

Chapter Twenty

Culture and Cognition

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Humans are unique among animals for both the diverse complexity of our cognition and our reliance on culture, the socially-transmitted representations and practices that shape experience and behavior. Adopting an evolutionary psychological approach, in this essay we consider four different facets of the relationship between cognition and culture. We begin with a discussion of two well-established research traditions, the investigation of features of mind that are universal despite cultural diversity, and the examination of features of mind that vary across cultures. We then turn to two topics that have only recently begun to receive attention, the cognitive mechanisms that underlie the acquisition of cultural information, and the effects of features of cognition on culture. Throughout, our goal is not to provide comprehensive reviews so much as to frame these issues in such a way as to spur further research.

1. Psychological universals

Psychological universals can be defined as those traits, processes, dispositions, or functions that recur across cultures, with at least a subset of each population (e.g., individuals of a specific gender or at a specific developmental stage) exhibiting the trait. The search for psychological universals has a long tradition, as illustrated by Darwin's

(1872) investigation of universal emotions, behaviorists' search for universal laws of learning (Hull, 1943), and the Chomskian approach to language and cognition (e.g., Chomsky, 1986). This tradition has been in part motivated by the desire to establish the "psychic unity" of humanity.

Because traits may recur across cultures due to cultural influences alone (via common cultural descent, cultural diffusion, or cultural evolutionary convergence), the strongest test of the universality of a given psychological trait is to search for it across maximally disparate cultures. One methodological concern, however, is that whether or not a trait is identified in different cultures will depend in part on how the trait is defined. For instance, if the specific circumstances that trigger shame in the USA are included in the definition of this emotion, shame is unlikely to qualify as a psychological universal; however, if the eliciting conditions are described more abstractly, shame is a good candidate for a universal emotion (e.g., Fessler, 2004). It is worth keeping this in mind to avoid empty verbal controversies about the universality of traits (Mallon & Stich, 2000). Relatedly, for many traits, similarities and differences across cultures will coexist (Brown, 1991; Norenzayan & Heine, 2005). Thus, shame might be present in all cultures, yet be triggered by different circumstances, or be expressed differently (see the notion of culture-specific emotion display rules in Ekman & Friesen, 1971).

1.1. Generatively entrenched homologies

Because cultures vary tremendously with respect to their ecology, social organization, scale, and technology, and because cultural variables affect cognitive development, one might wonder why psychological universals exist at all. The answer is simple for those

traits the development or acquisition of which reflects universal properties of physical or social environments, e.g., the belief that water is wet, or the distinction between males and females. The answer is not so straightforward for other psychological universals, because cultural variables could plausibly affect their development. One might argue that such universals are the product of evolution by natural selection, and that natural selection tends to select for species-typical traits (Tooby & Cosmides, 1992). However, this would be a mistake on two counts. First, much recent research emphasizes that natural selection has favored particular forms of phenotypic plasticity in humans, including the capacity to adapt to, and exploit, parochial cultural information. Second, one cannot presume that natural selection generates homogeneity. In most species, many traits are adaptive polymorphisms, either as a result of frequency-dependent selection or as an adaptive response to environmental variation in the species' range.

So, where do psychological universals come from? Some traits may be psychological universals because they are homologies—features possessed by humans and their relatives by virtue of common descent—that are generatively entrenched. A trait is generatively entrenched if its development is a necessary condition for the development of other traits (Wimsatt, 1986). Most modifications of a generatively entrenched trait are selected against because they prevent the development of these other traits. If a psychological trait in humans is homologous to traits in other species, then, given the general absence of culture outside of our own lineage, it follows that the trait originally evolved in a species that had little (if any) capacity for culture. If this trait became generatively entrenched, then natural selection had little scope to act on its development, which remained insensitive to cultural variables.

The approximate numerical sense provides a clear example of a generatively entrenched homology. Research in the USA and in Europe has established that children and adults possess an approximate number sense (Hauser & Spelke, 2004; Piazza & Dehaene, 2004), being able to approximate the cardinality of sets of visually presented objects or of sequences of sounds without counting, to compare the cardinality of different sets or sequences, and to approximate the results of adding several sets of objects. The accuracy of people's numerical evaluation obeys Weber's law: the mean evaluation is identical to the cardinality of the target set, and the evaluation's standard deviation linearly increases as a function of the cardinality of the target set. Because evaluation is thus increasingly noisy, the accuracy of the numerical comparison between sets or sequences increases as a function of the distance between the cardinality of the sets or sequences to be compared. These are the signature properties of an analogical encoding of the cardinality of sets or sequences.

Recent studies by Pica, Lemer, Izard, and Dehaene (2004) and Gordon (2004) provide strong evidence that this approximate number sense is a psychological universal.ⁱ Pica et al. studied approximate estimation, comparison, and addition among the Mundurukú, a small-scale society in Brazilian Amazonia having limited contact with non-indigenous people. Most Mundurukú have not received any formal education. Their language has words for only the numbers 1 to 5; above 5, the Mundurukú rely on locutions signifying "some" or "many." Strikingly, the numbers 3, 4, and 5 are also used to refer to approximate quantities. For instance, in Pica et al.'s experiments, the word for 4 was used for sets of 4 and 5 objects, and the word for 5 was used for sets of 5 to 9 objects. In spite of the differences between the Mundurukú counting system and that in

European (and other) languages, and in spite of the many other differences between the respective cultures, the Mundurukú's approximate number sense is identical to Europeans'. Their performances in estimation, comparison, and addition tasks show the signature properties of the analogical system assumed to encode the cardinality of sets or of sequences. Gordon (2004) found similar results with the hunter-gatherer Pirahã tribe in the Lowland Amazonia region of Brazil. Most strikingly, the language spoken by the Pirahã has words for only 1, 2, and 3. Nonetheless, their performances in tasks tapping into their approximate number sense were very close to Europeans' and Americans', providing further evidence for the universality of the approximate number sense.

The approximate number sense, evident in cultures as diverse as small-scale hunter-horticulturalist societies and modern, technologically complex societies, is also present in numerous animal species (Hauser & Spelke, 2004). Thus, in line with our discussion of the origins of psychological universals, the approximate number sense is plausibly a generatively entrenched homology.

1.2. Canalized traits

Not all psychological universals are generatively entrenched homologies. A number of uniquely human psychological traits are also universal because their development has been canalized during the evolution of human cognition. Natural selection selects against development pathways that rely on specific environmental inputs when these environmental inputs vary, when variation in these environmental inputs cause the development of variable traits, and when there is a single optimally adaptive variant (Waddington, 1940).ⁱⁱ When this happens, natural selection buffers the development of

the relevant traits against environmental variation by selecting for developmental pathways that do not depend on these environmental inputs. This phenomenon, known as canalization, likely explains the origins of some psychological universals. Note that, in contrast to the explanation of the evolution of psychological universals examined above, this second account can explain the universality of psychological traits that are not homologies.

Research on so-called folk theories provides some of the best evidence for such universals (Sperber & Hirschfeld, 2004; Boyer & Barrett, 2005). Folk theories are domain-specific, often implicit bodies of information that people use to reason. Although many folk theories vary across cultures, in some domains, folk theories have a universal core; folk biology and folk psychology are two such cases.

Some aspects of folk biology vary across cultures: in some cultures people have much more extensive biological knowledge than in others, and some reasoning strategies about the biological domain are found only in some cultures (for review, see Medin, Unsworth, & Hirschfeld, 2007). Despite such heterogeneity, across cultures, people classify animals and plants in a similar way (Berlin, Breedlove, & Raven, 1973; Berlin, 1992; Atran, 1990, 1998; Medin & Atran, 2004; Medin et al., 2007). Plants and animals are organized into hierarchically organized taxonomies of kinds that include (at least) three levels: a “generic species” category (e.g., dogs and cedars), a superordinate category of biological domains (e.g., animals and plants), and a subordinate category of species varieties (e.g., particular breeds or strains).ⁱⁱⁱ At any level, membership in a kind is exclusive. For instance, no animal is both a dog and a cat or a fish and a mammal.

From a cognitive perspective, the generic species level is of particular importance. Atran and colleagues have shown that while Itza' Maya's biological knowledge is much more extensive than American undergraduates', both Itza' Maya and American undergraduates avoid generalizing biological properties to the members of categories whose level is above the generic-species level (Coley, Medin, & Atran, 1997). Furthermore, in a range of diverse cultures, membership in generic species is associated with "psychological essentialism" (Medin & Ortony, 1989; Gelman, 2003; Medin & Atran, 2004): people believe that membership in a biological kind is associated with the possession of a causal essence—that is, some property or set of properties that define membership in the kind and cause the members of this kind to possess the kind-typical properties independently of their rearing environment. An essentialist disposition has been found among American children and adults (Keil, 1989; Gelman & Wellman, 1991), Yucatek adults (Atran, Medin, Lynch, Vapnarsky, et al., 2001), Brazilian adults (Sousa, Atran, & Medin, 2002), and among children and adults from Madagascar (Astuti, Solomon, & Carey, 2004)

Similarly, in spite of many differences in the way people across cultures explain their and others' behavior (Lillard, 1998), psychologists have identified a universal core in folk psychology. In every known culture, people explain behavior in mentalistic terms, i.e., by ascribing mental states such as beliefs and desires (Wierzbicka, 1992). Furthermore, in their meta-analysis of children's performances in the false belief task, Wellman, Cross, and Watson (2001) have shown that children's understanding of beliefs develops similarly across cultures. They report studies conducted in Western cultures (USA, Austria, Australia), Eastern cultures (Japan, Korea), among the hunter-gatherer

Baka (Avis & Harris, 1991), and among Quechua-speaking Peruvian Indians (Vinden, 1996). Although culture affects how early children come to understand that beliefs can be false, 3-year-old children from Western, Eastern, African, schooled, and non-schooled cultures initially fail to understand this, then progressively come to grasp the notion of false beliefs.

2. Cross-cultural psychological diversity

An entirely different approach to the relations between culture and cognition focuses on differences across cultures. Many differences are best described as ethnographic: because across cultures, people live in different social and physical environments, and different cultural framings thereof, and have correspondingly different experiences, their beliefs, concepts, and desires—in brief, the contents of their minds—will often similarly vary. However, looking beyond such differences, scholars have explored the effects of cultural variation on cognitive processes, personality, and perception (for an extensive review, see Cohen & Kitayama, 2007). The search for cross-cultural differences is deemed successful to the extent that the differences across cultures are marked and are explained by relevant differences among these cultures.

The search for cross-cultural psychological differences has a long history. Particularly, numerous scholars have addressed the role of linguistic differences in producing psychological differences. The anthropologist Edward Sapir and the linguist Benjamin Whorf famously proposed that the syntax and the vocabulary of different languages promote irreducibly different patterns of thought—what is known as the Sapir-Whorf hypothesis (Whorf, 1956). Similarly, Soviet psychologists, particularly Lev

Vygotsky and Alexander Luria, argued that languages as well as social activities (e.g., counting routines) constitute tools that allow children to develop symbolic thinking (Vygotsky, 1986).

2.1. Proximal origins of cross-cultural differences: Extended cognition

Traditionally, psychologists and anthropologists searching for cross-cultural differences have given little thought to the evolutionary origins of this diversity, assuming that evolutionary considerations were only relevant for universal traits, or that evolution was only relevant in so far as it produced an undifferentiated “capacity for culture.” As discussed in the next two sections, recent theories and findings belie these assumptions. Here, we successively focus on two proximal causes of cross-cultural psychological diversity.

First, while cognitive science has tended to be methodologically solipsist (Fodor, 1980), neglecting the social and physical environment in which cognition takes place, an influential approach, termed “extended cognition,” now insists that social practices, such as counting routines and formal education, as well as physical artifacts dramatically modify (or, in some formulations of this idea, are constitutive of) people’s cognitive processes (e.g., Hutchins, 1995; Clark, 1997). Because practices and artifacts vary tremendously across cultures, their effect on the mind is a potent source of cross-cultural diversity.

Language is one of the social practices that can potentially cause cognition to differ substantially across cultures. Since the 1990’s, a flurry of cross-cultural work in linguistics and psychology has revived interest in the Sapir-Whorf hypothesis (for

reviews, see Gentner & Goldin-Meadow, 2003; Gleitman & Papafragou, 2005; Chiu, Leung, & Kwan, 2007). We consider in turn the research on spatial orientation and the more decisive research on color perception.

Levinson and colleagues have shown that languages encode spatial orientation in a variety of ways (Levinson, 2003; Pederson, Danzinger, Wilkins, Levinson, et al., 1998). They identify three main ways of describing the location of objects. Speakers who use an intrinsic frame of reference locate objects by describing the relations between these objects (the spoon is besides the plate). Speakers who use a relative frame of reference locate objects by describing the position of these objects in relation to themselves and others (the knife is on my/your right). Speakers who use an absolute frame of reference locate objects by using cardinal directions (the knife is west of the plate).

Levinson and colleagues have argued that these linguistic differences affect people's spatial reasoning. In the rotation experiment (Pederson et al. 1998), subjects are shown an array of objects displayed on a table in front of them. Then, they are asked to turn by 180°. They are then given the objects and asked to recreate the original array on a new table. If speakers of a language with a predominantly relative frame reference also reason relatively, they should preserve the orientation of the objects with respect to their own body: the object that was on the subject's left on the first table should be on her left on the second table, and so on. If speakers of a language with a predominantly absolute frame reference reason absolutely, they should preserve the absolute orientation of objects, thereby changing the orientation of the objects with respect to their own body: the object that was on the subject's left on the first table should now be on her right on the second table. As predicted, Dutch and Japanese subjects, whose languages use a

relative frame of reference, preserved the relative orientation of the objects, while Mayans, whose language uses an absolute frame of reference, preserved the absolute orientation of objects. Levinson and colleagues take this and other findings to support the Sapir-Whorf hypothesis.

This finding has, however, been criticized (Gallistel, 2002; Li & Gleitman, 2002). Li and Gleitman (2002) have shown that when a salient object is present in their physical environments, American subjects can be primed to replicate the first array in an absolute manner. Since subjects who replicated the array of objects in a relative manner and those who replicated it in an absolute manner speak the same language (English), it would seem that the linguistic differences between Teztlan and Dutch (or Japanese) do not explain Pederson et al.'s original findings (but see Levinson, Kita, Haun, & Rasch, 2002). Li and Gleitman propose that the task description of the rotation experiment, "Make it the same," is ambiguous, because there are two different ways to reproduce the original array of objects. Subjects use the fact that their language relies predominantly on a relative or on absolute frame of reference to disambiguate the task. Thus, Levinson and colleagues' work does not show an effect of language on thought, but rather an effect of language on the interpretation of a linguistic expression. Furthermore, Li, Abarbanell, and Papafragou (2005) have shown that Teztlan speakers are not only able to use a relative frame of reference to solve spatial problems, but are better at doing it than at using an absolute frame of reference—in clear contrast to the Sapir-Whorf hypothesis.

This is not to say that the Sapir-Whorf hypothesis is unsupported by recent research, as shown by the research on color. The color lexicon varies tremendously across languages (Berlin & Kay, 1969). While English has 11 basic color terms, the Dani,

a hunter-horticulturalist society in Papua New Guinea, use only two, one for light colors and one for dark colors. Color vocabulary is not entirely arbitrary, however (Kay & Regier, 2006). Focal colors constrain languages' color vocabulary: Regier, Kay, and Cook (2005) found that the best examples of color terms for 110 languages from non-industrialized societies cluster around the focal colors. Furthermore, colors tend to be grouped by similarity. Finally, Kay and Regier (2007) have shown that the boundaries between color terms are not arbitrary, but rather map closely across languages.

Because color vocabulary varies across languages, one might wonder whether people's perception and memory of colors vary across linguistic communities. Heider (1972) and Heider and Olivier (1972) have answered negatively to this question, as the Dani's limited color vocabulary seems to have limited effect on their color perception and memory. Heider and Olivier showed Dani and American subjects a color patch. After a 30-second interval, subjects were shown an array of similar color patches and were asked to identify the original patch in this array. The pattern of color recognition was very similar between the two groups. Particularly, in both groups, focal colors were recognized more easily (that is, less confused with other colors) than non-focal colors.

This body of evidence against the Sapir-Whorf hypothesis has been challenged in recent years (Davidoff, Davies, & Roberson, 1999; Roberson, Davies, & Davidoff, 2000; Roberson, Davidoff, Davies, & Shapiro, 2005; see also Lucy & Schweder, 1979; Kay & Kempton, 1984). Davidoff and colleagues (1999; Roberson et al., 2000) have focused on color perception among the Berinmo in Papua New Guinea, who have only five basic color terms. They failed to replicate Heider and Olivier's (1972) experiments. In contrast to Americans, the Berinmo were not more accurate at recognizing focal colors than non-

focal colors. Furthermore, when Davidoff and colleagues compared the Berinmo's pattern of color confusion with their pattern of color naming and with the American pattern of color confusion, they found that the Berinmo pattern of color confusion was more similar to the Berinmo pattern of color naming than to the American pattern of color confusion. In line with the Sapir-Whorf hypothesis, this suggests that the Berinmo's color vocabulary affects their color memory.

Additional evidence shows that the effect of color terms on cognition is, at least sometimes, driven by the on-line use of color words (Roberson & Davidoff, 2000; Winawer, Witthof, Frank, Wu, et al., 2007). Similarity judgments and color identification (identifying two patches as being the same color) are affected by the boundaries between color categories drawn by the color terms in the subjects' languages. Winawer et al. (2007) simultaneously presented subjects with a target color patch on the one hand and a pair of color patches on the other. Subjects were asked to determine which of the two patches in the pair was identical to the target patch. Reaction times show that this color identification task was easier when two different color terms (in the subject's color vocabulary) applied to the two patches in the pair than when the same term applied to both patches—a form of categorical perception. Importantly, this and other effects of color vocabulary disappear when a verbal dual task prevents subjects from articulating subvocally.

2.2. Proximal origins of cross-cultural differences: Effects of environmental differences

A second approach to the proximal origins of cross-cultural differences notes that people typically have various processes and strategies for fulfilling a given psychological

function (for instance, categorizing, reasoning inductively, making decisions under uncertainty, etc.). In any given environment, these strategies do not equally well fulfill their functions. For instance, the different types of spatial orientation do not work equally well in all environments. As a result, people can learn to rely on the processes and strategies that are most efficient in their environments. It is therefore important that social and physical environments vary across cultures. Indeed, culturally transmitted norms directly shape people's social environments, and cultural practices can powerfully modify people's physical environments. Culture is thus a source of diversity in social and physical environments; hence, across cultures, people might come to learn to rely on different processes and strategies, because these are the best ways to fulfill the relevant functions in the environments they inhabit.

It is important to note that the two proximal causes we have considered lead to two different forms of cross-cultural psychological diversity. The idea that artifacts and social practices dramatically modify or are constitutive of people's cognitive processes implies that particular cognitive processes (and other psychological traits) might exist in some cultures, but not in others. In contrast, the idea that people learn to rely on the strategies and processes that are most efficient in their environment suggests that the same processes (and other psychological traits) are present (if only in nascent form) in all cultures, but are differently employed.

Recent work on cultural differences in attention and reasoning provides a good example of the second type of cross-cultural psychological diversity.^{iv} Nisbett and colleagues distinguish two cognitive styles (Nisbett, Peng, Choi, & Norenzayan, 2001; Nisbett, 2003; Norenzayan, Choi, & Peng, 2007). The analytic cognitive style involves

detaching focal objects from their context (field independence), focusing on the properties of objects in contrast to relations between objects, relying on rules to classify and reason, and appealing to causal explanation. By contrast, the holistic cognitive style involves paying attention to the context (field dependence), focusing on the relations between objects, and relying on similarity to classify and reason. Nisbett and colleagues have gathered an impressive body of evidence showing that Westerners exhibit an analytic cognitive style, while East Asians display a holistic cognitive style.

Westerners' attention abstracts objects from their context, while East Asians' attention relates them to their context. In the rod-and-frame test, subjects are shown a rod inside a frame and are asked to adjust the rod to a vertical position. People are considered field-dependent to the extent that their judgment is affected by the verticality of the frame. Ji, Peng, and Nisbett (2000) found that Chinese subjects are more field-dependent than American subjects. These different patterns of attention affect Westerners' and East Asians' perception (for review, see Nisbett & Miyamoto, 2005). Using an eye-tracking method, Chua, Boland, and Nisbett (2005) have shown that Chinese and American students have different patterns of visual exploration of a scene, Americans focusing on the main object of the scene, and Chinese paying greater attention to the background. They propose that the differences between Westerners' and East Asians' attentional patterns might result from the differences between the visual scenes that are characteristic of the two cultures.

Westerners and East Asians also reason differently in a large number of contexts. According to Norenzayan, Smith, Kim, and Nisbett (2002), when asked to assess the similarity between a target object and members of two different categories, East Asians

rely on the family resemblance of the target object to the members of each category, while Euro-American look for properties that are necessary and sufficient for belonging to one of the categories. Furthermore, although East Asians are perfectly able to reason according to the rules of propositional logic, they are less disposed than Westerners to do so.

3. The cognitive mechanisms underlying culture acquisition

As exemplified by the work reviewed above, a substantial body of research now documents the extent to which cultural information can play an influential, at times even determinative, role in cognitive processes. Missing from much of this literature, however, are ultimate explanations as to why the human mind is so reliant on, or plastic with respect to, cultural information. Some scholars content themselves with the generalization that because much of human social, economic, and even biological life is structured by culture, the general propensity to think in the same manner as those around one evolved because it facilitates coexistence. Congruent with the “extended cognition” perspective described earlier, others argue that human cultures themselves owe their existence to the effectiveness with which cultural concepts, ways of thinking, and artifacts extend basic human information-processing capacities, thereby bootstrapping our innate potential to a higher level of behavioral complexity. Without contesting either of these generalizations, a nascent school of thought adopts a more explicitly mechanistic evolutionary perspective on the relationship between culture and cognition. This perspective begins with the long-recognized observation that, to a much greater extent than is true of other species, humans depend on cultural information to cope with the

challenges posed by their physical and social worlds. The adaptive significance of cultural information suggests that natural selection can be expected to have crafted the human mind so as to maximally exploit this resource. We suggest that the evolved mental mechanisms that serve this goal fall into two general categories, reflecting differences in the degree of specificity of the types of information that they acquire (see also Boyer, 1998 and Henrich & McElreath, 2003 for relevant discussions). We turn first to mechanisms dedicated to the acquisition of specific bodies of knowledge.

3.1. Domain-specific cultural information acquisition mechanisms

Two principal obstacles confronting learners who seek to benefit from others' knowledge are the richness of the informational environment and the incompleteness of the discernable information therein. First, human behavior is enormously complex, varying across contexts and persons, while linguistic utterances convey information ranging from the trivial to the life-saving. If, as is often tacitly presumed, learners were indiscriminate sponges, then a) learners would often fail to understand how to apply what they have learned, and b) learners would fail to properly prioritize their acquisition efforts, often resulting in both precocity in domains irrelevant to the learner and retardation in relevant domains. Second, much social learning involves the problem of the poverty of the stimulus, as many actions and utterances explicitly present only fractional portions of the information that motivates them (Boyer, 1998). We suggest that, for many domains of learning, natural selection has addressed both of these problems by endowing the mind with inborn mechanisms, possessing considerable content, that serve to structure the acquisition of cultural information. Such a system can address the prioritization problem

via variable motivational valence, as the attentional resources that various mechanisms command in pandemonium-style competition can be calibrated by natural selection to reflect the relative importance of acquiring cultural information in the respective domains: to foreshadow the discussion that follows, acquiring cultural information about dangerous animals likely has recurrently had a greater impact on children's survival than has learning to perform adult rituals, and, correspondingly, natural selection appears to have crafted the mind such that children find the former much more interesting than the latter. Likewise, by adjusting the developmental timing of such mechanisms, natural selection can ensure that learners acquire the cultural information that is most relevant to the fitness challenges characteristic of their current stage of life (for example, we postulate that young children are more interested in dangerous animals than they are in courtship behaviors). Finally, as has been argued extensively for the case of language acquisition, innate content can help to overcome the poverty of the stimulus problem, as such structure can serve as a foundation that narrows the possible referents or implications of statements and actions.

We believe that investigations aimed at uncovering what we term *domain-specific cultural information acquisition mechanisms* can shed considerable light on how, when, and why knowledge is acquired from others. In designing such investigations, it is important to recognize that, for any given learning domain, three factors can be expected to constitute necessary conditions for the evolution of a domain-specific cultural information acquisition mechanism. First, the domain must have been of substantial and relatively uniform importance to biological fitness across the diverse socioecological circumstances that characterized ancestral human populations, as this will have provided

the steady selection pressure necessary for the evolution of a complex adaptation. Second, the domain needs to involve content that will have varied significantly across said circumstances as, on the one hand, this precludes the evolution of extensive innate knowledge, and, on the other hand, this maximally exploits culture's ability to effectively compile information of parochial relevance. Lastly, the domain must be one in which individual learning through trial-and-error or direct observation would have been either very costly or impossible much of the time under ancestral circumstances.

To illustrate the above three factors, consider Barrett's (2005) proposal that a dedicated mechanism or set of mechanisms facilitates learning about dangerous animals. Dangerous animals were a persistent threat to ancestral humans. A few classes of dangerous animals will have been ubiquitous, sharing key perceptual features across disparate environments. For example, poisonous snakes are found in most of the ecosystems inhabited by humans. While snakes vary in their morphological details, all snakes share the same basic body plan. This combination of a significant and recurrent source of selection pressure and uniform perceptual features allowed for the evolution of a template-driven learning mechanism that requires only minimal input to produce a fear of snakes, a homologous trait shared with other primates (Öhman & Mineka, 2003). Notably, however, in contrast to the case of snakes, many dangerous animals are either confined to discrete geographical areas, do not exhibit categorically-distinguishing features, or both. As a consequence, natural selection cannot construct a learning mechanism with the same type of content as that responsible for the fear of snakes—at most, selection can assign innate salience to cues, such as large sharp teeth, that are imperfectly associated with dangerousness. Nevertheless, because cultures can be relied

upon to contain information about the identity and attributes of, and strategies for dealing with, locally dangerous animals, natural selection could construct a mechanism dedicated to acquiring this kind of information from others. Importantly, fulfilling the third criterion listed above, learning about dangerous animals from other actors is almost always vastly cheaper than learning through trial and error.

With regard to the informational challenges, described earlier, that confront the human learner, Barrett (2005) suggests that what we would term a *dangerous-animal domain-specific cultural information acquisition mechanism* likely contains conceptual primitives (“animal,” “dangerous”) that a) are rapidly mapped onto local lexical terms, b) have high salience (leading to enhanced attending to, and retention of, any co-occurring information), c) assist in solving problems of reference and inference (e.g., the learner presumes that statements concerning dangerousness refer to whole species rather than individual instances, that dangerousness will loom large in others’ minds as well, allowing for inference as to the topic being discussed, etc.) and d) structure the manner in which information is organized and stored (e.g., the learner constructs a danger-based taxonomy of animals, etc.). This mechanism may also be linked to other mechanisms that govern defensive strategies (e.g., freeze, hide, flee, seek arboreal refuge, etc.) such that learning consists of reinforcing one of a number of preexisting potential responses. Next, because the threat posed by dangerous animals begins early in life (and, all else being equal, is often inversely proportional to an individual’s size), this mechanism can be expected to begin operating early in development. Finally, children are expected to not only preferentially attend to and retain cultural information about dangerous animals, but, moreover, to actively pursue such information (e.g., more frequently asking

questions regarding dangerous than non-dangerous animals, allocating time to social contexts in which information regarding dangerous animals is likely to be available, etc.).

What other domains of learning might meet the triple criteria of universally high fitness relevance, parochial content, and costly individual learning necessary for the evolution of a domain-specific cultural information acquisition mechanism? Below we list a number of possibilities:

- *Diet.* Humans are generalists, capable of subsisting on a wide variety of foods. However, many ingestible items are inedible or, worse, poisonous. Obtaining nutrition and avoiding toxins are principal determinants of fitness, yet the features of both edible and poisonous substances differ widely across ecosystems. As in the case of predators' sharp teeth, a few perceptual cues (e.g., sweet taste versus bitter taste) offer some guidance in acquiring locally-useful information, but, once again, these cues are imperfect and incomplete. Importantly, a) cultures can be reliably expected to contain locally-useful information in this domain, and b) the costs of individual trial-and-error learning will generally be vastly higher than the costs of cultural learning (consider the two ways in which one might obtain the answer to the question "Is this mushroom poisonous?"). With regard to timing, acquiring competence in this domain first becomes important at weaning, then becomes increasingly important with greater mobility and, eventually, foraging self-sufficiency. Lastly, it is likely that a phylogenetic precursor of a dietary domain-specific cultural information acquisition mechanism set the stage for the evolution of such a mechanism, as social learning plays a role in the dietary behavior of a variety of language-less mammalian generalists (Galef & Giraldeau, 2001).

- *Social structure.* All societies operate in part based on a set of interrelated culturally-defined roles that demarcate identities and prescribe actions. Roles dictate social behavior in a relational fashion, as the appropriate actions depend not simply on one's own role, but on the interface between that role and the role of the individual with whom one is interacting (e.g., the appropriate actions of a "daughter" depend on with which parent she is interacting). Accordingly, actors must acquire information concerning not only their own roles, but also many that they will never occupy themselves. Relatedly, coalitions and corporate groups (associations having a collective identity such that the actions of one member affect all) are of critical importance, as a) they are often the principal sources of aid, and b) social conflict often occurs along such lines of cleavage. Because both coalitions and corporate groups form along culturally-defined lines, actors benefit from acquiring role-related cultural information regarding the nature, composition, and boundaries of such groups. Lastly, at a still larger scale, actors benefit from preferential assortment with those who share a similar cultural background, as this facilitates coordination and cooperation; conversely, it often pays to understand disjunctures or conflicts between those who resemble oneself and others who possess different cultural affiliations.

From roles all the way up to ethnic groups, the scope of social structural knowledge to be obtained is potentially very large; importantly, it is also highly parochial. While social structures share common conceptual elements, such as distinctions based on age, gender, kinship, hierarchy, communality, and group membership (Brown, 1991), these core elements map only indirectly onto local forms—most roles, for example, cannot be defined in terms of these primitives. Because social

relations would have been a fundamental determinant of fitness in ancestral societies, we can expect selection to have crafted mechanisms specific to the task of acquiring social structural information (Hirschfeld, 1996, 2001). Such mechanisms likely contain the aforementioned conceptual primitives, using these as scaffolds to construct simple role concepts early in life that can, in turn, subsequently serve as the foundations for more complex concepts. Consistent with this premise, learners seem predisposed to a) acquire labels for, and information concerning, a variety of social categories, b) rapidly recognize coalitions and corporate groups, and c) apply essentialist reasoning to larger categories of individuals (technically termed ethnic groups) who resemble one another by virtue of their common possession of indices, such as dialects and other markers of ethnicity, of shared cultural knowledge (Hirschfeld, 1996, 2001; Gil-White, 2001; Machery & Faucher, 2005).

- *Tool Use.* Skill in using tools is a determinant of fitness in all known small-scale societies. Some of the informational basis of tool use skill can be obtained through trial-and-error learning, as artifacts' affordances will often bias experimental efforts in the direction of techniques congruent with the tool's design. However, in many instances, trial-and-error learning will be more expensive (in terms of time, and in terms of risk of injury to self, the tool, or the other objects or persons) than social learning; even in technologically simple societies, acquiring mastery of some tool techniques (e.g., flintknapping) is laborious, or even impossible, without cultural information. We can therefore expect natural selection to have crafted domain-specific cultural information acquisition mechanisms dedicated to this domain (see also Csibra & Gergely, 2006). These mechanisms may contain conceptual primitives, such as "piercing tool," "cutting

tool,” “lever,” “carrying tool,” “container,” and so on, that aid in the acquisition of cultural information linking a specific tool, a specific objective, and a specific technique. Testifying to our reliance on socially-transmitted information in conceptualizing artifacts, even brief exposure to another’s use of a novel artifact suffices to create a categorical representation of its function (Defeyter & German, 2003). The predisposition to conceptualize tools in a socially-determined fashion is apparently so strong that, even in technologically simpler societies, such categorization reduces the improvisational application of tools to novel purposes, a constraint termed “functional fixedness” (German & Barrett, 2005).

The above discussion is intended to be illustrative, not exhaustive; other domains in which domain-specific cultural information acquisition mechanisms likely operate include navigation, fire building (Fessler, 2006), disease avoidance, gathering, hunting (Barrett, 2005), courtship and mateship, and, perhaps most importantly, morality (Haidt & Joseph, 2004). Moreover, research aimed at mapping domain-specific cultural information acquisition mechanisms will likely overlap somewhat with, and should draw on, existing work on psychological universals of the type discussed in Section 1. For example, the postulated dangerous-animal domain-specific cultural information acquisition mechanism is likely either part of, or linked to, broader mechanisms responsible for learning about living things; these mechanisms likely contain considerable innate content, generating the universality of core features of folk biology described earlier. Our goal here, however, is not simply to expand the scope of the search for psychological universals, but rather to direct attention to the means whereby cultural information is acquired.

We hope that, by considering the three criteria of universal ancestral fitness relevance, parochial content variation, and high-cost individual learning, scholars will identify numerous areas in which domain-specific cultural information acquisition mechanisms likely exist, and will then test predictions that ensue. However, even if this enterprise proves successful, it will necessarily capture only a portion of the domains for which cultural learning is important. This is because much of the information that must be acquired to succeed in any given society is parochial in both content and type. For example, although it is true that public performance is universally an avenue for achieving prestige, nevertheless, the nature of such performance is so variable across cultures (and even across roles within a culture) as to likely have made it impossible for natural selection to have provided substantial foundations for the acquisition of the relevant information (e.g., while the category “performance” may be a conceptual primitive, it probably does not subsume more specific concepts, and thus lacks a rich structure that can serve as a scaffold for learning).

3.2. Domain-general cultural information acquisition mechanisms

Our species’ reliance on cultural information that is parochial in both content and type suggests that natural selection may have favored the evolution of *domain-general cultural information acquisition mechanisms*. At least two classes of such postulated mechanisms are relevant to the present discussion; both address the problems of the complexity and opacity of cultural information and related behavior discussed earlier. First, selection may have favored the evolution of mechanisms dedicated to the complementary tasks of pedagogy and the receipt of pedagogy. Second, whether the

agent serving as the source of cultural information is an active pedagog or a passive target of imitation, in a crowded social world, learners must select whom to attend to as a source of cultural information, a task that may be subserved by evolved mechanisms.

Csibra and Gergely (2006) argue that much cultural information transfer is achieved through a goal-directed social process of teaching and learning contingent on ostension, reference, and relevance. Ostension denotes the act of indicating that one's current actions are communicative efforts, thereby differentiating such behavior from the stream of potentially-observable actions. Reference addresses the need to constrain the topic of the communication from the class of all possible topics. Both ostension and reference can be enacted by either the pedagog (who strives to indicate "now I am *teaching* about *X*") or the learner (who strives to indicate "I *need information* about *X*"). Csibra and Gergely argue that specific cues, and the cognitive mechanisms that process them, have evolved to facilitate, respectively, ostension (e.g., eye contact, eyebrow flashing, and turn-taking contingency by both parties; motherese by pedagogs interacting with infants) and reference (e.g., gaze directing / gaze-direction detection; pointing). Relevance, a feature of the inferential process engaged in by the learner once a teaching/learning interaction has been established, involves the presumption that actions lacking an ulterior explanation are designed to convey information in light of the learner's state of knowledge.

To date, the work of Gergely, Csibra, and colleagues has focused primarily on adult/infant interactions. However, ostension, reference, and relevance ought to characterize all teaching/learning interactions, the only principal modification being that bidirectional linguistic communication expands the channels available for ostension and

reference. A more substantial difference, however, between infant learners and older learners is that infants have a vastly smaller range of potential pedagogs from which to choose. Older learners therefore face the problem of selecting the targets from whom they hope to learn. This is true both with regard to pedagogical interactions and with regard to imitating a passive (non-teaching) model (while noting that the cognitive mechanisms underlying imitation are deserving of attention from students of the evolved psychology of culture acquisition, we leave this topic for another day—see Tomasello, Kruger, & Ratner, 1993). However, the selection criteria differ for the two types of targets. Because pedagogs scale their communication to the competence of the learner, learners can usefully solicit pedagogy from individuals who possess vastly superior skills. In contrast, because cultural information is complex and opaque, in the case of imitation without pedagogy, learners must select targets that are closer to their own current competence, else much of the model's behavior will be subject to misinterpretation.

Differences between the two types of learning are reduced somewhat when the issue of social structure is considered, as the distribution of cultural information over roles is such that individuals will often benefit from seeking to learn from others whose position in the social structure is not too distant from their own, since similar roles entail similar resources, opportunities, and obligations (for seminal empirical work, see Harris, 1995). Lastly, the task of target selection is complicated by the bidirectionality of the interaction: even imitation in the absence of pedagogy often has a bidirectional component, as the target must tolerate the presence of the learner. Henrich and Gil-White (2001) argue that, in exchange for access, learners grant higher status to individuals whom they wish to imitate; market forces then influence individual choices, with less-

desired targets willing to grant more access. In contrast to Csibra and Gergely (2006), who argue that the costs to the pedagogue are such that pedagogy can be expected to be primarily kin-based (as kin have an interest in the welfare of their relatives), we suggest that the same market model applies to pedagogy: in both cases, the costs that accompany being targeted by a learner can be outweighed by the elevated prestige and power that flows from social support. The learner must thus trade off the value of the knowledge possessed by the target (skill, success, etc.) against the costs of access, keeping in mind that other learners are also competing for access.

The task of selecting targets from whom to learn is characterized by both sufficient importance and sufficient overarching uniformity as to suggest that evolution has created domain-general cultural information acquisition mechanisms for this purpose. We thus expect that actors will be adept at identifying others who possess the optimal combination of superiority and role-relevant knowledge; that observation of such individuals will be more acute, and subsequent information better retained; that ostensive cues will be both displayed toward and sought from such individuals; and that learners will be quite good at optimizing the access/cost ratio in a fluid market.

An alternative strategy to selecting a single individual as the focus of learning is to adopt the prevailing pattern of behavior in the local group. Because a single individual's success may be the product of many factors, raising the dual problems that a) it may be unclear which aspects should be acquired by the learner, and b) some of these factors may not be acquirable through learning, the conformist strategy will often prove profitable (Boyd & Richerson, 1985; Henrich & Boyd, 1998). Note, however, that this is not so much a method of learning as it is a method of deciding which of a number of

variants of behavior to adopt. This is because at least some understanding of those variants (and hence some learning) must precede this decision; presumably, this process must be iterated, with the actor coming to recognize finer distinctions among variants as her command of the relevant information increases. Accordingly, many of the same cognitive learning processes must underlie both information acquisition strategies that target particular individuals as sources and conformist strategies that survey larger numbers of individuals. There are also some parallels as regards the task demands of target selection, since the relevance of behavior common across a set of prospective models is in part contingent on their degree of similarity to the learner: behavior that is common among individuals who occupy positions in the social structure similar to the learner's will generally be most relevant to, and hence should be most salient to, the learner. We can thus expect some form of a domain-general cultural information acquisition mechanism to combine information about the respective behaviors of actors with information about their relative social structural similarity to the learner in order to efficiently promote conformist acquisition. Lastly, the conformist strategy is less complex than individually-focused learning in regard to calculating cost/benefit ratio in target selection: because the goal is to acquire the most common variant of behavior, there is no shortage of potential models; hence it is a buyers' market, and the learner should be unwilling to pay much for access to prospective models.

4. The effects of cognition on culture

Thus far, we have explored the extent to which cultural information shapes cognition, and examined how the acquisition of cultural information may be underlain by evolved

psychological mechanisms of varying degrees of domain specificity. This may give the impression that cultural information is a static feature of the environment. However, because culture exists in the minds of individuals, the relationship between culture and cognition is bidirectional, and thus dynamic. Specifically, because culture is instantiated through processes of the transmission, retention, and application of information, the composition of culture is subject to the influence of actors' minds, as information that is more likely to be transmitted, retained, and applied will come to predominate, while information for which this is less true will become rarer, and may disappear entirely (Sperber, 1996, Ch. 5).

4.1. Design features of mental mechanisms can influence cultural evolution

Anthropologists have long recognized that some ideas are “good to think” (Lévi-Strauss, 1962), meaning that they interdigitate with the mind in ways that make them attractive. Originally, this notion was developed with regard to the manner in which the affordances of real-world objects and entities (e.g., animals) facilitate symbolic distinctions that usefully organize human social life. Such nebulous intuitions were later more rigorously reconceptualized by cognitive anthropologists, who observed, for example, that folk taxonomies tend to be structured in ways that complement features of short-term memory (D’Andrade, 1995, p. 42-43). More generally, the relative learnability (ease of acquisition, retention, and use) of cultural information can be expected to influence its persistence and spread. With regard to information acquired via domain-general cultural information acquisition mechanisms, learnability will in part be a function of the way that information is organized (as in the case of folk taxonomies), and will in part be a function

of features of social transmission (e.g., *ceteris paribus*, because of the costs of pedagogy, ideas that can be acquired through imitation alone will spread faster than those that require pedagogy). With regard to information acquired via domain-specific cultural information acquisition mechanisms, learnability will in part be a function of the extent to which ideas contact the evolved content of the respective mechanisms (see also Boyer, 1998). For example, Sperber and Hirschfeld (2004) and Barrett (2005) note that the special salience of information regarding dangerous animals is such that ideas concerning dangerous animals are more likely to spread and persist over time, even to the extent that erroneous information about actual creatures (e.g., the belief that wolves often prey on humans, see Sperber & Hirschfeld, 2004) and fantastical notions about nonexistent creatures (Sasquatch, the Loch Ness Monster, see Barrett, 2005) become widely accepted (for a pressing contemporary example, see Lombrozo, Shtulman, and Weisberg [2006] on the obstacles to learnability of evolutionary theory). Similarly, using both experimental and naturalistic data, Heath, Bell, and Sternberg (2001) have shown that the likelihood that urban legends will be transmitted, and will persist, is in part contingent on the degree to which they elicit disgust. Given that disgust is prototypically elicited by cues associated with pathogen transmission (Curtis & Biran, 2001), this pattern is parsimoniously understood as the result of the operation of a domain-specific cultural information acquisition mechanism dedicated to the acquisition of knowledge relevant to disease avoidance.

A general principle that can be expected to apply to many of the mechanisms postulated thus far is that of error management (Haselton & Buss, 2000): natural selection will have built biases into information processing systems such that, when these

mechanisms err, they do so “on the safe side,” making the mistake that, under ancestral conditions, would have been the least costly of the possible errors. One consequence of this is that, as illustrated by the above examples, domain-specific cultural information acquisition mechanisms that address possible hazards will lead to credulity, as actors will accept without evidence, and will not seek to test, socially-transmitted information; aggregated over many individuals, the result will often be a proliferation of wholly imaginary dangers. Consistent with this perspective, preliminary evidence from an extensive evaluation of ethnographic materials suggests that, around the globe, supernatural beliefs tend to depict a world filled with anxiety-provoking dangerous agents and processes (Fessler, Pisor, & Navarrete, n.d.). At a more general level still, the content of beliefs that describe hazards in the world will influence the likelihood that those beliefs will persist over time. For example, many proscriptive beliefs include notions of supernatural sanctions. We can expect that the most successful proscriptions will involve sanctions that either a) are vague, referring to a wide class of possible events (e.g., misfortune, etc.), or b) though specific, nonetheless refer to a negative event that is relatively common, and for which the objective causes are not readily evident (e.g., infant death in small-scale societies). Given the issue of credulity mentioned earlier, proscriptions enforced by vague supernatural sanctions will be likely to persist because bad things eventually happen to everyone; hence, when a taboo is violated, it is inevitable that sooner or later events will unfold that can be interpreted as evidence of the veracity of the belief. Likewise, proscriptions enforced by more specific sanctions will be likely to persist if the events described therein happen with sufficient frequency that, eventually, they will occur in the lives of rule-breakers.

4.2. Misfirings of other mental mechanisms can influence cultural evolution

In addition to the question of how design features of domain-specific cultural information acquisition mechanisms and domain-general cultural information acquisition mechanisms influence cultural evolution, a growing literature seeks to explain widespread cultural traits in terms of the accidental misfiring of evolved cognitive mechanisms that are not dedicated to the acquisition of cultural information per se. This approach arguably began with Westermarck (1891), who hypothesized that incest taboos result from the accidental triggering by third-party behavior of mechanisms that evolved to reduce inbreeding among close kin. More recently, Boyer (2001) argues that beliefs in supernatural agents are more likely to persist if they are minimally counterintuitive, meaning that the agents possess nearly all, but not all, of the properties expected by mechanisms that serve to detect agents and predict their actions; Fessler and Navarrete (2003) suggest that the centrality of meat in food taboos is an accident of the salience of meat as a stimulus in toxin-detection and pathogen-avoidance mechanisms; and Boyer and Lienard (2006) argue that the combination of constraints on working memory, the operation of mechanisms devoted to avoiding hazards, and the parsing of actions generates a non-functional attraction to ritualized behavior. While we feel that efforts such as these are to be encouraged, such hypotheses are necessarily developed on an ad hoc basis, in contrast to the bottom-up predictive potential of a dedicated effort to explore the nature, and consequences for cultural content and evolution, of mechanisms dedicated to the acquisition of cultural information.

5. Conclusion

There are many ways to study the relations between culture and cognition. In this chapter, we have discussed two traditional approaches in psychology and anthropology: searching for psychological universals and for cross-cultural psychological differences. Furthermore, we have attempted to describe what we take to be two of the most exciting contemporary approaches to studying these relations: looking for domain-specific and domain-general cultural information acquisition mechanisms, and identifying the influences of the structure of our minds on how information is retained and transmitted.

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ⁱ These studies also show that cultural counting systems dramatically affect numerical cognition. People with a limited counting system (a few number terms) are unable to count beyond three and cannot accurately conduct arithmetic operations.

ⁱⁱ By contrast, as will be discussed at length later, selection favors developmental pathways that rely on environmental inputs when the adaptive value of variants is contingent on features of the environment that are stable within an organism's lifespan and home range, yet variable over larger expanses of time and space occupied by the species.

ⁱⁱⁱ For Atran and colleagues, a generic species is a population of interbreeding individuals that possesses distinctive physiological and behavioral traits. These traits distinguish it from other generic species, and they are easily recognizable by ordinary people. For many organisms people are acquainted with, generic species correspond to scientific genera (e.g., oak) or species (e.g., cat) or to local variants thereof.

^{iv} For a different research program on culture and reasoning, see Medin and Atran, 2004; Atran, Medin, and Ross, 2005; Medin et al., 2007.