The apparently irrational ritual behaviors discussed by Boyer & Liénard (B&L) may be related to the double-edged sword of having windows of increased plasticity. There is considerable evidence from epidemiology, ontogeny, ethology, and neurobiology that patterns of “normal” and adaptive ritual through childhood, romantic love, family life, and religious experience overlap with obsessive-compulsive disorder (OCD) (Fergus et al. 2006). During vulnerable periods, the capacity to recruit reward systems to motivate and learn survival behaviors without reasoned justification might confer significant evolutionary advantages. However, these periods might also render humans susceptible to irrational or psychopathological behaviors transmitted through the impact of comorbid psychopathology, culture and family.

Much of human behavior may be thought of as the result of reward-seeking or harm avoidance so that one might imagine behavior is based on an overall cost function associated to each action in which rational decisions are based on the conscious weighing of “pro’s and con’s.” However, when time is limited, stress is increased, or dangers are great, perhaps survival has evolutionarily favored brains that acted without rational review—that is, that performed rituals. Ritual behavior, then, would include behaviors that do not stand up to rational review, such as behaviors in which faith, rather than verifiable facts, determine actions. Children may represent a development- 
al window when threats are greater, cognitive capacity is lower, and perhaps even reward/learning circuits are primed to accept whatever they are told, with little rational review. Further, the behavior of children is influenced by the introduction of false positives and negatives. For example, children are told, and they accept, that if they do certain things then fictional entities such as Santa Claus or religious figures will be pleased and perhaps reward them. In the case of the Santa Claus myth, actual material rewards are provided by parents in addition to other parental caring behaviors. Alternatively, children may be threatened with negatives such as imaginary monsters or religious concepts like “hell” for failure to conform to whatever is required of them. Ideas of harm befalling a parent (reminiscent of OCD) may also be introduced. The capacity to be irrational, then, may be programmed during childhood to support a wide variety of fallacious cognitions that may go on to be part of rituals and OCD. It appears that a tendency toward magical thinking may underlie links between superstition and OCD severity (Einstein & Menzies 2004). In the case of religious beliefs, the acceptance of patently un-testable hypotheses (such as the nature of life after death) can even be rewarded, under the general guise of “faith.” It is an interesting observation that early-onset OCD is more severe (Rosario-Campos et al. 2001). It might be interesting to study the converse—that is, would a delay of ritual-based teachings to mid-late adolescence result in a decrease in ritual behavior and OCD?

As we might predict, then, increased religiosity (significantly mediated by childhood instruction) is associated with increased OCD. For example, Catholics with a high or moderate degree of religiosity scored higher on measures of OCD-related obsessional thoughts, compulsive washing, intolerance for uncertainty, need to control thoughts, beliefs about the importance of thoughts, and inflated responsibility, than did less religious Catholics (Sica et al. 2002). In another study using self-report questionnaires, differences in OCD-related phenomena between highly religious Protestants, moderately religious Protestants, and atheist/agnostic participants drawn from an undergraduate sample were studied (Abramowitz et al. 2004). Highly religious versus moderately religious Protestants reported greater obsession symptoms and compulsive washing. Also, compared with atheists and agnostics, the highly religious had more obsession symptoms, including compulsive washing, intolerance for uncertainty, need to control thoughts, beliefs about the importance of thoughts, and inflated responsibility. In another study of 45 outpatients with OCD, 42% of patients had religious obsessions (Tek & Ulug 2001). Relationships between religious practices and OCD have also been reported among Hindus (Khanna & Chandrasekharan 1988), Orthodox Jews (Greenberg & Shefler 2002), and Muslims (de Bilbao & Giannakopoulos 2005), underscoring the influence of particular religious affiliations on the expression of OCD.

It is likely that many brain systems are involved in ritual, including the fronto-striatal networks mentioned by B&L. Also of particular importance would be the reward systems that normally motivate various behaviors involved in learning and affiliation (Depue & Morrone-Strupinski 2005). These might, however, be vulnerable to hijacking, such as in the acquisition of irrational, ritualistic, and pathological behaviors in OCD (Leckman & Mayes 1999), and addictions (Kufahl et al. 2005; Swain et al. 2005). Some of these systems have been shown to be activated in parents who are also undergoing a period of increased stress, learning, and preoccupation in the first few months after childbirth (Leckman et al. 1999). Several groups are also contributing to this field using different functional brain imaging experimental paradigms and populations (Swain et al., in press). These imaging studies hold the promise of identifying brain circuits associated with the formation of parent–infant attachment during the critical postpartum period. Some of these areas overlap with the ritual areas suggested by B&L and with OCD regions (Friedlander & Desrocher 2006). For example, first-time parents responding to their own infant’s cries versus those of other infants’ at 2 weeks postpartum, had activated basal ganglia, orbitofrontal cortex and caudate. These activations were also correlated with measures of OCD-like postpartum preoccupations.

Certain neurotransmitters may be critical to rituals. For example, CSF levels of the affiliative neuropeptide oxytocin are elevated in some individuals with OCD (Leckman et al. 1994). Another example is serotonin since serotoninergic drugs are commonly used to treat OCD. In addition, serotonin has been associated with spiritual experiences (Borg et al. 2003), and OCD-related moral or religious scrupulosity can be effectively treated with serotonin uptake blockers (Fallon et al. 1990). Indeed, much more research is needed on the common and distinct neural correlates of various OCD symptom dimensions with symptom provocation paradigms, combined with neuropsychological tasks and neuroimaging techniques. Certain groups that bear particular attention include “normal” subjects during critical periods such as childhood, or high stress.

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The evolved architecture of hazard management: Risk detection reasoning and the motivational computation of threat magnitudes

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Abstract: The architecture of the hazard management system underlying precautionary behavior makes functional sense, given the adaptive computational problems it evolved to solve. Many seeming inelegencies in its outputs, such as behavior with “apparent lack of rational
motivation” or disproportionality, are susceptibilities that derive from the sheer computational difficulty posed by the problem of cost-effectively deploying countermeasures to rare, harmful threats.

Boyer & Lienard’s (B&L’s) landmark work represents a decisive advance in the understanding of the evolutionary psychology of ritual behavior, viewed as a byproduct of adaptations for avoiding danger. We strongly endorse the view that there is an evolved, species-typical suite of neurocomputational adaptations designed to deal effectively with dangers and the deployment of countermeasures – what we have called hazard management or precaution systems (Feldick et al. 2000). We also agree that the themes of ancestrally recurrent danger (e.g., contagion, danger to offspring) that pervade obsessive-compulsive disorder (OCD) ideation, together with the hyperactivation of precautionary checking subroutines, indicate that OCD results from breakdowns in these evolved systems (Cosmides & Tooby 1999). In particular, we have been pursuing the hypothesis that there is an evolved domain-specific inferential specialization designed to reason about whether an appropriate precaution has been taken, conditioned on the presence of the danger it protects against. A growing body of evidence suggests that such a risk detection specialization exists (somewhat parallel to the cheater detection system) and is cognitively distinct (Feldick et al. 2000), neuropsychologically dissociable (e.g., from reasoning about social contracts; Stone et al. 2002), and involves distinct patterns of neural activation, as judged by neuroimaging findings (Ermer et al., in press).

This risk detection reasoning (and attentional) subsystem appears to use cognitive primitives at the level of hazard, (present/absent), countermeasure for i (in effect, not in effect), and it draws attention to conditions in which a danger may be present but its appropriate precaution may not have been taken. We believe that when this checking subroutine produces the inference that a specific hazard might be present in the absence of its specific countermeasure, this output potentiates the risk of the threat index. Although what might be called optimal defense theory has some powerful analogies with optimal foraging theory, it also has disanalogies which would have selected for the hazard management system to become a computationally differentiated part of the motivational architecture.

A well-engineered system should supplement observations of the incidence of rare costly events and countermeasures with other sources of information. These include (1) correlated cues to conditions of heightened threat (Neyman-Pearsonian decision theory suggests that the system ought to be biased to overinterpret the diagnosticity of candidate predators, as in post-traumatic stress disorder [PTSD]); (2) non-frequentist causal models of countermeasures (e.g., physical barriers to threats); (3) decoupled imaginative simulations (Tooby & Cosmides 1990) and quasi-counterfactual representations such as “near misses” (when dysregulated, these recalibrations constitute obsessions); (4) possible transgenerational epigenetic reweighting (see Tooby et al. 2003); (5) genetic inheritance (the heritable personality dimension psychoneuroticism may exist as an adaptation to allow local and transgenerational recalibration of threat indices through genetic or epigenetic reweighting (see Tooby et al. 2003); and (6) social sources of information.

The social dimension especially illuminates collective ritual behavior. Observations gathered by multiple conspecifics provide more accurate estimates of actual threat magnitudes – the adaptationist rationale for circuits that reset threat indices partly based on observed fear reactions in others (Cook & Míneka 1987). Moreover, the high uncertainty hovering over incidences and countermeasures effectiveness leaves the hazard system susceptible to error, volatile reweighting, individual differences, and social entrainment (including manipulation). Seeing others devote considerable effort to a collective ritual presented as a countermeasure advertises their threat indices, inducing observers to reweight. Finally, because of human improvisational intelligence (Tooby & DeVore 1987), we think there is a proper domain for some precautionary ritual behavior, where it functions as preparation for complexly managed, instrumental activity in dangerous and unpredictable environments whose negotiation necessitates high levels of skill acquisition, rapid reaction time, and organized material readiness. Aspects of military training, sea-manship, katas, mountain climbing – even medicine concoction

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and some cooking – exemplify aspects of functional precautionary ritual behavior. This minor caveat aside, B&L have powerfully illuminated underlying commonalities in ritual behavior.

R ritual: Meaningful or meaningless?
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Abstract: In conflating opposing meanings of the term “ritual,” arising from historical Western cultural conflicts regarding church and state, this target article begs fundamental questions. Its appeals to cognitive science concepts such as “working memory” are poorly informed and obfuscate what could have been a far more penetrating and less biased discussion of stereotyped human action.

In English, it is not unusual for the same word to come to possess two almost opposite meanings – for example, the word “sanction” – which require careful distinction. The term “ritual” is similar, denoting pointless actions and also those with great meaning for participants. Boyer & Lienard (B&L) (and Cosmides and Tooby, whom they acknowledge as inspirations for this study) seem to have been fixed by this etymological quirk. Otherwise, their use of the term “ritual” to refer simultaneously to both opposite meanings might be regarded as disingenuous.

Much ethnography has been devoted to teasing out authentic interpretations of the rituals that are found universally in every culture (even those of university academics). Cultural anthropologists’ definitions of the term “ritual” are indeed vague, for excellent reasons. Because the meanings of rituals are generally deeply embedded in the local network of social institutions and collective representations, which are to a large extent taken for granted by participants in a given culture, it is often difficult to find simple interpretations for specific component actions of any given ritual. For instance, Sperber (1975) found it quite impossible to understand why members of the tribe he studied applied butter to their hair. But absence of evidence is not evidence of absence, as all good scientists are aware.

B&L have adopted their compatriot Sperber’s rationalistic bias and are content, at least at the outset of their article, to fully equate cultural ritual with the pathological and apparently irrational behaviour of humans suffering from obsessive-compulsive disorder (OCD), and with the repetitive actions of small children (who perhaps delight in their freshly-acquired ability to give order to their personal space and time). But they do not appear to appreciate that their definition of “ritualized behavior” as stereotypy, rigidity, repetition and apparent lack of rational motivation” (target article, sect. 1), applies precisely as well to more approved, adult, and non-pathological cultural forms such as theatre, music, and poetry. It is not at all clear how these latter forms might relate to “inferred threats to fitness” arising from a “Hazard-Precaution System” (as the authors call it, perhaps using the term “system” to distance themselves from Pinker’s wholesale misuse of the term “module”; see, e.g., Pinker 1997). In any case, cultural ritual clearly serves many purposes, such as worship, dedication, marking a social commitment, enacting a rite of passage, which it would be ridiculous to associate with inferred threats to fitness. Ritual is often effective in these contexts because of its dramatic power, bringing together in a choreographed and synergistic process symbols that have great resonance in the cultural understanding of its protagonists (cf. Victor Turner 1989). Perhaps B&L have had no personal experience of this power, which would explain how easily they have confused the two opposite senses of the term “ritual.”

It is also important to stress that religious ritual, like other performative genres, is rarely rigidly repetitive. On the contrary, it is often tailored to suit the occasion and/or the individuals concerned, particularly in rituals that are intended to be curative. Ritual experts frequently draw from an extended repertoire of approved variants, as do Western medical practitioners (e.g., E. L. B. Turner 1992). The relatively invariant form of the proceedings can easily be seen to provide an acceptable context or frame (see Goffman 1974) for social actions, enabling the participants to interpret them appropriately.

Far from “swamping working memory,” repetitive ritual actions are typically easily memorized, and thus rapidly become overlearned, relieving any potential burden on working memory and allowing a greater focus on the affective and cognitive content of the ritual context. The reader should be aware that “swamping working memory,” a favourite phrase of Boyer, is not an accepted cognitive science concept – perhaps the authors mean “increased attentional load” (e.g., Lavie 2006). Over-learning is also a vital aspect of musical performance. Indeed, humans very often rely on over-learned behaviours, consciously or unconsciously fitting themselves into predictable and thus interpretable roles. Ritual action is thus a particularly striking example of role-play.

To argue that such adherence to custom results from a narrowly defined brain Hazard-Precaution System is question-begging and has limited explanatory power, like Molière’s virtus dormitiva. In my view, this aspect of human social behaviour is supported by a more “domain-general” brain system (or systems!) for planning, scenario development, and prediction, which uses Bayesian computational algorithms to imaginatively assess the potential benefits and costs of a range of possible actions. Cognitive scientists are familiar with this system as the “central executive” (Baddeley 1990; Norman & Shallice 1980). It is obvious that the ability to acquire, learn, and represent stereotypical patterns for action greatly increases the efficiency of such neural computations by limiting the range of possibilities, and could thus increase evolutionary fitness. B&L are tendentious in separating out actions which they happen to believe are “pointless,” as the products of a special evolutionary module which could give rise to the pathological behaviour of patients with OCD.

The appeals to brain science made in this target article are also unconvincing. The authors ascribe a major role in the production of ritualized behaviour to the anterior cingulate cortex (ACC), and ascribe the symptoms of OCD to its defective performance. However, this is one of the largest anatomically defined cortical areas, and recent studies (e.g., Chein & Schneider 2005) show that regions within it support a wide variety of functions, such as domain-general learning, emotional response, placebo effect, and internally directed attention. While indeed part of the subgenual ACC might possibly support the postulated Hazard-Precaution System (Van Laere et al. 2006), this area has also been firmly implicated in mood disorder (Mayberg et al. 2005). The functional anatomy of the ACC is an area of intensive research, and the authors have reached premature conclusions.

Ultimately, B&L reveal their disdain for what quite clearly gives most of us our major motivation, delight, and satisfaction – participation in social rituals such as weddings, funerals, christenings, sporting occasions, graduations, and other initiation ceremonies – by referring to them as a “waste of time” (sect. 9.3). Such an elitist viewpoint undermines the credibility of much of this article.

Ritualized behavior as a domain-general choice of actions
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Commentary/Boyer & Liénard: Precaution systems and action parsing

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