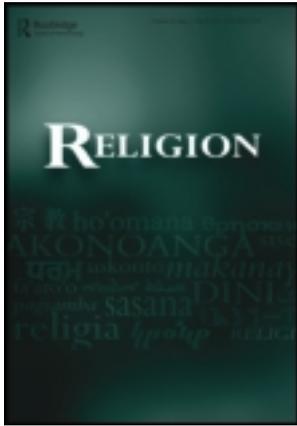


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Publisher: Routledge

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Religion

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rrel20>

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Available online: 08 Nov 2011

To cite this article: Joseph Bulbulia & Richard Sosis (2011): Signalling theory and the evolution of religious cooperation, *Religion*, 41:3, 363-388

To link to this article: <http://dx.doi.org/10.1080/0048721X.2011.604508>

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Signalling theory and the evolution of religious cooperation

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ABSTRACT How does religion motivate cooperation? How do the factors (genetic and cultural) that cause these motivations variously evolve, and why are they conserved? Cooperative-signalling theories of religion answer these questions by generalising from well-supported principles and research in the life sciences. Cooperative-signalling theories are interesting because they explain existing puzzles in the data about religions, and lead to testable hypotheses. This article discusses how signalling theory has been applied to explain the evolution and conservation of religiously motivated cooperation at small and large social scales, and reviews evidence relevant to evaluating these applications.

KEY WORDS cognition; cooperation; religion; metaconstitution; niche construction; signal

Signalling theory and the evolution of religious cooperation

Theorists have long conjectured that religions evolve, at least in part, to support cooperation, but how can we evaluate these conjectures? We use signalling theories to explain the evolution of religiously motivated cooperation, at both familiar and anonymous social scales.¹ Signalling theories are interesting because they (1) explain otherwise puzzling properties of religions as adaptations for cooperation; and (2) make testable predictions.

Part 1 briefly explains honest-signalling theory, a well-supported and general biological model for explaining the evolution of cooperative communication across the diversity of life.

Part 2 describes how evolutionary scholars of religion have used honest-signalling theory to explain cooperation among religious partners who are able to perceive personal commitment displays. This application of signalling theory helps to

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¹We make no distinction here between 'theories' and 'models' in this article, although a more detailed discussion of signaling theory would clarify this difference. Theories aim for true explanations. Models frequently simplify the complexity of the world to describe important properties and dynamics. Strictly speaking, such simplifications *lie* in the service of truth: they simplify as a means to improving explanations (Maynard-Smith 1993: 9).

explain the evolution of religious displays that enable participants to reliably discriminate between cooperative partners and cheaters.

Part 3 briefly explains niche-construction theory, a well-supported general biological framework for explaining the evolution of ecological systems and behavioural strategies that modify and stabilise selective environments. Signalling theory is interested in modifications to information properties of these environments, as mechanisms that express and stabilise cooperative patterns of exchange.

Part 4 describes how evolutionary scholars of religion have used niche-construction theory to explain cooperation among religious partners who cannot perceive each other's personal commitment displays, but who are able to build worlds in which impersonal factors – which we call 'charismatic ecologies' – evolve to express strong cooperative motivations. This application of cooperative niche-construction theory helps to explain the evolution of religious ecologies and institutions as exquisite signalling systems whose information properties evolve to reliably cause and stabilise cooperative motivations among estranged partners.

Part 1. Signalling theory and the evolution of honest displays

Cooperation and the evolutionary problem of cheating

Theorists have long speculated that religion evolves to support cooperation, yet why should cooperation require support? Evolutionary biologists notice that cooperation brings many benefits. For humans, such benefits include collective defence and trade, improved resource extraction, divisions of labour and expertise, as well as a host of related benefits. While cooperative partners go farther than they would by attempting life alone, cooperation frequently comes at an individual cost. Though the benefits of cooperation are typically not threatened when only a few take cooperative goods without contribution, when too many take without giving, cooperative benefits vanish.² If we were to join efforts to produce or protect a collective resource – by managing our fisheries, water resources, CO₂ emissions and so on – we would all be better off. Yet if cheating were to mainly favour exploitation, only collective suffering, relative to the cooperative goods that were possible, would evolve: no goods to share, no goods too take. To evolve, then, the payoffs from exchange must be adjusted to deter cheating. While terminology varies, many call the general form of the cheating problem described above a 'two-person Prisoner's Dilemma', and the three or more person version of this cheating problem an 'n-person Prisoner's Dilemma' (Binmore 2007). The cheating problem in large groups as it affects the unrestrained consumption of goods is often called a 'tragedy of the commons' (Hardin 1968: 1244).

Notably, cooperation clearly does evolve in our and own and many other lineages, implying the evolution of reliable cooperative mechanisms. Signalling theory considers how communication, perception and control systems co-evolve as elements of intricate, robust designs to manage cooperation's problems.

²Evolutionary treatments of cooperation assume 'payments' in the form of 'fitness advantages'. For clarification about the question of selection's currency, in this issue see Sosis and Bulbulia (2011).

Personal displays as cooperative prediction devices

Personal displays that reliably predict cooperative behaviours may evolve to facilitate cooperation by allowing partners to discriminate between co-operators and defectors. Imagine two partners, YOU and ME. Suppose that our cooperation presents a prisoner's dilemma: our mutual cooperation pays better than our mutual defection, but our unilateral defection maximally benefits each of us, no matter what the other chooses. To benefit from cooperation, we must each, at some level, accurately predict that the other will be de-motivated to defect relative to a motivation for cooperation. What sort of information might enable such prophecy, in situations where defection strictly dominates cooperation? None. Strictly dominated cooperation cannot evolve. Needed is some mechanism that changes payoffs so that defection is no longer strictly dominated.

An 'honest signal' is an expression, behaviour or marking that predicts that a cooperative strategy is likely for the signaller in the relevant circumstances. It does so by *indexing* the cooperation-relevant property. By receiving MY honest signal, YOU can know that I will not defect on YOU. Similarly, by receiving YOUR honest signal, I can know that YOU will not defect on ME. Honest signalling allows for the evolution of cooperative strategies by facilitating the sort of cooperative prediction required for reliable cooperative assorting among partners for whom defection is not a live option. Partners can use honest displays, wherever these evolve, to discriminate between trustworthy and untrustworthy partners. Notably, a cooperation-relevant trait could be a motivation, a belief, an intention, a physical attribute, or combinations thereof. The key interest, for both signaller and audience alike, is whether this property predicts a salubrious outcome. If so, there is scope for signallers and receivers to evolve systems that reliably communicate these properties (although the probability that such systems evolve depends on numerous factors; see Skyrms [2010]).

Examples

Ed offers Trundle a diamond engagement ring. Ed can only afford one diamond and Trundle knows it. With this gift, then, Ed proves his commitment to Trundle who perceives Ed's commitment more reliably than from any words: generating the gift has foreclosed Ed's defection options, ensuring cooperation by limiting his choice. Must Trundle produce an honest-display too? Not necessarily. Payoffs to exchange may favour certain parties disproportionately. This example assumes that Trundle has more to lose and that Ed should be so lucky.

Another example. Suppose that Sally talks to Mary every night about Mary's troubles. From Sally's time-investment Mary can know that Sally is a committed friend. Here again, deeds speak more reliably than words. Sally can only interact with just so many people and Sally chooses Mary. Because time is a finite resource, Sally's use of time indexes Sally's commitment without any need for expensive gifts. The signal is 'costly' in the sense that it is hard to fake, without being financially or reproductively costly per se. All the money in the world cannot create more time for the day. For this reason, how we use time may serve to index our social commitments reliably.

Another example. Suppose that Alice visits Pat when Pat is sick with a bad flu. From these visits, Pat can infer Alice's commitment, for Alice acts without concern for Pat's infectious disease. Alice's deeds cannot lie – at least not easily. For this reason, the deed functions as a barometer for Alice's commitment to Pat.

Another example. Ray sometimes smiles, erupts with anger, sheds tears and generally wears his emotions on his sleeve for all to see. Why might Ray do this? Why might we? Signalling theorists explain such riddles by focusing to the indexical properties of such displays – Ray’s and ours – noticing that emotions are both hard to fake (try expressing rage or suppressing strong sorrow without feeling rage or strong sorrow; this is difficult) and strongly correlate with social motivations. The emotional expression written onto one’s face tends to correlate in an interpretable way with the emotional state that one’s face displays. This indexical relationship enables audiences to predict an emotional person’s likely behaviours, intentions and alliances. If Ray is angry, watch out! Life scientists theorise that those factors that support the expression and interpretation of emotional displays have evolved as devices for the assurance of social commitments (Frank 1988). Of course, the poker face has evolved too. We can present and suppress emotions to give false impressions. To evolve, honest signals need not be perfect, however, only better relative to alternatives in which signallers do not produce signals and audiences do not act on them.

A final example. One of our favourite illustrations of honest signalling comes from the energetic jumping displays of Thomson’s gazelles. The display, called ‘stotting’, generally occurs only in the presence of predators (cheetahs). It consists of leaping up and down with a rigid, arched back, as if the gazelle were learning to use a pogo stick. The evolution of stotting is fascinatingly bizarre precisely because we would not expect any creature to exhaust itself in the presence of its most dreaded predator, the world’s fastest land animal! How remarkable that any Thomson’s gazelle would fatigue itself immediately before a potentially life-ending chase. Nevertheless, the mysterious effect is well explained as a signalling device that facilitates a compromise between predator and prey (FitzGibbon and Fanshawe 1988). Cheetahs wish gazelles to expose their necks without a chase. On the other side, gazelles wish their predators to starve without a chase. Between these two extremes there lies an area for compromise. Cheetahs would prefer to avoid chasing gazelles they will never catch. Fit gazelles share this interest: they too would prefer to avoid life-or-death chases at each encounter with a cheetah. Stotting, then, offers a communication mechanism that supports cooperative prediction. Only fit gazelles are able to stot, allowing their jumping behaviours to evolve as honest signals of fitness and speed. By responding to stotting with apathy, cheetahs receive a benefitting rest. Two astonishing facts, a gazelle’s strange leaping, and a cheetah’s indifference can be explained as elements of an honest-signalling system that has evolved to facilitate cooperation.

Certain critics object that honest signalling cannot evolve because it is always in a defector’s best interest to imitate a commitment signal and join a cooperative venture, only to defect (Murray and Moore 2009). However our examples reveal why such an objection misses the point. Honest signals differ from other types of communication because honest signals index commitment-properties such that one cannot easily produce the signal absent the commitment. Honest signals are ‘hard to fake’ (see also in this issue Sosis and Bulbulia [2011]).

These examples generalise to the explanation of cooperative communication in our own, and across innumerable many other lineages besides. (For an accessible overview see Zahavi and Zahavi [1997]). The general point: wherever a cooperative creature may perturb the world in just such a way that a non-cooperative creature could not, and wherever such perturbations may be observed by a cooperative audience in need of assurance, evolution has scope to target and amplify

mechanisms that give rise to the indexical displays. Such perturbations – ‘honest signals’ – evolve to enable the sort of cooperative assorting necessary to overcome prisoner’s dilemmas and tragedies of the commons.

Part 2. Honest-signalling theory applied to religion

The evolution of personal religious displays

In a series of papers published in 1996, William Irons used honest-signalling theory to explain the evolution of religious behaviours (Irons 1996a; 1996b). (For earlier applications of signalling theory to religion see: Cronk [1994] and Iannaccone [1992]). Irons approached religion as a field biologist approaches stotting, by considering what appear to be puzzling costly behaviours as candidates for honest-signalling devices. Similarly to stotting, religious behaviours appear wasteful and occasionally dangerous: religious living requires significant investments of time and material resources, and presents dysphoric ordeals (Whitehouse 2004). Such apparent inefficiencies seem out of place in Nature’s thrifty economy. Second, religious traits appear to be associated with dispositions for powerful within-group cooperation. If one is genuinely religious, one will tend to feel motivations to cooperate with those who one perceives to share one’s religion. (We will discuss the mechanisms of religiously motivated cooperation shortly). For this reason, Irons theorised that levels of religious commitment could evolve to predict levels of in-group cooperation – much as the height of a gazelle’s stotting has evolved to predict speed. According to the honest-signalling theory, religion evolves at least in part because religious displays tend to honestly index cooperative dispositions, enabling cooperative signallers and audiences who exchange such displays to reliably assort while avoiding defectors. The benefits of reliable cooperation conserve the factors (genetic and cultural) that express honest religious displays.

Evidence for honest-signalling theory of personal religious displays

Soon after Irons presented his version of the honest commitment-signalling theory of religion, one of us (Richard Sosis) derived hypotheses from this theory and employed data from communal societies to test them. In an analysis of 19th-century collectivist communes, Sosis discovered that in any given year, religious communes were four times as likely to outlast their secular counterparts, and that the most successful of these religious communes had the strictest entrance requirements (Sosis 2000). In a follow up study, Sosis and Bressler (2003) found that it was the costliest religious communes that were the most likely to survive over this period, yet costly secular communes did not enjoy a similar advantage (Sosis and Bressler 2003). These data are consistent with the prediction that religious costs may be configured to facilitate cooperative success, yet puzzling on other hypotheses. Soon after publishing this study, Sosis and Ruffle used an economic game to assess cooperation among Israelis in both religious and secular settings, finding that ritual participation strongly predicted giving to fellow ritual participants when compared to the giving of secular Israelis. Moreover, the authors found that the frequency of ritual participation positively predicted levels of generosity (Sosis and Ruffle 2004). These findings have been replicated outside of Israel – in Brazil (Soler 2008) and New Zealand (Bulbulia and

Mahoney 2008) – and are consistent with the prediction that participation in religious rituals tends to support an especially powerful form of cooperative solidarity.

An interesting extension of the honest-signalling theory of religion comes from its application to the explanation of permanent ritual markings (Sosis, Kress and Boster 2007). The authors of this study were interested in comparing the frequency of permanent-marking rituals with various social and ecological factors relevant to evaluating hypotheses for their causes, including honest-signalling hypotheses. The authors extracted data about the prevalence of permanent marking as well as other social and ecological data from a random sample of 60 of the 90 societies described in an electronic database called the Human Relations Area Files (eHRAF). The authors were interested in the economic and political covariates of permanent body-marking rituals – tattoos, scarification, teeth pulling, foot binding, neck elongation and other such practices – as compared to rituals with no such lasting body-effects – body painting, distinctive dress, song and dance, altered states of consciousness – and similar behaviours that leave no readily identifiable trace. The team employed coders to rate the relevant economic, ritual and political aspects of these societies, noting that the frequency of permanent-marking rituals could be analysed to discriminate between the hypotheses of different theories, which make different predictions on the data. According to a mate-selection hypothesis, for example, males in polygynous societies would be expected to perform costlier rites than males in nonpolygynous societies, as a way to attract more high-quality mating partners.³ A third hypothesis predicts no correlation between the demands of commitment-testing and those of costly ritual displays. If permanent displays were not linked to the demands of cooperative prediction, then we might expect no significant correlations between social and ecological variables.

The researchers found that the strongest predictor of permanent marking strategies was the frequency of warfare. While polygyny was positively correlated with permanent marking, the effect disappeared when the researchers controlled for subsistence strategies or frequency of war (Sosis, Kress and Boster 2007: 243). The authors point out that permanent ritual markings are especially powerful devices for pre-committing members of symbolically organised groups to cooperative futures. For when one is forever branded with the marks of a group, life becomes grim wherever the group's opponents take power. A simple explanation for these data comes from the power of permanent body markings to cause cooperative motivations, by effectively eliminating defection as an option in a manner that is readily detectable from an irreversible marking to a signaller's body.

A final example comes from Daniel Chen (2010), whose study of the Indonesian financial crisis of the late 1990s offers a natural experiment by which to assess the predictions of honest-signalling theory. During the two-year period from 1997 to 1998, Indonesia's currency value fell through the floor. At the beginning of the period, it cost 2400 Indonesian rupees to purchase a single US dollar. However by the end of 1998 it cost nearly 16 000 rupees to purchase a single US dollar. The consumer price index rose sharply, with food costs during the two-year interval nearly trebling. Such conditions led to a rapid decline of living standards among many Indonesians, with wage earners hit much harder than farmers,

³Notice that mate-selection is also a form of cooperation, one that relies on honest signalling between mate-seekers and the more selective sex.

whose real income remained relatively stable by comparison. Chen used a survey from the Indonesian Central Statistics Office to develop a measure for religious intensity from data about the degree to which families participated in Koran study and sent their children to Islamic school (activities that incur resource and opportunity costs). Chen found that for every dollar decline in monthly expenditures on items other than food, families were nearly two percent more likely to attend Koran readings. Moreover, households that intensified their religious investments by increasing their levels of Koran study and Islamic schooling experienced a near 50 percent reduction in their need for welfare or loans four months later. Whereas those families that either reduced or did not participate in such religious activities only saw 21 percent and six percent reductions in this need, respectively. Crucially, such effects disappeared in areas where credit from banks was readily available. Chen's findings are consistent with the hypothesis that religious institutions provide social provisions and that the ability to access these provisions requires verifiable principles of exclusion (here measured in terms of time and money investments in religious communities). Notably, the effect of increasing contributions to religious institutions as one's resource pie is shrinking remains otherwise poorly explained outside an honest-signalling theory.

Summary: the interest of honest-signalling theories of religion

It is worth pausing to note how honest-signalling theories of religion improve upon past cooperation theories of religion (for example, upon the theories of Durkheim [1995/1915] and Rappaport [1999]).

First, honest-signalling theories of religion build on quite general and well-established principles in the evolution of cooperation and communication literatures. The honest-signalling framework finds support from both mathematical models of animal signalling (Johnstone 1998) and from numerous field investigations (Zahavi and Zahavi 1997), as well as from behavioural economics experiments (Frank 2001).

Second, the theory has since been integrated with proximate systems research. Honest signalling developed within the framework of behavioural ecology, a discipline that models the evolutionary effects of behaviours, without reference to the proximate mechanisms that modulate them. (See in this volume Sosis and Bulbulia [2011]). Yet researchers have used signalling theories to develop hypotheses about the proximate perceptual, motor and learning systems that enable and conserve honest religious-signalling systems (Bulbulia 2004a; Sosis 2003). For example, Sosis hypothesised that repeated religious rituals (even if conducted in private) would affect a 'self-signalling' response that would bolster cooperative commitment, favouring frequent religious practices both in public and in private (Sosis 2003). Bulbulia conjectured that concepts of supernatural causation and agency associated with religions would produce especially powerful representations for motivating cooperative commitments, from concepts of supernatural agency and causation whose power exceeds natural sources (Alcorta and Sosis 2005; Bulbulia 2004b). Subsequent research has confirmed the involvement of both types of motivational resources. (For evidence of repetition and motor effects, see McKay, Mijović-Prelec and Prelec [2011]; Randolph-Seng [2007]; Schjoedt [2007]; Schjoedt et al. [2008]); for evidence of supernatural observer effects, see Atkinson and Bourrat [2011]; Bering [2006]; Norenzayan and Shariff [2008]; Shariff and

Norenzayan [2007]); for evidence of more extensive motivational resources, see Schjoedt et al. [2010]).

Third, honest-signalling theory has been extended to cultural learning models, according to which pro-social learning from moral exemplars who signal their virtues honestly through CREDS (credibility-enhancing displays) can evolve to amplify religious cultures through cultural transmission (Henrich 2009). This particular extension of signalling theory is interesting because it productively integrates findings from the cultural evolutionary literatures with classical signalling literatures in behavioural ecology (see; Gervais et al. [2011] in this volume).

Fourth, a core interest of honest-signalling theory has been its capacity to explain the otherwise puzzling apparent costs of religious cognition and behaviours. When viewed from an evolutionary perspective, it remains mysterious why religious costs should be tolerated in nature's economy (Atran 2002; Dennett 2006). Natural and cultural selection tends to generate increasing efficiencies, while eliminating wastes. However, honest-signalling theory shows how religious costs can be viewed as efficient displays that are conserved because they index cooperative commitments. The application of a scientific theory to solve known puzzles is called 'abductive reasoning' or 'inference to the best explanation' (Harman 1965). Researchers infer signalling theory as 'the best explanation' for the puzzling ostensible costs of religion, which the theory takes to be elegant designs for stabilizing cooperative exchange among religious partners.

Fifth, we have seen that the theory has led to testable hypotheses, which enable an evidence-based comparison of signalling theories with rival theories. Because even well-intentioned, clear-thinking researchers can disagree about which explanations are 'best', the prospect for evaluating honest-signalling theories of religion by rendering them as testable hypotheses for which discriminating evidence may be sought is surely a commendable intellectual virtue because such testing may resolve otherwise interminable theoretical debates.

Part 3. Signalling theory and cooperative niche construction

Cooperation and evolutionary problem of insecurity

Honest-signalling theory explains cooperative prediction among partners who may observe each other's displays, yet partners can, and often do, benefit from anonymous cooperation for which pre-exchange communication is impractical. We call partners to such inscrutable exchange 'strangers'. The need to predict the cooperative responses of strangers grows more acute as exchange populations increase in numbers and become more geographically diffuse. Consider the post-industrial human predicament. As you fly across the ocean you must trust that the airplane mechanic has been vigilant, that the pilot is not drunk, that the air-traffic controller is awake and attentive, that the chefs have washed their hands, that the components of the aircraft have been well built and inspected properly for flaws, that when you land you will not be assaulted, robbed, enslaved and so forth. A spoof news report recently ran the headline: 'Life Put In Hands Of 2,000 Complete Strangers Every Single Day.' The article continues: 'We have no choice but to trust that these individuals are always being very careful and know exactly what they're doing. Which is of course something we have no way of actually knowing' (The Onion 2011). The story exaggerates, but in the wrong direction: every day we place our mortal fates in the hands of innumerable many more strangers (Richerson and Boyd 2005). Daily

you entrust your life to obscure partners who will not grieve for its loss. How do we manage cooperation under such conditions? Strangers, in our sense (those who cannot send/receive information from each other) cannot signal their cooperative commitments, and so cannot use honest signals to assure their cooperative futures.

Signalling theory, taken in its widest sense, looks for mechanisms that link information properties – *signals* – to mechanisms that generate mutually benefiting social-interactive behaviours – *cooperation*. Strangers (in our sense) cannot readily identify, from personal displays, the cooperation-relevant qualities of those partners whose futures they must anticipate. It would therefore seem that signalling theory should be irrelevant to explaining the expression and conservation of cooperation among strangers. Yet we believe that signalling theory may be extended to help unlock the mysteries of cooperation's large-scale successes.

To understand how, we must first distinguish between the concept of 'cheating' and the concept of 'defection' – for not all defection arises from cheating. Especially in large and anonymous cooperative worlds, it is not the predictability of a gain from cheating that threatens the stability of collective efforts so much as the unpredictability of a gain from cooperation (Bulbulia 2009). We will characterise cooperation for which defection is motivated from a combination of uncertainty and risk as 'insecure'. (For an informative discussion of related issues see Binmore [2008] and Calcott [2008]). While complex social worlds present a mix of incentives, we believe that insecurity presents a particularly common, and damaging, problem for the cooperation of strangers.

Examples

Ed and Trundle wish to write a book together. Ed is an expert on THIS; Trundle is an expert on THAT. Their collective efforts will lead to a better book, one explaining both THIS and THAT, which neither could do alone. Yet the project is only viable if the other contributes. To start the project, each needs to predict that the other will do THIS or THAT part of it. There is no defection incentive here, only the uncertainty and risk of undertaking a project that cannot be completed alone.

Another example. Mary and Jane are in a large and loud cafeteria where to be heard they must shout at each other across the table. This is so because others in the cafeteria are shouting across tables. We assume that no one finds this shouting pleasant. All would prefer to collectively restrain their volume of speech. A lone shouter would be vexing in a quiet room, out of place, ridiculed and left off invitation lists. No incentive to cheat here. Yet in an already noisy room, a single 'co-operator' who opts to restrain her voice will not be heard and so will be punished for a senseless cooperation. There is a cost to cooperating in the loud cafeteria, even though all would prefer quiet to noise without any scope for unilateral gain from cheating.

Another example. Ann and Ray attend a folk-music festival and notice that they are standing to see the stage. We imagine they would prefer to sit, spread a woollen blanket, mellow out. We imagine a similar preference to sit holds for nearly everyone at the concert. Why is everyone standing? Ann and Ray don't know. Perhaps earlier some feckless youth near the front opted for the dancing strategy (defection), causing those immediately behind to stand to see the stage, causing their successors to stand ... eliciting a contagion of defection (standing). The folk-majority could easily police the first defectors, and they would willingly do so, if only they could manage to coordinate. Now that everyone is standing, however, the sitting

preference cannot easily spread, at least not without a design for it – perhaps a sniper in the bell tower – or so Ann and Ray fantasise. Lacking such an instrument, however, they would only be punished for unilaterally sitting, without any gain from their cooperation. So Ann and Ray defect, not from any incentive to cheat, but rather from a sensible preference to avoid a fruitless cooperation.

A final example, this one from the 18th-century philosopher David Hume:

Two neighbours may agree to drain a meadow, which they possess in common; because 'tis easy for them to know each others mind, and each may perceive that the immediate consequence of failing in his part is the abandoning of the whole project. But 'tis difficult, and indeed impossible, that a thousand persons should agree in any such action. (Hume 1739: B.3.2.7.)

Hume describes a problem for organising a large-scale cooperative venture that all in his meadow would desire, without any incentive for opportunism from cheating.⁴ Here again we discover a problem of cooperation's insecurity. There are two equilibriums, by which we mean stable patterns of action: (1) All Cooperate, the (Pareto) optimal equilibrium; and (2) All Defect, the risk-sensitive equilibrium. Henceforth we shall call problems of insecure cooperation, after Hume's parable, 'tragedies of the meadow'. The formal and experimental literatures that have investigated the tragedy of the meadow show that only the defection equilibrium is stable (Bicchieri 2006; Young 1993) (these literatures are reviewed in Bulbulia [2009]).⁵ The reason is clear enough: whereas mutant defectors can destroy the cooperative equilibrium, mutant co-operators cannot save the defection equilibrium wherever many are needed to gain cooperation's rewards. How can partners cooperate in conditions where they remain estranged from each other? To answer this question, evolutionary scholars of religion have sought to extend classical honest-signalling theories of religion by integrating them with another well-established framework within the life sciences called 'niche construction'.

Cooperative niche construction and social prediction

The general process by which organisms alter the conditions upon which selection operates on them is called 'niche construction' (for discussion, see Odling-Smee [2007]; Odling-Smee, Laland and Feldman [2003]). Considered at its most general level of abstraction, the process of niche construction:

occurs when an organism modifies the feature-factor relationship between itself and its environment by actively changing one or more of the factors in its environment, either by physically perturbing factors at its current location in space and time, or by relocating to a different space-time address, thereby exposing itself to different factors (Odling-Smee, Laland and Feldman 2003: 41).

Many lineages alter their environments – or flee to better environments – to stabilise the effects of selection. Organisms migrate, conceal themselves, build shelters,

⁴Here we suppose that all partners are required to clear the meadow for the relevant gain, so there is no incentive to slack, but this is idealisation: the world is, of course, complex. There is a wide spectrum of risks and opportunities, variably known and knowable that any idealisation will miss. Game-theoretic models of the kind we use here are heuristic devices to help clarify the nature of this variation (Schelling 1960: ch. 2).

⁵By stable we mean 'stochastically stable', for we assume random failures and mutant strategies (Young 1998).

burrows, dams and hives, as well as emit toxins, odours and adjust their worlds in innumerable different ways to alter selection's effects. Notably, we have seen that honest-signalling theory is built on the idea that organisms can generate indexical-personal displays that modify the epistemic circumstances of their audiences, in ways that foster mutually enhancing exchange. Personal commitment displays adjust the 'feature-factor' relation of a cooperative environment. Through honest signalling, a tough cognitive problem of anticipating the effects of cooperative exchange may be reduced to the production of a gesture given in an instant, and its interpretation taken at a glance.⁶ Certain types of modifications that organisms make to their worlds have only temporary effects. A stotting gazelle perturbs her body, a signal is generated, interpreted and then lost. However, many other transformations are durable. Indeed, certain transformations produce effects on the selective environments of offspring. A common example comes from the lowly earthworm:

Through their burrowing activities, their dragging organic material into the soil, their mixing it up with inorganic material, and their casting, which serves as the basis for microbial activity, earthworms dramatically change the structure and chemistry of the soils in which they live ... it follows that most contemporary earthworms inhabit local selective environments that have been radically altered, not just by their parent's generation, but by many generations of their niche-constructing ancestors. (Odling-Smee, Laland and Feldman 2003: 11)

A niche-construction perspective is interesting for considering the adaptations that facilitate the success of cooperation among strangers because the mechanisms for this success cannot reside entirely within the relevant agents' control (at least not straightforwardly). Niche-construction theory focusses to the possibility for the evolution of exogenous designs that express and synchronise the cooperative motivations of isolated partners. Moreover niche construction suggests that durable, trans-generational designs embedded within the natural (including social) ecologies of exchange partners may provide a separate vehicle of inheritance for efficient cooperative behaviours: a 'dual inheritance' of both cooperative cultures and genes. (For theoretical perspectives see Boyd et al. [2005]; Henrich and McElreath [2007]; Sterelny [2006]; Sterelny [2010]; Sterelny [2011]; for empirical evidence see Kim et al. [2010]). Might religious ecologies evolve as part of 'the cooperative niche'?

Recall that a crucial difference between the tragedy of the commons and the tragedy of Hume's meadow is that all partners in a meadow have an incentive to find a solution to their tragedy without any risk from cheating. Put another way, the greediest of all partners in Hume's meadow will want cooperation to succeed most of all. This prospect can select feature-factor manipulations that guide the cooperative expectations of estranged partners in a quite specific way, by favouring increasing reliability for cooperative assorting at efficient (but risky) equilibriums

⁶Odlin-Smee et al. distinguish between inceptive, perturbation, and relocation niche construction, in which organisms initiate changes or expose themselves to novel selective environments, and 'counteractive' perturbation/relocation niche construction, in which organisms counteract or respond to a prior changes in their environment by modifying or moving from their surroundings (Odling-Smee, Laland and Feldman 2003: 47–49). Each of these types of niche construction is relevant to the study of religion, though we forego discussion here.

without demanding honest signalling (Binmore 2006). The possibility of such a coincidence of interest motivates Hume's proto-evolutionary theory of cooperative niche construction, according to which expectations evolve from regularities of conduct:

Two men who pull the oars of a boat, do it by an agreement or convention, although they have never given promises to each other. Nor is the rule concerning the stability of possessions the less derived from human conventions, that it arises gradually, and acquires force by a slow progression, and by our repeated experience of the inconveniences of transgressing it. On the contrary, this experience assures us still more, that the sense of interest has become common to all our fellows, and gives us confidence of the future regularity of their conduct; and it is only on the expectation of this that our moderation and abstinence are founded. In like manner are languages gradually established by human conventions without any promise. In like manner do gold and silver become the common measures of exchange, and are esteemed sufficient payment for what is of a hundred times their value. (Hume 1739: B3.2.2.)

Contemporary evolutionary researchers have followed Hume's lead, offering explicit models for the cultural evolution of these regularities in conduct, which they call 'norms'. (See for example Gintis [2009]). Their idea is that normative cultures evolve to facilitate predictable patterns of cooperative exchange under conditions that would otherwise remain insecure. Norms evolve to manage uncertainty and risk, to use Gintis's appropriate phrase, as 'choreographers' (Gintis 2009: location 4984–4988).

We believe that cultural evolutionary scholars are correct to notice, with Hume, that norms evolve to manage problems of cooperative prediction among strangers, the solution of which is a condition for the possibility of cooperation in large social worlds. Yet we also believe that such observations need to be supported by models that account for the *stability* of cooperation in Hume's meadow. While a coordinating authority may help partners in this meadow, the presumption of such an authority only repeats cooperation's problem. For how can such an authority be organised? Moreover, we need some account for the stability of these controlling mechanisms. When a government body fails or becomes corrupted, for example, how might cooperative confidence be restored? For in Hume's meadow, we have seen, there are two equilibriums, and only the defection equilibrium is stable.

Elinor Ostrom makes this point against the sufficiency of appeals to 'norms': 'Simply explaining puzzling findings post hoc, as "they must somehow share some norms", is not a satisfactory strategy in the long run. Focussing on norms and other-regarding preferences is not enough ... to explain fully how individuals do overcome social dilemmas. Rules are needed to back up these norms (or counteract dangerously escalating negative reciprocity). We then need to dig into the analysis of institutions so that we can understand how individuals adopt norms as well as rules to overcome social dilemmas' (Ostrom 2005: location 2676).

In 2009, Elinor Ostrom won a Nobel Prize for the results of her 'digging' into the nitty-gritty empirical details of living cooperative institutions. The generalisations that she uncovered suggest the strong relevance of collaboration between classical scholarship in religious studies and researchers in the life sciences. Consider Ostrom's findings.

Cooperative niche construction and 'metaconstitutional' cultures

Ostrom's research reveals that tessellating structures of rules make up what we are calling a 'cooperative niche' by forming layered institutional structures that coordinate and frame the expectations of social actors in different settings (what Ostrom calls 'action arenas'). These structures permit flexible modifications for behaviours to accommodate adaptive response to changing worlds and novel technologies. Yet the structures also remain resilient to the entropic forces that threaten institutional breakdown. Ostrom's investigations reveal that the key to this combination of dynamic flexibility and robustness to breakdown is the manner in which the various layers of these structures are arrayed to support each other. Given our interest in niche-construction theory we might call this cradling structure of rules, *the human nest* (Figure 1). At its innermost layer, Ostrom describes 'action situations': these are given as the material forums of commerce in which partners transact. Rules in this dimension present clear interpretations for social behaviours and expectations within specific 'action arenas'. Beneath action situations are 'operational situations' which define the rules for adjusting action arenas. Beneath this layer are 'collective choice situations' which define the rules by which operational institutions may change. Beneath this layer are 'constitutional situations' which proscribe rules for changing collective choice situations (Ostrom 2005: location 1359). And beneath constitutions, 'one can ... think about a "metaconstitutional" level underlying all the others that is not frequently analysed' (Ostrom 2005: location 1415).

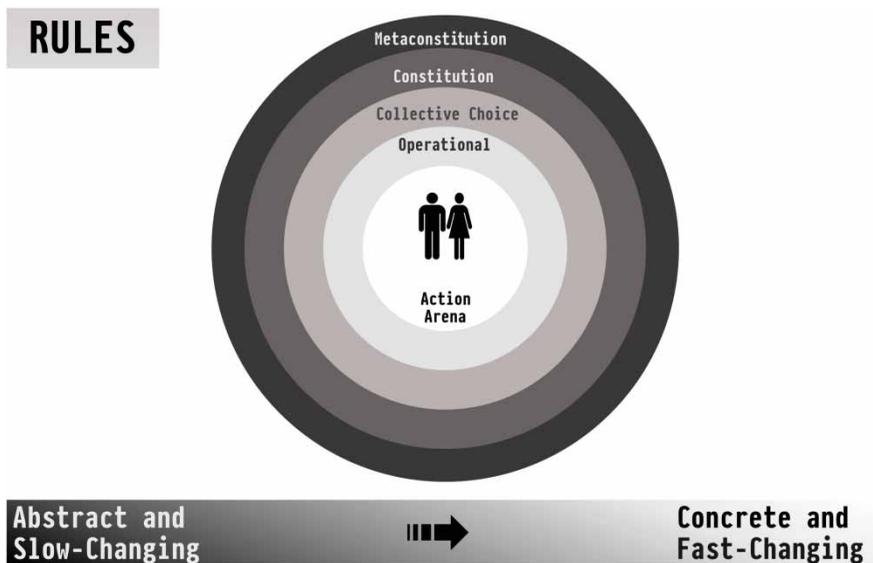


Figure 1. A summary of Ostrom's hierarchy of rules and institutions that answer specific questions relevant to cooperative prediction: (1) Operation situations: Where am I and what should I do?; (2) Collective situations: What rules govern these types of situation for people like my exchange partners and me?; (3) Collective-choice situations: Who decides how to change the collective situation rules, and by which procedures?; (4) Constitutional situations: What are the rules that govern the establishment and revision of collective situation rules?; and (5) Metaconstitutional situations: What are the rules and institutions that govern the establishment and revision of constitutions?

For each institutional stratum of rules, Ostrom's research describes different degrees of abstraction and different rates of change, with the constitutional and metaconstitutional levels being the most abstract the slowest to change (Ostrom 2005: location 1415).

Niche-construction theories of religious cooperation are interested in the information properties of the institutions and material arrangements that comprise this 'metaconstitutional level', which 'is not frequently analysed' – at least not by social scientists. Niche-construction theory hypothesises that cooperation's stability, as given from its deepest, most abstract and slow-to-change scaffolds, is assisted by the information properties of natural (including social) ecologies as these have evolved from the cumulative effects of human feature-factor adjustments (Bulbulia 2008). Such models theorise that it is the religious niche that affords those habitats whose information properties are capable of enduring the slings and arrows of cooperation's inevitable frustrations, which favour inefficient but safe patterns of transaction. (For a similar, and widely misunderstood account, see Freud 1962/[1927]. For a somewhat different account of religious niche construction, see [Kydd 2008]).

Part 4. Cooperative niche-construction theory applied to religion

The evolution of charismatic ecologies

We call the information properties of the systems that operate at a metaconstitutional level, 'charismatic ecologies'. We use the term 'charismatic' loosely in Weber's sense, as an exceptional quality that forms the basis for controlling authority (Weber 1947 [1924]). We favour the term 'charismatic' because we are interested in how dynamic systems evolve to *compel* relatively powerful and automatic cooperative responses across large populations.

Recall that signalling theory, taken in its widest sense, looks for mechanisms that link information properties – *signals* – to mechanisms that generate mutually benefiting collective behaviours – *cooperation*. According to both honest-commitment and charismatic-ecological signalling theories, commitment displays evolve to motivate cooperative behaviours by anticipating their benefits. According to the charismatic-ecology model, the causal arrow running from a display (including those of charismatic persons) to commitment is reversed: a charismatic display is not functionally configured to index the cooperative traits of specific partners, but rather configured to cause such traits, relatively automatically, with an authority that governs estranged partners (in our sense of estranged: isolated so that personal displays are infeasible). Notably, the model allows that that automaticity may be subject to learning. It does not suppose that all audiences will express the relevant responses without prior training: cooperative ecologies include those developmental environments that coordinate sensibilities to charismatic factors.

Consideration of these twin design targets – automation and access – suggests that cooperative niche construction at the 'charismatic' level will tend to be both 'embodied', from factors that express strong cooperative dispositions without second-guessing them, and 'embedded', in salient features of those natural (including social) habitats by which partners synchronise their concordant expectations.

Target 1. Embodied designs demand automation

Knowing nothing else, we might suppose that charismatic mechanisms will act to *disable* strategic choice making, retaining only efficient cooperative options. Indeed,

wherever ecological factors cause insensitivity to insecurity (the sort of pervasive blindness to risk that enables the spoof news story above to appear comical, rather than horrifying) partners will be less likely to take refuge in the safety of defection, and less likely to second-guess that others will take such a refuge. Such affects are important to the functions of a coordination device in Hume's meadow. Beyond insensitivity cooperation must be motivated, in the sense that populations must feel compelled to opt for it, again relatively automatically and across variable natural (including social) ecologies. The problem of constructing automatic designs is no easy feat. Cooperative niche construction at its most basic level requires configuring the bio-cultural world in such a way that its information properties will express the relevant sensibilities across dispersed populations, and against the headwinds of prediction-damaging change.

Target 2. Embedded designs demand synchronous access

The demand for a coordinated expression of the cooperation-relevant sensibilities is obvious. If cooperation is to succeed, thus paying the costs of maintaining the cooperative niche, charismatic factors must reach sufficiently many partners, and affect them for sufficiently long periods of time to support the profit-making interactions. While we suppose that the relevant ecological designs admit of varieties, with distinctive geophysical, temporal and institutional properties, the evolution of the spatial and temporal properties of these ecological designs is strongly constrained by the functional demands, suggesting the prospect for generalisations across the solution class press. For example, the relevant designs must appear focally within a common cooperative habitat, or diffusely across a large geographical range. Ordinarily, the information properties of such designs may be expected to change at a slower rate, on the hypothesis that they function as metaconstitutional frameworks. Where cooperation devices coordinate meta-ethnic communities, such designs must be familiar across ethnic, cultural and linguistic divides, a demand that favours conservation from the positive externalities of fixing the perceptual qualities' charismatic designs so that they remain recognisable. (For discussion see Bulbulia [2009]). Such demands predict an evolutionary tendency for the durability of core symbolic, architectural and prescriptive properties of charismatic cultures (that is, for old religions), patterns of migration to focal targets (for example, pilgrimages), patterns of repetition (for example, daily prayer) and many other general temporal and spatial properties. (For discussion, see Bulbulia and Freaun [2010]). While presently little is known about the nature of these metaconstitutional designs, as Ostrom points out, recent research nevertheless offers several tantalising clues about their embodied and embedded properties.

Examples

Consider an old military legend about the Spanish explorer Hernando Cortes. According to the lore, probably apocryphal, Cortez was able to win a decisive battle over the port of Cuba by burning his ships. Legendary incompetence? No, legendary genius! By leaving no way out, Cortes pre-committed his soldiers to battling for the port, come what may.

How did Cortes's men know that the others were committed? Such thoughts were irrelevant: the soldiers had no way out. In seeing the ship lost, any of Cortez's soldiers

would have known that it was in their mutual interests to wage the battle, for there could be no retreat. They lost their choice. The flames would have consumed both cowardice and the second-guessing of partner decisions. Were they to consider the matter, however, the sight of a burning ship would have been sufficient for each to instantaneously anticipate the responses of others, who also lost their defection options to the flames. Their game, too, was obviously and irrevocably transformed. Cortes's problem for generating cooperation among strangers reduced to a problem of engineering their perceptual environments so that the image of the burning ships would have projected to embolden sufficiently many warriors to win the fight. The twin targets, automatic affect and synchronous access come together in a vivid display of the army's ships, destroyed. This example illustrates the essential mechanisms of charismatic designs, though it does not cast light on the metaconstitutional levels by which they normally operate.

Another example. Peter Turchin describes the extraordinary capacity for early Romans to coordinate a powerful cooperative solidarity, which remained strongly resilient even after their many bitter defeats (Turchin 2006: locations 2497ff). The core values were called '*mos moaiorum*' or 'ancestral custom'. These values included '*Virtus*' (the capacity to discern good from evil and to pursue good actions), '*Pietas*' (the willingness to acknowledge the authority both of family leaders and the gods in public rituals), '*Fides*' (the value of remaining true to one's words and promises), '*Gravitas*' (the value of maintaining discipline and a calm attitude) and '*Constantia*' (the value of perseverance). Such values formed part of what the Romans called '*RELIGIONES*' (Turchin 2006: location 2522) – the bonds and the obligation that link humanity and the gods. Turchin argues that sacred Roman values were among the key ingredients of the robust solidarity and cooperation that eventually lead to Rome's spectacularly extensive and enduring empire:

Until the first century B.C. Romans did not need a police force to keep public order. The internally motivated discipline of early Romans, the formalized and ritualized behaviours of their culture, was enough to maintain public order ... One cannot overemphasize the importance of these personal qualities of early Romans to their subsequent rise as an imperial nation ... Romans held no physical or technological advantage of the peoples they conquered. An average Roman was smaller and weaker than an average Gaul [their main adversaries] ... curiously enough, the Romans were pretty lousy at winning battles. The typical sequence of any war between the Romans and their numerous opponents was to lose battles early in the war, but then, nevertheless to win the war. (Turchin 2006: location 2523–2555)

Turchin's intriguing study of the rise and fall and rise of empires repeatedly points to the role that charismatic ecologies play in fostering and extending especially powerful forms of cooperation in ethnically, culturally and linguistically diverse worlds, among unfamiliar and estranged partners, in ways that enable rapid motivational recovery from cooperation's inevitable defeats: 'A nation with high collective solidarity can lose many battles and still prevail in the end' (Turchin 2006: location 1658).⁷ Signalling theory focuses to how meta-constitutional institutions

⁷Turchin uses the term '*asabiya*' to name such collective commitment, after the dynamic quality of solidarity that the 14th-century philosopher Ibn Khaldun theorised to be essential for nation-making (Turchin 2006: location 156–162).

express and sustain cooperation motivations, through thick and thin to support enduring solidarity, even among strangers.

Evidence for the cooperative niche-construction theory of charismatic ecologies

Recall that we are interested in how two types of evidence bear on the evaluation of signalling hypotheses for religion: (1) puzzling data by which we may evaluate a signalling theory from its capacity to explain such mysteries; (2) experimental data, by which we may derive predictions for a signalling theory, relative to other theories, by which to compare evaluate their relative merits. We consider how both types of evidence support the cooperative-niche construction theory of charismatic ecologies.

Resolution of puzzles

First puzzle: evidence that religious belief is *not necessary* for religious ecologies to express cooperative motivations.

One reason to suppose that religions evolve to support cooperation is from the power of religious beliefs to modulate pro-social behaviours. Indeed there is evidence for pro-social enhancement merely from tacit cues that supernatural observers are watching. For example, Bering and colleagues found that by suggesting to participants that ghosts were watching, participants would act more cooperatively in tasks that encouraged cheating (Bering, McLeod and Shackelforth 2005).

Moreover, Shariff and Norenzayan notice that participants who were presented with subtle reminders of religious concepts (from word de-scrambling tasks) became more charitable in sharing a random cash offering (Shariff and Norenzayan 2007). A common explanation for the effects of supernatural suggestions is that they evoke concerns for reputation, which combine with fears of punishments, to motivate pro-social responses (Johnson and Bering 2009; Johnson and Fowler 2009; Johnson and Kruger 2004; Norenzayan and Shariff 2008).

Yet similarly moderating effects from religious suggestions hold among those who profess no religious commitments (an effect that Shariff and Norenzayan noticed in one of their experiments). For example, after being asked to recollect the Ten Commandments, student participants became less likely to cheat, irrespective of accuracy of recall, and irrespective of levels of religious belief. Religious students, moreover, were equally likely to cheat when not reminded of their religions (Mazar, Amir and Ariely 2008). Commitments to the existence of gods cannot explain such effects, at least not straightforwardly. These effects rather operate generically in response to contextual arrays containing signals that are 'charismatic' in our loosely Weberian sense, of being empowered to generate a governing authority across potentially large and anonymous groups. (For an ideo-motor interpretation of such effects see Randolph-Seng and Nielsen [2008]).

Second puzzle: evidence that religious beliefs are *not sufficient* to express cooperative commitments.

We see this evidence already from Mazar et al.'s discovery that religious participants were as likely to cheat as non-religious participants across all of their experimental conditions. However similar observations are common in the social psychological literatures. One of the most intriguing illustrations of such effects

comes from a widely discussed experiment in which Darley and Batson (1973) asked participants at a Christian seminary to prepare a talk on the parable of the Good Samaritan, a Gospel story extolling the virtues of helping behaviour (Darley and Batson 1973). The authors discovered that levels of religious commitment, denomination and other religious attributes did not predict helping behaviour toward a subject in need, whom the participants encountered on the way to giving the talk. Moreover participants instructed to give a sermon on the parable were no more likely to help than those who were instructed to present a job talk. Thus, being reminded of the parable of the Good Samaritan did not encourage participants to act as Good Samaritans. The only quality that was found to predict helping behaviour across all conditions was the degree to which participants were in a hurry. Those participants who were not in a hurry helped approximately 63 percent of time, compared to the 45 percent helping rate found among participants in the moderate hurry condition, and the 10 percent helping found among those in the high hurry condition (Darley and Batson 1973: 105) (discussed in Norenzayan and Shariff [2008]). The Darley and Batson study suggests that being in a hurry swamps the effect of religious belief, denominational affiliation and level of commitment on helping behaviour expressed to those in need.

Resolution

The puzzles of the (1) insufficiency and (2) irrelevance of religious beliefs for religious cooperation may be resolved under a common explanation, that of cooperative niche-construction theory. The finding that cooperation tends to be expressed relatively automatically from religious cues is consistent with the expectation that designs evolve to automate the activation of cooperative behaviours, largely outside the reflective capacities that inform belief-assertions. Indeed, the theory predicts that such designs will operate best, at the meta-constitutional level in which we are interested, when they are *felt* before they are declared. The mediating role of contexts on behaviours is also consistent with the predictions of cooperative niche construction, which suggests that human natural (including social) ecologies will evolve to strongly govern the behaviour of cooperative populations, offloading strategic control from individuals to the information properties of their worlds. Indeed, Darley and Batson noticed that their experiment could have *enhanced* cooperation of another sort, for those under time pressure might have followed a higher duty by ignoring a quick gratification of helping another in need. The idea here is that it is anti-social to let down a waiting audience. Moreover, the authors notice that those who stopped to help appeared to have disregarded the idea that a person in moderate need might wish to be left alone:

doctrinally committed helpers were ... persistent. These superhelpers ... often would not leave until the final appeal was repeated several times by the victim (who was growing increasingly panicky at the possibility of the arrival of the next subject). Since it usually involved the subject's attempting to carry through a pre-set plan (e.g., taking the subject for a cup of coffee or revealing to him the strength to be found in Christ), and did not allow information from the victim to change that plan, we originally labelled this kind of helping as rigid. (Darley and Batson 1973: 107)

Darley and Batson recognise, then, that the dynamics of helping behaviour, in situ, are sufficiently complex to discourage simple generalisations from their data. They notice that religious associations, religious styles and time-pressures interact to affect social decision making on the ground. Again, little is known about these systems and dynamics. Investigating *the human nest* will occupy researchers for many generations.

Experimental evidence: from synchronous rituals

Experiment 1. A laboratory investigation of generalised charity from synchronous body movements

An emerging experimental literature in social psychology reveals that individuals who synchronise their behaviours with each other tend to express higher levels of solidarity and cooperation when compared to those who engage in asynchronous motions, or with those who do not move. (For discussions see Cohen et al. [2009]; Hove and Risen [2009]; Kirschner and Tomasello [2009]; Valdesolo and DeSteno [2011]; Wiltermuth and Heath [2009]). Notably, similar cooperative effects have been found among pairs of individuals who mimic each other (van Baaren, Holland and Steenaert 2003). However, among pairs who mimic each other, cooperative responses have also been found to extend to individuals outside the interacting dyads, leading to non-specific or 'generalised' charity (van Baaren, Holland and Kawakami 2004). From the vantage point of cooperative niche-construction theory, generalised charity is interesting because it suggests the possibility that *positive contagions* of cooperation may arise from ritual events that employ synchronous regimes.

To test whether generalised cooperative effects turned up in groups larger than mimicking dyads, Reddish and colleagues developed a motor coordination task that aligned partner movements to a focal source (a metronome) (Reddish, Fischer and Bulbulia 2011, under review). One of the most well-supported theories in social psychological research, called 'the minimal group paradigm', reveals that when participants are placed in groups of any kind, even totally random groupings, they tend to rapidly exhibit social discriminating responses, preferring those with whom they are grouped to the exclusion of those outside (Tajfel 1969). Whereas the minimal group paradigm predicts that cooperative effects would be limited to fellow participants, a cooperative niche-construction model predicts generalised giving of the kind observed from dyadic mimicry interactions, on the theory that ritual movements function as metaconstitutional factors that support cooperative patterns of exchange among strangers.

To determine the effects of synchronised body motions, Reddish and colleagues assembled participants into small groups, and varied levels of synchrony and asynchrony among each group's movements (including a no-movement condition). The team also varied conditions in which a target for charity was selected from within their experimental group or from outside. Consistent with previous research, the team found that synchronous body movements enhanced pro-social responses in subsequent tasks. However, against the minimal group hypothesis and in favour of the generalised giving hypothesis, statistical analysis showed that the effect of synchronous movement on charity did not respect group membership. Those who moved synchronously were equally likely to give to someone outside their

participant condition as they were to someone from within. These findings are remarkable, in the first instance, because they confirm the result that cooperation can be expressed even in the emotionally impoverished setting of the laboratory, merely from synchronous body regimes. More interesting for our purposes, the data reveal that the effect of such cooperation is not discriminating in favour of known participants, but rather also extends to strangers.

While the data from this study are surely limited – the laboratory must not be mistaken for the world – the study's findings are consistent with the predictions of the cooperative niche-construction theory, which forecast generalised pro-social effects our most basic cooperative cultures, bringing some preliminary motivation to theory that ritual ecologies embed metaconstitutional institutions through ritual embodiments.

Experiment 2. A field investigation of the synchronous effects on participants and spectators in a highly arousing naturally occurring ritual

A recent investigation of the physiological affects of a highly arousing Spanish fire-walking ritual, regarded by participants to be sacred, revealed surprisingly high levels of synchrony in a bio-marker of arousal, heart rhythms, among both participants and observers (Konvalinka et al. 2011). The study occurred in the village of San Pedro Manrique in northern Spain at the height of the village's most important annual celebration: the festival of San Juan. The fire-walk occurred in an amphitheatre that seats about 3000 spectators, roughly five times the village population. The team obtained heart rhythm data from 12 firewalkers, and nine 'related' spectators who were either relatives or friends of at least one firewalker, as well as from 17 unrelated visitor-spectators. The data were analysed using a technique called 'recurrence quantification analysis' and 'cross-recurrence quantification analysis', which enabled numerical comparisons between both individuals and groups in this sample. The team theorised that there would be synchronous arousal detectable in the heart rhythms of both the participants (those who walked across the fire) as well as among observers, an 'effervescence' that has been described by anthropological observers, yet which prior to this research had not been demonstrated using quantitative measures. For our purposes, there are three important results from this study:

- (1) Recurrence plots revealed that the heart rhythms of firewalkers and other firewalkers were the most synchronized during the ritual. The team explained this effect from an empathic response whereby firewalkers identified most strongly with the ordeals of fellow firewalkers from a shared experience of the ordeal.
- (2) The heart rhythms of firewalkers and 'related' spectators were found to be semi-synchronised. This suggests that there is a kind of empathetic projection on the part of spectators, even though they did not have to personally undergo a trial by fire. The nature of this empathetic association is especially interesting, and subtle. Being 'related' appears to define membership in a community of empathetic response whereby knowing at least one firewalker elicits a semi-synchronous response to the trials of all firewalkers, including those who are not closely 'related' to them, eliciting a spreading of commitment.

- (3) Much less synchronisation among heart rhythms was found among unrelated spectators, as they witnessed the ritual ordeals of the firewalkers, suggesting that the ritual does not operate invariantly without prior experiences and associations, the nature of which remain unknown.⁸

These effects of the fire-walk on its various constituents are the result of the specific information properties of the ritual, as these properties combine with the effects of the past associations, education and experiences of different ritual constituents to coordinate subtle empathetic body responses, which extend from known participants to strangers.

Does this study demonstrate that the San Pedro Fire-walk is a metaconstitutional design? No. The findings are merely consistent with the predictions of a cooperative niche-construction hypothesis that predicts such effects. The answers to larger questions about the operations of these designs, their variance and similarities, remain on the horizon of future interdisciplinary explorations.

Summary: the interest of cooperation niche-construction theories of religious ecologies

Let us step back and consider how the cooperative niche-construction theory of charismatic ecologies explains religiously motivated cooperation in a way that improves upon past cooperation theories.

First, the cooperative niche-construction model reveals how explanations can be both limited and interesting. We have argued that honest-signalling theory explains certain properties of religious cooperation among partners who are able to project and evaluate indexical cooperative displays, whereas cooperative niche construction focuses to the ecological factors that manage and sustain cooperative motivations where personal displays are inefficient or impossible. There are surely domains of overlap between these models. Indeed, we have described honest-signalling theory as a kind of perturbation niche construction, whereby a signaller alters the factor-feature relationship of an audience. Moreover, supplemental theories will be required to address the daunting complexity that religious cognition and cultures present to naturalistic investigations. Signalling models seek generalisations only where the data warrant but otherwise caution restraint and patience.

Second, cooperative niche-construction theory shows how the information properties of ecologies can co-evolve with participant sensibilities to sustain cooperative exchange by *causing* powerful preferences for cooperative behaviours. Such effects require engineering natural (including social) ecologies to express cooperative responses relatively automatically among partners exposed to them. Though data not reviewed here suggest that ritual effects depend on prior learning regimes. (For discussion see Schjoedt et al. [2009]).

Third, we have noticed that a cooperative niche-construction theory of charismatic ecologies contributes to a more sophisticated understanding of cooperation's problems. Whereas some cooperation appears threatened by freeriding, much cooperation, particularly at large and anonymous scales, appears to be threatened by social predictive uncertainty and risk.

Fourth, we have noticed how cooperative niche-construction theory explains the puzzles of pro-social response to religious cues without religious belief. The theory

⁸Robert Rowthorn, personal communication.

also explains the failure of religious belief alone to ensure pro-social responses irrespective of context. Both puzzling effects are predicted by the design properties of charismatic systems that evolve to offload strategic control from individuals to authoritative sources embedded in their common ecologies.

Fifth, we have considered two experiments that bring something in the way of preliminary evidence for the hypothesis that ritual ecologies function as metaconstitutional designs which spread cooperative commitments beyond a familiar cohort.

Part 5. Conclusion

We hope that our readers will, by now, share our view that a signalling theory is more than ‘just a theory’. Signalling theories are interesting because they resolve known puzzles in the data on religions, and because they enable researchers to formulate precise and testable hypotheses about the designs that support and conserve cooperation, at small and large social scales. Yet we also hope that our readers will appreciate that a signalling theory is less than ‘just another theory’, in the sense of what certain humanists have come to expect from a theory: a comprehensive explanation that accounts for everything; (see for example Girard [1997]). All scientific explanations are partial. This is a good thing. The living world, including those regions occupied by persons and cultures, is complex.

Quite generally, signalling theories of religion expand the perspective of those who seek to understand the cooperative foundations of small and large-scale societies, about which relatively little is known. Peter Turchin writes that: ‘We are in the process of a major scientific revolution, which will ensure that the social science of the twenty-first century will differ significantly from that of the last century’ (Turchin 2006: location 1691). As the articles of this special volume ably demonstrate, the project of integrating religious studies with the life sciences has already begun in earnest, with many fascinating results. (For reviews see Boyer and Bergstrom [2008]; Bulbulia and Slingerland [2011 under review]; Sosis [2009]; Wilson and Green [2011]). However, the participation of classically trained scholars of religion is needed to sustain progress in the revolution of which Turchin speaks, because currently only classically trained scholars of religion possess the relevant empirical acquaintance with the facts. Advancing understanding about the metaconstitutional designs that support small and large-scale civilisations will depend upon the degree to which the expertise of both life scientists and scholars of religion becomes collaboratively integrated – the recurring mantra of this special issue of *Religion*.

Acknowledgements

We are grateful to Edward Slingerland, Michael Stausberg, Steven Engler, and three anonymous referees for helpful comments. Thanks also to the *Adaptive Logic of Religious Belief and Behaviour Group* (<http://evolution-of-religion.com>) headed by Dominic Johnson, and funded by the John Templeton Foundation, for supporting part of this research, and especially to David Slone Wilson and Robert Rowthorn for helpful suggestions to earlier presentations of this research.

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