

This article was downloaded by: [University of Connecticut]

On: 07 January 2014, At: 08:49

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Israel Journal of Ecology & Evolution

Publication details, including instructions for authors and subscription information:
<http://www.tandfonline.com/loi/tiee20>

The extended religious phenotype and the adaptive coupling of ritual and belief

Benjamin G. Purzycki^a & Richard Sosis^b

^a Centre for Human Evolution, Cognition, and Culture, University of British Columbia, 1871 West Mall Vancouver, British Columbia V6T 1Z2, Canada

^b Department of Anthropology, University of Connecticut, 354 Mansfield Road, Storrs, Connecticut 06269-2176, USA

Published online: 07 Oct 2013.

To cite this article: Benjamin G. Purzycki & Richard Sosis (2013) The extended religious phenotype and the adaptive coupling of ritual and belief, *Israel Journal of Ecology & Evolution*, 59:2, 99-108, DOI: [10.1080/15659801.2013.825433](https://doi.org/10.1080/15659801.2013.825433)

To link to this article: <http://dx.doi.org/10.1080/15659801.2013.825433>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

The extended religious phenotype and the adaptive coupling of ritual and belief

Benjamin G. Purzycki^{a*} and Richard Sosis^b

^aCentre for Human Evolution, Cognition, and Culture, University of British Columbia, 1871 West Mall Vancouver, British Columbia V6T 1Z2, Canada; ^bDepartment of Anthropology, University of Connecticut, 354 Mansfield Road, Storrs, Connecticut 06269-2176, USA

(Received 14 February 2013; accepted 7 July 2013)

In this paper, we consider the idea that religion is a transsomatic adaptation. At the genic level, the religious system constitutes an extended phenotype that has been fashioned by natural selection to overcome socioecological challenges inherent in human sociality, primarily problems of cooperation and coordination. At the collective level, the religious system constitutes a cognitive niche. We begin our discussion focusing on the former and concentrate our attention on the “sacred coupling” of supernatural agency and ritual behavior. We detail the complex connections between genes, cognitive faculties, and their expression in religious contexts, followed by a discussion of how religious ritual functions to maintain relative social order. We conclude with a discussion about the relevance of niche construction theory for understanding the adaptive nature of religious systems.

Keywords: cognition; extended phenotype; niche construction; religion; ritual

Notes on contributors

Benjamin Purzycki is currently a post-doctoral research fellow at the University of British Columbia’s Centre for Human Evolution, Cognition, and Culture. He is a sociocultural anthropologist who conducts fieldwork in the Tyva Republic. He investigates the evolution of religious systems with a particular emphasis on how people represent gods’ minds.

Richard Sosis is Professor of Anthropology and Director of the Evolution, Cognition, and Culture Program at the University of Connecticut. His work has focused on the evolution of cooperation and the adaptive significance of religious behavior, with particular interest in the relationship between ritual and intra-group cooperation. To explore these issues, he has conducted fieldwork with remote cooperative fishers in the Federated States of Micronesia and with various communities throughout Israel. He is co-founder and co-editor of the journal *Religion, Brain & Behavior*, which publishes research on the biological study of religion.

Introduction

In the *Extended Phenotype* (1982), Dawkins asks us to consider the case of a beaver in relation to its environment. He persuasively makes the case for the idea that “its environment” is more a part of the beaver than we might typically think:

By building a dam across the stream the beaver creates a large shoreline which is available for safe and easy foraging without the beaver having to make long and difficult journeys overland. If this interpretation is right, the lake may be regarded as a huge extended phenotype, extending the foraging range of the beaver in a way which is somewhat analogous to the web of a spider. As in the case of the spider web, nobody has done a genetic study of beaver dams, but we really do not need to in order to convince ourselves of the rightness of regarding the dam, and the lake, as part of the phenotypic expression of beaver genes.

It is enough that we accept that beaver dams must have evolved by Darwinian natural selection: this can only have come about if dams have varied under the control of genes (p. 200).

Compare this to Leslie White’s (1952) famous definition of culture as “an extrasomatic mechanism employed by a particular animal species in order to make its life secure and continuous” (p. 8), or consider Binford’s (1962) revision of White’s definition of culture as humans’ “extrasomatic means of adaptation... to its total environment both physical and social” (p. 218).

At the level of the individual, religion – something often considered prototypically cultural – may be understood as an extended phenotype in Dawkins’ sense and therefore an “extrasomatic” adaptation. While lakes and dams are made of water and wood respectively, the religious phenotype is made of concepts, propositions, rules, narratives, artifacts, and behaviors. The faculties that give rise to the features of religion are ultimately linked to individuals’ genes for their behavioral outputs. However, religions consist of more than behavioral outputs; *sharedness* is a central feature of the adaptive religious system (Purzycki & Sosis, 2010). That is, the constituent components of religious systems exist within individuals, extend between and affect individuals, and reach beyond human communities through generations (Purzycki & Sosis, 2009). As such, at the level of religious groups, religion may be understood as transsomatically adaptive insofar as it requires shared models and effects in order to function optimally for individuals.¹ Here, we isolate the basic components of religion at the level of the individual and situate the religious phenotype within its social and cognitive niche.

*Corresponding author. Email: bgpurzycki@alumni.ubc.ca

Like the extended phenotypic effects of the “mound-building genes” of the termite, “It is incidental that. . . the proximal theatre of within-body gene effects happens to be distributed among the cells of a large number of . . . bodies” (Dawkins 1982, p. 201). Likewise, religion is a transsomatic adaptation insofar as what people typically call “religion” is the aggregate phenotypic shadow cast by shared genetic factors that co-occur across human bodies. Like any other “animal artefacts” such as a beaver’s dam or spider web, a considerable amount of religion can be “regarded as a phenotypic tool by which that gene could potentially lever itself into the next generation” (Dawkins 1982, p. 199). In the present piece, we discuss how advances in the evolutionary and cognitive sciences have improved our understanding of the features that constitute religious systems, and we illustrate how religion has been an essential – but neither exclusively *internal* nor *external* – feature of the human experience that has been fashioned by natural selection.

Several questions that arise from these perspectives warrant serious consideration. Like the beaver’s lake, can we consider human manifestations of culture such as tools, jewelry, and residences as extended phenotypes of human genes (see Dawkins 2004)? Does selection favor such extrasomatic features in humans? How would selection actually shape such extrasomatic features? In other words, what types of selective forces might design such features? Is it cultural selection or genic selection, or some combination of both? In Dawkins’ terms, there need not be genes exclusively *for* lake-construction, just as there need not be genes exclusively *for* projectile or necklace production. Rather, such phenotypes are “product[s] of the interaction of many genes whose influence impinges from both inside and outside the organism” (1982, p. 239).

The evolutionary study of religion is advancing at a rapid pace (Bulbulia et al. 2008; Feierman 2009; Voland & Schiefenhövel 2009) and the evidence for the heritability of traits typically associated with religiosity is mounting (see Bouchard & McGue 2003; Bouchard 2004; Koenig & Bouchard 2006). Researchers generally do not emphasize the genetic underpinnings of religious expression but rather explore the proximate foundations of religious experience and employ evolutionary models to explain variation in religions. Considerable debate exists, especially concerning whether religion is an adaptation or merely a by-product of other evolved capacities (see Bulbulia et al. 2008; Sosis 2009; Pyysiäinen & Hauser 2010; Purzycki et al. *in press*). There is also the question of whether religion is inherently maladaptive. Dawkins (2006, pp. 200–208), for instance, likens religious adherents to a moth that engages in “self-immolation behavior” by flying into a candle flame; the moth’s perceptual algorithms inform it to do so as these mechanisms serve moths for navigational purposes. Because such an apparatus evolved in moths, false positives under new conditions may entail an individual’s demise (or at least nightly devotional practices toward porch lights). The analogy, however, suffers from a gross oversimplification of what religions are insofar as they are not merely beliefs that lead people to do things. Moreover, like the other

accounts we describe below, it ignores the remarkably consistent logic of religious systems’ constituent parts (i.e. its design features), and the benefits that people can often reap through participation (i.e. its fitness effects). Additionally, it ignores the fact that around the world, the features of religious systems often converge under similar conditions.² We do not deny that religion can lead to disastrous effects for individual fitness (e.g. suicide cults), but such cases are not representative of religious systems around the world.

Here, we offer a different approach to understanding religion that takes account of these patterns and features of religious systems: We view religion as an adaptation that exists within, between, and beyond individuals that increases the chances of genetic survival. In this view, religions’ essential components are supernatural agent concepts, rituals, and their coupling. We discuss this coupling first by detailing the evolved machinery behind mentally representing other minds and how this translates to the perception of supernatural agents. We then address the nature of religious ritual and how it forges the social bonds necessary to minimize the deleterious effects of isolation from social groups. This is followed by a discussion of the convergence of religious belief and ritual. We then build upon this foundation by using contemporary insights from biology and systems theory to further develop the idea that religion is a transsomatic adaptation.

The machinery behind supernatural agency

Let us first consider supernatural agent beliefs. It is typically held that the same cognitive processes that allow us to make sense of other people’s minds are the same processes that allow us to conceive of and interpret the thoughts and behaviors of supernatural agents. Normally functioning people readily and rapidly attribute agency to a wide variety of entities in our world, even when those entities do not have minds (e.g. “my car doesn’t want to start”). This ability to mentally represent others’ mental states is made possible by a complex suite of evolved mechanisms generally considered to be part of the “theory of mind” complex (ToM) (Premack & Woodruff 1978; Baron-Cohen 1995). Agency detection, attribution, and related forms of anthropomorphism are often considered to be the hallmark of religiosity. Indeed, central to all religious traditions are the mental representation of and the commitment to gods, spirits, and other supernatural agentive forces. These patterns, therefore, are likely to be a part of our evolved pan-human cognitive architecture (Barrett & Keil 1996; Barrett 2004). Most people are wanton agent-detectors and religious concepts hinge on this ability (Guthrie 1980, 1995). Barrett (2012) argues that we have a “hypersensitive agency detection device” (HADD), a cognitive mechanism designed to attribute mental states. HADD is “hypersensitive” as it attributes agency even to agentless events and things such as rustling bushes, moving dots on a computer screen, surprising events, gods, and spirits.

While the relationship between mentalizing and religion still requires further investigation, it undoubtedly has become clearer in recent years. First, mentalizing faculties are variable; people with autism spectrum disorder are often diagnosed with deficits in theory of mind, a form of “mindblindness” (Baron-Cohen 1995; Moran et al. 2011; Vivanti et al. 2011). Notably, mentalizing activates specific regions in the brain (see Gallagher & Frith 2003). Among these, the superior temporal sulci in particular has been directly associated with autism spectrum disorder (Zilbovicius 2006). While the question of the precise genetic foundations of autism spectrum disorder remains unanswered, there is considerable evidence that it is partly heritable (El-Fishawy & State 2010). Remarkably, deficits in mentalizing predict reduced religiosity (Norenzayan et al. 2012). Moreover, variation in other aspects of religiosity correlates with variation in neuroanatomy as well, beyond religious upbringing (Kapogiannis et al. 2009). Here, then, we see clear glimpses of the otherwise blurry connections between genetic variation, cognitive faculties, and how they are expressed in social environments. In sum, theory of mind systems constitute the biological foundations of mentalizing and variation in ability of mentalizing predicts variation in religiosity. However, it is not simply mentalizing that is at work in supernatural agency detection. Rather, gods’ minds have *content*.

Religious discourse often converges around what gods know and care about (Boyer 2001, p. 144). Some researchers have argued that humans commit to supernatural agents because these agents have access to important otherwise unknown social information (Boyer 2001, 2002; Atran 2002; Barrett 2008; Purzycki et al. 2012; Purzycki 2013). Their access to “socially strategic knowledge” makes them particularly salient, and a growing evolutionary literature demonstrates that concepts of supernatural punishment actually minimize antisocial behavior and often promote prosocial behavior (Bering & Johnson 2005; Johnson 2005; Shariff & Norenzayan 2007; Norenzayan and Shariff 2008; Schloss & Murray 2011). So, while representing minds appears to be a central process of religious cognition, the *contents* of those minds – what gods know and care about – are cross-culturally variable (Purzycki 2011, 2013; Purzycki & Sosis 2011). In other words, what exactly counts as “socially strategic” varies across contexts, just as what counts as “moral” varies from group to group (Shweder et al. 1987, 1997) and from time to time. However, catch-all notions such as these do not explain the limited diversity we find in what gods care about around the world, nor do they answer the question of whether or not a unified cognitive apparatus underlies religious and moral cognition.

It appears that despite the estimated 4200³ religions around the world, supernatural agents primarily care about only a handful of domains – interpersonal social behavior, ritual behavior, nonmoral taboos and etiquette, and resource maintenance – all of which have direct implications for interpersonal behavior. All populations have conceptions of these, but we do not know if these domains are rooted in the same evolved apparatus. In other words, are these domains unified somehow by some underlying

“moral” or “social strategy” system? Presumably, tightly connected to each of these is a generic psychological sense of “right and wrong.” However, as mentioned before, even if it were the case that a moral system undergirds all of these domains, it remains to be explained why some gods, for instance, care about *ritual* whereas others care more about *morality* (see Purzycki 2010, 2013; Purzycki & Sosis 2010 for further discussion). As understanding the nature of ritual is prerequisite for addressing the question, we now turn to this feature of the extended religious phenotype.

Ritual behavior and the forging of human bonds

From an outsider’s perspective, religious behavior often appears to be curiously taxing for individuals and remarkably wasteful. The pageantry, time and resource expenditures, body-mutilations (e.g. circumcision, subincision, scarification, piercing, etc.), activism, organization, and so forth all demand considerable investment on the parts of those who engage in them. While traditions vary in terms of their emphasis on religious belief and practice, we often say someone is “really religious” when they devote a lot of resources (time, thought, money, etc.) to the tradition. Individual variation in religious commitment can be measured in terms of such investments. Some evolutionary approaches to religious ritual consider individuals’ religious investments as signals to other people (Sosis & Alcorta 2003; Bulbulia & Sosis 2011). So, while religious rites may appear to be a squandering of resources, the trade-off for paying the costs of these investments can be prolonged cooperative behavior.

The animal kingdom is rife with communicative signals (Hauser 1996; Searcy & Nowicki 2005), defined as the “behavioral, physiological, or morphological characteristics fashioned or maintained by natural selection because they convey information to other organisms” (Otte 1974, p. 385). Obviously, all one needs to do to appreciate the cacophony of animal communication is take a step outside and listen; mating and warning calls, the colors and songs of birds, and so forth are all streams of ongoing communication between animals. One inherent challenge in communication is how effective and reliable information actually is, and this challenge becomes particularly acute when an individual’s reproductive fitness is at stake. The “Handicap Principle” set out by Zahavi and Zahavi (1997) explains that selection favors organisms when they pay high costs to produce signals that reliably indicate their own quality. For example, the peacock’s tail requires a significant energy investment to produce, and it certainly increases the risk of predation. However, the tail serves as a reliable indicator to peahens of the male’s quality; males of lower quality are unable to pay the costs to produce an extravagant tail. Note the dynamic nature of this process; not only do genes, regulatory systems, and ontogenetic factors influence the growth of the tail, but the ability to equate variation in tail-quality with variation in mate quality has been forged by natural selection just as much as the tail has.

In terms of religious beliefs, Cronk (2005, p. 608) suggests that even a “willingness to suspend reason and to

embrace beliefs that appear ridiculous to nonbelievers is itself a hard-to-fake sign of commitment to the religion and a defining feature of the boundary dividing believers from nonbelievers.” Consider the social repercussions of “appearing ridiculous to nonbelievers” by engaging in unusual behaviors or simply rejecting a behavior that is common practice. Just like the somatic displays of other animals, the costs of religious rituals vary within and across individuals. Costly signaling theory, which has been remarkably useful for anthropologists to account for a vast array of behaviors (see Cronk 1994; Bird & Smith, 2005 for reviews), anticipates a positive correlation between the cost of a ritual and the stakes or risk involved in cooperative ventures. Human groups are difficult to maintain and human bonds are potentially tenuous, but religious rituals maintain costs that convey important social information that may help to mitigate these challenges. Rituals can do this in at least three important ways.

First, paying religious costs conveys commitment to the group to which one belongs. This overcomes problems of cooperation insofar as receivers are able to determine that high-cost rituals would not be engaged in if one weren't committed to the group. By indicating one's commitment to the group, costly religious rituals serve as an effective signal that one is a worthwhile partner for prolonged cooperative interaction (see Dawkins & Krebs 1979; Axelrod 1984; Iannaccone 1992, 1995). Second, as such, religious rituals also communicate to outsiders who might be considering participation. Specifically, costly requirements serve as a gatekeeper preventing potential defectors from joining the group. Third, collective rituals convey messages to out-group members who can gauge the level of solidarity between individuals in the observed group (Sosis 2005; Bulbulia 2012).

The evidence supporting the costly signaling theory of religious ritual has considerable breadth from an array of cross-cultural studies of traditions both past and present (for an archaeological example, see Kantner & Vaughn 2012). For example, in economic game experiments, Israeli religious kibbutz members contributed more to the common pool than secular kibbutz members (Sosis & Ruffle 2003, 2004; Ruffle & Sosis 2007), and Afro-Brazilians who were more engaged with their religious communities were more generous than those who were less engaged (Soler 2012). Also, religious communes with costlier obligations outlive those with fewer requirements (Sosis & Bressler 2003).

One indication of the bonds forged by religious ritual is perceived trustworthiness (Sosis 2005). Religiosity has been found to predict trustworthiness in a number of studies from diverse populations (Tan & Vogel 2008; Purzycki & Arakchaa 2013; Ruffle & Sosis n.d.). These studies show that this sense of trust extends beyond religious contexts; religiosity predicts trustworthiness in individuals' economic transactions, reliability in returning lost objects, and even the likelihood of allowing anonymous ritual participants to babysit one's children (Purzycki & Arakchaa 2013). This approach to the communicative aspects of ritual participation addresses how costly rituals facilitate and maintain cooperation, which

can increase individual fitness. If this view is correct, then when others' reliability is acutely unclear or perceptions of risk are especially heightened, rituals should be manifest. In a cross-cultural study Sosis et al. (2007) found that higher rates of warfare were correlated with costlier ritual obligations. In contexts such as war, where the challenges of organization and mobilization are especially acute, the costs and benefits of defecting are particularly high because one's life and the lives of one's kin are at stake. In such conditions costlier rites may serve to strengthen social bonds and minimize the likelihood of defection. Likewise, many pastoralists (Sierksma 1963; Purzycki 2012, pp. 341–360), hunters-gatherers, and fishers (Watanabe 1972; Jordan 2003, p. 146) engage in ritual costs at other groups' territorial borders in order to honor local spirits and signal prosocial intentions. This indicates that trust-enhancing costs are located precisely where resident groups would desire outsiders' subservience to the *rest* of the local norms.

The religious phenotype: the sacred coupling

At its core, the religious phenotype is the coupling of ritual behavior and supernatural agency attribution. Rituals without supernatural agents are otherwise superstitions, forms of secular etiquette, and patterned, repetitive behaviors designed to serve some proximate end. Supernatural agency detection without ritual might be mythical, explanatory, or merely our general tendency to promiscuously find minds in the world at work. Of course, however, features of religion are largely shared and institutionalized; humans share meanings, motivations, and the justifications for behaviors. Also, there is interindividual variation in the mental models, roles, and costs involved in ritual, as well as the models of gods to whom such rites are devoted. Moreover, while there is considerable variation between populations, the coupling of ritual and supernatural agent beliefs is virtually constant all over the world. Stripped of the noise, religious *groups* are aggregate, global properties of these local phenotypic couplings expressing themselves with relatively similar – but not identical – content. Increased bonds offer increased benefits for individuals, which outweigh the costs of participation.

The cognitive structures that produce religious concepts, such as HADD and ToM, provide the foundation for religious beliefs and behaviors. But the underlying cognitive structures of religion comprise only the seeds that provide the potential for the religious system itself. To be sustained across the life course and across generations, religious beliefs require learning and reinforcement, and religious behaviors require practice. Religious expression requires cultural inputs and cultivation, not just cognitive potential. Whether one believes in Zeus, Vishnu, or Allah will depend on the cultural environment in which one was raised. But exposure to these supernatural agent concepts is not enough to generate commitment to them. So, what does? Adherents throughout the world believe in their gods and not other people's, regardless of exposure, because adherents perform rituals for their particular

deities (Alcorta & Sosis 2005). In other words, while humans possess the cognitive machinery to believe in gods, the particular gods that humans commit to require cultivation and maintenance. Belief in this regard is not automatic but rather achieved *through* ritual behaviors, such as supplications to a particular god, ritual presentations of myth, ascetic practices, and healing ceremonies, all of which instill an experience of what religious persons would call the “sacred.” Herein lies the essence of the dynamic nature of the “adaptive religious system.” In other words, ritual behaviors and religious beliefs exist in a feedback loop in which behaviors affect beliefs and beliefs affect behaviors.

In terms of cultivating religious experience, religious ritual is universally used to identify the sacred, and in so doing separate it from the profane (Durkheim, 1915/2001). But, as noted by Rappaport (1999), ritual does not merely identify that which is sacred – it *creates* the sacred. For instance, holy water is not simply water that has been discovered to be holy, or water that has been rationally demonstrated to have special qualities; rather, it is water that has been *transformed* through ritual. This is because the sanctifying ritual of holy water collectively alters the participants’ cognitive schema of water itself, rendering them with a template for differentiating holy water from profane water. Most importantly, from a behavioral perspective the emotional significance of sacred and profane water is quite distinct: not only is it inappropriate to treat holy water as one treats profane water; it is emotionally repugnant to do so. The central point can thus be summarized. While religious adherents differentiate sacred and profane things, their cognitive discrimination would be empty without having an emotional reaction to the sacred (Alcorta & Sosis 2005). For it is the emotional significance of the sacred that underlies “faith”, and it is ritual participation that invests the sacred with emotional meaning.

To recapitulate, the two central features of religion are supernatural agency detection and ritual behavior. The former is made possible by the evolved systems devoted to mental state attribution and detection whereas the latter is the behavioral expression of the acceptance of local mores (Rappaport 1999; Purzycki & Sosis 2009). While we frequently engage in both ritual performance and agency detection in our secular lives, religion emerges in their dynamic coupling. This coupling is a human universal (Brown 1991, p. 139), but there is significant cross-cultural variation in content. Some people devote rituals to ancestor spirits while others commit themselves to gods or omnipresent forces. Moreover, there is variation in the materials, relative costs, types of costs, timing, and placement of rituals. We now examine ways in which we can explain this variation.

Extended phenotypes, niche construction, and the evolving religious system

Of course, religious systems are much more than beliefs, rituals, and the cognitive underpinnings that make them possible. Religions also consist of external objects,

spaces, and places; using *internal* representational systems, people *navigate* the external religious environments that were established by previous generations. And again, those religious environments exhibit diversity around the world. This is the crux of the debate concerning extended phenotypes and niche construction theory (see Dawkins 2004; Jablonka 2004; Laland 2004; Turner 2004; Hunter 2009). Dawkins (2004, p. 377) notes that “the success or failure of buildings does not affect the frequency of architects’ genes in the gene pool. Extended phenotypes are worthy of the name only if they are candidate adaptations for the benefit of alleles responsible for variations in them.” Keeping this in mind, we must not confuse individual expressions of the religious phenotype (i.e. the sacred coupling) with the social environments in which they are a part (i.e. religions). Religions are the aggregate expression of the religious phenotype. Variation across religions lies primarily in the *content* of those aggregate phenotypes (e.g. currency of cost, timing of rituals, type of supernatural agent, etc.). What, then, explains this variation? Anthropologists have long known that socioecological factors affect patterns of religious expression and new studies reassessing this relationship strongly suggest that religious content shows predictable variation in order to overcome problems posed by specific environmental challenges. We now turn to this research.

Current evolutionary approaches to religion tend to focus on the evolution of psychological mechanisms and explain how we *retain* religious concepts and behavioral scripts for ritual protocol. They also suggest the importance of researching receiver psychology, and how variation in religious signals and concepts affect behavior. However, religious phenotypes operate *within* contexts of a multitude of *other* religious phenotypes (i.e. religious communities and institutions), and by way of shared expectations, behavioral protocols, and the parameters of acceptable behavior, individuals must navigate such contexts (e.g. rules, regulations, expectations, institutions, etc.). How can we account for the persistence of these contexts and their features?

Let us revisit Dawkins’ (1982) notion of the extended phenotype. Extended phenotypic behaviors can take the form of a variety of things such as beaver lakes, spider webs, caddis fly houses, and a bowerbird’s cache of blue objects (see Turner 2000 for more examples). One of the obvious distinctions here between the extended phenotype of, say, blue bits of glass in a bower and religious concepts is that the content of the latter is transmitted through language; specific religious information is transmitted between bodies through direct communication. Bower decorations are the content of the extended phenotypic expression of genes working “at a distance.” In the case of religion, the machinery required to be a religious species is genetically transmitted, whereas the specific informational flourishes – interestingly, Bering (2011, p. 37) calls this “cross-cultural plumage” – which become attached to these faculties (e.g. ancestor spirits, zoomorphic gods, etc.) are transmitted across minds. The same is true for ritual; people convey the same things across cultures using different materials in their offerings.

So, the essential components of religion are rooted in biological systems, while socioecological context determines when and how these faculties are expressed. A bower's blue bits of glass and other objects differ from the religious phenotype's ancestor spirits, gods, myths, and so forth because the socioecological contexts of bowers are not maintained by the *social* transmission of information. Even though there is some evidence that bowerbird males can learn elements of displays from other males, including calls from birds of other species (and even a dog's bark; Loffredo & Borgia 1986; Diamond 1987; Borgia 1995a, 1995b), bowerbirds are not born into their bowers or explicitly taught that bowers are the correct or optimal form of mate attraction, and they are certainly not scolded or ostracized when they fail to make bowers altogether (they just don't attract mates as successfully). Religions, on the other hand, are a part of the environment into which individuals are born and the content of religion is socially transmitted. Once religious phenotypes become part of the social landscape that individuals navigate, they may introduce novel selection pressures that would otherwise not be there. As such, the extended phenotypic expressions of one's social environment and the shared *content* of these phenotypes constitute a social niche. In other words, *religions* ontogenetically fashion the content, form, timing, and costs of individuals' phenotypic expressions of the sacred coupling.

Laland et al. (2000, pp. 132–133) define niche construction as “the activities, choices, and metabolic processes of organisms, through which they define, choose, modify, and partly create their own niches.” Odling-Smee (1996, p. 196) details a number of “[o]rganisms [that] change selection pressures by choosing or perturbing their local habitats, or by constructing artefacts.” An anthill, for instance, is a perfect example of a colony of organisms that alters their natural environment, thus introducing new selection pressures. Ants are genetically predisposed to alter their environments and presumably have modules which prevent them from building colonies with unsuitable materials. As such, by crafting a niche, organisms introduce new selection pressures just as much as they may overcome previously endured ones.

Geertz (1973, p. 44) notes that “man is precisely the animal most desperately dependent upon such extragenetic, outside-the-skin control mechanisms, such cultural programs, for ordering his behavior.” As we have seen above, and as others have illustrated quite beautifully (Pinker 2002; Ridley 2004), there is no clear point at which genes stop and culture begins. Moreover, such “cultural programs” are very much “inside the skin” of people. Humans are masters of niche construction – or what Dawkins (2004) calls “niche changing” – as we create landscapes, institutions, and communities that change how individuals interact with the environment. However, we also create social realities in the form of interpenetrating institutions which, as already discussed, create particular avenues that we navigate. A “cognitive niche” is the “dramatic increase in the use of contingent information for the regulation of improvised behavior that is successfully

tailored to local conditions” (Tooby & DeVore, 1987; Cosmides & Tooby 2000, p. 53). Our social environments operate as natural environments insofar as individuals must ontogenetically acclimate to them and behave in such ways that do not violate the boundaries by which our institutions delimit. These environmental pressures, in turn, regulate how the religious phenotype is expressed.

Scholars have begun to recognize the value of approaching religion as an environmental niche (Sørensen 2004). Bulbulia (2008, p. 21), for example, argues that religion is

a system of organized behavior and knowledge, together with whatever artifacts and other symbolic structures (musical scores, texts, religious architecture) that is supported, retained, improved, and transmitted at least in part because we possess cognitive capacities to believe and morally commit to supernatural realities and purposes.

Additionally, however, religions are *moral communities* in the sense that there are encoded expectations and forms of appropriate and inappropriate conduct. Moreover, people navigate this social niche by engaging in rituals which, as discussed above, communicate sharedness and commitment: “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” (Bulbulia & Sosis 2011, p. 376; see also Kydd 2008). Natural selection favors genes that make social organisms engage in stable and reliable cooperative endeavors. Such endeavors have inherent problems that rituals function to minimize. In this way, religion is a “phenotypic tool by which. . . gene[s] could potentially lever [themselves] into the next generation” (Dawkins 1982, p. 199) and the “cognitive niche” aspect of religious groups introduces additional pressures that motivate conformity to social mores. This niche provides the content to which the religious phenotypes of incoming generations must conform, the parameters of what constitutes appropriate costs, and when those costs are appropriately paid.

Conclusion

What, then, of the formation of religious niches' content? Viewing religions as niches into which people are born and which they become part of is a helpful view, but it does not necessarily address how the specific content of particular niches emerges in the first place. Humans located in different geographic regions face different adaptive challenges. One persistent problem for all humans, however, is our reliance on others to maintain the cooperative relationships that have undoubtedly served our species for millennia. Who are reliable partners? How can we negotiate access to limited resources?

Different modes of subsistence have locally specific problems of cooperation and coordination. In a number of studies, state-level social organization predicts the presence of moralistic high gods (Swanson 1960; Wallace 1966; Stark 2001; Johnson 2005; Sanderson 2008; Lahti

2009), particularly those with high levels of out-group conflict (Roes & Raymond 2003). Such gods may have emerged, however, in pastoralist societies where warfare and the challenges of coordination are especially acute (Peoples & Marlowe 2012). It has also been found that the greater the population density, the higher the rate of religious ritual performance (Atkinson & Whitehouse 2011). Religious diversification has been linked to pathogen stress (Fincher & Thornhill 2012) and the development of revitalization cults predictably corresponds to resistance to colonialism around the world (Wallace 1956). As noted earlier, traditional communities with a strong sense of territory often sacralize boundaries and entail corresponding ritual piety from outsiders upon entry. These facts all suggest that under particular conditions the religious phenotype will express itself collectively in the form of the religious niche, which evolves in specific ways in order to overcome specific socioecological challenges.

The traditional notion of phenotype limits evolved traits to features of an organism's morphology, physiology, and behavior. Dawkins' notion of the extended phenotype – extrasomatic and often transsomatic adaptations that exist outside of the body – accounts for a remarkable variety of phenomena in the world. It also wonderfully characterizes religion at its core. The genetic foundations for religious expression have a greater chance of replication when the content and form of religious systems are responsive to locally specific socioecological challenges. The content of these responses is transmitted across individuals, and this content corresponds to those challenges. Successful religious systems not only have mechanisms that enable adaptive responses to local conditions, but they employ structural elements, such as ritual costs and supernatural agent concepts, that safeguard against exploitation of such a system.

Acknowledgements

Purzycki thanks the SSHRC-funded Cultural Evolution of Religion Research Consortium (CERC) for support during the preparation of this work. Sosis thanks and acknowledges support from a CTI Fellowship (Evolution and Human Nature) and an ESRC Large Grant (REF RES-060-25-0085) entitled "Ritual, Community, and Conflict." The authors thank Leon Loveridge, John Shaver, and the reviewers for their helpful comments on an earlier draft of this paper.

Notes

1. The question will likely arise as to whether or not the view of religion as a transsomatic adaptation is one which endorses the idea that religious groups are somehow a unit of selection or that selection operates at various levels (see Pinker 2012; Wilson 2002). To illustrate why we do not need to appeal to multilevel selection, we may return to the example of lake size and beavers. As Dawkins notes,

beyond a certain size of beaver lakes, it would become hard to regard further increases in size as adaptations. The reason is that, beyond a certain size, other beavers than the builders of the dam are just as likely to benefit from each increase in size as the dam-builders themselves. A big lake benefits all the

beavers in the area, whether they created it or whether they just found it and exploited it (1982, p. 234).

Note that in this case, freeriding may in turn overrun such a system to the point where genes for the big-lake phenotype become outcompeted. As we discuss below, religious ritual functions to prevent such exploitation by imposing costs upon participants as a means to keep freeriding at bay.

However, if it is the case that under particular external conditions, religious systems provide advantages for individual agents when their constituent parts, both internal and external to the individual, converge in a particular way, then the question of whether or not natural selection also "operates" at an emergent level is an important one. So, while genes are the foundational replicators of the evolutionary process, it may be that emergent properties of human social systems – when their components "lock into place" – may provide benefits for individuals which would otherwise be unobtainable. But the benefits are only reaped when this convergence of units consists of a particular logic and that logic must exist within a compatible socioecological context. In other words, selection may favor the expression of specific kinds of religious systems, a possibility that lies beyond the scope of strictly cognitive approaches to religion (see Malley 1995, 1997; Sørensen 2004; Purzycki et al. in press).

2. Dawkins' hostility toward religion is well-known, but his characterization of religion as a maladaptive by-product is notably odd in light of his other work. Of course, he knows the distinctions between "adaptive", "good", and "accurate." He also understands how flimsy "byproduct" arguments can be:

A geneticist colleague has argued that there are virtually no behaviour-genetic traits, because all those so far discovered have turned about to be 'byproducts' of more fundamental morphological or physiological effects. But what on earth does he think *any* genetic trait is, morphological, physiological or behavioural, if not a 'byproduct' of something more fundamental? If we think the matter through we find that all genetic effects are 'byproducts' except protein molecules (1982, p. 197).

Presumably, Dawkins' primary concerns are with religions in contemporary state-level societies rather than smaller, traditional societies. As such, it is perfectly conceivable that under contemporary conditions, religion may be maladaptive, but research suggests that religious people in state societies are doing remarkably well on the reproductive front (Frejka & Westoff 2008; Blume 2009, 2010; Kaufmann 2010).

3. This number was taken from <http://www.adherents.com/> on 22 April 2013.

References

- Alcorta CS, Sosis R. 2005. Ritual, emotion, and sacred symbols: The evolution of religion as an adaptive complex. *Hum Nat.* 16(4):323–359.
- Atkinson QD, Whitehouse H. 2011. The cultural morphospace of ritual form: examining modes of religiosity cross-culturally. *Evol Hum Behav.* 32(1):50–62.
- Atran S. 1998. Folk biology and the anthropology of science: cognitive universals and cultural particulars. *Behav Brain Sci.* 21(4):547–609.
- Atran S. 2002. *In gods we trust: the evolutionary landscape of religion.* New York (NY): Oxford University Press.
- Axelrod R. 1984. *The evolution of cooperation.* New York (NY): Basic Books.

- Baron-Cohen S. 1995. *Mindblindness: an essay on autism and theory of mind*. Cambridge (MA): MIT Press.
- Barrett JL. 2004. *Why would anyone believe in God?* New York (NY): AltaMira Press.
- Barrett JL. 2008. Why Santa Claus is not a god. *J Cogn Cult*. 8(1–2):149–161.
- Barrett JL. 2012. *Born believers: The science of children's religious belief*. New York: Free Press.
- Barrett JL, Keil FC. 1996. Conceptualizing a nonnatural entity: Anthropomorphism in God concepts. *Cogn Psychol*. 31: 219–247.
- Bering, J. 2011. *The belief instinct: the psychology of souls, destiny, and the meaning of life*. New York (NY): W. Norton & Company.
- Bering JM, Johnson DDP. 2005. "O Lord... you perceive my thoughts from afar": recursiveness and the evolution of supernatural agency. *J Cogn Cult*. 5:118–142.
- Binford L. 1962. Archaeology as anthropology. *Am Antiquity*. 28(2):217–225.
- Bird RB, Smith EA. 2005. Signaling theory, strategic interaction, and symbolic capital. *Curr Anthropol*. 46(2): 221–248.
- Blume M. 2009. The reproductive benefits of religious affiliation. In: Volland E, Schiefelhövel W, editors. *The biological evolution of religious mind and behavior*. New York (NY): Springer; 117–126.
- Blume M. 2010. Von Hayek and the Amish fertility: how religious communities manage to be fruitful and multiply. A case study. In: Frey U, editor. *The nature of god: evolution and religion*. Marburg: Tectum Verlag; p. 159–175.
- Borgia G. 1995a. Complex male display and female choice in the spotted bowerbird: specialized functions for different bower decorations. *Anim Behav*. 49:1291–1301.
- Borgia G. 1995b. Threat reduction as a cause of differences in bower architecture: bower decoration and male display in two closely-related bowerbirds *Chlamydera nuchalis* and *C. maculata*. *Emu* 95(1):1–12.
- Bouchard Jr. TJ. 2004. Genetic influence on human psychological traits: a survey. *Curr Dir Psychol Sci*. 13:148–151.
- Bouchard Jr. TJ, McGue M. 2003. Genetic and environmental influences on human psychological differences. *J Neurobiol*. 54(1):4–45.
- Boyer P. 2001. *Religion explained: the evolutionary origins of religious thought*. New York (NY): Basic Books.
- Boyer P. 2002. Why do gods and spirits matter at all? In: Pyysiäinen I, Veikko A, editors. *Current approaches in the cognitive science of religion*. New York (NY): Continuum; p. 68–92.
- Brown D. 1991. *Human universals*. New York (NY): McGraw-Hill.
- Bulbulia J. 2008. Meme infection or religious niche construction?: an adaptationist alternative to the cultural maladaptationist hypothesis. *Method Theory Study Rel*. 20:67–107.
- Bulbulia J. 2012. Spreading order: religion, cooperative niche construction, and risky coordination problems. *Biol Philos*. 27(1):1–27.
- Bulbulia J, Sosis R. 2011. Signaling theory and the evolution of religions. *Religion* 41(3):363–388.
- Bulbulia J., Sosis R, Harris E, Genet R, Genet C, Wyman K, editors. 2008. *The evolution of religion: studies, theories, and critiques*. Santa Margarita (CA): Collins Foundation Press.
- Cosmides L, Tooby J. 2000. Evolutionary psychology and the emotions. In: Lewis M, Haviland-Jones JM, editors. *Handbook of emotions*. 2nd ed. New York (NY): Guilford Press; p. 91–115.
- Cronk L. 1994. Evolutionary theories of morality and the manipulative use of signals. *Zygon* 29(1):81–101.
- Cronk L. 2005. The application of animal signaling theory to human phenomena: some thoughts and clarifications. *Soc Sci Inf*. 44(4):603–620.
- Dawkins R. 1982. *The extended phenotype: the long reach of the gene*. New York (NY): Oxford University Press.
- Dawkins R. 2004. Extended phenotype – But not *too* extended. A reply to Laland, Turner and Jablonka. *Biol Philos*. 19:377–396.
- Dawkins R. 2006. *The god delusion*. New York (NY): Mariner Books.
- Dawkins R, Krebs JR. 1979. Arms races between and within species. *Proc Royal Soc Lond B. Biol Sci*. 205(1161): 489–511.
- Diamond, J. 1987. Bower building and decoration by the bowerbird *Amblyornis inornatus*. *Ethology* 74:177–204.
- Durkheim, É. 1915/2001. *The elementary forms of religious life*. New York (NY): Oxford University Press.
- El-Fishawy P, State MW. 2010. The genetics of autism: key issues, recent findings and clinical implications. *Psychiatr Clin North Am*. 33(1):83–105.
- Feierman JR, editor. 2009. *The biology of religious behavior: the evolutionary origins of faith and religion*. Santa Barbara (CA): Praeger.
- Fincher CL, Thornhill R. 2012. Parasite-stress promotes in-group assortative sociality: the cases of strong family ties and heightened religiosity. *Behav Brain Sci*. 35(2): 61–79.
- Frejka T, Westoff CF. 2008. Religion, religiousness and fertility in the US and in Europe. *Eur J Popul*. 24:5–31.
- Gallagher HL, Frith CD. 2003. Functional imaging of "theory of mind." *Trends Cogn Sci*. 7(2):77–83.
- Gathercole SE. 1997. Models of verbal short-term memory. In: Conway MA., editor. *Cognitive models of memory*. Cambridge (MA): MIT Press; p. 13–44.
- Geertz, C. 1973. *The interpretation of cultures*. New York (NY): Basic Books.
- Guthrie SE. 1980. A cognitive theory of religion. *Current Anthropol*. 21(2):181–203.
- Guthrie SE. 1995. *Faces in the clouds: A new theory of religion*. Oxford: Oxford University Press.
- Hauser MD. 1996. *The evolution of communication*. Cambridge (MA): MIT Press.
- Hunter P. 2009. Extended phenotype redux. *Eur Mol Biol Org*. 10(3):212–215.
- Iannaccone LR. 1992. Sacrifice and stigma: reducing free-riding in cults, communes, and other collectives. *J Political Econ*. 100(2):271–291.
- Iannaccone LR. 1995. Voodoo economics? Reviewing the rational choice approach to religion. *J Sci Study Rel*. 34(1):76–88.
- Jablonka E. 2004. From replicators to heritably varying phenotypic traits: the extended phenotype revisited. *Biol Philos*. 19(3):353–375.
- Johnson DDP. 2005. God's punishment and public goods: a test of the supernatural punishment hypothesis in 186 world cultures. *Hum Nat*. 16:410–446.
- Jordan, P. 2003. *Material culture and sacred landscape: The anthropology of the Siberian Khanty*. Walnut Creek (CA): Rowman and Littlefield Publishers.
- Kantner J, Vaughn KJ. 2012. Pilgrimage as costly signal: religiously motivated cooperation in Chaco and Nasca. *J Anthropol Archaeol*. 31(1):66–82.
- Kapogiannis D, Barbey AK, Su M, Krueger F, Grafman J. 2009. Neuroanatomical variability of religiosity. *PLoS ONE* 4(9).
- Kaufmann, E. 2010. *Shall the religion inherit the earth?* London: Profile Books Ltd.
- Koenig LB, Bouchard Jr, TJ. 2006. Genetic and environmental influences on the Travidional Moral Values Triad – Authoritarianism, conservatism and religiousness – as assessed by quantitative behavior genetic methods. In: McNamara P., editor. *Where god and science meet: how brain and evolutionary studies alter our understanding of religion*. 1st vol. Westport (CA): Praeger; p. 31–60.
- Kydd D. 2008. Supernatural niche construction incubates brilliance and governs the ratchet effect. In: Bulbulia J, Sosis R, Harris E, Genet R and Genet C, editors. *The evolution of*

- religion: studies, theories, critiques. Santa Margarita: Collins Foundation Press; p. 93–98.
- Lahti DC. 2009. The correlated history of social organization, morality, and religion. In: Voland E, Schiefenhövel W, editors. The evolution of religious mind and behavior. New York (NY): Springer; p. 67–88.
- Laland KN. 2004. Extending the extended phenotype. *Biol Phil.* 19(3):313–325.
- Laland KN, Odling-Smee J, Feldman MW. 2000. Niche construction, biological evolution, and cultural change. *Behav Brain Sci.* 23:131–175.
- Loffredo CA, Borgia G. 1986. Sexual selection, mating systems, and the evolution of avian acoustical displays. *Am Nat.* 128(6):773–794.
- Malley BE. 1995. Explaining order in religious systems. *Method Theory Study Rel.* 7(2):5–22.
- Malley BE. 1997. Causal holism in the evolution of religious ideas. *Method Theory Study Rel.* 9(4):389–399.
- Moran JM, Young LL, Saxe R, Lee SM, O’Young D, Mavros PL, Gabrieli JD. 2011. Impaired theory of mind for moral judgment in high-functioning autism. *Proc Natl Acad Sci.* 108(7):2688–2692.
- Norenzayan A, Shariff AF. 2008. The origin and evolution of religious prosociality. *Science* 322:58–62.
- Norenzayan A, Gervais WM, Trzesniewski KH. (2012). Mentalizing deficits constrain belief in a personal god. *PLoS ONE* 7(5).
- Odling-Smee FJ. 1996. Niche construction, genetic evolution and cultural change. *Behav Processes.* 35:195–205.
- Otte D. 1974. Effects and functions in the evolution of signaling systems. *Annu Rev Ecol Syst.* 5(1):385–417.
- Peoples HC, Marlowe FW. 2012. Subsistence and the evolution of religion. *Hum Nat.* 23(3):253–269.
- Pinker S. 2002. *The blank slate: the modern denial of human nature.* New York (NY): Penguin Books.
- Pinker S. 2012. The false allure of group selection. *Edge* [Internet]. Available from: <http://edge.org/conversation/the-false-allure-of-group-selection>.
- Premack DG, Woodruff G. 1978. Does the chimpanzee have a theory of mind? *Behav Brain Sci.* 1:515–526.
- Purzycki BG. 2011. Tyvan *cher eezi* and the socioecological constraints of supernatural agents’ minds. *Religion, Brain, Behav.* 1(1):31–45.
- Purzycki BG. 2012. Finding minds in the natural world: Dynamics of the religious system in the Tyva Republic [dissertation]. Storrs: University of Connecticut.
- Purzycki BG. 2013. The minds of gods: A comparative study of supernatural agency. *Cognition* 129(1):163–179.
- Purzycki BG, Arakchaa T. 2013. Ritual behavior and trust in the Tyva Republic. *Curr Anthropol.* 54(3):381–388.
- Purzycki BG, Sosis R. 2009. The religious system as adaptive: cognitive flexibility, public displays, and acceptance. In: Voland E, Schiefenhövel W, editors. The biological evolution of religious mind and behavior. New York (NY): Springer-Verlag; p. 243–256.
- Purzycki BG, Sosis R. 2010. Religious concepts as necessary components of the adaptive religious system. In Frey U, editor. *The nature of god: evolution and religion.* Marburg: Tectum Verlag; p. 37–59.
- Purzycki BG, Finkel DN, Shaver J, Wales N, Cohen AB, Sosis R. 2012. What does god know? Supernatural agents’ access to socially strategic and nonstrategic information. *Cogn Sci.* 36(5):846–869.
- Purzycki BG, Sosis R, Haque O. In press. Extending evolutionary accounts of religion beyond the mind: religions as adaptive systems. In: Watts F, Turner L, editors. *The evolution of religion: critical perspectives and new directions.*
- Pyysiäinen I, Hauser M. 2010. The origins of religion: evolved adaptation or by-product? *Trends Cogn Sci.* 14(3): 104–109.
- Rappaport RA. 1999. *Ritual and religion in the making of humanity.* Cambridge: Cambridge University Press.
- Ridley M. 2004. *The agile gene: how nature turns on nurture.* New York (NY): Harper Perennial.
- Roes FL, Raymond M. 2003. Belief in moralizing gods. *Evol Human Behav.* 24:126–135.
- Ruffle BJ, Sosis R. 2007. Does it pay to pray? Costly ritual and cooperation. *BE J Econ Anal Policy* 7:1–35.
- Ruffle BJ, Sosis R. n.d. Do religious contexts elicit more trust and altruism? An experiment on facebook [Internet]. Available from: <http://ssrn.com/abstract=1566123>.
- Sanderson SK. 2008. Religious attachment theory and the biosocial evolution of the major world religions. In: Bulbulia J, Sosis R, Harris E, Genet R, Genet C, editors. *The evolution of religion: studies, theories, critiques.* Santa Margarita (CA): Collins Foundation; p. 67–72.
- Schloss JP, Murray MJ. 2011. Evolutionary accounts of belief in supernatural punishment: a critical review. *Religion, Brain Behav.* 1(1): 46.
- Searcy WA, Nowicki S. 2005. *The evolution of animal communication: reliability and deception in signaling systems.* Princeton (CA): Princeton University Press.
- Shariff AF, Norenzayan A. 2007. God is watching you: priming god concepts increases prosocial behavior in an anonymous economic game. *Psychol Sci.* 18: 803–809.
- Shweder RA, Mahapatra M, Miller JG. 1987. Culture and moral development. In: Kagan J, Lamb S, editors. *The emergence of morality in young children.* Chicago: University of Chicago Press; p. 1–83.
- Shweder RA, Much NC, Mahapatra M, Park L. 1997. The “big three” of morality (autonomy, community, divinity) and the “big three” explanations of suffering. In: Brandt AM, editor. *Morality and Health.* New York (NY): Routledge; p. 119–169.
- Sierksma F. 1963. Sacred cairns in pastoral cultures. *History Religion.* 2(2):227–241.
- Soler M. 2012. Costly signaling, ritual and cooperation: evidence from Candomblé, an Afro-Brazilian religion. *Evol Hum Behav.* 33(4):346–356.
- Sosis R. 2005. Does religion promote trust? The role of signaling, reputation, and punishment. *Interdiscip J Res Religion.* 1:1–30.
- Sosis R. 2009. The adaptationist-byproduct debate on the evolution of religion: five misunderstandings of the adaptationist program. *J Cogn Cult.* 9:339–356.
- Sosis R, Bressler ER. 2003. Cooperation and commune longevity: a test of the costly signaling theory of religion. *Cross-Cult Res.* 37(2):211–239.
- Sosis R, Ruffle B. 2003. Religious ritual and cooperation: testing for a relationship on Israeli religious and secular kibbutzim. *Curr Anthropol* 44:713–722.
- Sosis R, Ruffle B. 2004. Ideology, religion, and the evolution of cooperation: Field tests on Israeli kibbutzim. *Res Econ Anthropol.* 23:89–117.
- Sosis R, Kress HC, Boster JS. 2007. Scars for war: evaluating alternative signaling explanations for cross cultural variance in ritual costs. *Evol Hum Behav.* 28:234–247.
- Stark R. 2001. Gods, rituals, and the moral order. *J Sci Study Religion.* 40(4):619–636.
- Swanson GE. 1960. *The birth of the gods: the origin of primitive beliefs.* Ann Arbor (MI): University of Michigan Press.
- Sørensen J. 2004. Religion, evolution, and an immunology of cultural systems. *Evol Cogn.* 10(1):61–73.
- Tan JHW, Vogel C. 2008. Religion and trust: an experimental study. *J Econ Psychol* 29(6):832–848.
- Tooby J, Cosmides L. 1992. Cognitive adaptations for social exchange. In: Barkow JH, Cosmides L, Tooby J, editors. *The adapted mind: evolutionary psychology and the generation of culture.* New York (NY): Oxford University Press; p. 163–228.
- Tooby J, DeVore I. 1987. The reconstruction of hominid behavioral evolution through strategic modeling. In: Kinzey W,

- editor. Primate models of hominid behavior. New York (NY): SUNY Press; p. 183–237.
- Turner JS. 2000. The extended organism: the physiology of animal-built structures. Cambridge (MA): Harvard University Press.
- Turner JS. 2004. Extended phenotypes and extended organisms. *Biol Philos.* 19(3):327–352.
- Vivanti G, McCormick C, Young GS, Abucayan F, Hatt N, Nadig A, Ozonoff S, Rogers SJ. 2011. Intact and impaired mechanisms of action understanding in autism. *Dev Psychol.* 47(3):841–856.
- Voland E, Schiefenhövel W. 2009. The biological evolution of religious mind and behavior. New York (NY): Springer-Verlag.
- Wallace AFC. 1956. Revitalization movements. *American Anthropologist* 58(2):264–281.
- Watanabe H. 1972. The Ainu. In Bicchieri MG, editor. *Hunters and gatherers today: a socioeconomic study of eleven such cultures in the twentieth century.* Prospect Heights (NY): Waveland Press; p. 448–484.
- White L. 1952. *The evolution of culture.* New York (NY): McGraw Hill.
- Wilson DS. 2002. *Darwin's cathedral: evolution, religion, and the nature of society.* Chicago (IL): University Of Chicago Press.
- Zahavi A, Zahavi A. 1997. *The handicap principle: a missing piece of Darwin's puzzle.* New York (NY): Oxford University Press.
- Zilbovicius M, Meresse I, Chabane N, Brunelle F, Samson Y, Boddaert N. 2006. Autism, the superior temporal sulcus and social perception. *Trends Neurosci.* 29(7):359–366.