Table 1. *Car-locking ritual in OCD patient (A) and control individual (B)*

LOCATION/OBJECT				
Ignition key	Light switch	Steering wheel	Gear stick	Other actions
A. Ocd Patient				
Switch engine off				
Take out the key	{Switch on and off} × 3			
Insert the key				
Switch on and off		Hold it	Lock it	
			{Move it forth and back} × 4	
			Press it down	
			{Move it forth and back} × 2	
		Rotate left	Press it down	
			{Move it forth and back} × 2	Collect handbag
		Rotate right		
Switch on and off				
Take out the key		Rotate right		
		Rotate left		
	Switch on and off		Move it forth and back	
			Press it down	Get out of the car
Total acts:				
6	*4*	*5*	*13*	*2*
B. Control Individual				
Switch engine off				
Take out the key			Lock it	Get out of the car
Total acts:				
2	*0*	*0*	*1*	*1*

acts ($2 + 0 + 0 + 1 + 1$) for the control individual who performed the same task of car-locking (=script). Moreover, a comparison of acts (gestures) at the various locations (episodes) in 14 OCD rituals revealed that there were 1–3 locations at which acts were repeated significantly more than any of the control movements, resulting in the repetitive manner of OCD rituals (= many repetitions of the same few movements). Thus, as suggested in the target article, OCD rituals consist of excessive focus on simple gestures (movements). Our current data (Eilam et al. 2006) add to this a spatiotemporal component: gestures are coupled with specific locations, and gesture repetition accounts for the extended ritual duration.

A central contention of the target article relates to the high concentration involved in displaying ritualized behavior. Indeed, the vigor, precision, and high concentration of OCD patients when displaying their rituals is striking to a bystander. B&L suggest that a swamp of working memory and an urge for precise performance account for the high concentration, resulting in the ironic outcome of higher anxiety in patients with more rituals. Our study adds to this the finding that high concentration is the discriminator of compulsive rituals from other rituals in animal and human behavior (Serruya & Eilam 1996). Repetitive, stereotyped, or well-practiced performance in animals and humans has been suggested as a mechanism for minimizing the involvement of information-processing systems that are required for motor performance, enabling the direction of attention elsewhere (Fentress 1976). For example, when driving along an unfamiliar road we are required to concentrate more compared with driving along a familiar road, where we are more relaxed and may direct attention elsewhere. In animals, familiar paths enable directing attention to other aspects of the environment, such as the presence of potential predators (Serruya & Eilam 1996). Thus, unlike compulsive rituals, other rituals involve lowered attention.

Nonetheless, the link between attention and performing rituals is bidirectional and rituals may be constructed in order to concentrate and avoid goal-demotion, as, for example, the intensive religious rituals that enhance concentration during rigorous prayer, or sportsmen rituals that facilitate concentration in performance and disassociation from spectators. In all, although some of B&L's contentions, such as the "threat to fitness" may remain hypothetical in being hard to assess or quantify, the data collected during our observations on OCD patients strongly support several of B&L's measurable hypotheses.

Contextual features of problem-solving and social learning give rise to spurious associations, the raw materials for the evolution of rituals

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Abstract: If rituals persist in part because of their memory-taxing attributes, from whence do they arise? I suggest that magical practices form the core of rituals, and that many such practices derive from learned pseudo-causal associations. Spurious associations are likely to be acquired during problem-solving under conditions of ambiguity and danger, and are often a consequence of imitative social learning.

Boyer & Lienard's (B&L's) model describes the underpinnings of a Sperberian attractor (Sperber 1996, Ch. 5) in the cultural

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

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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