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The Skilful Origins of Human Normative Cognition

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Abstract: I briefly present and motivate a 'skill hypothesis' regarding the evolution of human normative cognition. On this hypothesis, the capacity to internally represent action-guiding norms evolved as a solution to the distinctive problems of standardizing, learning and teaching complex motor skills and craft skills, especially skills related to toolmaking. We have an evolved cognitive architecture for internalizing norms of technique, which was then co-opted for a rich array of social functions. There was a gradual expansion of the normative domain, with ritual playing an important role in bridging the gap between concrete, enacted norms and general, abstract norms, such as kinship norms. I conclude by stating nine predictions arising from the skill hypothesis.

Keywords: normative cognition, skill, cognitive control, norms, evolution

1 The Skill Hypothesis

Norms govern every aspect of human social conduct. Some are very context-specific: Brush your teeth twice a day! Wear a mask in shops! Some, by contrast, are very general and abstract: Treat people fairly! Keep your promises! Kinship systems are one source of particularly abstract norms. For example, many such systems permit marrying a cross-cousin (e.g. a child of your mother's brother) but forbid marrying a parallel cousin (e.g. a child of your mother's sister) (see Allen et al. 2011).

In what sense do such norms 'govern' our conduct? We are not always explicitly aware of the norms that guide us, and we do not always reflectively endorse them. In many cases, we simply internalize them in a way that involves three key ingredients: we notice and anticipate norm violations, we feel affective pressure (e.g. discomfort, shame, anger) to correct or prevent such violations, and we know what to do (e.g.

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punish, correct, apologize, beg forgiveness) to restore conformity and relieve the affective pressure (cf. Sripada/Stich 2006; Railton 2006).

While norm-like phenomena are sometimes observed in other animals such as chimpanzees (Andrews 2009; von Leeuwen et al. 2012; 2014), no other animal microregulates every aspect of its own behaviour and that of others to maintain conformity with a vast set of learned social norms. We are talking here about a strange and uniquely hominin capacity. Why are we like this? How did the normative micromanagement of human behaviour come about?

My aim here is to state and briefly motivate a hypothesis I call the skill hypothesis.[1] The basic idea is that technical norms, such as norms of tool manufacture, preceded non-technical norms, such as norms of ritual, reciprocity, fairness and kinship. We have an evolved cognitive architecture for internalizing norms of technique, which initially evolved to help us internalize specific styles of toolmaking. This ability to internalize action-guiding norms was then co-opted for a rich array of social functions. There was a gradual expansion of the normative domain, with ritual playing an important role in bridging the gap between concrete, enacted, context-specific norms and general, abstract norms, such as kinship norms.

In short, the skill hypothesis comprises the following core commitments:

1. In modern humans, complex motor skills and craft skills, such as toolmaking, are guided by internally represented norms of correct performance.
2. The capacity to internally represent action-guiding norms of correct performance evolved as a solution to the distinctive problems of standardizing, learning and teaching complex motor skills and craft skills, especially skills related to toolmaking.

A third claim, dependent on (1) and (2), is that this cognitive architecture for internalizing technical norms was then co-opted for internalizing a wide range of other social norms. If these claims are correct, then the evolution of skilled action and the evolution of normative cognition are entwined: rather than thinking of them as two separate stories, we should try to understand the evolution of norm-guided skill.

To motivate the skill hypothesis, I will first consider psychology, and then turn to evolution. *Section 2* considers the cognitive basis for a link between skills and norms, highlighting the importance of model-based cognitive control. *Sections 3* and *4* offer a conjectural account of why technical norms might first have evolved, and how the normative domain might then have expanded to encompass all of

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[1] For a longer and more detailed defence of the skill hypothesis, see Birch 2021.

human social life. Finally, *Section 5* sets out nine testable predictions to which the skill hypothesis gives rise.

2 Internalizing Norms Through Model-Based Cognitive Control

The skill hypothesis meshes well with recent theoretical and experimental work on the psychology of skill. On the theoretical side, recent work has stressed the importance of cognitive control (Toner et al. 2015; Montero 2016), and in particular cognitive control models (Pacherie 2008; Christensen et al. 2015; 2016), for the guidance of skilful action. Complex motor skills and craft skills require flexible, rapid, on-the-fly adjustment to technique in the face of anticipated and emerging problems that are specific to the present situation. Cognitive control models are posited to explain this on-the-fly adjustment.

A cognitive control model is a representation of the causal structure of a complex skill and the situation in which it is executed. These models are hypothesized to mediate between explicit plans and low-level (cerebellar) motor control, representing "causal relations among performance parameters" that allow the individual "to flexibly and appropriately identify and influence [...] parameters in a particular situation" (Christensen et al. 2015, 344). To visualize intuitively the content of such a model, imagine a causal graph, linking direct handles of agential control (e.g. the force or location of a strike on a flint) to their predicted effects and the sensory feedback resulting from those effects (how the strike will sound, how the flint will break and where) in a particular situation (this particular specimen). These models generate context-specific predictions about the effects of actions. Relative to these predictions, the actual execution of a skill may involve errors.

I propose that, if you have model-based cognitive control of skill execution, you also have the possibility of internalizing technical norms, provided the control system is also integrated with affect (cf. Railton 2017). The idea is that some mismatches between predicted and realized performance trigger affective responses: the mismatch makes the performance *feel wrong* to the agent. A particular strike of a stone may feel wrong (for example, because of the way it sounds), and the way a specimen is developing across multiple strikes may also feel wrong. The affective response may simply be one of what Rietveld (2008), following Wittgenstein, has called 'directed discontent': discontent directed towards a particular aspect of performance. Training in a skill can be seen as tuning these feelings of directed discontent. For an expert, even a very small mismatch between predicted and realized performance (e.g. between the predicted sound and the sound actually heard) will trigger an affective response. They will feel discomfort at even the slightest error. Such an expert has internalized an exacting standard for satisfactory performance: a technical norm.

On the experimental side, recent work in cognitive archaeology has highlighted the demands Acheulean-level (or ‘mode 2’) toolmaking places on cognitive control in modern humans. Acheulean bifaces (Figure 1) show remarkable symmetry and craftsmanship (Lycett 2008; Iovita et al. 2017), and this is especially true of Late Acheulean tools (from around 700-250 thousand years ago), which tend to display greater symmetry and thinner cross-sections than Early Acheulean tools (Stout 2011; Stout et al. 2014). This leads naturally to the hypothesis that Late Acheulean toolmaking involved a form of cognitive control (Stout 2010).

Fig. 1: An Acheulean handaxe. Photograph by the Portable Antiquities Scheme. CC-BY 2.0.

Cognitive archaeologists, especially Stout and collaborators, have used neuroimaging methods to explore this hypothesis. For example, a positron emission tomography (PET) study of expert flint knappers carried out while they executed the skill showed activation in the ventrolateral prefrontal cortex, a brain region associated with cognitive control of ongoing action sequences (Stout et al. 2008). Another study used functional magnetic resonance imaging to investigate the activation and functional connectivity of the dorsal prefrontal cortex, a brain region associated with action planning and prediction, and found that “making technical judgments about Lower Paleolithic toolmaking affects neural activity and functional connectivity … that effect magnitude correlates with the frequency of correct strategic judgments, and that the ability to make such judgments is predictive of success in Acheulean, but not Oldowan, toolmaking” (Stout et al. 2015, 13). Another, by Putt et al. (2017), used functional near-infrared spectroscopy to investigate brain activation in subjects with no prior toolmaking experience as they acquired basic skills. They found a role for the supplementary motor area, which they hypothesize to be “the cognitive control centre of a medial premotor system, the function of which is to plan complex action sequences” (Putt et al. 2017, 2). Such studies cannot be seen as directly testing for the presence or absence of cognitive control models, but they are broadly supportive of the idea that Late Acheulean toolmaking marks an important watershed in the evolution of cognitive control (Sterelny 2012; Stout/Hecht 2017).

3 Technical Norms as the First Norms

There is evidence of between-group variation in styles of toolmaking from the Late Acheulean onwards (Wynn 1993; Shipton 2010). A recent study of Late Acheulean handaxe types in Britain found a range of distinct subtypes at different sites, leading the authors to propose that that “the distinctive and difficult to produce handaxes types that characterize the British Late Acheulean were reproduced according to normative expectations of what handaxes should look like” (Shipton/White 2020, 1).

This might be interpreted as a mere by-product of normative cognition: once normative cognition is on the scene, for some other reason, one of the things hominins could do with it was apply it to toolmaking styles. I conjecture, however, that it was not a mere by-product, and that the benefits of standardizing technique drove the evolution of cognitive adaptations for internalizing norms.

What was the benefit of standardizing technique? The manufacture of Acheulean bifaces was, in at least some cases, a collaborative activity involving a division of labour. Shipton and Nielsen (2015) report evidence of spatial division of labour at a site in India, with the early stages and finishing stages of cleaver manufacture carried out at distinct locations. The best explanation, they argue, is that different group members were undertaking different tasks.

Inherent to collaborative tool manufacture is a special kind of coordination problem resulting from the causal opacity of complex skills. Individual agents at the early stages of the process will not be fully aware of what the finishers do, and consequently will not be fully aware of the downstream consequences of their actions. Small variations of technique in the early stages may result in the finisher receiving a tool that cannot be finished. The consequences of these variations will not be readily foreseeable unless the agents at the beginning of the production line have also mastered the skills to be performed later, which would undercut the advantages of dividing the labour. What is needed is a way of reliably coordinating on mutually compatible ways of executing each role, despite mutual ignorance of what each other's roles involve. Internalizing a norm within a cognitive control model is a solution to that coordination problem.

Such norms are norms only in a broad sense of the word. It might be objected that the benefits of coordination could be achieved by agents who feel *instrumentally* motivated to conform to a group-wide standard—and that, if the motivation is instrumental, we should not use the word 'norm'. But I further conjecture that the evolution of *non-instrumental* (or *intrinsic*) motivations to adhere to group-wide standards was also linked to toolmaking, and in particular to the problem of motivating sustained practice. Mastering Acheulean tool manufacture requires years of sustained practice. Achieving mastery would plausibly have yielded long-term direct fitness benefits, especially if high quality tools could be exchanged for other resources, but it is implausible to suppose that years of practice were motivated by explicit knowledge of the long-term fitness benefits. Given the long-term fitness benefits and the difficulty of being motivated by them, I hypothesize that selection favoured agents who were *intrinsically motivated to master skills*—agents who felt satisfaction at improving their skill level, and discontent at any aspect of performance that fell short of their internalized standard.

So far, our focus has been on the *self-regulation* of skill execution and practice. However, human normative cognition involves monitoring *other people's* behaviour for conformity with norms, not just one's own behaviour (Bicchieri 2005). I propose that this other-directed side of normative cognition was driven by the need to *teach*, and not just execute, standardized toolmaking techniques. Once agents have cognitive control models, it is a small step from using them to regulate one's own behaviour to using them to regulate the behaviour of others. Taking this step was advantageous for hominins because the manufacture of Acheulean bifaces is a dangerous activity in which small errors can lead to serious injury, especially to the hands (Hiscock 2014). Intentional teaching, in which an adult closely monitors the performance of a learner and anticipates errors, is a way of managing that risk. Injuries can be forestalled, and low-cost micro-punishments can be administered in their place, benefiting the direct fitness of the learner and (provided teacher and learner are genetically related[2]) the inclusive fitness of the teacher.

A note here on timing: the core commitments of the skill hypothesis (as outlined in Section 1) do not rely on a link to the Acheulean. One could hold on to these core commitments while pushing the origin of standardized toolmaking supported by technical norms and teaching back into the Oldowan, or forward into later modes of toolmaking. Nonetheless, I think it is worthwhile to put forward a specific version of the skill hypothesis, including a link to the Acheulean, in the interests of starting debate and facilitating empirical testing.

4 The Expanding Normative Domain

How might a capacity for the micro-regulation of technique have been co-opted for the internalization of much more general and abstract social norms? Once hominins possessed a versatile capacity for internalizing technical norms, they could use it for other things, including other collaborative activities. Simple norms of fairness may have arisen in the context of collaborative hunting: skilful execution of a hunt would end with a skilful division of the spoils, guided by technical norms specifying our way of carving up a carcass. Norms of equitable division would have been favoured in this context because they benefited the agent, in the long run, by showing them to be a trustworthy and profitable cooperation partner (Baumard 2016; Tomasello 2016).

Norms of reciprocal exchange may have originated with the emergence of large-scale exchange networks in the late Palaeolithic (Marwick 2003). Sterelny (2014) has argued that expanding social groups and exchange networks created a ‘Palaeolithic reciprocation crisis’, a package of coordination problems resulting from the demands of reciprocity in large networks. Larger groups favour greater specialization: in a late Pleistocene network of 500 or more individuals there might, for example, be market for a full-time specialist toolmaker or spear-thrower. But specialization requires reciprocal exchange (e.g. of tools for food), and reciprocal exchange requires norms of market value: one must know how much food a handaxe is worth, for example. These norms, although apparently quite abstract, may have begun as norms of skilled behaviour in specific situations: norms of how to

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[2] On the importance of parent-offspring transmission of craft skills in hunter-gatherer societies (especially transmission from the same-sex parent), see Hewlett/Cavalli-Sforza 1986; Shennan/Steele 1998; Shennan 2002; Mameli 2008.

barter skilfully round the campfire, norms of what to offer and what to accept in one-on-one interaction.

Larger groups also faced the problem of creating group cohesion by means other than one-on-one bonding (Dunbar 2014). A solution was ritual: skilful collective performances, high in emotional and mnemonic resonance. A capacity to internalize technical norms, including norms concerning long sequences of actions, would bring with it a capacity for ritual. Indeed, toolmaking practices can resemble rituals. Norms of ritual may have begun as norms of skill execution: norms of how to dance, or make music, our way.

Norms of ritual are, in turn, a step towards norms of kinship. At some rituals, inter-band monogamous pairings would have been initiated, guided by norms of who can pair up with whom (Chapais 2008; Allen et al. 2011). As we noted earlier, kinship norms are among the most abstract norms, specifying (for example) that one may marry a cross-cousin but not a parallel cousin. However, the first kinship norms may have been concrete norms of skill execution in group rituals: a skilled performer knows where to go, whom to dance with, which moiety (descent group) to attach to, and is led by norms of ritual behaviour to an appropriate mating partner.

In short, humans have evolved highly elaborate systems of abstract norms encompassing trade, ritual and family life. I hypothesize that these norms were learned, stored and executed using mechanisms that had originally evolved for the standardization and teaching of toolmaking techniques.

5 Testing the Skill Hypothesis

The preceding sections have outlined a *hypothesis*. I have not claimed that this hypothesis commands compelling evidential support, only that it meshes well with the evidence we currently have. The skill hypothesis leads to several predictions that, if confirmed, would strengthen the positive evidence in its favour. Here are five predictions regarding the role of internalized technical norms in the execution of complex skills:

1. When executing an existing skill in challenging (not easy) conditions, performance will be impaired (not enhanced, or left unchanged) by a distracting cognitive task.
2. The effect of a distracting task will be more severe when the task is normative in character (e.g. making evaluations of others, or ruling on the severity of norm violations) than when it is non-normative, holding fixed task difficulty.

3. The ability of an agent to provide verbal reasons for their adjustments to technique when executing a skill will be correlated with their ability to provide verbal reasons for their intuitive normative judgements. In other words, 'moral dumbfounding' (Haidt 2001) will be linked to 'skill dumbfounding'.
4. People who feel stronger affective responses to their own failures of skill execution (e.g. strong feelings of shame) will also feel stronger affective responses to their own social norm violations.
5. Likewise, people who react more strongly to others' violations of technical norms (e.g. with strong feelings of anger) will react more strongly to others' violations of social norms.

And here are four predictions regarding the ethnographic and archaeological records:

6. Technical norms (as shown by standardized toolmaking) will not post-date more abstract norms of ritual, reciprocity, fairness and kinship.
7. Abstract social norms, such as norms of kinship, will be such that they could, at least initially, have been enacted as norms of skilled performance in a specific context, such as a ritual.
8. The complexity of the technical and non-technical norms a society can support will be correlated, both in the ethnographic record and over archaeological time. A population's ability to support more complex technical norms will be linked to an ability to support more complex norms in the rest of the social world.
9. A clear step up in the sophistication of technical norms, such as the shift from mode 2 to mode 3 toolmaking, will be followed (rather than preceded) by a step up in the sophistication of non-technical norms.

In sum, although it has yet to receive serious empirical attention, I take the skill hypothesis to be consilient with recent trends in the psychology and archaeology of skill. By bringing out a neglected connection between the psychology of skill and the psychology of norms, my hope is that the hypothesis will open up new lines of investigation for cognitive science, archaeology, evolutionary anthropology and philosophy.

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