



Original Articles

Examining memory for ritualized gesture in complex causal sequences

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ABSTRACT

Humans have created and maintained an exponentially large and sophisticated behavioral corpus over evolutionary time. In no small part this was achieved due to our tendency to imitate behaviours rather than to emulate outcomes. This tendency, however, can lead to inefficiency and redundancy in our behavioral repertoires. Drawing on evidence from multiple fields of psychology, we propose two novel competing hypotheses. The ‘catalyst hypothesis’ suggests that low (but not high) proportions of ritualized gesture in instrumental action sequences will improve subsequent recall of the entire action sequence (without itself enhancing the instrumental utility of the sequence). Conversely, the ‘cost hypothesis’ suggests that increasing proportions of ritualized gesture will impair recall, due to the introduction of cognitive load. The null hypothesis states that ritualized gestures are neither beneficial nor costly. In a pre-registered experiment, we presented participants with multiple versions of two complicated 2-min action sequences in which we varied the proportion of ritualized gesture. We then quantified the influence ritualized gesture had on recall for individuals gestures, overall outcomes, and described detail. We found clear evidence that high proportions of ritualized gestures impair recall for individual gestures and overall success, and weak evidence that low proportions increase overall success. At present, we may reject the null, but cannot rule out either of our competing hypotheses. We discuss potential implications for cultural evolution, and generate competing predictions that allow for adjudication between Ritual Modes theory (Whitehouse, 2004) and the ‘Cognitive Resource Depletion’ account of Religious Interaction (Schjoedt et al., 2013). All files (including data and syntax) are freely available at <https://osf.io/spz68/>.

1. Introduction

“Make an eyesalve against a wen: take equal amounts of cropleac [an *Allium* species] and garlic, pound well together, take equal amounts of wine and oxgall, mix with the alliums, put this in a brass vessel, let [the mixture] stand for nine nights in the brass vessel, wring through a cloth and clarify well, put in a horn and at night apply to the eye with a feather; the best medicine.” – Bald’s Leechbook (Voth, 2017), as described in Harrison et al., 2015)

In 2015 a team of chemists, biologists, and historians attempted to exactly re-create a 1100 year old medicine for the treatment of a Sty (an infection of the eyelash follicle; Harrison et al., 2015). Given the ritualistic features of the recipe it was to their surprise, that not only was the treatment efficacious, but it was efficacious against MRSA – a particularly problematic strain of treatment-resistant bacteria. The roles played by some ingredients seemed intuitive – garlic, onion, and brass are known to have antimicrobial properties - while the role of other

ingredients was less clear. What role did wine play, for example? Did it contribute antimicrobial qualities, or did it merely act as a solvent (p. 2)? Similarly, some of the processes seemed clear and important – pounding and mixing are, in principle, causally relevant – while other processes are opaque. Did the mixture really need to sit nine days, be mixed in a brass vessel, and applied at night with a feather? The team found that a 9-day latency was superior to a 5-day latency, but the use of the brass vessel was irrelevant. These results are surprising, not least because a decade earlier Brennessel, Drout, & Gravel, (2005) concluded, with reference to the same recipe, that “some of the Anglo-Saxon recipes take biologically efficacious ingredients and process them into ineffective mixtures” (pp. 184)

One reason it is difficult, a priori, to determine whether such sequences will be effective or not is due to causal opacity: causal opacity can be attributed to an action or a procedure when it is difficult or impossible to determine the physical-causal relationship between the action and the outcome (Kapitány & Nielsen, 2015, 2016; Legare, Wen,

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Box 1

Key terms and definitions.

Ritualized gesture: *Ritualized gestures are gestures that are causally opaque and frequently goal demoted, that are constituted by repetitive, redundant, stereotyped features, and formality of performance. Ritualized gestures are distinct from rituals, inasmuch as such gestures are often a part of rituals, but not themselves necessarily symbolic and/or culturally shared.*

Causal Opacity: *Causal opacity can be attributed to an action or a procedure when it is difficult or impossible to determine the physical-causal relationship between the action and the outcome.*

Goal Demotion. *Goal demotion can be attributed to an action or a procedure when it is difficult or impossible for the observed to determine the goal or intention of the actor.*

Overimitation: *The tendency for humans to copy with high-fidelity entire modelled sequences, even when such sequences contain obviously redundant, ineffective, and/or costly actions.*

Partonomics: *The study of action perception with regard to how we parse what we see into meaningful units and subunits of information based on multiple levels of prediction and observation.*

Predictive Coding: *Predictive coding is a cognitive model of perception in which the brain predicts actions based on sensory input from a top-down perspective, while actively updating these predictions (via subsequent input) when affirmed or violated via bottom-up error-checking processes.*

Herrmann, & Whitehouse, 2015; Nielbo & Sørensen, 2015; Watson-Jones, Legare, Whitehouse, & Clegg, 2014; Wen, Herrmann, & Legare, 2016). Causal opacity occurs when the causal dependency structure of ordinary actions is disrupted (Schjoedt et al., 2013). Ritualized gestures are causally opaque (and frequently goal demoted; see Box 1) due to repetition, redundancy, formality, and/or stereotypy of action (Kapitány & Nielsen, 2015, 2016) – features which disrupt and obscure causal interpretations.¹ Causally opaque actions in context (e.g., the nine day latency, the horn, and the feather) may be causally necessary or entirely arbitrary, the point is that the veridical causal relationship cannot be easily determined.

Ritualistic actions may become embedded, or maintained, within instrumental sequences fairly often (Cohen & Bacdayan, 1994; Keren, Boyer, Mort, & Eilam, 2013). What are the consequences of this? We propose here that the inclusion of ritualistic elements in action sequences has ‘fitness consequences’ for the sequence itself, as the cognitive cost associated with unnecessary and redundant actions may influence the overall quality of recall (particularly as the sequence gets longer and more complicated). We propose two hypotheses, one in which we expect to see a curvilinear relationship between ritualized gesture and recall, such that a small proportion of ritualized gestures will *improve*, rather than *impair* recall (while high proportions will be detrimental), and a second, in which any non-zero proportion of ritualized action leads to impaired recall. As will be described, these effects may be contingent upon a range of cognitive factors, such as predictive coding, executive function, and memory.

Ritualized gestures, particularly in cultural and community rituals, are regarded as costly, requiring expenditure that seems disproportionate to the ostensible outcomes of the act (Henrich, 2009; Ruffle & Sosis, 2007, 2003; Sosis & Bressler, 2003). The same is true at smaller scales, when an ordinary and instrumental sequence contains degrees of redundancy (as in recipes, or procedures for making an artefact, particularly when such procedures are important or hazardous; Boyer & Liénard, 2006; Keren et al., 2013). It is important to note that we use the term ‘costly’ to refer to the inefficiency of ritualized gesture with regard to the *additional cognitive load* required to remember and reproduce something instrumentally unnecessary (Rybanska, McKay, Jong, & Whitehouse, 2017) – it is not an equivocation between the physical, emotional, financial, and/or opportunity cost associated with participation in large communal rituals. Do we see ritualized gestures within sophisticated action sequences because they are simply not

costly enough to be selected against over time and iterations? Or might their presence be explained by a benefit that offsets their costs? Or, finally, are ritualized gestures sufficiently costly that they are selected against and eliminated above a certain threshold? To the extent that ritualized gestures are costly, then their inclusion may represent something of a handicap for cultural learners who have – over evolutionary time – relied on pedagogy, observation, and oral culture to acquire behavioral skills (Cavalli-Sforza & Feldman, 1981; Hewlett, Fouts, Boyette, & Hewlett, 2011; Kline, 2014; Lozada, Ladio, & Weigandt, 2006).

In a rational world, we would evaluate the actions we wish to learn based on the efficacy and efficiency of the technique itself, omitting what doesn’t work, selecting that which does, and updating our behavior when we observe a better alternative. But this is not what happens. Rather, we acquire things as a function of learning strategies that may only be proximally related to efficiency or efficacy. In part, this is due to the fact that as our behavioral and technological repertoire became increasingly sophisticated over historic time, it also became increasingly difficult to causally evaluate each individual technique (Legare & Nielsen, 2015). Thus, humans use a range of strategies to acquire important behaviors. Such strategies involve copying *individuals* who are successful or competent (Mesoudi, 2008) particularly when they belong to the in-group (Over & Carpenter, 2012), and using a wider range of models when in a larger group (Kempe & Mesoudi, 2014). And yet, we’re not perfect: adults may use prestige information and success-related information equally, even if the former is less useful than the latter (Atkisson, O’Brien, & Mesoudi, 2012), and children may prefer to copy adults rather than age-mates, even if those age-mates have demonstrable competence (Wood et al., 2016; Wood, Kendal, & Flynn, 2012). On the whole, such strategies are excellent at arriving at *pretty good* solutions (p. 349; Gigerenzer & Selten, 2002), relative to the difficulty and cost of arriving at *optimal* solutions. That is not to argue, however, that certain features aren’t cues to efficacy (Barrett & Thomas Lawson, 2001; Legare & Souza, 2012), but rather that the cost of *exclusively* attending to this information is, on average, too high, too difficult, or too costly. The consequence of this is that the strategies we do employ may maintain behaviors which may not be directly, physically-causally, relevant. Such actions, however, may be important. Here we suggest (as others have) that ritualistic actions may cue attention (Rossano, 2012) producing cognitive capture (Boyer & Liénard, 2006) which may facilitate memory and subsequent reproduction.

There is a rich literature on how humans learn motor sequences in order to perform them later (typically referred to as ‘*delayed motor intentions*’; for review see Badets & Osiurak, 2015). Broadly, there are two dimensions for planning and performing a motor action: ‘action-based’ and ‘goal-based’ mechanisms. The former are the [motor] actions required to bring about an effect (e.g., holding and thumbing the flint of a

¹ Importantly, ritualistic actions should not be confused with rituals, per se. That is, we make no claim that our stimuli, and the phenomenon under consideration, are ritualistic in the sense that they are symbolic (Durkheim, 2012), or culturally shared (Whitehouse, 2004), merely that they are a set of identifiable actions conforming to the given definition.

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