evolution of rituals: the model generates the prediction that practices that produce the appropriate load on working memory are more likely to be maintained and spread, as they have an addictive component to them, temporarily ameliorating, but ultimately exacerbating, panhuman concerns. While this usefully explains why many rituals share core features, it does not address how rituals arise. To complement the authors' model, I therefore summarize here (with no claim to originality) some possibilities in regard to the latter, based on the premise that magical practices lie at the root of rituals, and spurious associations lie at the root of magical practices.

The relationship between actions and consequences is often difficult to discern. Consequences may be delayed, making the effects of actions unclear, or actions may be efficacious only in the presence of an undetectable mediator, such as microbes, that is sometimes absent. Ambiguity regarding the relationship between actions and consequences opens the door to learning spurious associations – people will often erroneously conclude that a given action produces a given consequence (cf. Bruner & Revusky 1961). This is particularly likely when no readily discernable avenues for influencing events exist – when the solution to a problem is not obvious, people will expand the scope of prior actions with which they compare a given outcome (cf. Gmelch 1978). Furthermore, both the acquisition of spurious associations and their stability over time will be enhanced when the goal involves avoiding substantial harm, as this simultaneously increases the benefits of searching for possibly efficacious actions and the costs of systematically putting such actions to the test.

Readers will recognize here elements of Malinowski's (1948) "theory of the gap"; paralleling aspects of B&L's model, Malinowski argued that magic arises as an attempt to assuage anxiety in situations of uncertainty and danger. Disaggregating the uncertainty of a situation and the anxiety generated by a situation, Felson and Gmelch (1979) found that both uncertainty and anxiety increase the use of magic, and that these effects are independent; that is, the anxiety attending a situation is a product of the stakes at issue, not of uncertainty. These findings are consistent with the factors postulated above – uncertainty is equivalent to ambiguity as to the most effective course of action, while anxiety reflects the goal of avoiding substantial harm. Note, however, that whereas Malinowski, like B&L, focuses on the anxiety-reducing function of the performance of magical rituals, I seek to highlight the contextual determinants of the acquisition of spurious associations – although the performance of magical rituals may indeed serve intrapsychic goals, uncertainty and danger lead to problem-solving strategies likely to generate spurious associations regardless of their affective consequences.

B&L stress that, to properly tax memory, rituals must involve multiple components, to be carried out with precision. Although spurious associations can be simple (e.g., a lucky rabbit's foot), such associations will often achieve the complexity demanded by B&L's model. All actions are potentially multiplex, as even simple motions can be broken down into many constituent movements. Because the causal contribution of any given facet of a multiplex action (a) is difficult to discern, and (b) can only be determined by process-of-elimination experimentation that is frequently avoided due to cost, actors will often attempt to reproduce an apparently efficacious action in its entirety. In turn, attempts to maintain complete fidelity in subsequent iterations lead to memory-taxing recipes of minutely specified behavior.

Spurious associations will often be produced by social learning. Imitating successful individuals can be an effective problem-solving strategy. Whenever it is difficult to identify which aspects of a successful individual's behavior led to her success, learners benefit from maximal fidelity of imitation, with the result that many irrelevant behaviors are incorporated into the action sequence (Richerson & Boyd 2004). The situation is complicated by the fact that, in the absence of explicit pedagogy (something frequently missing in small-scale societies; Fiske, n.d.), even if the target of imitation understands which actions are actually efficacious, this distinction is easily lost during the process of imitation. Hence, the version of the action practiced by the learner will often become more complex than that practiced by the target. Iterated over multiple generations, the number of spurious associations incorporated into an action sequence can grow large. As the behavior becomes more complex, it necessarily also becomes harder to learn, whereupon mastery of the behavior can become an index of the intimacy of the learner's relationship with the prestigious target (see Henrich & Gil-White 2001). Because similarity to the target then generates prestige-by-proxy, a new goal – prestige acquisition – is introduced; because this goal is independent of the original pragmatic objective, its introduction further decreases the likelihood that spurious associations will be ferreted out and discarded.

The authors note that both completeness and sequentiality are heavily emphasized in ritual behavior. Both are also often features of complex behaviors that are efficacious, hence actors may adopt a quasi-ritualistic approach as a practical strategy – many rock climbers, for example, always follow the same sequence in donning their equipment. Observation suggests that such actions often become imbued with some of the psychology of rituals, as faithful reiteration of the specified actions leads to a reduction in anxiety, whereas interruptions or modifications enhance anxiety (cf. Gmelch 1978). This likely augments the concretization of a particular form of behavior – although equally effective alternative methods may exist, their negative affective entailments preclude their utilization. Although such behavior constitutes only a nascent ritual (since the actions are goal-directed and effective), when combined with social learning, this kernel may become increasingly ritual-like.

Pragmatic features of problem-solving and social learning thus make it likely that individuals will often acquire spurious associations. This result is particularly likely among persons having low evidential criteria (Brugger & Graves 1997) (probably including most children), making some individuals more vulnerable to the acquisition of spurious associations than others. Associations that are sufficiently complex and sequential as to overload working memory constitute the raw materials out of which rituals are born; these, in turn, are refined by cultural evolution.

The rituals of explanation

DOI: 10.1017/S0140525X06009393

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Abstract: Boyer & Lienard's (B&L's) explanation of ritualized behavior is plausible because it fits so well with elementary facts about evolution of plasticity in our behavioral repertoire. Its scope, however, may be broader than its authors explicitly admit. Science itself may be illuminated as ritual behavior. Science, like other rituals, can sustain both healthy and pathological forms.

One ritual of scientific explanation is to begin with a grand theory that later is qualified (sometimes to within an inch of its life) to yield a modest proposal. As Boyer & Lienard's (B&L's) title announces, they propose to explain "Ritualized Behavior" – and this is very exciting, Newtonian, one might say, in its scope. Just as Newton's physics explained terrestrial and celestial motions in one theory, so B&L propose to explain the full spectrum of ritual, from non-pathological forms like religion to unhealthy forms like obsessive-compulsive disorder (OCD). This heady promise propels readers through the article, where we observe the

https://doi.org/10.1017/S0140525X06009393 Published online by Cambridge University Press

ritual death by a thousand cuts of the grand theory. It can only come as a disappointment to discover B&L saying, "*Ritualized actions are not 'rituals'*" and "*Cultural ritual is not individual ritual writ large*" (sect. 8.6; B&L's italics): this is no doubt true, but what, then, are we to make of their earlier explanation of religious rituals and cultural ceremonies? And when they urge us to "discard the common intuition that there is a natural kind of phenomenon called 'rituals'" (sect. 9.3), we might wonder what it is, then, that they take themselves to be explaining. B&L's answer is that theirs is merely a modest proposal to explain only the *urge* (sect. 8.2, para. 2) of individuals towards ritual, not its social organization.

This is in no way to say that this is a bad theory. In fact, I think it is a very good theory, one that illuminates ritual in an interesting way: OCD is a behavioral analogue of an auto-immune disease, a quite useful protective mechanism that has gone awry; religion is a harmless, if idle, capture of the same precautionary mechanism during its "calibration" (or recalibration). What this good science leaves out is itself – or so I will argue. Science, too, is, (at least in part) a ritual.

The plausibility of B&L's theory derives not so much from successful tests of it as from elementary facts about evolution. For example, complex multi-cellular organisms evolved from relatively simple single-celled organisms. The behavior of the simplest organisms is ritualized in the sense defined by B&L (see target article, Abstract): a single cell, for instance, has receptors on its surface which swing into action automatically, transferring materials into the cell stereotypically, rigidly, repetitively, and mechanically (without rational motivation). By contrast, the food-seeking, predator-avoiding, competitor-besting behavior of complex organisms is creative, plastic, original, and rational. The evolutionary strategy of *Homo sapiens* has been to free behavior from totalitarian genetic control so that individuals can adapt within their own lifetimes to the conditions that obtain, rather than waiting for the creeping, tectonically slow, genetic adaptation of behavior. Intelligence and learning permit a more rapid form of natural selection, namely selection for adapt*ability* of behavioral repertoire.

So, what really demands explanation is how human behavior overcame ritualization, rather than how it remains in some ways ritualized. And yet, despite the fact that that their explanatory goal goes in precisely the opposite direction, it is B&L's presuppositions about the process of overcoming ritual that makes their explanation of ritualized behavior plausible. History teaches us that it is the unexpected explanatory dividends of a theory that convince us it is true, not the specific phenomenon it was cooked up to explain in the first place. This is the case with B&L's model. It assumes that our ancestors' Precaution System was a healthy evolutionary product with two components, a Potential Hazard Repertoire (sensory mechanisms that enabled the recognition of specific hazards) and an Evolutionary Precaution Repertoire (motor mechanisms that enabled defensive behavior). Though some of the resulting mechanisms are genetically hardwired (like more primitive creatures we automatically scratch what itches and spit out what tastes foul), some also permit "calibration" (sect. 7.4) or learning. Rituals arise during this learning process, specifically when the hazard repertoire is queued by an implicit hazard (one not consciously recognized as a hazard) even when the precaution repertoire contains nothing to adequately deal with it. This B&L denote, cleverly and plausibly, as an instance of *capture*. Capture is the Achilles' heel of our Precaution System. Because "any system of this kind is vulnerable to *capture*" (sect. 8.3), we hardly need be surprised by the ubiquity of religion or by the existence of OCD. Thus, the explanatory dividends begin to roll in.

Indeed, I would argue that the scope of this explanation is even broader than B&L claim. Given that learned responses to implicit hazards are included, science itself (or at least the scientific urge) is explained. Scientific method is our ritualized response to the implicit hazard of ignorance.

In religion there is at least the possibility that ritualized behavior may silence the queuing mechanism: through a religious ritual one might, for instance, expiate one's guilt before God (implicit hazard). But implicit hazards, being not consciously present (by definition?), may persist despite the ritual. The implicit queuing of the OCD sufferer's uncleanliness detection system might persist despite hand washing – permitting temporary relief only when attending to the washing itself (goal demotion, sects. 6.2–6.4): a formula for obsession if ever there was one, and a lovely explanation of OCD. Bravo! But note well that nothing prevents such pathology in religion: adherents who cannot shake off the implicit hazard of guilt may tirelessly repeat religious rituals to get momentary relief.

Running through B&L's account is an implicit (even unconscious?) distinction between the pathological and the healthy. Is it because the explanation of religious ritual as pathology is so implicitly hazardous that B&L ritually back away, protesting that there is more to cultural ritual than ritual behavior "writ large"? They point out that religion involves social organization – but isn't that an accidental difference? How hard is it to imagine an OCD religion based on the ideal of cleanliness and prescribing obsessive rituals to fend off the relentless uncleanliness of this world?

Darwin, too, hesitated to offend religious sensibilities. No wonder B&L don't even mention a more dangerous idea: science, too, is a ritual. Note well that it is at least capable of sustaining pathology – we needn't mention the arms race or eugenics to see that this is so. Scientific ritual may also be healthy, just as the normal ritual of washing before meals is healthy, only science defends us not from uncleanliness, but from ignorance – and this is a very good thing.

Multicultural religious and spiritual rituals: Meaning and praxis

DOI: 10.1017/S0140525X0600940X

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Abstract: This commentary argues against the theory that cultural ritual behavior is meaningless or that ritual action is solely a by-product of fear-based precautionary and action-parsing systems. Humans demonstrate the ability to spontaneously change their use of proximate intentions and attribute ultimate intentions to ritual actions that are not dependent upon fear or physical and emotional/mental dysfunction.

Boyer & Lienard (B&L) theorize that ritual is not rationally based, and is an attempt to attain relief from anxiety-based cognitive intrusions. They base their theory on a premise, stemming from obsessive pathology etiology, security motivation theories, and neurocognitive adaptive functions, that ritualized actions emerged from an evolutionary fear-based system that acts to protect the human from inferred threats to fitness. They propose that ritual actions are a by-product of precaution and action-parsing systems.

The authors' stance is reminiscent of Freud's widely accepted idea (Strachey 1976) that adherence to a Western religious practice is a neurotic excursion as "wishing thinking," in that individuals feel the need: for protection from untamed nature, to reconcile with the privations of social life, and to fulfill longing for the lost father figure. Philosophically, these assumptions surface from the earlier biomedical and current psychobiomedical model in which the "interiors of the human" (e.g., perception, beliefs) are now recognized as having at least a semi-causal role in health. However, neither model allows for the possibility of Cartesian duality, which has been rejected by Western science for some time. Nonetheless, duality is central to most religious and/or spiritual rituals.

https://doi.org/10.1017/S0140525X06009393 Published online by Cambridge University Press