Whence Cultural Rituals? A Cultural Selection Model of Ritualized Behavior

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Whence Collective Rituals?
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Abstract. We propose a neuro-cognitive model of the recurrent features of Ritualized Behavior (stereotypy, rigidity in performance, sense of urgency) and the recurrent themes of collective rituals (potential danger from contamination, predation, social hazard). This can only be explained if we consider the broader domain of ritualized behaviour, present in childhood rituals, obsessive-compulsive pathology and in normal intrusive thoughts or compulsions in adults. On the basis of neuro-cognitive models of clinical and non-clinical individual ritualization, we describe the implication of a Hazard-Precaution system, specialized in the detection of and response to potential threats to fitness. Collective rituals include description of potential hazards and prescriptions for actions that closely match those engaged in security motivation. Indeed, compulsive pathologies and collective rituals are so similar in both themes (contamination, social hazard) and organization (ritualization). In our selectionist model, action-prescriptions that match the input conditions for security systems thereby become highly attention-demanding and intuitively compelling, which contributes to their transmission from place to place or generation to generation. We explore empirical consequences for the study of collective rituals.

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Whence Collective Rituals?
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1. The issue and the program

1.1. Why perform rituals at all?

Why do people, the world over, seem compelled to engage in ritual practices? Why invest time and resources in such behaviors? Our aim here is to suggest that we now have at least the rudiments of an answer. Rituals are compelling because specific aspects of human cognitive architecture make these behavioral sequences attention-grabbing, intuitively appropriate and compelling. Specifically, we consider that collective rituals activate a cognitive-emotional system focused on the detection of and reaction to *potential danger*. This "Hazard-Precaution" system, present in all normal human beings, responds to a specific set of cues in people's environments and makes certain types of precautionary action seem intuitively appropriate. The system is manifest not just in rational reactions to potential danger but also in individual ritualization, either normal or pathological. In our view, instructions and actions typically found in collective rituals mimic some of the clues that activate this precaution system. This makes them attention-grabbing and compelling, which in turns explains their good cultural transmission.

1.2. Why a "theory of ritual" is neither possible nor desirable

According to the late Roy Rappaport, anthropological accounts of ritual should have addressed the simple question, *Why do human beings engage in rituals at all?* As Rappaport also pointed out, this question has not been properly tackled in anthropological or psychological theories of ritual (Rappaport, 1999). There are specific reasons for this general failure, that we will consider presently. But there is also a general problem with the very notion of a "theory of ritual", namely that it cannot be a coherent empirical project.

The problem is with the concept itself. There is no clear criterion by which cultural anthropologists or other scholars of religion or classics determine that a particular type of behavior is or is not an instance of a ritual. True, there seem to be many "definitions" of ritual in anthropology (see for instance (Gluckman, 1975) among many others). But these so-called definitions are, in general, summaries of causal theories (e.g. "ritual expresses symbolism", "ritual is the manifestation of social status", etc.) rather than behaviorally precise criteria.

Does this matter? One might object that in many empirical projects one does not propose or indeed ever need a "definition" as a starting point. The projects of explaining reproduction in mosquitoes or echo-location in bats do not begin with a

definition of mosquitoes or bats. But that is because those are *natural kinds*. We start with the assumption that objects in a natural kind share some common, non-trivial causal properties. We then describe and explain these causal properties. We do no bother to "define" the kinds or even worry about the extension of the terms. Indeed, we only consider the proper extension of our terms when our investigations reveal that they did not neatly correspond to natural kinds, for instance when some apparently *bona fide* category turns out to include two distinct natural kinds (this happened for 'jade' and 'zebra'). In the same way, we might consider – in the spirit of Rappaport's question – that 'ritual' in humans is a natural kind of behavior, whose causal properties anthropologists should investigate.

However, it is very unlikely that ritual is a natural kind of behavior. Consider the way the term got to be used. "Ritual", like "marriage" or "religion", is not really an analytical category. The way such terms entered the descriptive lexicon of anthropology was by recruiting local terms from the traditions with which anthropologists and other scholars were familiar, Christianity and classical Antiquity, and gradually extending them to various exotic social institutions that seemed to share some features with the original referent (Stocking, 1984, 1995). In the case of "ritual", the process created what is often called a family-resemblance category, but one of a very special kind. Usually, family-resemblance terms are based on similarity to a prototype. For instance, we intuitively rate various avian genera as more or less "bird-like" as a function of their similarity to a mental prototype of a robin- or sparrow-like passerine (Rosch & et al., 1976). But the case of "ritual" is different. As anthropologists proceeded to extend the term, they applied it to a particular social institution A because it shared a feature m with their prototype, to institution B because it shared n with it, but also to institution C because of some feature shared with B, not with the prototype. This process created what Needham identified as a "polythetic" category, in which instances A and B may share features $[m, n, p]$, instances Y and Z may share $[p, q, r]$, Z and W share $[q, r, s]$ and so on. In such categories, all instances share some features with some other instances but there is no single feature, not even a degree of similarity to a single prototype, that is shared by all instances, (Needham, 1975).

In our view, this may explain why "theories of ritual" fail. Many such theories start from the assumption that we should collect many instances of what are commonly called "rituals" and try to tabulate their common features. This too often results in very vague formulations that would potentially apply to any social institution. This is not the place to review such attempts, but we must discuss two possible conclusions one may draw from this state of affairs. One is that there is simply no natural phenomenon to discuss here, that anthropology cannot have proper analytical categories but only interpret or translate local idioms. The other one is that theories of ritual failed because they were not looking at the proper object, which is what we will try to show here.

1.3. The focus on Ritualized Behavior

In this project we aim to address a more specific version of Rappaport's question. We will start from the notion of Ritualized Behavior[ii], which we construe, in a manner directly inspired by Rappaport, as *a specific way of organizing the flow of behavior*, characterized by compulsion (one must perform the particular sequence), rigidity (it must be performed the right way), redundancy (the same actions are often repeated inside the ritual) and goal-demotion (the actions are divorced from their usual goals: e.g. one washes a sword that is already clean) (Bloch, 1974; Humphrey & Laidlaw, 1993; Rappaport, 1999). Ritualized Behavior in this precise sense may not be found in all the ceremonies we usually call "rituals". Conversely, there may be many contexts outside "rituals" that include Ritualized Behavior.

Why should we abandon "rituals" and focus on Ritualized Behavior? Because the latter is characterized in terms that make the identification of particular instances empirically tractable. A behavior will be said to belong to the Ritualized domain if it includes the features listed above. There may be ambiguous cases at some point, but as we saw above this is nothing to worry about, as long as our characterization lends itself to empirical investigation. Given that some human behaviors seem to have the features listed above, we can now ask why that is the case and how that came about in human evolution.

So we are effectively asking the question, *What are the effects of ritualized behavior, such that individuals find collective rituals attention-grabbing and participation in such ceremonies compelling?*

Obviously, there are many specific reasons (including coercion, commitment, habit or belief) why a particular person should find a particular ceremony of interest and participate in it. These factors will vary so much between cultures, periods and individuals that they cannot explain the cultural recurrence of Ritualized Behavior. Some *general* features or effects of this kind of scripted, rigid, etc., behavior should explain why, all else being equal, it appears with such extraordinary frequency in human cultures.

1.4. Ritualized Behavior in a selectionist framework

We address this question in the framework of a *selectionist* account of human cultures. The main points of such a framework have been explained by others (Boyd & Richerson, 1985; Sperber, 1985; Durham, 1991), so we will only mention those general points that impinge on our argument in the following pages.

One important point is that *recurrent* features of human cultures are the winners in a constant process of generation and selection of new variants. What we observe as *cultural* representations and practices are the variants found in roughly similar forms in a particular place (Boyd & Richerson, 1985). Another important point is that the acquisition, storage and communication of those representations we call "cultural" are crucially affected by general features of human minds that

should and can be independently established. Cultural transmission does not consist in the downloading of information from cultural elders, but in the inferential construction of conceptual structures from available (and generally fragmentary) information (Sperber, 1996). Inferential processes are generally not accessible to conscious inspection, which is why experimental methods are required. Applied to the problem at hand, this suggests the following:

1. There are collective rituals in human groups because certain sets of actions are selected through cultural transmission as more "obvious", compelling or natural than other possible sets of actions. We need not assume a specific human need to perform collective rituals. All we have to assume is that, in given circumstances, these sets of actions seem more appropriate than others, certain ritual "recipes" are more attention-grabbing or memorable than others.

2. The selection that results in the "cultural" of particular ritual recipes can be explained in terms of specific features of human psychological architecture. Rituals are not performed simply because "that's the rule" and because people absorb the conceptual schemata of their cultures. Ritual performances produce specific effects in participants that result in subsequent performance. So we must document those cognitive systems most likely to be activated by ritual performances, and gather independent evidence on the effect of such activation.

2. Ritualized behavior as a missing link

2.1. The "obvious" general features of ritualization

When Rappapport enjoined anthropologists to explain ritual, he listed what he called the "obvious" (i.e. obvious to all anthropologists) aspects of ritual, those features that a decent model should explain (Rappaport, 1979). These included rigidity, repetition, scriptedness, etc., in other words the features we listed above as characteristic, not of "ritual" but of Ritualized Behavior. Here we will provide a brief description of these features before examining their likely psychological underpinnings.

2.1.1. No obvious empirical goals: "meaningless" acts

In rituals, one typically washes instruments that are already clean, one enters rooms to exit them straightaway, one talks to interlocutors that are manifestly absent, etc.. Frequent repetition bolsters this intuition that actions are disconnected from their ordinary goals. People enter a room and come out several times, they bow or kneel repeatedly, they walk round a temple seven times, which clearly signals that no effect is achieved by any specific iteration of the action. Also, many rituals include actions for which there could not possibly be any clear empirical goal, such as passing a chicken from hand to hand in a circle, going round a temple seven times, etc.. True, a given ritual generally has a specific purpose (e.g. healing a particular person) but the set of sequences that compose the ritual are not con-

nected to this goal in the same way as sub-actions connect to sub-goals in ordinary behavior (Boyer, 1994). In other words, the standard connections between means and ends seem broken in ritual. Practitioners themselves often concur that the actions are meaningless, although efficacious (Humphrey & Laidlaw, 1993). Obviously, in many religious traditions some scholarly specialists and theologians can produce justifications for each particular action but these rationalizations are absent in most non-literate societies (Barth, 1987), and remain unknown to most participants in all traditions (Boyer, 2001). Moreover, far from providing a straightforward rationale for ritual actions, the specialists' exegesis often creates mysteries that require further symbolic exegesis (Sperber, 1975).

2.1.2. Compulsion

Given certain circumstances, people just feel that they *must* perform the specific ritual, that it would be dangerous or unsafe or improper not to perform the ritual. It is important for conceptual clarity and for the model presented below to distinguish these feelings, this compulsive character of ritualized action, from the explanations people may have about the reasons for performing the ritual (Boyer, 2001).

2.1.3. Literalism and rigidity

People also feel that they should perform the ritual in the exact way it was performed before. This obviously does not mean that rituals are *actually* performed in the same way. Indeed, the impression of accurate repetition in fact accommodates all sorts of changes in ritual episodes (J. Goody, 1972, 1986a). What is important is that people *strive* to achieve a performance that matches their representation of past performances, and that they attach great emotional weight to any deviation from that remembered pattern (Boyer, 1990).

2.1.4. Repetition, reiteration, redundancy

Repeated enactments of the same action or gesture as well as reiterations of the same utterances, are typical of many collective rituals. A given sequence is executed three or five or ten times. What matters is the exact number. What matters too is that the action should seem identical in all these iterations. This makes many ritual sequences clearly distinct from everyday action, in which there is either no repetition of identical sequences (e.g. in assembling a musical instrument, one performs a series of unique actions), or each repeated sequence has a specific outcome (in weaving, the warp is changed at each step), or repetition is cumulative (the eggwhites rise only after a long period of stirring). In ritual action, repetition itself is not motivated but strongly prescribed and perceived as intrinsically efficacious.

2.1.5. Order and boundaries

In many rituals, people create an orderly environment that is quite different from the one of everyday interaction. People line up instead of walking, they dance instead of moving, they wear special clothes or make-up, they build alignments of rocks or logs, they create elaborate color and shape combinations, etc.. There is a

lot of ordering in rituals that is quite distinct from the comparatively unpredictable patterns of non-ritual environments. Related to this is the recurrent concern with delimiting a particular space (a sacred circle, a *taboo* territory) often made visually distinct from the other, unmarked space. People also often emphasize the boundary between this space and the rest, for instance by special prohibitions (only men enter the sacred circle, only women sit on the left side, etc.) or by restrictions on communication between marked and unmarked spaces.

2.1.6. Pollution and cleansing

This is a central theme in many collective rituals. For instance, the ritual space or instruments are described as "pure" (or on the contrary as the locus of concentrated "pollution") or the point of the ritual is to "purify" people or objects, to "cleanse" minds or bodies, etc.. This is not just a matter of metaphors. In many rituals blood, semen or excrement are a primary concern, the miasma or smells of decaying corpses are important, the use of water or fire as possible ways of getting rid of pollution and contaminants is also recurrent. There are also innumerable examples of allusions to purity and pollution in ritual requirements. People must wash before prayers, they immerse themselves in water to rid themselves of pollution, they must wear spotless garments, the sacrificial animal must be absolutely clean, menstruating women (supposedly polluted) are barred from rituals spaces, etc.. This concern with pollution and cleansing is so prevalent that it has been considered a foundation of religious ritual (Douglas, 1982).

2.2. External models of ritualization

Rappaport rightly pointed out that most cultural anthropological accounts of ritual simply *ignore* these "obvious" properties (Rappaport, 1979). Many ethnographic accounts focus on the specific reasons for participation in ritual in a given cultural context (e.g. a specific ritual legitimizes claims to high status, or marks territorial boundaries) rather than the general features of this kind of behavior (Gluckman, 1975). Also, anthropological theories often emphasize processes (the transmission of norms, or of shared cultural symbolism, a demonstration of social commitment, etc.) that could and do occur also outside ritualized behavior, and therefore do not explain the specific features of rigidity, scriptedness, etc. (Staal, 1990; Rappaport, 1999). This is particularly true of functionalist accounts. Theories claim that rituals provide ethnic affiliation or reinforce religious belief, but do not provide any account of why or how these functions require rigid sequences or repeated episodes or any other of the recurrent features of collective rituals. From a different perspective, rituals are often said to be "symbolic" (Basso & Selby, 1976) which has led anthropologists to see rituals as conveying culturally specific "coded meanings". Again, this interpretation begs the question of why such meanings would require *ritualized* actions, why they would require those actions to be expressed or sustained. Besides, most rituals do not actually convey coded meanings except in the vaguest sense (Sperber, 1975). Typical features of rituals such as the use of standardized formulaic speech, repetitions and redundancy, as well as the

great number of obviously pointless actions, would seem to *reduce* or even eliminate the possibility of deriving information from rituals (Bloch, 1974; Staal, 1990).

Here we only discuss potential explanations for ritualization itself. What is to be explained is why ritual performance is compelling and non-performance intuitively dangerous, why it includes scripted, repetitive, apparently purposeless actions, why it creates orderly environments and why it is so often connected with safety and precaution themes.

2.2.1. Cognitive background: ritual and ordinary action

Our starting point here is that ritual action should be studied in the context of human dispositions for organized action in general. Understanding the cognitive processes engaged in the ritualization of behavior surely requires at least some minimal understanding of the cognitive underpinnings of action representation. Although it may seem self-evident, the requirement is ignored in most anthropological and evolutionary accounts of ritual.

A notable exception is Lawson & McCauley's cognitive account of religious ritual (Lawson & McCauley, 1990) which inaugurated the field of cognitive studies of religion. Although most of the argument is about the specific features of *religious* ritual, and therefore only partly relevant to our problem, it makes much sense to take this framework as a starting point. A central assumption of the model is that ritual actions are only a subset of actions, and therefore a large number of principles that govern action-representation are inherited in the specific domain of ritual. These principles specify, for instance, that the structure of action-representation must be hierarchical (small units with specific goals are included in larger units with larger goals, but do not straddle the boundaries of two larger units) (Newtson, 1973; Zacks *et al.*, 2001) and that there are only limited possible mappings between specific ontological categories (person, object, animal) and "slots" in action-description (agent, patient, instrument) (Lawson & McCauley, 1990). Religious believers' intuitions about the format of their rituals, as well as the format of possible rituals they never witnessed, are governed by these general rules of action-representation (Barrett & Lawson, 2001). What is specific to religious ritual, then, is not a way of representing action but the insertion of supernatural agents in the agent and patient positions of otherwise ordinary rules (McCauley & Lawson, 2002).

2.2.2. Phylogenetic aspects: animal and human rituals

What is the connection between collective rituals practiced by human beings on the one hand, and animal displays and routines on the other? Some authors have chosen to emphasize the common features, which are particularly important as regards the sequencing and repetition of action (Gluckman, 1975; Staal, 1990). On the other hand, it is quite clear that human rituals include all sorts of preoccupations (e.g. with ritual cleansing, with unseen dangers) that do not seem to be present in animal displays or other rituals (Fiske & Haslam, 1997). Debating whether animal and human rituals are continuous or not may not be the most fruitful strategy, unless we understand what these parallels could explain and how.

The main point of continuity between human and other animal rituals may lie in the simplification of communication, in the ostension of intentions that is accomplished through rituals. Rituals in many animals reduce the cost of communication by transmitting honest signals of fitness or dispositions (Bradbury & Vehrencamp, 2000; Gintis *et al.*, 2001). For instance, ritualized fights save males the fitness cost of actual fights (Watanabe & Smuts, 1999). More generally, displays and rituals greatly reduce the amount of information that can be inferred from ambiguous behavior, and therefore make the transmission of simpler messages more efficient (Payne, 1998). Human rituals too set up a special form of communication with greatly impoverished propositional content (Bloch, 1974, 1998).

However, phylogenetic considerations do not by themselves provide a full evolutionary account of any behavior (Tooby & Cosmides, 1989). If we consider that ritualization in several species is a single phenomenon, it remains to explain whether rituals in humans are only an atavism or constitute a specific adaptation. What would be the possible adaptive value of this propensity for rigid scripting of joint action?

2.2.3. Adaptationist models: group cohesion and signaling

Some evolutionary anthropologists have suggested that rituals create coordination and therefore group-cohesion (Sosis, 2000). One argument for this functional role is that collective rituals typically require group-scale coordination between agents. However, while it is true that rituals require coordination, it is also true that many domains of everyday social interaction in humans require it too, but are not accompanied by Ritualized Behavior. Indeed, cognitive capacities that allow large-scale coalitional alliances is thought to be part of our human evolved cognitive equipment. It is also, to a lesser degree, a capacity that has a long history in primates (Harcourt & de Waal, 1992). This would suggest that there is no need for humans to use rituals as a way of creating social alliances – they already have the tools for that.

It is clear, however, that rituals may seem intuitively appropriate for *demonstrations* of commitment (Gintis et al., 2001; Sosis, 2003). To perform the ceremonies, people must not only agree on a particular script of what actions must be performed when, they also collaborate in the performance and they *display* this cooperation. In this way, rituals may reinforce not just cohesion but public commitment to cohesion, which in itself constitutes a powerful incentive for other agents' display of commitment (Kuran, 1998). In other words, ritual coordination is perhaps more *demonstrative* than *generative* of social cohesion.

This is related to the fact that many collective rituals are exceedingly expensive, either in resources or in direct fitness, as they put some participants to great danger. The willingness to engage in dangerous rituals is mysterious given the explicit rationale for the ceremonies. Male initiation for instance is said to turn boys into full-blown men, but its often painful ordeals transmit none of the skills or knowledge associated with manhood in the groups concerned (Bloch, 1992; Houseman, 2002). What would motivate people to engage in such rituals?

One possible answer is that these rituals constitute "commitment" devices (Schelling, 1960; Frank, 1988). Expensive or fitness-reducing rituals may constitute an elaborate form of signaling fitness, not despite their costs but because of them (Zahavi & Zahavi, 1997). Evolutionary anthropologists have noted that expensive religious rituals in particular constitute hard-to-fake signals of commitment to statements, the only guarantee for which is other people's commitment (Irons, 2001; Sosis, 2003; Bulbulia, 2004). In this way many aspects of religious behavior could be construed as commitment signals – rituals being appropriate for this as they have no obvious empirical goals (Boyer, 2001).

2.3. The missing link: the cognitive process of ritualization

We consider all these findings and hypotheses of great interest – indeed they provide the foundations of the model presented below. However, it is also clear that they still leave a crucial piece of the explanation missing. There is simply no account of the capacities involved in the acquisition, storage and communication of ritual scripts. There is no general account of how and why human minds find these sequences attention-demanding and compelling. In other words, Rappaport's question remains largely unanswered. Cognitive models focus on continuities between ordinary and ritual action, and it remains to explain the differences. Phylogenetic models provide little explanation for the possible adaptive value of the ritual disposition. Adaptationist models are still tentative, as they do not include a precise description of the cognitive machinery underpinning ritual action. So they fail so far to provide the description of proximate cognitive mechanisms required for testable evolutionary psychological models (Ketelaar & Ellis, 2000). This is precisely what we aim to provide here.

3. A necessary detour: Processes of individual ritualization

3.1. Diverse domains of ritualization

In our view, features of collective rituals can be explained only if we leave aside cultural institutions for a while and turn to Ritualized Behavior that can be observed in diverse circumstances and with different consequences. This is why we must review the occurrences of such behavior in contexts that are neither collective nor "ritual" in the usual anthropological sense – but whose psychological underpinnings may illuminate collective ritualization.

3.1.1. Children's rituals

Most children engage in ritualistic behaviors at a particular stage of development, starting at 2, peaking at 5 and subsiding around 7). These behaviors are usually considered part of normal development, distinct from the severe symptoms of OCD (see below) (Leonard *et al.*, 1990). Some aspects of ritualization are very fa-

miliar, such as the development of elaborate rituals around meals and bedtime. The ages of onset and themes are similar among American and other cultural groups, comforting the hypothesis that the ritualistic phase is a normative developmental one following strict universal epigenetic rules (Zohar & Felz, 2001). Even more impressive is the similarity in the themes of ritualistic behavior: perfectionism, attachment to favorite object (imbued with a special value), concerns about dirt and cleanliness, preoccupation with just-right ordering of objects, preferred household routines. These action sequences *must* be performed – there is a compulsion to engage in the activity (Evans et al., 1999). The ritual must also be performed in a precise way – deviations are intuitively felt to be dangerous.

3.1.2. Obsessive-compulsive disorder

Most children's ritual behaviors gradually subside with development. In some children, however, and in a number of adults, intrusive thoughts and compulsions can evolve into full-blown obsessive-compulsive disorder. The main feature of the pathology are familiar: a strong compulsion to engage in stereotyped and repetitive activities with no rational justification (American Psychiatric Assn, 1995). Some patients engage in bouts of washing, cleaning tools or utensils (Hodgson & Rachman, 1972). Others verify that they locked their door, rolled up the car window or turned off the gas knobs (Hodgson & Rachman, 1977). Still others are engaged in constant counting activities or need to group objects in sets of particular numbers (Radomsky *et al.*, 2001).

In most cases the compulsion is accompanied by obsessive thoughts and the rituals are the intuitive response to these thoughts. Typical obsessions include contamination and contagion (fear to catch other people's germs, to ingest contaminated substances, to pass on diseases to one's children or others), possible harm to others or to oneself (e.g. handling kitchen utensils and wounding people), as well as social ostracism following shameful or aggressive acts (thoughts about assaulting others, shouting obscenities, exhibitionism, etc.). These obsessions are almost invariably about *potential* danger.

3.1.3. Life-stage-relevant intrusive thoughts

Thoughts about such dangers and about possible precautions are not confined to the clinical population. On the contrary, systematic studies of the themes of OCD have shown that most normal people experience the same kind of intrusive thoughts as patients and to some degree generate the same ritualized action-plans to avoid such dangers (Rachman & de Silva, 1978).

Intrusive thoughts often become more focused and more bothersome at particular phases in the life-time, notably the final stages of pregnancy, motherhood and fatherhood. A review of these phenomena suggests that senseless, intrusive, unacceptable ideas, thoughts, urges and images about infants are common among healthy parents of newborns. The content of these intrusions resembles that found in clinical obsessions (Abramowitz *et al.*, 2003). A common underlying theme is uncertainty and doubt concerning whether one may be responsible for harm to the

infant (Abramowitz et al., 2003). In the same way as in OCD, some ritualized behaviors develop, repetitive checking in partic ular (Leckman *et al.*, 1999).

3.2. A neuro-cognitive model of individual Ritual-ized Behavior

On the basis of anthropological and neuro-psychological evidence, we proposed a synthetic model of individual ritualized behavior (Boyer & Lienard, forthcoming 2006) that we will summarize here.

3.2.1. The Hazard-Precaution Repertoire: potential danger.

Human cognitive structures include a specific safety-motivation system, the "Hazard-Precaution System" (Szechtman & Woody, 2004) for dealing with *potential* danger, supported by neural structures distinct from fear-systems responding to *actual* danger (LeDoux, 2003). This system is specifically focused on recurrent hazards such as predation, intrusion by strangers, contamination, contagion, social offence and harm to offspring. The system does not seem to respond in the same way to more recent potential dangers such as tobacco or cars (Mathews *et al.*, 2004). The system also includes so me rudimentary descriptions of possible pre-cautions, including avoidance (of other people), contact avoidance and disgust (against contamination), attention to traces and indirect signals (against intrusion and predation), hyper-vigilance and heightened anxiety.

This is especially clear in OCD obsessions. The initial trigger to the individual ritualization process is a set of thoughts about potential dangers within a *narrow range* of possible concerns that we called the Potential Hazard Repertoire. Also, some features of ritual compulsions make sense as precautions against these par-ticular hazards:

- Thoughts about contamination and contagion trigger compulsions centre on washing and cleansing, as well as precautionary measures, such as protecting oneself from intrusive material by moving to a different place, avoiding con-tact, avoiding breathing, etc..
- Thoughts about possible harm to one's own offspring trigger fears of handling tools and utensils in a dangerous way, smothering or dropping the infant, as well as forgetting about the baby and losing it (particularly in stores and other public places) with predictable precautionary measures: constant monitoring or repeated checking.
- Thoughts about possible acts that would offend or upset other people, resulting in social exclusion trigger a hyperactive monitoring of one's own actions, in particular the minutiae of one's own behavior, well beyond the "normal" limits. Another common feature is that people choose to avoid social contact lest they insult or assault others, which again is intuitively appropriate as a precautio n-ary device.

3.2.2. Complex ritual rules and working memory

Many individual rituals turn usually automatic behavior (speaking, washing, getting dressed etc.) into highly controlled behavior that requires sustained atten-

tion. An example is having to tie one's shoe-laces *three* times with the right hand and *four* times with the left hand. In patients' compulsive rituals, this results in "swamping" of working memory, so that the person cannot attend to stimuli and situations outside the ritualized action (Ursu *et al.*, 2003; Zalla *et al.*, 2004).

Many patients state that performing the ritual is one way of inhibiting or re-pressing unwanted thoughts (Salkovskis, 1985). In our view the "swamping" of working memory may constitute a spontaneous and moderately efficient form of *thought-suppression*, with some similarities to the suppression processes studied experimentally by Wegner and colleagues (Wegner & Erskine, 2003; Wegner & Schneider, 2003). So patients with complicated compulsions spontaneously design a kind of activity so demanding in cognitive control that intrusive thoughts can be, at least for a while, pushed away from consciousness.

3.2.3. Ironic outcomes

Studying normal subjects instructed *not* to think about a particular item, Wegner showed that thought suppression typically results in a "rebound", in higher salience of the unwanted thoughts (Wegner & Schneider, 2003). This in Wegner's model is caused by the combination of two distinct processes engaged in thought suppression. While an explicit process directs and monitors the suppression, im-plicit processes are engaged that detect material associated with the target item (Wegner & Erskine, 2003).

Clinical models of OCD also concur in the conclusion that rituals often seem ex-acerbate the obsession they temporarily appease (Rachman & de Silva, 1978). The patients who perform more rituals are typically more anxious, and also more both-ered by their intrusive thoughts. The thoughts also seem to become more frequent with higher ritualization. In other words, the long term effects of ritual perform-ance are the opposite of its short-term results.

4. A model of collective rituals

4.1. The Fiske hypothesis

Despite many common features, individual rituals are generally not considered in the same explanatory framework as collective ones by cultural anthropologists. A notable exception is Alan Fiske (Dulaney & Fiske, 1994; Fiske & Haslam, 1997), who re-opened an issue famously framed by Freud a long time ago (Freud, 1928). Many features of collective rituals make the comparison tempting: [1] Collective rituals are often centered on themes related to potential danger. [2] A constant theme in collective rituals is that non-performance is highly dangerous, although in many cases no coherent account is available. [3] The actions are highly scripted and there is a definite intuitions that deviations from the script are dangerous. [4] The actions are highly repetitive and redundant. [5] The specific actions performed are divorced from their usual goals. So it would seem perverse (*pace* anthropologi-cal tradition) to try to explain collective ritual without considering this and the

other domains of ritualization as (clearly different) manifestations of a common set of cognitive processes.

Comparing hundreds of ritual sequences with clinical descriptions of OCD cases, Fiske and colleagues showed that the same themes recur over and over again in both domains (Dulaney & Fiske, 1994; Fiske & Haslam, 1997). OCD-typical features that also enter into rituals include specific (lucky or unlucky) numbers, use of special colors, repetition of actions, measures to prevent harm, ordering and symmetry, stylized verbal expressions, washing, concern with contagion, etc. (Fiske & Haslam, 1997). Those thoughts and practices are generally ego-dystonic in personal rituals. That is, people perceive them as unwanted, unpleasant, shameful or irrational. But the very same thoughts and practices are construed as ego-syntonic, indeed socially approved, in the case of rituals. Obviously, anxiety can be among the powerful emotions induced by some collective rituals. But they are channeled through socially approved themes and expression, which again distinguishes the ceremonies from private compulsion.

To Fiske, the similarities and differences between individual and socially acquired rituals suggest a general human capacity to perform rituals, usually channeled towards socially approved contexts, that becomes hyperactive in personal pathologies (Fiske & Haslam, 1997). Contrary to the Freudian hypothesis, personal compulsions are a side-effect of capacities for cultural creation rather than their origin. In this view, humans developed a capacity to engage in coordinated social action and also developed a sub-set of this as a capacity for collective rituals. The capacity helps channel personal fears or doubt into culturally transmitted conceptual schemes, thereby making them shared and probably less anxiogenic. This is because rituals, at least during performance, seem to make environments simpler, more predictable and more meaningful than outside performance (Fiske & Haslam, 1997).

In our view, the Fiske model provides some important elements of a general account of collective rituals – not least of which the crucial comparison with the cognitive processes engaged in individual rituals. However, we also think the hypothesis may be less than parsimonious in terms of explaining ritualization in general. Specifically, it seems difficult to postulate a general "capacity for collective ritual". As far as cognitive processes are concerned, we do not have much evidence that rituals are produced by a specific functional system. That is, all the processes engaged in collective ritual can be explained in terms of capacities documented in other, non-ritual contexts. Collective rituals make use of scripted actions but so do recipes and other routinised behaviors (Abelson, 1981; Zacks et al., 2001). They focus on security-related issues but so do many intrusive thoughts outside rituals (Rachman & de Silva, 1978). Collective rituals engage low-level parsing of action but that is true of other circumstances (Lassiter *et al.*, 2002). What is specific to ritual is the combination of all these elements – but a combined use of different systems does not require a separate system.

4.2. A selectionist model: mimicry of hazard and precaution

Our model is based on selectionist assumptions about cultural transmission. Specifically, we want to suggest that many collective rituals are culturally successful to the extent that they activate the information-processing and motivation systems described above, which is why they become attention-grabbing and compelling to participants.

4.2.1. Information and inference

To understand the cognitive effects of collective rituals, we must describe the kinds of information available to various people who participate in them. At first sight, it would seem that most people who participate in most rituals do not have much information at all. As we said above, they certainly do not seem to have an explicit, coherent justification for most aspects of the ritual, for the actions included or their sequencing. People do not generally hold a "theory" of their own rituals – this is what makes ethnography indispensable and difficult.

However, this is not to say that people participate in a ritual on the basis of mere imitation, peering at their cultural elders and simply performing similar gestures. This would be implausible, given that very little human cultural transmission actually involves such mindless imitation (Sperber, 2000). In this particular case, it is quite clear that information is conveyed by cultural elders to cultural novices. Only we have to remember that conveying information about one's behavior does not necessarily imply *explaining* the behavior, or explicitly commenting on it, or even having the deliberate intention of conveying it. All that is required is that some behavior activates some mental templates in the mind of observers, and triggers non-random inferences about what is accomplished by the behavior. This, we contend, may be sufficient to explain the cultural success of Ritualized Behavior.

We propose that the individual reaction to a particular collective ritual can be functionally described as consisting in the following elements, presented here in a highly summarized form before further explanation:

1. People receive specific information about the ritual:
    a. They are told that a ritual should be performed and led to infer that non-performance is a dangerous option. For instance, one is told that because of a particular event (someone's illness, a death or a birth, the change of seasons, a war with another group, possible damnation), it is necessary to go through a particular ritual sequence.
    b. People also receive information and produce inferences about the kind of danger against which the ritual is supposed to protect the group, e.g. "pollution" by invisible substances, attacks by invisible predators like witches or spirits, threat of disease, possible famine, etc.. These themes substantially overlap with the Potential Hazard Repertoire.

2. This triggers a (dampened) activation of Hazard-Precaution system (see details below).
3. People are instructed to participate in the ritual in particular ways. That is, people are generally not allowed to just add to their ritual whatever action they think fit. They are enjoined, more or less explicitly, to follow a particular script. Information about the script has the following properties:
   a. Action descriptions include themes that mimic some of the typical outputs of the Hazard-Precaution system: actions such as cleansing, washing, checking.
   b. Descriptions of prior conditions, particular taboos, substances to avoid, etc. reinforce activation of security motivation system.
   c. There is great emphasis on the details of each action, inducing low-level parsing of the action flow during performance, especially because of negative prescriptions (see below).
   d. Description induces goal-demotion, by insisting on repetition, redundancy, apparently pointless acts, etc.
4. Performance enacted in these conditions temporarily swamps working memory because of the attentional demands of the tasks.
5. Performance ironically strengthens the salience of particular themes associated with gestures or situations to avoid during ritual.

In the next pages we present some evidence for these various claims and for the psychological and cultural effects of the processes.

4.3. Cognitive capture of the Hazard-Precaution system

We assume that the Hazard-Precaution system only responds to information that is couched in a specific *input format*. This in fact is a general point that applies to many other functionally specific neural systems. Linguistic parsing systems require words of a known language as an input, stereoscopic vision systems require slightly different retinal projections. To say that the Hazard-Precaution system requires a particular input format is simply a more specific way of saying that efficient information processing requires at least some filtering out of information, so that the system does not "fire" in each and every situation the organism faces, as this would be grossly maladaptive. The security motivation system is activated by information about *potential* danger (in a narrow Potential Hazard Repertoire) for which *indirect clues* can be found in the environment.

Another general assumption we import in the model is that any functional system with a specific input format is vulnerable to *cognitive capture*, that is, activation by signals that are not part of its intrinsic functional repertoire. This point is particularly salient in evolutionary adaptations. There is a difference between the *proper* (evolutionary) and the (usually broader) *actual* domains of a system (Sperber, 1994). Mimicry and camouflage use this non-congruence between the functional domain and the actual domain of inputs that activate a system. Non-

poisonous butterflies evolve the same bright colors as poisonous ones to avoid pre-dation by birds. The proper (evolved) domain of the birds' bright-colored bug avoidance system is the set of poisonous insects, the actual domain is that of all insects that look like them (Sperber, 1994). The frog's visual system includes an evolved motion-detection system that reacts to passing insects (proper domain) but also to any small object zooming across the visual field (actual domain).

Our contention is that many items of information acquired in ritual contexts activate the Hazard-Precaution system by including typical clues for relevant potential dangers. This would be conveyed by messages about [a] the occasion for the ritual, [b] the danger of non-performance and [c] the details of performance.

Rituals may be periodic (e.g. seasonal rites such as harvesting or planting ceremonies), propitiatory (e.g. sacrificing to ancestors to receive their protection), therapeutic (a specific case of illness or misfortune), apotropaic (a preventative measure to ward off evil or bad luck) or function as rites of passage (birth, initiation, wedding, funerals) (Lehmann & Myers, 1993). There is of course considerable overlap in these categories. For the present purposes, it may be of more help to notice that the occasions for ritual often allude to clues of possible danger that overlap with the Ancestral Potential Hazard Repertoire. This is quite clear in most apotropaic rituals, the explicit point of which is to prevent disasters to fitness such as famine or illness. But the same can be said of most therapeutic rituals, in the sense that the ultimate cause of illness is generally described in terms of non-observable processes (from germs or miasma to witchcraft). Rites of passage too include such themes as removing pollution from newborn infants (as in baptism) or protecting people from the danger of indirect contact with corpses (Bloch & Parry, 1982; Metcalf & Huntington, 1991).

The danger of non-performance is a very general feature of collective rituals. In cases where the goal of the ritual is very clearly specified (healing rituals for instance), the danger is also clearly specified. But that is not always the case for rituals. That is, most people develop the intuition that it would be really wrong and certainly dangerous not to perform a ritual without specific thoughts about what the risk is.

Details of prescribed performance are of course the major source of security-related motifs. As we said in Introduction, most rituals include such operations as washing and cleaning, checking and re-checking that a particular state of affairs really obtains, as well as creating a symmetrical or otherwise orderly environment. As we said above, Fiske and colleagues have documented these features extensively (Dulaney & Fiske, 1994; Fiske & Haslam, 1997), so we will not comment any further.

Our contention is that all these items of communicated information result in a *weak* activation of the security-motivation system. What we mean by that is that the activation is probably (in most participants, in most rituals, most of the time) less intense and direct than in situations where people actually encounter clues for potential danger. The activation is bound to be weak because it is mostly indirect – from other people – and mostly through verbal communication. For instance, peo-

ple are told that witches may be lurking near the village but this is not the same as having the direct experience of seeing evidence of a predator's recent intrusion.

4.4. Action-representation in collective ritual

4.4.1. Forcing goal-demotion

Given the action-parsing processes engaged when *any* behavior is witnessed or produced, there are not many tricks that could force people to focus on the low-level, fine-grained description of action. Among these features are repetition, which creates chunks but without the goal-ascription that is usually associated with natural breakpoints in action flow. Another such device, obviously, is to borrow a sequence from ordinary scripts and perform it in a context that makes goal-ascription impossible, e.g. wash objects without using water, pretend to trace an imaginary line, etc.. What results from these "tricks" is what we called "goal-demotion" above. Actions are represented without attaching a goal to each behavioral unit as would be the case in non-ritual contexts.

This may be why the phenomenology of collective ritual is sometimes described as analogous to a behavioral "tunnel" where the only action considered is the one that will follow the present one, but one does not and cannot focus on the motives of each action and especially not on possible alternatives (Bloch, 1974). This is our view is a result of goal-demotion. People feel they perform them because they *ought* to follow the precise rule, not because there is a rationale for the different acts to perform. Contrary to ordinary action, rituals include sub-actions that have no corresponding sub-goals (Boyer, 1994).

4.4.2. Swamping of working memory

Many ritual prescriptions resemble the tasks designed by cognitive psychologists in the study of working memory. They require focused attention on a set of different stimuli and their arrangement. For instance, a requirement to turn round a ritual pole three times clockwise without ever looking down imposes executive control of two tasks at the same time. Generally, the frequent combination of a positive prescription ("do *x...*") and a negative one ("...while avoiding to do *y*") would seem to engage working memory and executive control in a way that is not usually present in everyday action flow.

The combinations of positive and negative prescriptions generally make it difficult to perform actions by engaging automatic routines. For instance, in everyday contexts one can tie one's shoelaces in a fairly automatic way; if however one adds the requirement that the laces should at no point touch the front of the shoe or that the fingers should never touch the sole, this imposes a high degree of attention and disengagement of routinised action-patterns.

This feature too is in broad agreement with the phenomenology of ritual action as described in cultural anthropology (Bloch, 1974). Although many rituals can become routinised, especially for ritual specialists who perform them repeatedly, the focus on details of action precludes automatized performance. In a ritual, contrary

to most other domains of behavior, repeating an action five times does not result in disengagement of attention.

5. Collective rituals in cultural transmission

5.1. Transmission: relevance and selection

So far we discussed the psychological underpinnings of collective ritual in terms of individual responses to socially transmitted rituals. If accepted as (provisionally and roughly) valid, the model would seem to raise the question, why are rituals so organized? Where and what is the engineering process that made them so effective in terms of creating conceptual associations and motivation?

A selectionist model implies that cultural distribution is simply the aggregate of many individual processes of acquisition and storage of information (Boyd & Richerson, 1985; Durham, 1991). Cultural information, however "traditional", is not and has never been stable. It is subject to incessant addition, deletion and distortion that occur in individual minds. Those particular sets of representations that we find recurrent between different people, between generations and across different groups are simply those which, better than others, resists change and distortion through innumerable processes of acquisition, storage, inference and communication (Sperber, 1985; Boyer, 1998). This may be because they constitute local "attractors", that is, optimal activation of particular mental resources (Sperber, 1996).

There is in cultural performances a large degree of creative improvisation, personal innovation followed by selective "pruning" of unnecessary features or intuitively inappropriate ones. This is very familiar to anthropologists in the case of collective rituals. These are described as rigidly performed, but the vagaries of human memory mean that variants are constantly introduced (J. Goody, 1972; J. R. Goody, 1986b). Some of them are then considered valid (and retrospectively declared authentic) while others are promptly discarded. Similar processes inform the diffusion of collective rituals between groups (Barth, 1987).

So collective rituals are generally not "engineered" in the sense of a deliberate process. In our model, scripts for collective ceremonies enjoy a transmission advantage, to the extent that they include Ritualized Behavior as described here, that is, include enough Hazard-Precaution cues to activate the relevant systems by cognitive capture. This obviously does not imply that anyone is deliberately including such themes in collective rituals — but only that variants of the collective rituals that do include them should, all else being equal, be more attention-grabbing and compelling that variants that do not, and therefore potentially better transmitted.

This implies that cultural transmission of recipes for collective rituals in a population is a function of specific cognitive effects in individuals. Here as in any model based on such individual effects, the question, whether people actually participate in the ceremony, becomes crucial (McCauley & Lawson, 2002). In this particular case, one might object that the cognitive processes we described here may not be general or even widespread in the population. In some collective rituals, many par-

ticipants do not seem to participate very much, as it were, and in fact do not ac-complish much in the way of actions described here as Ritualized Behavior. Some may be attentive to the ritual prescriptions (e.g. making sure they pass the sacrificial objects clockwise, only using their left hand) while others just play the thing by ear, as it were, until corrected by others.

These differences are real and important – but they should not be taken as an objection against the relevance-based transmission advantage described above. In cultural transmission as in other modified-descent models, very small effects aggregated over many cycles of transmission are sufficient to create massive trends. That is, even in the (probably rare) limiting-case where few people produce infe r-ences about Hazard-Precaution, the fact that they do and that no other equally sa-lient template for understanding the collective ritual is available, should result in a slightly be tter transmission of Hazard-Precaution themes over other ones.

There is another way in which differences between participants are important to transmission. In many collective rituals, different roles are assigned to different categories of participants, men vs. women, old vs. young, agnatic vs. maternal kin, etc.. Indeed, in many cases participants from these different categories may have substantially different views of what is going on in the ritual. These differences in perspective may be essential to the attention-grabbing potential as well as the dy-namics and transmission of some collective rituals, of rites of passage in particular (Houseman & Severi, 1998; Houseman, 2002). This is however orthogonal to the question addressed here, of the connections between Ritualized Behavior and Haz-ard-Precaution system.

5.2. Some empirical predictions

The core ritualization model presented here, with the specific adjustments for the case of collective ritual, are proposed as a way of generating significant empiri-cal hypotheses in the study of ritual. It is extremely difficult to generalize over col-lective rituals because of the absence of systematic data-collection and comparison in cultural anthropology. So we offer these as suggestions for further research rather than conjectures that could be easily verified by consulting extant sources.

5.2.1. Ritualization is not routinization

In this model, ritualized action is described as quite different from routinised behavior, indeed as its opposite. In most ceremonies reported by cultural anthro-pologists, historians or classicists, we find an alternation between "ritualized ac-tion" (high control, attentional focus, explicit emphasis on proper performance) and "routinised action" (possible automaticity, low attentional demands, lesser emphasis on proper performance).

5.2.2. Ritual context and parsing

The model requires that people who perform goal-demoted actions parse them at the low-level of minimal action-units rather than goal-associated macro-units. In our view, this is a direct result of activation of safety-related programs. This could be established experimentally. It is possible to use experimental manipula-

tions to force participants to pay more attention to this lower level of action de-scription (Lassiter et al., 2002). This shows that ongoing high-level goals have an effect on the recall of either low- or high-level action descriptions. So it should be possible to see to what extent a focus on particular themes (such as the evolutionary hazards mentioned here) focuses attention on low-level action parsing.

5.2.3. Ceremonies match working memory constraints

The model suggests a trial-and-error processes whereby ritual sequences are gradually "improved", especially in those contexts in which ritual performance is used as an anxiety-reducing gimmick. What makes some ritual sequences intuitive appropriate may be the way they overload working memory and make it difficult to maintain other goals in mind while performing them. It may be that not all action sequences are equally good for that purpose. This is why it might be of interest to compare what we know of collective rituals with the vast experimental literature on the components and functions of working memory (see surveys in (Baddeley, 2002; Cowan *et al.*, 2002). In particular, current models of working memory suggest independent phonological and a visuo-spatial components (Baddeley, 2000). An anthropological study should investigate the extent to which collective ritual, contrary to most everyday action, makes use of these two components at once to make concurrent goals more effortful.

5.2.4. Ironic effects and displacement: magic and ritual

If ritual performance has "ironic" effects, we should expect the intrusive thoughts the ritual was supposed to alleviate to become more salient. However, we should expect this only to the extent that the ritual material is directly associated with the obsession. That is, when people obsessed with contamination wash constantly, they probably make contamination cues even more salient than they were to begin with. Now this would also predict that a ritual that does *not* mention the intrusive thoughts, would indeed make the latter less salient.

This would be the case, for instance, if people worried by contamination engage in a ritual in which they must be careful to avoid a particular act (e.g. shout obscene words) which in itself is not conceptually associated with contamination. In such a case, one would expect the ironic processes to make thoughts about the avoided action (obscene words) to become more salient – and therefore thoughts about contamination to be relatively less salient. So one should be able to compare two processes, which we could call *ironic rebound* and *ironic displacement* respectively (taking inspiration from (Wegner & Erskine, 2003)).

Now most personal rituals seem to illustrate the former process. Clinicians and patients concur that frequent ritual performance makes the intrusive thoughts more salient. This may also be the case in many cases of individually invented or socially acquired simple magical recipes, in which the content of the action often resembles that of the intended result, as anthropologists have long noted (Frazer, 1890; Malinowski, 1954). By contrast, many collective rituals, although they may include many such "magical" recipes, often strike the observer by the absence of a

clear conceptual connection between the explicit occasion (e.g. a case of illness) and the ritual recipes (e.g. bury a white chicken in the mud).

The effects of thought suppression can be studied in both explicit (self-reports) and implicit (priming, word-completion) protocols. Both should be applied to participants in rituals, to investigate the cognitive effects of direct ironic salience (a thought becomes more salient because of negative prescriptions) and ironic displacement (the process make some of the original point of the ritual less salient).

5.2.5. Cognitive effects of quasi-negative positive prescriptions

The possible ironic effects of negative prescriptions in rituals should be another domain where it is possible to document the processes engaged during and after performance. Many collective rituals include very specific negative prescriptions (e.g. do not walk beyond this line) but also positive ones (e.g. walk in this direction making sure you tread on this particular line). In our model the latter should in many cases have the same cognitive effects as the negative ones, in terms of working memory usage, goal-demotion and ironic outcomes, because they force the participant to *control* actions that are normally accomplished through automatic behavioral routines. People for instance walk without being aware or indeed controlling the specific position of each foot at each step; all they are usually aware of is their speed and bearing. One possible implication of this model is that ritual prescriptions would generally and with greater effect bear, not on those actions that are usually controlled (e.g. threading a needle) but on those acts or gestures that are usually automatic in performance (e.g. walking, breathing).

6. Collective rituals in human evolution

6.1. Adaptation or recruitment of other adaptations?

Is there a general human *capacity* for collective rituals, as a product of evolution by natural selection? Some features of ritual seem to cry out for such an interpretation. Some form of ritual is found in all human groups. Also, we can infer distinct features of ritualization from the archaeological record, especially in burial procedures, for the earliest modern human groups and for Neanderthals (Trinkaus *et al.*, 1993; Mithen, 1996). Moreover, human ritual is sufficiently different from its phylogenetic cousins in animal behavior to suggest a specific human adaptation. Seeing collective ritual in the light of evolution makes even more sense once we consider its connection to security motivation, the restricted range of concerns that intrusive and anxious thoughts focus on, as well as the restricted range of compulsive responses.

However, we consider the hypothesis of a specific capacity for rituals fraught with difficulties. To be evolved through natural selection, Fiske's proposed capacity for rituals should be beneficial to individual reproductive potential. Or, more specifically, one would need to consider that a higher or more focused involvement in ritual performance would result, on average, in better reproductive potential (or

better survival that would lead to better reproductive potential). One possible explanation would be that ritual is a good "trick" that associates individual, unmanageable anxieties with coordinated action with others and thereby makes them more tolerable or meaningful. But, again, it seems to us that we have very little direct evidence for the reproductive benefit of such a tool. Even though *excessive* anxiety may be maladaptive, anxiety in general is not. Indeed, evolutionary anthropologists have noted that most anxiety states seem functional rather than dysfunctional in terms of individual fitness (Nesse, 1998, 1999).

6.2. Atavistic procedures or evolved precautions?

As briefly mentioned above, Rapoport's model of basal ganglia dysfunction in OCD describes compulsions as the enactment of atavistic action-patterns, stored as whole sequences of acts and generally inhibited in normal behavior (Rapoport, 1990; Rapoport & Fiske, 1998). Although this is only tangential to the basal-ganglia model, this deserves discussion as it might (perhaps wrongly) suggest that the compulsive sequences themselves are inherited.

In our model the rituals themselves are *not* the direct expression of an atavistic behavioral repertoire. Washing incessantly, or spending all one's time checking the environment for intruders, probably are not evolved behaviors. Rather, the rituals combine, repeat, accumulate single behaviors (avoiding contact with certain items, checking the environment for possible traces of intrusion, washing, etc.) that were appropriate given evolutionary hazards.

The ritualization process consists in this special accumulation and distortion of originally appropriate actions. This is manifest even in animal models of the condition. For instance, Szechtman and colleagues observed a high rate of repetitive and pointless "ritualistic" behavior in rats treated with quinpirole (a dopamine agonist, potentially acting on some of the neurotransmitter circuits specially modified in OCD pathology), in comparison to saline-treated controls (Szechtman *et al.*, 1998). The animals checked and re-checked particular locations, returned to the same objects. Importantly, the effect of test treatment was the higher recurrence, repetition and redundancy of actions that were all performed (but with greater flexibility and no redundancy) by controls. In other words, rats that are induced to "ritualize" combine in a new way action components that are typical of the species-specific rat precautionary repertoire.

The same is in our view true for humans, which could account for the fact that OCD manifestations seem strikingly similar in different cultures, but also display culture-specific features. There are to date very few (reliable) comparative studies of the condition in different cultures, and most of them only bear on clinical populations (so we have no evidence of what thoughts are common or exceptional in the population at large). But their results are suggestive. For instance, two studies in Bali report culture-specific tweaking of the general OCD themes. Some patients need to identify all passers-by in terms of genealogy and status, others report obsessions about spirits and witches (Lemelson, 2003). Both are culturally specific variants of the social harm and social exposure obsessions, as hierarchy and status

are fundamental to social interaction in Balinese society and social strife is expressed through witchcraft accusations (Barth, 1993). Muslim patients seem to report concerns about pollution and contamination strongly influenced by religious prescriptions on hygiene and purity of thought (Al-Issa, 2000). Also, a sample of Bahrain patients showed that the fear of blasphemy was prevalent (about 40% of cases) (Shooka *et al.*, 1998) which may be a local expression of the fear of social harm and potential exclusion.

6.3. Capacity or disposition?

We proposed that collective ritual is not necessarily the outcome of an adaptive capacity but may well be the predictable by-product of adaptive capacities. In our model a collective ritual typically activates the Hazard-Precaution system. These may well be outcomes of evolution by natural selection, as specialized information-processing systems geared to detection and prevention of potential hazards (see (Boyer & Lienard, forthcoming 2006) for a more detailed discussion). Given these systems and their input format, a pattern of interaction that activates them may well become attention-demanding and intuitively compelling. This would make ritual a by-product of evolved cognitive architecture.

We are confident that this is a valid description of many of the behavioral sequences ordinarily described as "rituals" in the anthropological literature. However, we should emphasize that the model is a set of empirical hypotheses. Each of the features listed here can be assessed empirically as one observes a particular cultural performance. A particular ritual may or may not comprise evocation of evolutionary danger-cues, construction of appropriate action-sequences, association of goal-demotion and precaution-cues. Whether this is the case or not is a matter of empirical observation.

In this view, rituals can be considered highly successful cultural "gadgets" whose recurrence in cultural evolution is a function of [a] how easily they are comprehended by witnesses, [b] how deeply they trigger activation of motivation systems and cognitive processes that are present in humans for other evolutionary reasons. To say that a cultural creation is a "gadget" does not entail that it is unimportant. Many of the most important human cultural creations, such as literature, complex technology, music or the visual arts can be considered as by-products too. For us, Ritualized Behavior is another of these by-products of a species-specific human cognitive architecture, an indirect consequence of its evolution by natural selection.

7. References

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[ii] Throughout this article we use the capitalized form to remind readers that we are talking about a precisely defined category, not to any behavior that some people may judge "ritual-like" on the basis of some vague crtiterion.