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The role of cultural practices in the emergence of modern human intelligence

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Innate cognitive capacities are orchestrated by cultural practices to produce high-level cognitive processes. In human activities, examples of this phenomenon range from everyday inferences about space and time to the most sophisticated reasoning in scientific laboratories. A case is examined in which chimpanzees enter into cultural practices with humans (in experiments) in ways that appear to enable them to engage in symbol-mediated thought. Combining the cultural practices perspective with the theories of embodied cognition and enactment suggests that the chimpanzees' behaviour is actually mediated by non-symbolic representations. The possibility that non-human primates can engage in cultural practices that give them the appearance of symbol-mediated thought opens new avenues for thinking about the coevolution of human culture and human brains.

Keywords: cultural practices; evolution of cognitive processes; chimpanzee cognition; symbol-mediated thought; enacted representations

1. SEEKING THE SOURCES OF MODERN HUMAN COGNITION: CULTURE AND BRAIN

Many accounts of how humans became the creatures they are rely on speculations about changes in the neural architecture of the human brain. For example, Clark (2001, ch. 8) says, 'The idea is that some relatively *small* neural (or neural/bodily) difference was the spark that lit a kind of intellectual forest fire. The brain is, let us assume, wholly responsible (courtesy, perhaps of some quite small tweak of the engineering) for the fulfillment of some precondition of cultural and technological evolution'. It is certainly the case that anatomically modern human brains are different in important ways from the brains of any other present or past primates. Let us call these underlying preconditions cognitive capacities. In this paper, I will argue that the human cognitive system is best conceived as a distributed system that transcends the boundaries of the brain and body. This system includes objects, patterns, events and other living beings in the setting in which human (and non-human) cognition takes place. This is the so-called 'distributed cognition' premise. While it is certainly possible and productive to study processes that are internal to individuals, cognitive outcomes, including category assignments, inferences, decisions, judgements and so on, are often better understood as properties of the distributed cognitive system than as properties of any of the individuals participating in the distributed system. When cognition is understood this way, then it also becomes clear that cultural practices provide transformative elements of the human cognitive system. High-level cognitive outcomes emerge from the orchestration of the elements of distributed cognitive systems by cultural practices. This fact also implies that we must be careful when attributing cognitive processes to individuals who are engaged in cultural practices. There is a danger of attributing to the individual cognitive properties that belong to the larger distributed system.

The idea here is that a good deal of contemporary thinking, and probably an even greater proportion of ancient thinking, happens in *interaction* of brain and body with the world. This seems innocent enough and many people take it to mean simply that thinking is something that happens in the brain as a consequence of interaction with the world. That is not the claim being made here. The claim here is that, first and foremost, thinking *is* interactions of brain and body with the world. Those interactions are not evidence of, or reflections of, underlying thought processes. They are instead the thinking processes themselves.

If true, this approach to cultural practices has many implications. An obvious implication is that if two cognitive systems include different cultural practices, they can have dramatically different functional properties even when the brains and other physical resources in the system are identical. We are all familiar with this fact, and it is a primary motivation for educational activities.[1]

With respect to the emergence of modern human intelligence, this approach to cultural practices has some less obvious implications. First, because outcomes typically arise from the orchestration of capacities by practices, cognitive capacities cannot be inferred directly from outcomes. The mediation of the relation between capacities and outcomes by cultural practices also means that the evolutionary value of cognitive capacities cannot be inferred directly from the supposed use of cognitive outcomes. The material and social world are structured by cultural historical processes in a cognitive ecology. Outcomes are often

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the product of interactions between persons (capacities orchestrated by cultural practices) with the material and social world. The interpretation of cognitive capacities, as revealed by experimental methods, must be informed by an analysis of the cultural practices of experimentation. That is, because every experiment proceeds by the deployment of cultural practices in a richly structured material and social context, attributing the observed cognitive outcomes directly to the participants (subjects) may be problematic.

If cultural practices can transform cognitive systems, it means that the commonly assumed ordering of evolution and history can be rearranged (Ingold 2000, p. 392). Rather than assuming that biological evolution must have acted first to make our ancestors' brains capable of language and cultural processes, after which cultural history took over to produce the presently observed diversity of languages and cultures, it seems equally probable that the innovations that make modern thought possible were innovations in cultural practices. Once having arisen in the social world, of course, such changes would create new selective pressures to which biological evolution could respond (Strum *et al.* 1997; Hutchins 2006).

Undoubtedly, anatomically modern human intelligence emerges (in real time, not historically speaking for the moment) from the operation in the here and now of a system that includes a brain that is anatomically different from the brains that are involved in the emergence of animal intelligences. But how shall we sort out the relative contributions of cultural practices from those of brain anatomy?

2. HOW CULTURAL PRACTICES PRODUCE COGNITIVE OUTCOMES

Cultural practices are the things people do and their learned ways of being in the world. For my purposes, a practice will be labelled cultural if it exists in a cognitive ecology such that it is constrained by or coordinated with the practices of other persons. Virtually all external representations are produced by cultural practices. All forms of language are produced by and in cultural practices. Speaking is accomplished via discursive cultural practices. The specifics of each language require its speakers to attend to some distinctions and permit them to ignore others. This 'thinking for speaking' (Slobin 1987, 1996) implies that even low-level perceptual processes are often organized by cultural practices. Cultural practices include particular ways of seeing (or hearing, or feeling, or smelling) the world. Cultural practices are not cultural models traditionally construed as disembodied structural representations of knowledge. Rather they are fully embodied skills. Cultural practices organize the action in situated action.

Humans inhabit the worlds that are full of cultural meaning. The enaction approach (Havelange *et al.* 2003; Thompson 2007) reminds us that every meaning that is apprehended is made, not received. Noë's (2004) contention that perception is something we do, not something that happens to us, is especially true for the perception or apprehension of cultural meaning.

(a) *Two systems of preliterate cultural practices*

Let us consider two cases of preliterate cultural practices that are the foundation of important adaptive cognitive accomplishments: reading the sky as a sidereal calendar and navigating Micronesian style. I choose the practices of preliterate cultures here because literacy introduces many complexities and its effects permeate the cognition of literate societies.

On Boyowa Island in the Trobriand Islands of Papua New Guinea, a small number of specialists are given the responsibility of setting the agricultural calendar for all of the island's villages. Early in 1976, as part of a 2-year ethnographic study on Boyowa, I interviewed a magician cum astronomer named Dauya. Dauya lived in Wawela village, which is one of the only villages on the island with an unobstructed view of the eastern horizon. The weather patterns in the Solomon Sea vary from year to year, so that yearly changes in the weather, the onset of dry weather for example, are only approximate indicators of the season. Linking the timing of the preparations of the gardens to changes in the weather may leave the crops subject to unfavourable conditions months later. The problem is to fix the agricultural calendar to a seasonal calendar that is not subject to year-to-year variability in the timing of weather changes. Dauya does this by examining the sky. His general observation of the movement of a large number of named constellations tells him when he should begin making careful observations of the dawn sky. He searches for Kibi (what we call the Pleiades) among the stars that are visible just before dawn. When Kibi is visible in the pre-dawn glow, then it is time to begin preparing the gardens. This happens at the time of each year known on our calendars as early June. The search for Kibi in the dawn sky is a non-trivial activity. It depends on where and when Dauya locates his body on the beach at Wawela. It depends on the orientation of his body to the pre-dawn sky. His looking often involves first finding other, more prominent, stars and then using his embodied knowledge of their spatial relations to determine where to focus his attention in the search for Kibi. Dauya's incremental construction of the star patterns that may be partly occluded by cloud is a complex form of active interaction with the sky. The success of the process depends on Dauya's brain, of course, but also on his body and his eyes, and on a set of traditional cultural practices that orchestrate the interactions among a complex collection of elements. The physical properties of the night sky play a role too. For example, the stars are not evenly spaced in the sky. Their clumpy distribution makes the construction of constellations (groups of stars that can be conceived as being more related to one another than to other stars) possible.[2]

Dauya can do this job because he has been enculturated into the practices of Trobriand astronomy. The knowledge base (both procedural and declarative) that he commands is the product of millennia of incremental development. Dauya's cognitive accomplishment depends on this tradition and on the institutionalization of his role and the implied social relations of the astronomer to the other villagers. So, while it is certainly true that changes have taken place in Dauya's brain as a consequence of acquiring the skills of a Trobriand astronomer, it is not correct to say that the cognitive capacity to fix the agricultural calendar resides in Dauya's brain. That capacity is a property of the complex cognitive ecology that includes Dauya's brain, his body, his eye, the sky and the cultural practices that put all of the other parts into coordination in a productive way. Sidereal calendars are widespread in preliterate societies. The cognitive accomplishment of determining the seasons with great precision—regardless of the weather that is occurring—is orchestrated by a set of ways of seeing the sky and a way of being in the social and material world.

Setting a sidereal calendar is a relatively simple cultural practice. Let us now consider a more complex activity (perhaps one of the most complex activities) practiced in preliterate societies. Micronesian navigators routinely cross long stretches of open ocean without reference to any tools or material representations. They reliably make landfall on tiny specks of coral (Gladwin 1970; Lewis 1972; Hutchins 1983, 1995). Micronesian navigation is a form of embodied cultural practice. The navigators direct their attention to the night sky in ways similar to those used by Dauya to construct a sidereal calendar. The Micronesians see not only a calendar, but also a compass in the sky. They also master a set of cultural practices for attending to the sensations of their own bodies while sailing to judge the angle of the path of the canoe to the prevailing swell in darkness. One of their cultural practices seemed especially puzzling to Western researchers. When out of sight of land, Micronesian navigators imagine that their canoe is stationary under the dome of the sky and that the islands move past them.[3] These and many other cultural practices of seeing, imagining and remembering are orchestrated into a complex system that produces the powerful cognitive outcome of being able to guide a canoe over long distances without charts or other tangible navigation tools. Like the Trobriand sidereal calendar, this system is a cultural accomplishment, not the achievement of any individual. And like the Trobriand case, even in the moment of individual practice, the system that accomplishes the navigation feat includes the navigator, his environment for action and the learned cultural practices that establish and maintain the required relations among the elements of the distributed system.

These two examples illustrate how cultural practices build upon the human biological endowment to produce cognitive accomplishments. In fact, all high-level cognition is a product of a system that includes cultural practices, habits of attending, ways of using the body in interaction with one's material and social surrounds.

(b) *A simple capacity and a family of practices*

Key elements of the two palaeoastronomy systems described above are that a pattern in the world is simultaneously seen and 'seen as' something else entirely. Individual stars are seen, but groups of stars are seen as a related collection, a constellation. Seeing a constellation is an act of imagination, not a simple perception. A constellation may be seen as having a shape, a name and even a persona. This phenomenon of 'seeing as' is both very old and absolutely fundamental to cognition. While seeing stars as a constellation produces a static structure, the process of seeing the constellation is often dynamic. Trajectories are applied across some stars to create a path that leads to other stars in the constellation. The superposition of an imaginary trajectory onto visible structure is a powerful cognitive strategy for transforming spatial relations into temporal relations. We must assume that humans have an innate capacity to perform this superposition. But cultural practices organize this capacity into a surprising range of cognitive outcomes. A very early instance of this strategy appears in the construction of stone tools approximately 300 000 years ago (Wynn 1989). By that time, our ancestors were apparently imagining trajectories along the edge of stone tool cores. By striking the core in the order implied by the trajectory, a controlled sequence of impacts could be produced. In non-literate societies, counting tasks are often shaped by placing the objects to be counted in space such that the superposition of a simple trajectory across the objects ensures that each object is counted once and only once. The 'method of loci' is a more complex practice by which ideas are associated with spatial locations. A simple trajectory superimposed on the locations produces a sequence of ideas. In a theatre, an actor can remember his lines by associating them with elements of the architecture. A more complex version of the method relies on assigning the ideas to a remembered or imagined space rather than onto elements of the actual space occupied by the user of the method. While this strategy is known to us as a strategy developed by Greek orators, it also appears to structure many narratives in non-literate societies. For example, Trobriand Island myths often unfold across an imagined geographical space onto which a simple trajectory is superimposed, thus producing a sequence of events (Harwood 1976; Hutchins 1986). In contemporary settings, assembly and inspection sequences are often controlled by arraying objects in space such that a sequence can be created by superimposing a simple trajectory on the spatial array (Kirsh 1995). The widespread (but by no means universal) practice of standing in a queue involves *seeing* spatial order *as* a proxy for temporal order (Hutchins 2005). Finally, reading is a cultural practice par excellence, and it depends on the superimposition of trajectories of attention over spatial arrays of words or symbols, thus producing a temporal sequence of attending.

Imagining a trajectory across perceptible space is the basis for the more complex practice of superimposing an imagined trajectory on imagined space. This latter practice appears in cognitive linguistics as the 'trajectory image schema' and has been shown to underlie a wide range of conceptual structures (Lakoff 1987, p. 443; Gibbs 2006, pp. 95–96).

(c) *Enacting high-level cognition in the cultural practices environmentally coupled gesture: science and technology*

The practices of imagination via environmentally coupled gesture (Goodwin 1994) permit people to add motion to otherwise static external structures. A child imagines the arrival of her doll in the toy kitchen by animating the doll and moving her into the doll house. A pilot moves his hands across a control panel in an aeroplane while imagining the invisible flow of fuel in a pipe (Hutchins & Palen 1997). A biochemist imagines the dynamics of a molecule by aligning her hands with a graphical display and then moving her hands (Becvar *et al.* 2005). A brain scientist imagines a fictional deformation of a section of brain by touching a diagram and then moving her hands (Alač & Hutchins 2004). A ship navigator imagines non-existent lines of position by moving his fingers over a chart (Hutchins 2006). An architect moves his fingers on a building diagram and imagines the movements of an occupant of a building that has not yet been constructed (Murphy 2004). In each of these cases, two kinds of seeing as are combined. Each makes use of a rich culturally elaborated static medium (doll house, control panel, molecular diagram, brain image, navigation chart and architect's rendering). The static medium is both seen as a thing in itself and seen as the thing it represents. One's own body is simultaneously seen and seen as something quite different from a body. The dynamic relation of the body to culturally meaningful objects allows the body to be seen as some dynamic aspect of the domain that is represented by the objects. The body provides animation to an otherwise static cognitive lifeworld.

Cultural practices that orchestrate this seeing as phenomenon produce a huge range of cognitive effects in modern human intelligence. When humans engage in symbolic processes, they are engaging in cultural practices for seeing as. Since symbolic representation is a culturally orchestrated activity, one wonders how such a state of affairs might have arisen. What role did cultural practices play in the cognitive lives of our distant ancestors? What role do they play in the cognitive lives of non-humans? Unfortunately, cultural practices leave only indirect evidence in the archaeological record, so reconstructions of the practices of our ancestors are necessarily speculative.[4] Things are a little clearer with contemporary non-humans because in some cases, the transformative effects of cultural practices are directly observable. For example, it is widely accepted that with extensive language training some human-enculturated chimpanzees are capable of symbol-mediated behaviour. This is a nice demonstration of the idea that the acquisition of cultural practices can transform the cognitive abilities of non-humans.

3. CULTURAL PRACTICES UPGRADE THE MIND OF THE CHIMPANZEE

Thompson *et al.* (1997) caused some excitement recently by arguing that chimpanzees can do symbol-mediated reasoning (as indicated by the performance on a conceptual match-to-sample task) without prior language training. They claim to show that the chimpanzee mind can be 'upgraded' to a mind that can represent and reason about abstract relationships. According to Thompson *et al.*, this upgrade is achieved because the chimpanzees learn to treat physical tokens as symbols for abstract relationships and then can covertly manipulate (in this case, match) imagined symbols. Treating tokens as symbols is an instance of a cultural practice of seeing as, as discussed above. The chimpanzees appear to learn how to do this as they engage in social interactions with their keepers. This is relevant to the current argument because it shows that *a qualitative change of just the sort that is presumed to underlie the shift from pre-symbolic to symbolic reasoning could occur in a non-human primate as a consequence of a change in a cultural practice without any change in the nature of the animal's brain*. In this section, I will argue that while participating in cultural practices with humans in the experimental context does produce new cognitive outcomes for the chimpanzees, the reasoning they perform is probably not based on symbolic representations.

The key phenomena of the Thompson, Oden & Boysen study are these. It is known that infant chimpanzees who can match objects on the basis of physical appearance cannot match conceptual relations among objects even when given extensive training. However, infant chimpanzees do perceive 'similarities and differences between exemplars of identity and non-identity relationships despite their inability to judge the equivalence of such relationships in a conceptual matching task' (Thompson *et al.* 1997, p. 32). Thus, sensitivity to abstract relations exists before any training, but the animals cannot use that perceptual ability to judge relations among relations among objects.

Three activities are involved in the experimental procedure. There is a conditional discrimination task in which the chimpanzee learns to match tokens to the abstract property of same or different in the relation between pairs of objects. There is a physical match-to-sample task in which the chimpanzee faced with two alternative pairs chooses the alternative pair that is a match to a sample pair. Finally, there is the conceptual match-to-sample task in which a chimpanzee faced with two alternative pairs (neither of which is a physical match to the sample pair) chooses the alternative pair that exemplifies the within-pair relation, same or different, exemplified by the sample pair. The five animals in the study were all traditionally reared captive chimpanzees (*Pan troglodytes*). Four of the five were adults and one was a juvenile. One of the adults had received language training. The other three adults had a history of conditional discrimination training, as well as a 'history of counting in which they had been trained to associate Arabic numerals with numeric arrays' (Thompson *et al.* 1997, p. 32). The juvenile had neither language training nor training on conditional discrimination.

(a) *Conditional discrimination task*

The animals used in the experiment lived in a group housing complex in which they had access to indoor and outdoor areas. They 'had been taught to 'take turns' at entering an adjacent test room for experimental sessions'. We do not know the details of their day-to-day interactions with their keepers but we must presume that they know many ways to coordinate their behaviour with their human handlers. One of these is to participate in experiments. Critically, four of these animals also had the experience of *conditional discrimination training* using tokens and multiple pairs of objects.

A Lexan window extends along one side of the experiment room separating a chimpanzee indoor area from an experimenter area. There is a narrow shelf on the experimenter's side of the Lexan window. Stimuli can be presented by the experimenter on the shelf, and the chimpanzee can respond by touching images that appear on a touch-sensitive video monitor that is located in the chimpanzee side of the test room at right angles to the window. Rewards can be dispensed via a plastic tube that projects through the window. The experimenter presents a pair of objects on the shelf. The chimpanzee then chooses a token, from the two presented on the video monitor screen, to go with the pair of objects that has been presented. If the objects in the pair were physically identical, the animal was rewarded for choosing a particular token, in this case a heart shape. When presented with a pair of non-identical objects, the animal was rewarded for choosing a different token, in this case a diagonally shaped token. In this activity, Thompson *et al.* say that the tokens may be said to serve as a code for abstract relations among pairs of objects.

Thompson *et al.* then make a surprising prediction concerning chimpanzee performance on the conceptual match-to-sample task. They predict that chimpanzees who have had conditional discrimination training 'should match conceptually on their first encounter with the problem' (Thompson *et al.* 1997, p. 33). And the prediction is borne out by the experiments. The three chimpanzees who had no prior language training and no prior experience with conceptual matching tasks, but who had learned to code relations using physical tokens, did reliably succeed on the very first trials of the conceptual match-to-sample tasks. The language-trained chimpanzee that also had conditional discrimination training was successful. The juvenile that had neither conditional discrimination training nor language training, and that the authors say was not really enculturated into the experimental activities did not succeed at conceptual match-to-sample.

(b) *Conceptual match-to-sample task*

Blocks of physical match-to-sample trials were alternated with blocks of conceptual match-to-sample trials. In both physical and conceptual match-to-sample trials, an experimenter places a sample object pair on a shelf in the experimenter's side of the window. The choice alternatives then appear on the video screen. Two choice alternatives appear. In the physical match-to-sample task, one of the alternative pairs is a physical match to the sample pair. Choosing the physical match pair is considered to be the correct response. In the conceptual match-to-sample task, one is a pair of identical objects (but not identical to the sample pair) and the other is a pair of non-identical objects (neither identical to the elements of the sample pair). The chimpanzee indicates its choice by touching an alternative pair on the video screen. In the conceptual match-to-sample trials, choosing the identical pair alternative in response to an identical sample pair and choosing the non-identical alternative pair in response to the non-identical sample pair are considered correct responses. Since the alternative pairs never share objects with the sample pairs, correct performance requires the animal to match the relation between the objects in the sample object pair with the relation between the objects in the alternative object pair. Thus, it is conceptual relations rather than objects that must be matched. All responses, whether correct or not, were rewarded in the conceptual matching trials.

Thompson *et al.* argue that the experience of the conditional discrimination task provides the chimpanzee with the means to perform conceptual match-to-sample: the ability to represent the concepts of identity and non-identity and to code those representations with specific tokens. Thompson *et al.* say that the 'function of the token (learned in the conditional discrimination training) is to provide an animal with a concrete icon for encoding an otherwise abstract propositional representation' (Thompson *et al.* 1997, p. 41). Chimpanzees with these skills encounter the conceptual matching task. They encounter the sample pair, and they can partially deploy their skill with these objects by classifying the relation between the sample pair of objects. According to Thompson *et al.*, the chimpanzee can imagine choosing the token that would be chosen with this sample pair. But when they turn to the computer touch screen to choose a token, the tokens that were learned in the conditional discrimination task are not present. The chimpanzee encounters instead two alternative pairs of objects on the screen. The chimpanzee can then imagine choosing the token that would be chosen with each of the alternative pairs. Finally, the chimpanzee can choose the alternative pair that is associated with the symbol that matches the symbol associated with the sample pair. They describe the choice process as follows: 'The chimpanzee can now covertly match these representational icons (e.g. heart and diagonal) against the symbolic representation of heart or diagonal evoked by the sample' (Thompson *et al.* 1997, p. 42). Thompson *et al.* refer to this process as *covert symbol matching*.

The 'covert symbol matching' interpretation of the chimpanzees' behaviour assumes that the tokens play a role in the performance of the task. However, the experiment provides no direct evidence that this is the case. The covert process that is offered as an explanation is not observable. The involvement of the tokens is inferred from the lack of a competing explanation for the animals' behaviour.

(c) *A reinterpretation of chimpanzee match-to-sample behaviour*

I would like to attempt an alternative interpretation, one that is based on a combination of the cultural practices perspective with the theory of embodied cognition and enaction. This reinterpretation reinforces the point about the role of practices, but also provides a cautionary lesson about the attribution of the presumed abilities. Let us look more closely at the experiments.

It is important to note that the animals that participated in these experiments are enculturated. The distinction between 'human-enculturated' and 'traditionally reared captive' animals is not that the animals are enculturated in one case and not enculturated in the other. Of course, animals in both the human-enculturated and the traditionally reared captive conditions are enculturated into human practices. The difference has to do with the relation of the practices into which the animals are enculturated to the activities that humans normally engage in. If the practices are those of everyday human life, then the animal is said to be human enculturated. However, if the practices are those of the special form of human life that is animal experimentation, then the animal is enculturated, but is said to be not 'human enculturated'. If the practices are those of everyday life of the species as it lives in the wild, the animals are said to be not enculturated. The key observation here is that all animals in this study were enculturated to the settings of psychological experimentation. In a recent survey of experimental methods in research on social attention in non-human primates, Johnson & Karin-D'Arcy (2006) point out, 'Ecological validity also demands recognizing that the laboratory setting, itself, constitutes an ecology—that is, a complex set of relationships between the subject and its social and physical environment. This entails, in part, acknowledging that every trial is a social interaction.'

First, consider the conditional discrimination task. According to Thompson *et al.*, prior training on the conditional discrimination task is the key experience. As explained above, the chimpanzee will be rewarded for choosing a heart-shaped token in response to a pair of identical objects or choosing a diagonal-shaped token in response to a pair of non-identical objects. This interaction between experimenter and chimpanzee has the structure of a game. It is a repeated interaction with a reliable script-like structure. A particular abstract property of the experience of the interaction with the pair of objects must be 'noted'. The socially situated object-mediation activity is what brings the process of noticing this socially foregrounded property into coordination with the action of choosing a token to go with it. Learning to participate in a practice such that the choosing activity is made contingent on the noticing activity makes the relational property of the pair (identical or non-identical) part of what the interaction is about.

The animals' performance on the conditional discrimination task, thus, has two parts: discriminating identity pairs from non-identity pairs and learning to associate the appropriate token with each kind of pair. Thompson *et al.* focus on the tokens and give insufficient attention to the process of making the discrimination. We know that chimpanzees have the perceptual capacities needed to distinguish identical pairs from non-identical pairs. But this relation among the pair of objects is 'seen' much as a constellation is seen by humans. Seeing a within-pair relation is an act of imagination, not a simple perception. No one knows precisely what this seeing consists of for the chimpanzees. Thompson *et al.* refer to this as the 'relational dimension within pairs' the chimpanzees were using to 'denote sameness between pairs'. They say, 'Regardless of the functional within-pair relational dimension, the resulting matching judgement of relational equivalence between relations (AA=BB; CD=EF) could not be based on physical dimensions of colour shape or size'. This is probably true, but what of the process of seeing the relational dimension within pairs? Whatever this process is, the experience of finding the relation that humans denote as 'same' will be different in character from the experience of finding the relation that humans denote as 'different'. According to enactment theory (Havelange *et al.* 2003; Thompson 2007), the process or practice of seeing the within-pair relations is an enacted representation of the relation. The pair relation is 'brought forth' or 'rendered present' by this practice. While this representation is not symbolic, it may still be sufficient to enable some subsequent cognitive processes. For example, these enacted representations may be sufficient for judging relations among enacted representations. If that is true, then there is no need for token-as-symbol mediation in order to do conceptual match-to-sample tasks.

The success of chimpanzees at physical match-to-sample is not surprising. Physical matching is a common component of the practices that captive chimpanzees engage in. Note that with the enacted representation (a practice learned in the context of conditional discrimination task) it is not necessary to use the tokens to 'code' the relation. The chimpanzee can use the newly acquired practice to enact the relation between the sample pair.[5] It can use the same practice to enact the relations among the alternative pairs. It can then match the enacted representations to do either physical or conceptual match-to-sample. The physical match-to-sample trials have two additional helpful structural elements. First, the correct pair not only matches the relation, as seen via the practice of enacting the representation of the relation, but matches the physical properties as well. Second, the correct responses—those achieved redundantly by the physical matching procedure and by the use of the new cultural practice—are rewarded. In the experiment, physical match-to-sample can scaffold conceptual match-to-sample performance because the chimpanzee can employ the same cultural practices in both types of trial blocks.

The sufficiency of the enacted representation as a mediator of subsequent relational matching is especially probable when the enacted representation developed by a given animal is used by that same animal later to do conceptual match-to-sample. The enacted representation developed by one animal would be of no use to another animal because, given the rich and personal experiential nature of the representation, it would be difficult or impossible to communicate it to another animal. Symbolic representations would not be needed to support memory of a rich experience, but they are a way to solve the problem of dealing with the restricted bandwidth of inter-animal (inter-personal) communication (Minsky & Papert 1988; Hutchins & Hazlehurst 2002).

Vygotsky (1978) said that all higher level cognitive processes appear twice. They appear first as inter-psychological processes and only later appear as intra-psychological processes. The practice of discriminating between identity pairs and difference pairs arises in the conditional discrimination activity. Because this discrimination is always socially scaffolded in the conditional discrimination activity, we cannot know whether or not it is available as an intra-psychological process. The fact that it appears to mediate conceptual match-to-sample is an indication that the practice of discriminating identity from non-identity has been internalized. This practice is a resource that can be used later in both the physical match-to-sample task (where it works redundantly with physical matching practices to guide choices under conditions of differential reinforcement) and in the conceptual match-to-sample task where it is the principal mediator of task performance.

Thompson *et al.*'s inference that the chimpanzee must entertain a 'notion' that the token is a label may be illusory. The chimpanzee may be able to participate in this cultural practice without entertaining any such notion. From a phenomenological perspective, the desire to attribute a notion like this to the chimpanzee is a symptom of an analyst's point of view on a cognitive system, and is driven by an unarticulated assumption that reasoning about abstract properties requires symbolic representations. The enaction framework provides an alternative explanation.

The process of mediation by enacted representation described here is just as covert as the symbol matching process suggested by Thompson *et al.* Why should we prefer this explanation to theirs? First, it is simpler. The enacted representation is a precondition for the symbol mediation as described by Thompson *et al.* The enacted representation is the experienced activity to which the labels can be attached. And the enacted representation is sufficient for the observed behaviour. Second, approaching this phenomenon from the embodiment perspective highlights the animal's engagement with the task world. The data are not reported in sufficient detail to support an analysis of the development of the practice. All we know is that the frequency of correct responses increases during the conditional discrimination task. However, the embodiment perspective predicts that it should be possible to track the development of the practice through changes in the patterns of the animal's allocation of attention and in patterns of eye gaze or body motion.

Thompson *et al.* consider it unproblematic to say that the tokens are codes for the relations in the world. But this is a sort of short hand that obscures important phenomena. The within-pair relation does not have an existence in the world independent of the activity of seeing it there. The token can be associated with this activity of seeing the within-pair relations. That is, the cultural practice of using symbols consists of associating the cultural practice of apprehending the physical form of a symbol with other cultural practices that enact symbolic or non-symbolic representations. The chimpanzees are doing something important and cognitively powerful here. But what they are doing still probably falls short of full blown symbol-mediated cognition.

Given the right sort of scaffolding—mixing physical match-to-sample with conceptual match-to-sample in a carefully organized ecology of cultural practices—the chimpanzees do seem to judge relations among relations. This is a cognitive accomplishment that is orchestrated by cultural practices in a particular carefully arranged social and material context. Even if it is not full blown symbolic processing, it is accomplishing the same thing that symbol processing was assumed to be accomplishing in this activity. The experimental activity elicits a set of practices that orchestrate the capacities of the chimpanzee in interaction with the material and social world in a way that produces the matching of the within-pair relations of the alternative to the within-pair relation of the sample. The cognitive outcome, performing conceptual match-to-sample, is still not a capacity that belongs to the chimpanzee. If conceptual match-to-sample exists in this case, it belongs to the experiment as a complex system of cultural practices.

The same must be true of many human cognitive abilities as well. Many cognitive outcomes produced by human activity systems are properties of our interactions with material and social settings, but we routinely mistake them for properties of ourselves (Hutchins 1995, ch. 9). Our cultural practices guide us to direct our attention to aspects of our material and social surroundings in ways that produce powerful cognitive outcomes. Many of our practices depend on our being able to imagine aspects of the material and social worlds and then being able to direct our attention to those imagined worlds. How many human performances that are assumed to be mediated by symbolic processes are actually orchestrated in other ways? No one knows. In order to answer these questions, we will need more systematic observations of naturally occurring cognitive activities.

4. THE COSTS OF IGNORING CULTURAL PRACTICES

Even some of the best theorizing about the origins of modern human intelligence is fundamentally disembodied. For example, Donald (1991) develops the notion of Exogram as 'a memory record outside the brain'. This seems friendly enough to the distributed cognitive view, but it has the unintended side effect of rendering cultural practices invisible. Memory is a process, and theorizing an object in the world as a memory record hides the process that is necessary to engage a material pattern *as* a memory record. This engagement process, what the phenomenologists would call seeing as or 'rendering present' should be the focus of cognitive analysis. Yet it lies outside the field of view of an approach that speaks of 'memory records outside the brain'.

According to contemporary neurophilosophy, brains have evolved to anticipate the dynamics of adaptive courses of action (Churchland *et al.* 1994). In a seminal paper, Rumelhart *et al.* (1986) said that humans are good at three things: finding patterns in experience, interacting with the world and imagining simple dynamics.

As useful as these specifications of what the human cognitive system is good at seem, they say nothing about the organization of thinking processes. What determines which patterns are found in experience? The nature of sensory apparatus and gestalt principles provide biases that make some possible patterns more salient than others. Beyond that, however, we are in the realm of cultural practices. Both the techniques of perceiving patterns and the organization of the system of patterns that are perceived are matters of cultural practice. A huge literature in cognitive anthropology and linguistics documents the variability in systems of categorization. What organizes human interactions with the world? The answer to this question is: cultural practices—twice. Cultural practices organize interactions with the world first by furnishing the world with the cultural artefacts that comprise most of the structure with which we interact. Second, cultural practices orchestrate our interactions with natural phenomena and cultural artefacts that produce cognitive outcomes. What determines how the dynamics of the world are imagined? The answer again is at least partly cultural practices. The engagement of the brain and body with the social and material world through the performance of cultural practices accomplishes several important functions at once. It is the principal, and perhaps the only, means of producing high-level cognitive processes. The enactment of embodied, non-symbolic representations, through which phenomena are seen as instances of culturally meaningful events and objects, is a cultural practice, not a passive innate process. And this is essential, because the existence of symbolic processes requires both a special set of practices for seeing symbols as symbols and a set of practices for enacting the representations with which symbols can be associated. Imagining interactions with the world takes place both online, while the interactions are taking place in the present world, and offline in memory and anticipation when the world is imagined. The offline imagination of enacted representations is a very powerful cultural practice. This includes the practice of imagining the dynamics of an imagined world of symbols.

By failing to see the role of cultural practices in the operation of the human cognitive system, we risk distorting our accounts of human intelligence. The appeal of ignoring cultural practices is understandable because if evolving cultural practices are excluded from the discussion, then the problem of explaining cognition can be reduced to two principal elements: the cognitive/functional capacities and the neuro/brain processes that produce the capacities.

I have tried to show the role of cultural practices in the orchestration of the elements of a distributed cognitive system which includes the brain, the body and the material and social worlds. I claim that higher level human cognition is produced by these distributed systems. But this complicates things significantly. When we understand cognition to be fundamentally embodied, distributed and constituted in part by cultural practices, then there are few kinds of human cognitive development that can be fully understood without reference to cultural practices.

The temptation to ask what the brain is doing is motivated by the dominant explanatory logic in cognitive science. Under that scientific cultural practice, one imagines an abstract, generally disembodied, cognitive process or ability and then tries to imagine how the brain could do it. But this is a mistake, because the answer sought depends on how the question was framed. For example, building on tacit assumptions about symbolic representations, Thompson *et al.* concluded that chimpanzees covertly match internal representations of shape tokens which serve as labels for abstract relations. But searching the chimpanzee brain for the neural structures that could support the use of internal representations of tokens as components of propositional representations of abstract relations is probably misguided. In the case of chimpanzee match-to-sample, we saw that the mediation of the task is in the cultural practices that enact non-symbolic representations. There is no need of an internal symbolic mediator. The assumption that there must be an internal symbolic mediator is driven by a set of unexamined assumptions and practices that constitute the culture of contemporary cognitive science. As long as the phenomena to be explained are constructed in the scenarios in which the brain is functionally isolated from the body and the cultural world, then our explanations will posit processes in the brain that do not belong there.

Cultural practices organize the interactions of persons with their social and material surroundings. These interactions are the locus of inter-psychological processes. Culturally constituted inter-psychological processes change through historical time. They are also targets for internalization as intra-psychological processes. Intra-psychological processes set the selective pressures for the evolution of biological cognitive systems. Therefore, rather than imagining that ‘some relatively *small* neural (or neural/bodily) difference was the spark that lit a kind of intellectual forest fire’ (Clark 2001), it is equally probable that a series of small changes in cultural practices gave rise to new high-level inter-psychological processes, which in turn shaped certain intra-psychological processes, and these in turn favoured certain small neural or neural/bodily differences over other neural or neural/bodily differences. Adaptation to these selective pressures could lead to population-wide changes in neural or neural/bodily systems, which would in turn make possible new cultural practices. In this account, there is no reason to favour changes in the brain over innovations in cultural practices as drivers of primate cognitive development.

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ENDNOTES

[1]This is also probably the best explanation of the Flynn effect—the observation that measured IQ seems to be rising in developed countries over the past century. Changing cultural practices better prepare children to produce the cognitive outcomes that are called for by traditional measures of IQ (Flynn 2007).

[2]Interestingly, some of the constellations recognized in the Trobriand system roughly match constellations identified in our own tradition. Some of these similarities suggest the operation of the gestalt laws of continuity and proximity. However, cross-cultural variability in the composition of constellations shows that gestalt laws are not sufficient to account for the observed culturally specific groupings.

[3]This conceptual transformation produces important cognitive economies (See Hutchins & Hinton 1984).

[4]Some aspects of practices can sometimes be inferred from their material residues, as is the case for stone tools, but even with contemporary explicitly symbolic practices such as literacy, what can be inferred about cultural practices from material residues is limited.
[5]Unfortunately, Thompson *et al*. do not say how much time elapsed between the conditional discrimination training and the conceptual match-to-sample trials.

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