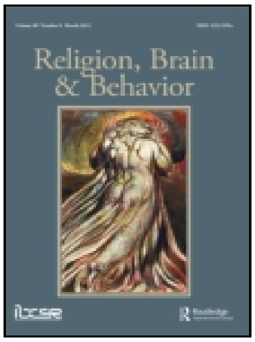

Religion, Brain & Behavior

ISSN: 2153-599X (Print) 2153-5981 (Online) Journal homepage: http://www.tandfonline.com/loi/rrbb20

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Religion, Brain & Behavior
Vol. 1, No. 1, February 2011, 18–30

Spontaneous processing of functional and non-functional action sequences

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Characterizing ritual and ritualized behaviors has been a core issue in anthropology and the study of religion for more than a century. Although varying in emphasis, most theories point toward several specific behavioral features that distinguish ritual from instrumental behavior. Specifically, we have chosen to focus on the derivedness from instrumental behavior, intentional underspecification and goal-demotion. In contrast to instrumental or functional behavior (i.e., actions that cohere causally and have a necessary integration of subparts), we propose to view ritual and ritualized action as sub-categories of non-functional behavior (i.e., actions lacking causal coherence and a necessary integration between subparts). New insights in human action processing can help us explain how cognition might vary depending on the type of behavior processed. Using an event segmentation paradigm, we conducted two experiments eliciting differences in participants' response patterns to functional and non-functional actions. Participants consistently segmented non-functional action sequences into smaller units indicating either an attentional shift to the level of gesture analysis or a problem of representational integration. Experimental studies of non-functional behavior can strengthen explanations of recurrent features of human action processing, such as ritual and ritualized behavior, as well as indicate potential sources and effects of breakdown of the system.

Keywords: ritual; ritualized behavior; goal-demotion; non-functional behavior; event segmentation

1. Introduction

It is a well-established fact reported by anthropologists and scholars of religion that people cross-culturally engage in ritual action. Wherever humans congregate in groups, collective ritual seems to follow, and numerous individual endeavors are also regularly related to ritualized behavior. For this reason ritual has been at the forefront of theoretical concern for anthropologists and scholars of religion since the commencement of the disciplines, even if little agreement has been found concerning the basic constituents of ritual and how it relates to other behavioral types. While some scholars have focused on ritual's relation to specific pragmatic goals and therefore understood it as a type of instrumental behavior informed by flawed causal theories (e.g., Frazer, 1990[1922]), others have been more concerned with its functional role in constructing and maintaining group cohesion, relegating ritual to the sphere of "the sacred" in contrast to profane instrumental endeavors (e.g., Durkheim, 2001[1912]).

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ISSN 2153-599X print/ISSN 2153-5981 online

DOI: 10.1080/2153599X.2010.550722
http://www.informaworld.com

With the advent of extended fieldwork in social anthropology the latter position won favor. Observers noted that in everyday living so-called "primitive people" employ a wide range of instrumental behaviors based on commonsense appreciation of causal structures of the world. Further, people themselves are perfectly capable of distinguishing instrumental from ritual action even if both are regarded as necessary in particular pragmatic endeavors (Malinowski, 1992[1948]). Ritual remained a behavioral anomaly in need of an explanation and numerous researchers have retained this position throughout the twentieth century. Most studies, however, have focused on the alleged social function of ritual or its expressive or semantic meaning and, with the notable exception of Arnold van Gennep (2004), few have embarked on a more formal investigation of the basic constituents of ritual.

From the late 1970s this picture began to change, and today there are several competing theories focusing on more formal aspects of ritual (e.g., Bloch, 1974; Staal, 1993). In the context of the present study, three approaches are of particular concern. First, inspired by ethological studies of animal ritualization, some scholars have linked such phylogenetically fixed behavioral patterns to human cultural ritual (e.g., Burkert, 1979). Of particular importance is the specification of ritualization as a *derived* behavior, that is, as behavior removed from its ordinary instrumental domain. Including animal ritualization in the general class of ritual allowed Rappaport to focus on the "obvious aspects of ritual:" how ritual actions on a formal level are distinct from ordinary actions (Rappaport, 1977, 1999).

Second, inspired by developments in the philosophy of mind, anthropologists have investigated ritual actions in terms of intentional specification. Building on Searle's distinction between constitutive and regulatory rules (Searle, 1969), Humphrey and Laidlaw (1994) emphasize the stipulative character of most ritual actions, which disconnects the performers' intentions of performance from the actual sequence of actions performed. Thus ritual action is constituted by a fixed action sequence considered unalterable by individual performers.

Third, in the early 1990s cognitively oriented approaches emerged. In their seminal work Lawson and McCauley argue that ritual engages an Action Representation System, inserting superhuman agents in structural slots as either agent or object (Lawson & McCauley, 1990; McCauley & Lawson, 2002). Understanding religious ritual as an essentially normal type of action made distinct only by the role of superhuman agents, however, disregards a number of surface features that distinguish rituals from ordinary actions (Sørensen, 2007a). More recently, Boyer and Liénard have argued that certain recurrent features of cultural rituals engage an evolved Hazard Precaution System (Boyer & Liénard, 2006; Liénard & Boyer, 2006). Motivated by cues related to potential dangers in the environment, ritualized behavior temporarily reduces anxieties produced by such cues. Ritualized behavior does this by depleting working memory resources, an effect that follows from several of its formal features, such as iteration, redundancy, rigidity, focus on detail, and, most notably, goal-demotion (i.e., the lack of causal nexus between the actions performed and any purported goal).

In summary, anthropologists and scholars of religion elicit three characteristics of ritual and ritualized behavior relevant to the present study: (1) ritual is derived from instrumental actions; (2) ritual is underspecified by the actor's intention; and (3) ritualized behavior is goal-demoted. These characteristics, however, raise the question of how such behavior is cognitively processed, an answer to which might help explain some of the effects traditionally ascribed to ritual, such as social cohesion (Alcorta & Sosis, 2005), and magical efficacy (Sørensen, 2007b). Conceptual issues aside, we consider rituals and ritualized behavior as belonging to a general category of non-functional behavior[1] (i.e., actions lacking causal coherence and a necessary integration between subparts) (cf. Zor, Keren, Szechtman, Mort, & Eilam 2009). Non-functional behavior then is contrasted with the canonical category of functional or instrumental behavior (i.e., actions that cohere causally and have a necessary integration of subparts). We therefore suggest systematically investigating the cognitive processing of non-functional behavior by means of experimental methods derived from the study of ordinary human action processing.

2. Ordinary action processing

The essentially derived nature of ritual points to the likeliness that such actions are processed by the same cognitive systems used to process ordinary actions, but that the peculiar features of ritual might alter this processing in non-trivial ways. Numerous cognitive studies supply convergent evidence on the structure of a human action representation. Action processing seems to employ a bidirectional process that combines bottom–up chunking of perceptual information into basic action gestalts with a top–down integration of these into larger action sequences enabling the prediction of observed behavior. Thus, developmental psychologists report that from an early age, infants distinguish intentional from non-intentional actions (Woodward, 1999), actively parse dynamic actions into intentionally specified chunks (Baldwin, Baird, Saylor, & Clark, 2001), and that the ability to integrate individual actions into a hierarchical goal-structure emerges when children are approximately one year old (Sommerville & Woodward, 2005).

Evidence of the hierarchical nature of human action representations can also be found in cases where the system fails to function. Two types of evidence are relevant in this connection: First, failure to hierarchically integrate fine-grained representations of sub-actions into sequences specified by the ultimate intention of the actor has been observed in patients suffering from schizophrenia (Zalla, Verlut, Franck, Puzenat, & Sirigu, 2004), as well as in patients with prefrontal lesions (Zalla, Pradat-Diehl, & Sirigu, 2003). Second, in some cases humans produce and observe action sequences that seem recalcitrant to hierarchical integration. Thus, non-functional behavior found in patients suffering from obsessive–compulsive disorder (OCD) has no connection to the imagined goal, a feature readily acknowledged by the patients themselves. The tendency of patients suffering from OCD to perform non-functional action sequences points to specific cognitive effects of these actions, and the similarities between these and cultural ritual performance has been noted (Fiske & Haslam, 1997; Boyer & Liénard, 2006).

Event segmentation is a particularly promising approach for understanding human action processing. Building on an experimental paradigm created by Newtson (1973), Zacks and colleagues have developed the Events Segmentation Theory (EST) in order to model how humans parse perceived actions into units that enable the prediction of future actions (Zacks, Speer, Swallow, Braver, & Reynolds, 2007; Zacks & Sargent, 2010). The theory states that sensory information is segmented into meaningful units with the help of Event Models (i.e., relatively stable models of "what goes on"). These, in turn, lead to the formation of predictions of what will come next, thus enabling some degree of behavioral control. When sensory data contradict these predictions, however, prediction error increases, leading to an environmental updating of the event model. Failure in prediction of the following actions will lead to either refinement of the event model or its substitution with a model with a closer fit. Thus, EST combines models of bottom–up perceptual processing with that of top–down schematic processing in order to replicate the continuous formation of predictions of observed human behavior. It is argued that ongoing activity is segmented based on prediction error. When sensory information and an event model are in conflict, the result is a cognitive representation of an event boundary. It is further argued that this process goes on simultaneously on several levels defined by different temporal resolutions. One might analytically distinguish three such levels.

For instance, (1) making coffee might be segmented into (2) distinct sub-actions at a coarse-grained level (boiling water, grinding coffee beans, etc.), but each of these actions will simultaneously be segmented at (3) a fine-grained level (lifting the kettle, moving it to the sink, turning on the water faucet, etc). Forming a hierarchical event representation, fine-grained event boundaries can be formed based on only minor prediction error, whereas coarse-grained event boundaries not only follow fine-grained boundaries but need a stronger error signal to occur.

Three early studies in the event segmentation literature are especially relevant to the present study because they probe the effect of unpredictability on segmentation (Newtson, 1973; Wilder, 1978a, b). Using two versions of approximately the same action sequence, a standard and a deviant version of a man assembling a molecule model, Newtson showed that segmentation rate increased when something unpredictable happened in the action sequence (Newtson, 1973, p. 35). This observation indicates that we should expect an increase in segmentation rate during observation of non-functional behavior, because the lack of an inherent goal should make the sequence structure less predictable. If the goal state of a non-functional action sequence cannot be inferred from perceptual cues early in the action sequence, the sequence becomes less predictable. As argued by Wilder (1978a), the value of Newtson's results is limited because unpredictability was implemented by introducing a task-irrelevant component in the deviant condition (Newtson, 1973, p. 35). Therefore, the increase in segmentation rate could have been caused by the insertion of a task-irrelevant action component that had no counterpart in the standard version (Wilder, 1978a, p. 281). Newtson did not present any justification for why the deviant stimuli contained as many action components as the standard, apart from both action sequences having the same duration. The result therefore might equally well have been caused by an increase in the number of sub-actions involved in the deviant action sequence. Finally, while the object-assembling task might have been somewhat infrequent, it was nevertheless functional in having a clearly defined goal state (i.e., an assembled object). Newtson's participants were actually taught this during a warm-up trial. The unpredictable action component related to the overall action sequence non-functionally because it was not a necessary component, but the entire sequence was functional in our technical sense. In other words, Newtson studied the effect of a non-functional component embedded in one specific functional action sequence.

Following up on Newtson, Wilder investigated the effect of unpredictability on segmentation rate in two studies (Wilder, 1978a, b). He did this by manipulating either the predictability of a sub-action based on the antecedent sub-action, or participants' knowledge about the goal state of the entire action sequence. In Wilder (1978a) the participants were presented with a movie of a man assembling 20 identical booklets. The stimuli were manipulated so the entire action sequence was either predictable, unpredictable or a combination. The results clearly indicate that lack of predictability in the first half of the movie increased segmentation rate, but also that an unanticipated change in pattern of behavior (i.e., the combination conditions) increased segmentation rate. Wilder (1978b) provided evidence that only a combination of unpredictable sub-actions and lack of goal state knowledge results in a higher segmentation rate (Wilder, 1978b, p. 606). The stimuli employed in Wilder (1978b) were a combination of two movies showing a male assembling a Tinkertoy tree or cube. Again these results lead us to believe that non-functional behavior is segmented using more units than functional actions as a result of the non-functional lack of goal structure and causal coherence. Several issues, however, make it necessary to investigate the effect of strictly non-functional action sequences. First, Wilder's results are based on functional actions. In both studies the action sequences had an implied goal state, that is, an anticipated outcome that necessarily followed from the action sequence. Therefore, the studies only probe the effect of variance allowed within a functional action sequence, but not the effect of goal demotion and lack of causal coherence. Although Wilder (1978a) used a highly repetitive action sequence (repetitiveness being diagnostic of ritualized behavior), every repetition had a specific outcome or goal (i.e., an assembled booklet), which made it a functional repetitive action sequence (c.f. Boyer & Liénard, 2006, p. 598). Second, a primary characteristic of ritual is its derivedness, that is, ritual is a transformation of functional behavior. Third, taken together both studies only used three infrequent action sequences of one very specific kind, namely object assembling. It is therefore relevant to investigate the effect of more frequent behaviors from a wider spectrum of possibilities, ensuring that the effects do not only follow from one type of action sequence. Fourth, Wilder gives us no explanation of how he made sure that every action sequence had approximately the same number of sub-actions except that several takes were made of each movie (1978a, p. 282; 1978b, p. 605). It is obviously necessary to make several takes of a precisely timed, complicated action sequence, but that does not guarantee that the sequences are comparable in terms of sub-action units. Finally, both studies indicate that familiarization with functional action sequences reduces segmentation rate. In Wilder (1978a) the sequences were highly repetitive, giving participants ample time to familiarize themselves with the action sequences that did not have a change in style, and these sequences resulted in a decrease in segmentation rate. In Wilder (1978b) increased segmentation rate was only found in conditions where participants had no familiarity with goal state and sub-action progression.

Since intentionality can be correlated with goal directedness, one recent study should be mentioned briefly, because it showed that both intentional movement and knowledge about intentions decreased segmentation rate (Zacks, 2004). Zacks manipulated the degree of intentional movement of abstract geometrical figures and thereby participants' intentional interpretation. The study showed that "stimuli that gave more cues to being intentional activity produced weaker relationships between movement features and event segmentation" (Zacks, 2004, p. 1005). Since non-functional behavior lacks the apparent goal directedness of functional behavior, Zacks's results lead us to expect that the segmentation rate will increase during non-functional behavior because observers are more attentive to the specific movement features of the stimuli.

In summary, numerous studies of action processing point to the crucial role played by an action segmentation system in the construction of causal models, memory of discrete events, and prediction of other people's actions. Whereas most studies have used ordinary functional actions as their stimuli, the aim of the present study is to investigate how observation of non-functional action sequences affects participants' spontaneous event segmentation. The present study builds upon two premises: (1) That humans have a cognitive system that parses behavior into units whose boundaries are the result of prediction error; and (2) that some cultural rituals expose a lack of integration of individual sub-actions and overarching goal structure, which have particular cognitive effects. Based on EST, we predict that viewing such non-functional action sequences will make participants parse them at a finer grain than in the case of functional action sequences.

3. Experiment 1: segmentation of non-functional actions

In experiment 1, we assessed spontaneous parsing of functional and non-functional action sequences using a variation of the event segmentation paradigm according to which participants segment action sequences into units typically by means of a response button (Newtson, 1973; Hanson & Hirst, 1989; Zacks, 2004). In contrast to functional action sequences, three features characterized every single non-functional action sequence: redundancy, rigidity, and goal demotion. We expected that the non-functional features would make it harder for participants to predict the structure of the action sequence (i.e., increase their prediction error). This, we predicted, would result in them segmenting the non-functional action sequences into smaller units than they would in the functional condition.

3.1. Method

Participants

Participants were 23 undergraduate students enrolled at the University of Aarhus.

Stimuli

Sixteen everyday functional actions with duration of 30 seconds were coded as action sequence scripts (e.g., "to make coffee") (see Table 1). Each script described the sub-actions and their relations (necessary and unnecessary). The number of sub-actions for each functional script was then counted. To transform the functional action sequences into non-functional action sequences we increased redundancy (e.g., turning the cup twice instead of once), rigidity (e.g., moving the cup slowly following a straight vertical trajectory), and produced goal demotion, which was operationalized as two sub-features: disturbance of the goal structure by reshuffling the conditional relations between sub-actions (e.g., putting coffee grinds in the cup after having lifted the cup to the mouth) and removal of the goal (e.g., not drinking from the cup). The transformation generated a set of non-functional action sequence scripts in which every single non-functional action sequence would have all these features. To counter-balance a potential increase of sub-actions in the non-functional sequences, we removed an original functional but unnecessary action each time we added a non-functional feature. This procedure generated two sets of actions, a functional set and a non-functional set, with 16 actions in each. Each action sequence in each set would have a counterpart in the other, giving a total of 32 action sequences. Two actors, a

Table 1. The sixteen everyday action sequences used as functional and transformed to non-functional stimuli in experiment 1

Functional action sequence:
1. Blow up a balloon
2. Brush teeth
3. Set table for one person
4. Use hand lotion
5. Brush hair
6. Make and drink instant coffee
7. Eat chocolate candy
8. Make paper plane
9. Water plant
10. Remove stain from glass
11. Tie shoelace
12. Remove latex from scratchcard
13. Make and drink tea
14. Prepare and taste a piece of toast
15. Lift hand weight
16. Drink wine and read newspaper

male and a female, carried out the actions, each performing half the action sequences in one set and their counterparts in the other set. The action sequences were filmed using a 3.1-megapixel video camcorder from a fixed position, showing the actor's front torso and face. To make sure that the filmed action sequences had approximately the same amount of units, each action sequence in both sets was segmented into its constituent units by a group of four experts consisting of members of the Religion, Cognition and Culture (*RCC*) research unit. The expert group did not have knowledge about theory or hypotheses, but was told how actions can be segmented at both a fine- and a coarse-grained level. They were given examples of this and asked to segment each action sequence as they found it natural and meaningful. The group's segmentation showed a slightly larger amount of sub-actions in the functional condition ($M = 2.4$, $SD = 1.4$) than the non-functional ($M = 2$, $SD = 1.4$).

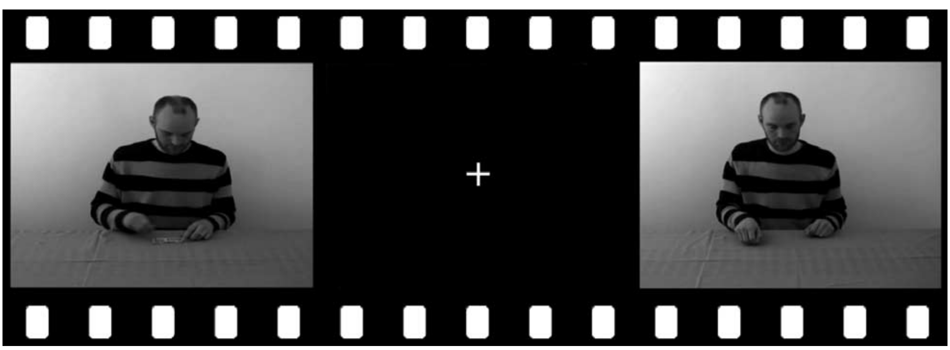

Figure 1. Still pictures from "Remove latex from scratchpad." First frame is the functional version and third frame the non-functional version at the same time step.

The segmentation of the expert group would then, against our prediction, lead us to expect more button presses in the functional condition.

Design

We used a within subjects design with two conditions: functional and non-functional action type.

Procedure

Participants were instructed as follows in Danish: "You will see a set of short action sequences, one following the other and separated by a black screen. What I want you to do is to segment each action sequence into the units that you find natural and meaningful. You do this by pressing the response button every time you think that an action sequence should be segmented." They were also told to press the button as many times as they liked during each action sequence and that there was no right or wrong way of doing it. Each participant was seated in front of a monitor and a response button, and was shown all the actions once while parsing them. The actions were presented sequentially, separated by intervals of 2 seconds, and the order of the actions was randomly organized across both sets for each participant.

3.2. Results and discussion

The participants did use significantly more button presses in the non-functional condition ($M = 3.5$, $SD = 2.4$) than in the functional ($M = 2.7$, $SD = 1.5$): $t(22) = 3.7$, $p < 0.01$, Cohen's $d = 0.77$. The results confirmed that non-functional features spontaneously make participants segment actions into smaller units. We believe that such behavior is caused by an increase in prediction error during perception of a non-functional action sequence because redundancy, rigidity, and goal demotion either make it more difficult to integrate the sequence into a coherent event model or shift attention to the level of gesture analysis.

Theoretically, goal demotion is the most important feature of non-functionality (c.f. Boyer & Liénard, 2006); the question is if that alone can generate similar results. Novelty and familiarity might be relevant issues because our functional actions were everyday actions and the non-functional counterparts were unusual transformations of these. In order to address these issues in experiment 2, we made two new sets of stimuli in which the non-functional set was only a goal-demoted version of the functional. To avoid the novelty effect, the functional set consisted of unusual instrumental action sequences, thereby removing participants' prior knowledge of both sets of action sequences. To probe the effect of familiarity, we familiarized the participants with half of each set with the intention of establishing stable event representations for items in both sets.

4. Experiment 2: segmentation of goal-demoted actions

The purpose of experiment 2 was to assess if goal demotion could elicit an increase in segmentation rate. Goal demotion was operationalized as a disturbance of an action sequence's goal structure by a reshuffling of the conditional relations between sub-actions. With reference to the discussion of Wilder (1978a, b) in Section 2, we also wanted to test if familiarization to both functional and non-functional actions had an effect. Finally, we wanted to remove the novel *contra* everyday stimuli difference from experiment 1 by using low-frequency actions in both conditions. We predicted that goal demotion would increase segmentation rate.

4.1. Method

Participants

Participants were 24 undergraduate students enrolled at the University of Aarhus.

Stimuli

Six low-frequency functional action sequences (see Table 2) with duration of 20 seconds were filmed with a 3.1-megapixel video camcorder from a fixed position showing only the hands and middle-front torso of a male actor. Each filmed functional action sequence was segmented into units by an expert group consisting of eight members from the *RCC*. As before the expert group did not have knowledge about theories or hypotheses. This time, they were asked to segment the actions at a fine-grained level. This level was chosen due to the short duration of the functional action sequences, a duration necessary to employ a larger selection of action sequences and to keep participants actively engaged during the entire experiment. The mean number of presses for each functional action sequence was then used to identify its relevant sub-units (action sequence with minimum number of units: $M = 4.7$, $SD = 0.95$, and action sequence with maximum units: $M = 7.6$, $SD = 2.6$). To generate the non-functional actions, we randomly reorganized the units within each functional action sequence, with the constraint that a sequence identical to the functional was not allowed. The non-functional action sequences were then filmed using the same procedure as in the functional action sequence. This generated two sets of action sequences, each containing six actions. As in experiment 1, each action in one set had a counterpart in the other.

Design

We used a within subjects design with two factors: action type, having two levels (functional and non-functional), and familiarization, with the levels familiar and non-familiar.

Table 2. The six low-frequency action sequences used as functional and transformed to non-functional stimuli in experiment 2

Functional action sequence:
1. Cut the pages of a book
2. Set up a mandolin
3. Measure map with opisometer
4. Prepare smoking pipe
5. Assemble tattooing-machine
6. Use lime zester

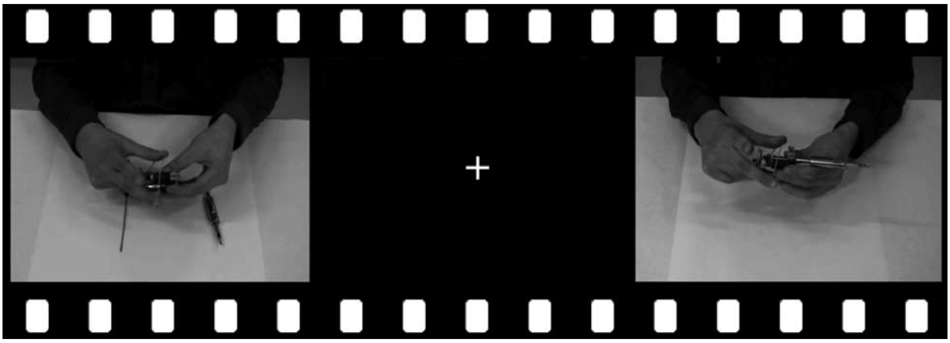

Figure 2. Still pictures from "Assemble tattooing-machine." First frame is the functional version and third frame the non-functional version at the same time step.

Procedure

Before the familiarization block, participants were instructed as follows in Danish: "You will see a set of short action sequences, one following the other, separated by a black screen. Please pay close attention to every single action sequence." The participants were presented with three action sequences from the functional set and three action sequences from the non-functional set, each presented three times. This gave a total of 18 ($3 \times 3 + 3 \times 3$) action sequences. The order of presentation was randomized across both sets for each subject.

Following the familiarization block, the participants were given the same instructions as in experiment 1 and then shown the total of 12 action sequences (six from each set, half of which were familiarized) in a randomized order across both sets for each participant. The actions were presented sequentially separated by intervals of 2 seconds and the setting was identical to experiment 1.

4.2. Results and discussion

Means and standard deviations for both conditions are shown in Table 3. The repeated measure two-factor ANOVA showed a significant main effect for action type, $F(1,23) = 8.22$, $p < .01$, $\eta^2 = 0.26$; no significant effect for familiarization, $F(1,23) < 1$; and no significant interaction between action type and knowledge $F(1,23) = 1.49$, $p = 0.24$, $\eta^2 = 0.06$.

The results replicated the finding from experiment 1 using stimuli that were only characterized by goal demotion, compared to the stimuli of experiment 1 that had two more features. Disturbance or lack of necessary relations between the units of an action sequence, in this case a randomized order, is sufficient to increase participants' segmentation rate. Taking the length of the action sequences into consideration,

Table 3. Means and standard deviations from experiment 2

	Knowledge	
Action type	Familiar	Non-familiar
Functional	$M = 3.17$ $SD = 1.25$	$M = 3.25$ $SD = 1.50$
Non-functional	$M = 4.10$ $SD = 2.14$	$M = 3.89$ $SD = 1.99$

participants used more button presses in experiment 2 than in experiment 1. This difference might originate in the slightly different procedure used to generate the non-functional actions (i.e., experts segmented on a fine-grained level instead of spontaneously).

Somewhat surprisingly, we did not find a significant effect for familiarization, which suggests that the use of everyday functional action sequences did not confound the results of experiment 1. The lack of effect might, however, be a consequence of our familiarization design not managing to build stable event representations. Given the relatively short duration of the movies and their low frequency in an everyday environment, it is possible that familiarity will demand a more extended or a different kind of exposure.

5. General discussion

The two experiments conducted in this study confirm that non-functionality increases participants' spontaneous segmentation rate. We believe that there are two possible, and potentially compatible, explanations for these results: (1) whereas functional actions can easily be integrated into coherent event models, such integration is more complicated in the non-functional condition due to the difficulty of attributing an obvious goal to the agent; (2) since non-functional behavior elicits a higher segmentation rate, because of its lack of causal coherence, participants might be more attentive to the level of gesture analysis during this condition (c.f. Boyer & Liénard, 2006, p. 605). We are in the process of designing a new set of experiments that will investigate these explanations. Participants are instructed to parse functional and non-functional action sequences at both a fine-grained level (i.e., the level of gesture analysis) and a coarse-grained level (i.e., the level of goal attribution) (Newtson, 1973; Hanson & Hirst, 1989). Several experiments have already shown that during observation of functional action sequences, participants' fine-grained segmentation (their low-level event boundaries) falls within the boundaries of their coarse-grained segmentation. In other words, the low-level units employed are a sub-set of the high-level units (Newtson, 1973). This inter-level agreement of units tends to be reliable both within and between participants (Zacks & Tversky, 2001, p. 8). Furthermore, it has been shown that participants doing more fine-grained segmentation do this by attending to movement features of the stimuli (Zacks, 2004). If explanation 1 is the case, we expect to find little agreement between fine- and coarse-grained segmentation units during the non-functional condition. Since the goal cannot be inferred, participants are expected to segment the coarse level more randomly and hence have less agreement between segmentation levels compared to the functional condition. According to explanation 2 we expect that there might still be a reasonable level of agreement within and between participants, but that the non-functional coarse level will be accommodated to the fine level in terms of segmentation rate, because attention is directed to low-level gesture analysis.

We have argued that non-functional behaviors are a characterizing aspect of human cultural rituals and that, as such, 'ritualized behavior' can be operationalized as non-functional actions within the experimental paradigm of EST. The utility of this approach is twofold. First, investigating less frequent modes of human behavior can be used to test predictions about the core properties of the system concerned. Thus, our experiments help validate a process of multilevel segmentation of actions that can be manipulated by means of specific types of sensory input. Second, these studies might help explain how core features of cognitive action processing are expressed and utilized in different cultural settings. Humans exhibit a wide array of behaviors and, even if it is likely to be canonical, functional action is only one such behavioral type.

We speculate that studies into less frequent types of human behavior, such as ritualized behavior, can help address a number of problems. Thus, ritualized behavior seems to be directly related to the symptomology of OCD. Understanding how ritualized behavior is processed by the human mind might help explain core features of this mental disorder (Boyer & Liénard, 2006; Zor et al., 2009; Zacks & Sargent, 2010). Further, non-functional actions seem to be crucial, not only for ritual, but for certain aesthetic genres as well (Dissanayake, 1990). Experimental studies might help explain why aesthetic practices, as well as ritualized behavior, can be understood as meaningful in particular contexts. Finally, an experimental agenda addressing core features of ritualized behavior will help shed light on particular effects of cultural ritual claimed by anthropologists and scholars of religion. The apparent lack of congruency between bottom–up and top–down processing of non-functional actions might explain features such as ascription of causal efficacy to ritual behavior and the often-noted correlation between ritual and expressed beliefs in superhuman agents – whether as side effects or increased cognitive relevance of culturally widespread explanations. In order to approach some of these questions, we aim to investigate how non-functional behavior affects attention to and memory of conceptual information, as well as if and to what extent non-functional behavior heightens attention toward particular perceptual aspects of sensory information.

Acknowledgement

We would like to thank Pascal Boyer and Jeff Zacks for their comments on several drafts of the article. We are grateful for the comments on an earlier version of the article by two anonymous reviewers. Jesper Sørensen's work was made possible by the Danish Ministry of Science, Technology and Innovations's UNIK grant MIND*Lab* at Aarhus University.

Note

1. In an evolutionary model non-functional behavior might serve a function, such as generating or maintaining group cohesion, but ultimate explanations are not the topic of this article.

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