

AN INTEGRATIVE FRAMEWORK OF COMMITMENT DISPLAYS IN RELIGIOUS SYSTEMS

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ABSTRACT

The occurrence of apparently costly and wasteful ritual behavior has long been puzzling for evolutionary scholars. We summarize two models of ritual behavior anchored in the theory of honest signaling. First, the costly signaling theory of ritual (CSTR) is introduced as a solution to the problem of cooperation by allowing ritual participants to signal their commitment to the social norms, which are often fostered by supernatural agents. Second, credibility enhancing displays (CREDs) are proposed as a cultural evolutionary extension of CSTR, which helps to spread the ritual practice and the associated commitment to moralizing supernatural agents. In our view, both mechanisms promote cooperation, and thus help spread and preserve costly ritual behavior. We outline a framework in which CSTR and CREDs can be hierarchically integrated and discuss the outstanding questions related to both CSTR and CREDs, including suggestions for future research.

Keywords: *Costly signaling, CREDs, cultural evolution, cooperation, religious ritual.*

INTRODUCTION

All around the world, religious behaviors and intensive cooperation frequently co-occur, posing a puzzle for evolutionary approaches to the study of human behavior (Norenzayan et al., 2016). Religious and ritual behaviors have many extreme forms that are very costly in terms of energy and resources and may even decrease the reproductive fitness of ritual participants, such as through long-term fasting or body mutilation. For example, during the Thaipooam *Kavadi* ritual performed by millions of Tamil Hindus across the world, participants pierce themselves with hundreds of needles, hooks, or rods through their cheeks (Xygalatas et al., 2013). However, even the less extreme forms of religious behavior, for instance, attending a mass or a local pilgrimage, seems to be ostensibly wasting believers' time, energy, and money that could otherwise be invested into foraging or reproductive behaviors. Moreover, even holding beliefs in supernatural agents can sometimes lead to an ultimate decrease in fitness, for example, when individuals refuse medical care based on their religious faith. Why do people become so intensely committed to religious beliefs?

Various scholars have argued that religion is an effective way for solving cooperative problems that humans have faced during their evolutionary history (Dunbar, 2013; Durkheim, 1912/2011). Unlike other species, we cooperate in large anonymous groups with non-kin individuals, often without a perspective of future reciprocal interaction. Nevertheless, game theoretical analysis suggests that the best choice for individuals is always to cheat when facing the dilemma whether to cooperate or defect (Axelrod, 1984). How is it that humans can overcome these everyday cooperative dilemmas? Beside kinship theory (Hamilton, 1966), some scholars have offered explanations based on direct (Trivers, 1971) and indirect reciprocity (Nowak & Sigmund, 1998; Trivers, 1971) or cultural group selection of prosocial norms (Boyd & Richerson, 2009). Others have argued that cooperation is facilitated by altruistic punishment (Fehr & Gächter, 2002) and that certain collective activities (e.g., synchrony: see McNeill, 1995) may activate hormonal mechanisms that are crucial for large-scale cooperation (Lang et al., 2017).

However, beside these mechanisms, contemporary evolutionary approaches to religion suggest that crucial role has been played by religious systems (Norenzayan, 2013). Nevertheless, the question remains, how can these systems stabilize cooperative exchange in the population?

To answer these questions, we first introduce and subsequently discuss several aspects of the *costly signaling theory*, which is deeply anchored in an ethological perspective, to explain why religious behavior and cooperation are so tightly intertwined. Moreover, we link the *costly signaling theory of religion* (CSTR) (Irons, 2001; Sosis, 2003) with a related approach called *credibility enhancing displays* (CREDS) (Henrich, 2009) through the framework of cultural evolutionary models of social learning (Richerson & Boyd, 2005). After introducing both approaches, we highlight their differences and similarities as grounds for an attempt to integrate both models into one framework of religious commitment displays. As such, we argue that (1) the conceptualization of display costs together with (2) the nature of evolutionary pressures that have shaped costly signals and CREDS and (3) the presence or absence of cultural learning are crucial

for explaining religious signaling systems. Finally, the strong and weak points of these theories are discussed with suggestions for prospective laboratory and field studies.

THE COSTLY SIGNALING THEORY

Before focusing on human religious and cooperative behavior, it is useful to first summarize the original argument of signaling theory. In a highly influential, yet at first controversial and challenged article (see Maynard Smith, 1976), Zahavi (1975, see also Zahavi & Zahavi, 1997) proposed that sexual selection employs a *handicap principle* – a fit individual bears a handicap to signal to its potential mating partners that it can withstand such a cost, advertising high biological fitness that is otherwise hidden. For example, a peacock's tail imposes various costs on a male peacock – it is heavy, it impairs flying, and displaying the tail increases the chances of being spotted by predators. The simple fact that a male peacock survives to maturity carrying such a handicap is an honest signal of the peacock's genotype quality. Therefore, such costly signals can increase the peacock's chances to mate with a high-quality female.

The handicap principle is not limited only to sexual selection but can be applied to other communication domains. For instance, when gazelles spot that a wolf is attempting to approach the herd, some of them begin to stot, which is costly behavior because it makes them visible to the wolf, depletes energy, and causes overheating. Nevertheless, it signals their endurance and speed, and thus the ability to escape the wolf. The wolf, as a receiver of their signal, is not going to chase the stotting gazelles but instead chase those that cannot undergo the handicap of stotting because these gazelles are less fit. This costly communication saves energy on both sides – fit gazelles do not have to run away while the wolf does not have to exhaust its energy in a pointless chase and can instead focus on those gazelles that are unable to signal their fitness through the handicap (Zahavi & Zahavi, 1997).

Regarding human signaling, there is a variety of traits that cannot be directly observed and the only way to provide others with information about such strategic qualities is to signal them by the behavior directly linked to that trait (e.g., Barker et al., 2019 identify material, embodied and social capital as different kinds of qualities that are beneficial for humans to signal). For example, Bliege Bird and her colleagues (2001) have utilized CST to reconceptualize hunting and altruistic meat sharing among the Meriam turtle hunters. While earlier theorists suggested a *tolerated-theft* explanation for why some hunters share their prey with others, CST understands specific forms of hunting, namely when hunting is less effective than other types of food acquisition, as signals communicating the hunters' strength, agility, willingness to risk, or generosity to potential allies and mates (Bliege Bird et al., 2001, for critical discussion of hunting as costly signaling see Stibbard-Hawkes, 2019). Other examples may be collective rituals that involve motor coordination and music production, which were studied as signals of group quality and cohesion directed at potential allies (Hagen & Bryant, 2003). Such signals might have evolved from territorial advertisement signals, as can be observed in hyenas, lions, primates, or wolves (Hagen & Hammerstein, 2009).

To make signals an effective way of communication between specimens, signals must be readily noticeable and understandable. Krebs and Dawkins (1984) suggested that the best way to achieve such effectiveness is to make the signals repetitive, ritualized, and extravagant. Human religious behavior not only meets these criteria, but repetitiveness, ritualization, and extravagance were proposed as defining aspects of human rituals (Rappaport, 1979; Lang et al. 2015). As such, rituals appear to be an optimal medium for commitment signaling.

COSTLY SIGNALING OF RITUAL BEHAVIOR

CSTR argues that ritual performances, which are seen as wasteful by non-religious strangers, can be adaptive for religious believers because these activities accurately broadcast the individual's intentions. Since people generally vary in their willingness to participate in collective action and individuals do not have direct access to others' intentions, a mechanism providing reliable information about others' willingness to cooperate should be favored by natural selection. Rituals and other costly religious requirements act as a reliable communicative channel because rituals provide a unique signaling space (Rappaport, 1979) where participants can monitor others and precisely calculate with whom to enter into trust-requiring interactions. This is due to the fact that those individuals who refuse to both participate in public rituals and to undertake the costs posed by a religious group are either not accepted into the community or do not become targets of interactions. Thus, the relative benefits for non-participants are lower than the benefits of individuals who participate in such demanding activities (Bulbulia, 2004; Ensminger, 1997; Irons, 2001). This scenario conjectures that relative net benefits from cooperation are, on average, higher than the ritual and religious costs because, otherwise, the costly signals would be suppressed by natural selection (Sosis, 2003).

The theory makes three basic predictions. First, higher signal costs should be positively associated with the signaler's actual cooperative intentions. Second, for the signal to work appropriately, receivers should perceive individuals who perform costlier signals as more trustworthy; and third, signals should be costlier in groups where there is more pressure to cooperate. To date, there is a number of studies supporting these predictions. For example, Sosis and Ruffle (2003) showed that Israeli kibbutz members who participated more frequently in public rituals cooperated more in economic games, and Xygalatas and colleagues (2013; 2018) found that engaging in extreme practices during the *Kavadi* ritual in Mauritius was associated with higher donations to the local charity and less selfish behavior in an economic game. Furthermore, people who perform public rituals are perceived as more trustworthy (Purzycki & Arakchaa, 2013; Power, 2017) and as Sosis and colleagues' (2007) analysis of ethnographic records revealed, rituals and religious markers are costlier during an intergroup conflict. Focusing on the long-term effects of the costly demands on a group's survival, Sosis and colleagues also found that 19th century US religious communes with costlier demands imposed on their adherents survived longer than communes with less costly demands (Sosis et al., 2003).

CSTR argues that costly ritual signaling is advantageous. However, if this is so, why would not everyone engage in such benefiting activities? Sosis (2003) speculates that belief in supernatural concepts related to costly demands is crucial since it may legitimize the ritual performance and decrease the perceived costs of committed signalers. In this respect, CSTR would predict that, for example, people who genuinely believe in Islam should find daily prayers less costly than non-believers (Sosis, 2003). Thus, religious belief may support and even facilitate ritual commitment signaling.

However, this conjecture leads to the second question, which is, whether we can also apply CSTR to secular groups such as armies, sports fans, and college fraternities? In other words, what are the necessary conditions for costly signals to work? We offer three possible answers. First, on the basic ethological level, signal costliness is directly linked to the willingness to cooperate without the need for any additional facilitators. In other words, people who are willing to sacrifice resources on costly signals posed by the group are also committed to cooperation, similarly as when only a fit gazelle can perform the stotting signal (Zahavi & Zahavi, 1997). A second possibility is that costly signals serve as markers for belonging to the group, similarly as language or dress style; hence, assorting cooperative individuals (Boyd & Richerson, 1987). For instance, Kurzban and Christner (2011) argue that even the supernatural belief itself could serve as a costly signal of coalitional membership because it makes the believers “unclubbable” for other groups. The last answer states that people signal their commitment to the ideas, norms, and moralizing supernatural agents (Norenzayan, 2013).

To date, the empirical support is not clear as there are studies supporting the second hypothesis (Shaver et al., 2018a) but also the third one (Hall et al., 2015). However, most studies suggest that only those costly signals that are related to the supernatural concepts are effective in increasing cooperation. For instance, research suggests that costly signals are more effective in religious groups compared to secular ones (Sosis et al., 2003) and a recent study on costly signals among secular groups found no effect of the costliness of their rituals on cooperation (Shaver et al., 2018b). A tentative conclusion would thus suggest that people signal commitments to both cooperative norms and moralizing gods (Lang et al., 2019; Purzycki et al., 2016; Norenzayan, 2013), which is deciphered as information on how strong is the faith in such punishment and as information about how motivated the signaler is to follow cooperative norms (Hall et al., 2015; McCullough et al., 2016). However, while CSTR addresses the problem of commitment to moralizing gods that foster inter-individual cooperation, it is not clear how such beliefs spread among populations in the first place.

CREDIBILITY ENHANCING DISPLAYS

The problem of the spread of belief in moralizing gods might be solved by utilizing another evolutionary line of research focused on costly ritual displays which has originated from mathematical models developed in the field of cultural evolution (Boyd & Richerson, 1985). Cultural evolutionists step outside the traditional conception of evolutionary theory by incorporating cultural dynamics into their models, claiming that humans have genetically evolved psychological mechanisms that enable them to learn

the cultural knowledge necessary for survival in the diverse palette of ecologies that humankind inhabits. These social learning biases, for example, the tendency to learn from prestigious individuals – *cultural models* – or to learn the most common cultural traits in the population influence the evolutionary dynamics of culture in a way that is different from genetic transmission, leading to different effects on populations (Richerson & Boyd, 2005).

At this point, we focus on one such a bias, namely CREDs. Henrich (2009) proposes that with the emergence of symbolic communication, cultural learners have faced the danger that others could manipulate them by verbally expressing beliefs that they do not really hold. The pressure was supposedly alleviated by natural selection, which made human ancestors sensitive whether others perform CREDs that support their verbal claims. In other words, to make sure that information receivers are not manipulated, the signalers have to observe others “walk the walk, not just talk the talk”. CREDs help to communicate that the *cultural models* honestly believe what they say because if they were not committed to their statements, they would not be willing to perform any supportive and persuasive CREDs. The CREDs hypothesis then predicts that such congruence makes the mental representation and the accompanying behavior more contagious, promoting their spread in populations. Furthermore, Norenzayan (2013) suggests that the combination of moralizing gods concepts with CREDs might increase a cultural group’s fitness through cultural group selection (Richerson et al., 2016), and thus help to outcompete other groups. This is because these moralizing gods pose cooperative norms on people while the CREDs mechanism ensures the transmission of such advantageous concepts.

Indeed, CREDs are especially critical in the transmission of religious beliefs and behaviors, because beliefs in supernatural agents are apriori unfalsifiable and unverifiable and individuals rely solely on the extravagant religious displays of others in assessing their relevance. Experiments have shown that religious mental representations are generally hard to believe in, but that CREDs that support the beforehand proclaimed mental representations overcome such an obstacle in cultural transmission, making congruent combinations of beliefs and behaviors much more likely to transmit to cultural learners (Willard et al., 2016).

To date, the CREDs bias was predominantly used to explain how religious concepts spread or decline among populations. Lanman and Buhrmester (2017) found that CREDs increase the possibility of adopting a belief in supernatural agents while their low intensity predicts the lack of belief, suggesting that religious CREDs are probably the most crucial component of religious socialization. In a similar vein, Willard and Cingl (2017) explored which factor best explains the surprising difference in religiosity between the Czechs and Slovaks, who otherwise share a very comparable socio-cultural milieu. They found that out of the many secularization theories predicting the decline of religiosity, the most critical factor was the lack of religious CREDs in the form of religious displays by parents and church attendance during childhood. Most recently, Langston, Speed, and Coleman III (2018) explored at what age a person becomes an atheist, controlling for various family background factors, and showed that exposure to religious CREDs generally delays the age at which one becomes an atheist.

COMPARISON OF CSTR AND RELIGIOUS CREDS

In the previous paragraphs, we introduced two models of religious behavior characterized by apparent wastefulness and costliness. Both models employ the conception of signaling as well as the notion of honesty and its impact on religious commitment and cooperation. However, their conceptual and formal relationship remains unclear. This is where we offer an integrative religious displaying framework where both models are hierarchically integrated depending on the absence or presence of the culture (i.e. the capability for cultural learning) in the model and on the way the models deal with the question of cooperation.

Both CSTR and CREDS are based on the concept of honest displays that communicate commitment to the supernatural concepts, and in turn, these concepts promote cooperation. Still, there are important differences creating possibilities for different predictions. First, while CSTR could be effectively employed only in the case of objectively costly performances, CREDS, in general, do not necessarily need to be costly; rather, the audience needs to perceive them as being costly. For example, when *cultural models* accompany their statement that a blue mushroom is safe and good to eat by eating the mushroom, they do not undertake any costs because they know that the mushroom is not poisonous; however, the targets of the mushroom CRED, naive cultural learners, are vigilant as to whether *cultural models* perform the actual behavior, because the cultural learners may worry that the *cultural models* are trying to poison them (Henrich, 2009). Contrarily, ritual signals of cooperation would not have evolved without being costly – the costliness is the reason why particular types of signals cannot be manipulated and thus provide adaptive communication channels.

Contrasted with the mushroom example, there is no apparent proof for religious concepts to be true, so the credibility of the display must be reached another way – if religious CREDS are to be transmissible, they need to be costly. For instance, when the *cultural model* says that there is an afterlife, it is not possible to perform a persuasive CRED (such as fighting for afterlife rewards) that is honest but not potentially costly at the same time because *cultural models* cannot objectively verify the existence of an afterlife. They can only rely on previously witnessed costly signals supporting the commitment to religious concepts, which acted as CREDS that transmitted the religious belief from one cultural model to another cultural learner.

Second, we identify another difference in the way cooperation is achieved through the display. Costly religious signaling is the way to exclude those who do not share the commitment to the group or cooperative norm posed by moralizing gods. In comparison, CREDS, although they are also linked to cooperation by helping to spread particular cooperative and/or punishment norms, are not primarily selected as the solution to the free-rider problem; instead, CREDS are a learners' mechanism on how to avoid being manipulated by *cultural models*. The cooperation enhancing role of CREDS is the result of co-optation (Gould & Vrba, 1982) by cultural group selection (Richerson et al., 2016) due to the CREDS' alliance with moralizing gods concepts. In other words, CREDS allow for the effective transmission of the moralizing gods concepts, which, in turn, may enhance within-group cooperation centered around costly rituals.

These two differences serve as grounds for the formulation of an integrative approach. However, a third difference must first be explicitly stated. CREDS bias is a

model of cultural learning and thus it cannot be applied where cumulative culture, a result of social learning (Richerson & Boyd, 2005), is missing. While the primary function of CREDs is to secure honest information transmission related to the display, costly signals are concerned with the increase of the signalers' reliability in order to promote their own payoffs in subsequent interactions. That is, costly signals also function in non-human animal communication, while CREDs, due to their dependence on cumulative culture, are mostly confined to humans.

Together, the difference between CSTR and CREDs can be harnessed to build a more comprehensive model of ritual honest communication that is vertically divisible into ethological and cultural signals. The ethological signals evolved to communicate strategic information between cooperators and when the cultural aspect enters the game, individuals become not only interactors in a game-theoretical manner but also models and learners in a cultural evolutionary sense, so the function of costly signals as reliability enhancing mechanisms is concomitantly transformed into a learning bias. As such, costly rituals signal individual commitment to moralizing gods and, at the same time, help to spread this belief to other receivers. Moreover, this belief also stimulates costly ritual performance, creating a self-propelling adaptive cultural complex.

Let us illustrate this on the example of *Kavadi* ritual introduced above. On the ethological level, *Kavadi* participants signal their personal commitments to the group norms and supernatural agents which increases their probability of being a target of future cooperative interactions, which indirectly results in the promotion of their biological fitness. On the level of cultural learning, these very same self-harming activities cause their own conservation and proliferation in the Tamil Hindu population because they serve as costly CREDs. Moreover, since *Kavadi* is dedicated to an empirically unverifiable supernatural agent, which makes it impossible to meet the requirement of congruence between the mental representation and a display without the display being costly, the costliness establishes and simultaneously enhances the reliability of commitment signals. In other words, the defining feature of religious systems – the unverifiability of supernatural beliefs – makes this unique package of norms and behaviors adaptive and at the same time contagious.

FUTURE DIRECTIONS

Since the supernatural concepts are a crucial element of the CREDs and CSTR integration, the first step should be to evaluate the role of supernatural beliefs and norms in the effectiveness of costly signals. Therefore, it is necessary to find a naturally occurring practice where the same costly activity is performed by both religious and non-religious people to determine whether the signals are effective only in a religious context.

Second, to date, most experimental CSTR studies were conducted with non-randomly distributed manipulation. This means that the level of cooperative incentives was not randomly manipulated but was naturally occurring, which does not enable to investigate the causal link between cooperative affordance and signal costs. Therefore, laboratory studies should be included in the CSTR empirical project to allow

experimenters to randomly assign people to the conditions where cooperative vs. noncooperative norms are invoked. In accordance with CSTR, it would be expected that participants in the condition with cooperative norms should play the economic games more cooperatively but, moreover, that they should be willing to sacrifice more money to signal their cooperative intention before the economic game.

Third, in regards to the CREDs, a prominent and quite paradoxical methodological shortcoming is the lack of behavioral measures. We are aware of only two studies (Kraft-Todd et al., 2018; Willard, Henrich & Norenzayan, 2016) that used behavioral assessment to test whether CREDs promote the transmission of an interlocked combination of belief and behavior. The majority of published studies employed self-report questionnaires concerning past exposure to religious CREDs (e.g., Willard & Cingl, 2017; Lanman & Buhrmester, 2017). While this does not devalue the results of the above studies on atheism, the CREDs hypothesis requires the emphasis on testing CREDs as actual behavioral cues, not just reports about past experiences or vignettes describing behavior (Turpin et al., 2018).

Fourth, CREDs are not unique to religious beliefs and behavior, but to date only Kraft-Todd and colleagues (2018) used CREDs to study the transmission of other pressing phenomena, namely public goods.

Finally, concerning the integrated framework of both approaches, for the time being, we ask general questions rather than propose specific predictions. Given that CREDs should co-optate the already established costly signals as mechanisms of reliability and the recent work on distinguishing between forms and content of signals (Baker et al., 2019; Bliege Bird et al., 2018; Power, 2017), we ask whether there is variance in what types of costly signals would make the most effective CREDs? We could expect that not all types of costly signals should be automatically effective as CREDs but that different displays should support different mental representations based on the content of mental representations.

To conclude, we discussed CSTR and CREDs and integrated them into one framework of religious commitment displays. We argued that both are based on honesty displays and that this honesty in religious signaling and religious CREDs is best achieved by the costliness of such displays. We also highlighted the necessity to focus more on laboratory studies to attain credible empirical evidence.

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REFERENCES

- Axelrod, R. (1984). *The evolution of cooperation*. New York: Basic Books.
- Barker, J. L., Power, E. A., Heap, S., Puurtinen, M., & Sosis, R. (2019). Content, cost, and context: A framework for understanding human signaling systems. *Evolutionary Anthropology: Issues, News, and Reviews*, 28(2), 1–14. [DOI](#)
- Bliege Bird, R., Ready, E., & Power, E. A. (2018). The social significance of subtle signals. *Nature Human Behaviour*, 2(7), 452–457. [DOI](#)
- Bliege Bird, R., Smith, E. A., & Bird, D. W. (2001). The hunting handicap: Costly signaling in human foraging strategies. *Behavioral Ecology and Sociobiology*, 50(1), 9–19. [DOI](#)
- Boyd, R., & Richerson, P. J. (1985). *Culture and the evolutionary process*. Chicago: The University of Chicago Press.
- Boyd, R., & Richerson, P. J. (1987). The evolution of ethnic markers. *Cultural Anthropology*, 2(1), 65–79. [DOI](#)
- Boyd, R., & Richerson, P. J. (2009). Culture and the evolution of human cooperation. *Philosophical Transactions of the Royal Society B*, 364(1533), 3281–3288. [DOI](#)
- Bulbulia, J. A. (2004). Religious costs as adaptations that signal altruistic intention. *Evolution and Cognition*, 10(1), 19–42.
- Dunbar, R. I. M. (2013). The origin of religion as a small-scale phenomenon. In: S. Clarke, R. Powell, & J. Savulescu (Eds.), *Religion, intolerance, and conflict: A scientific and conceptual investigation* (pp. 48–66). Oxford: Oxford University Press. [DOI](#)
- Durkheim, É. (2011). *The elementary forms of religious life*. Oxford: Oxford University Press. (Original work published in 1912)
- Ensminger, J. (1997). Transaction costs and Islam: Explaining conversion in Africa. *Journal of Institutional And Theoretical Economics*, 153(1), 4–29.
- Fehr, E., & Gächter, S. (2002). Altruistic punishment in humans. *Nature*, 415(10), 137–140. [DOI](#)
- Gould, S. J., & Vrba, E. S. (1982). Exaptation—a missing term in the science of form. *Paleobiology*, 8(1), 4–15. [DOI](#)
- Hagen, E. H., & Bryant, G. A. (2003). Music and dance as a coalition signaling system. *Human Nature*, 14(1), 21–51. [DOI](#)
- Hagen, E. H., & Hammerstein, P. (2009). Did Neanderthals and other early humans sing? Seeking the biological roots of music in the territorial advertisements of primates, lions, hyenas, and wolves. *Musicae Scientiae*, 13(2_suppl), 291–320. [DOI](#)
- Hall, D. L., Cohen, A. B., Meyer, K. K., Varley, A. H., & Brewer, G. A. (2015). Costly signaling increases trust, even across religious affiliations. *Psychological Science*, 26(9), 1368–1376. [DOI](#)
- Hamilton, W. (1964). The genetical evolution of social behaviour. I. *Journal of Theoretical Biology*, 7(1), 1–16. [DOI](#)
- Henrich, J. (2009). The evolution of costly displays, cooperation and religion: Credibility enhancing displays and their implications for cultural evolution. *Evolution and Human Behavior*, 30(4), 244–260. [DOI](#)
- Irons, W. (2001). Religion as a hard-to-fake sign of commitment. In R. M. Nesse (Ed.), *Evolution and the capacity for commitment* (pp. 292–309). New York: The Russell Sage Foundation.
- Kraft-Todd, G. T., Bollinger, B., Gillingham, K., Lamp, S., & Rand, D. G. (2018). Credibility-enhancing displays promote the provision of non-normative public goods. *Nature*, 563, 245–248. [DOI](#)

- Krebs, J., R., & Dawkins, R. (1984). Animal signals: Mind-reading and manipulation. In J. R. Krebs, & N. B. Davies (Eds.), *Behavioural ecology: An evolutionary approach* (2nd edition, pp. 380–402). Oxford: Blackwell Scientific Publications.
- Kurzban, R., & Christner, J. (2011). Are supernatural beliefs commitment devices for intergroup conflict? In J. P. Forgas, A. W. Kruglanski, & K. D. Williams (Eds.), *The psychology of social conflict and aggression* (pp. 285–299). New York: Psychology Press. [DOI](#)
- Lang, M., Bahna, V., Shaver, J. H., Reddish, P., & Xygalatas, D. (2017). Sync to link: Endorphin-mediated synchrony effects on cooperation. *Biological Psychology*, 127, 191-197. [DOI](#)
- Lang, M., Krátký, J., Shaver, J., Jerotijević, D., & Xygalatas, D. (2015). Effects of anxiety on spontaneous ritualized behavior. *Current Biology*, 25(14), 1892–1897. [DOI](#)
- Lang, M., Purzycki, B. G., Apicella, C. L., Atkinson, Q. D., Bolyanatz, A., Cohen, E., ... Henrich, J. (2019). Moralizing gods, impartiality and religious parochialism across 15 societies. *Proceedings of the Royal Society B: Biological Sciences*, 286(1898), 1–10. [DOI](#)
- Langston, J. A., Speed, D., & Coleman III, T. J. (2018). Predicting age of atheism: Credibility enhancing displays and religious importance, choice, and conflict in family of upbringing. *Religion, Brain & Behavior*, 1–19. [DOI](#)
- Lanman, J. A., & Buhrmester, M. D. (2017). Religious actions speak louder than words: Exposure to credibility enhancing displays predicts theism. *Religion, Brain, & Behavior*, 7(1), 3–16. [DOI](#)
- Maynard Smith, J. (1976). Sexual selection and the handicap principle. *Journal of Theoretical Biology*, 57(1), 239–242. [DOI](#)
- McCullough, M. E., Swartwout, P., Shaver, J. H., Carter, E. C., & Sosis, R. (2016). Christian religious badges instill trust in Christian and non-Christian perceivers. *Psychology of Religion and Spirituality*, 8(2), 149–163. [DOI](#)
- McNeill, W. (1995). *Keeping together in time: Dance and drill in human history*. Cambridge: Harvard University Press.
- Norenzayan, A. (2013). *Big gods: How religion transformed cooperation and conflict*. Princeton: Princeton University Press.
- Norenzayan, A., Shariff, A. F., Gervais, W. M., Willard, A. K., McNamara, R. A., Slingerland, E., & Henrich, J. (2016). The cultural evolution of prosocial religions. *Behavioral and Brain Sciences*, 39, 1–65. [DOI](#)
- Nowak, M. A., & Sigmund, K. (1998). Evolution of indirect reciprocity by image scoring. *Nature*, 393(11), 573–577. [DOI](#)
- Power, E. A. (2017). Discerning devotion: Testing the signaling theory of religion. *Evolution and Human Behavior*, 38(1), 82–91. [DOI](#)
- Purzycki, B. G., & Arakchaa, T. (2013). Ritual behavior and trust in the Tyva Republic. *Current Anthropology*, 54(3), 381–388. [DOI](#)
- Purzycki, B. G., Apicella, C., Atkinson, Q. D., Cohen, E., McNamara, R. A., Willard, A. K., ... Henrich, J. (2016). Moralistic gods, supernatural punishment and the expansion of human sociality. *Nature*, 530(7590), 327–330. [DOI](#)
- Rappaport, R. (1979). The obvious aspects of ritual. In R. Rappaport (Ed.), *Ecology, meaning and religion* (pp. 173–221). Richmond, California: North Atlantic Books.
- Richerson, P. J., & Boyd, R. (2005). *Not by genes alone: How culture transformed human evolution*. Chicago: University of Chicago Press. [DOI](#)
- Richerson, P., Baldini, R., Bell, A. V., Demps, K., Frost, K., Hillis, V., . . . Zefferman, M. (2016). Cultural group selection plays an essential role in explaining human cooperation: A sketch of the evidence. *Behavioral and Brain Sciences*, 39, 1–68. [DOI](#)
- Shaver, J. H., Divietro, S., Lang, M., & Sosis, R. (2018b). Costs do not explain trust among secular groups. *Journal of Cognition and Culture*, 18(1–2), 180–204.

- Shaver, J. H., Lang, M., Krátký, J., Klocová, E. K., Kundt, R., & Xygalatas, D. (2018a). The boundaries of trust: Cross-religious and cross-ethnic field experiments in Mauritius. *Evolutionary Psychology*, 16(4), 1–15. [DOI](#)
- Sosis, R. (2003). Why aren't we all hutterites: Costly signaling theory and religious behavior. *Human Nature*, 14(2), 91–127. [DOI](#)
- Sosis, R., & Bressler, E. B. (2003). Cooperation and commune longevity: A test of the costly signaling theory of religion. *Cross-Cultural Research*, 37(2), 211–239. [DOI](#)
- Sosis, R., & Ruffle, B. J. (2003). Religious ritual and cooperation: Testing for a relationship on Israeli religious and secular kibbutzim. *Current Anthropology*, 44(5), 713–722. [DOI](#)
- Sosis, R., Kress, H. C., & Boster, J. S. (2007). Scars for war: Evaluating alternative signaling explanations for cross-cultural variance in ritual costs. *Evolution and Human Behavior*, 28(4), 234–247. [DOI](#)
- Stibbard-Hawkes, D. N. E. (2019). Costly signaling and the handicap principle in hunter-gatherer research: A critical review. *Evolutionary Anthropology: Issues, News, and Reviews*, 1–14. [DOI](#)
- Trivers, R. L. (1971). The evolution of reciprocal altruism. *The Quarterly Review of Biology*, 46(1), 35–57. [DOI](#)
- Turpin, H., Andersen, M., & Lanman, J. A. (2018). CREDs, CRUDs, and Catholic scandals: Experimentally examining the effects of religious paragon behavior on co-religionist belief. *Religion, Brain & Behavior*, 9(2), 143–155. [DOI](#)
- Willard, A. K., & Cingl, L. (2017). Testing theories of secularization and religious belief in the Czech Republic and Slovakia. *Evolution and Human Behavior*, 38(5), 604–615. [DOI](#)
- Willard, A. K., Henrich, J., & Norenzayan, A. (2016). Memory and belief in the transmission of counterintuitive content. *Human Nature*, 27(3), 221–243. [DOI](#)
- Xygalatas, D., Kotherová, S., Maňo, P., Kundt, R., Cigán, J., Kundtová Klocová, E., & Lang, M. (2018). Big Gods in small places: The random allocation game in Mauritius. *Religion, Brain & Behavior*, 8(2), 243–261. [DOI](#)
- Xygalatas, D., Mitkidis, P., Fischer, R., Reddish, P., Skewes, J., Geertz, A. W., ... Bulbulia, J. (2013). Extreme rituals promote prosociality. *Psychological Science*, 24(8), 1602–1605. [DOI](#)
- Zahavi, A. (1975). Mate selection—A selection for handicap. *Journal of Theoretical Biology*, 53(1), 205–214. [DOI](#)
- Zahavi, A., & Zahavi, A. (1997). *The handicap principle: A missing piece of Darwin's puzzle*. New York: Oxford University Press.