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Culture and Modularity

The causal chains of culture

Members of a human group are bound with one another by multiple flows of information. (Here we use "information" in a broad sense that includes not only the content of people's knowledge, but also that of their beliefs, assumptions, fictions, rules, norms, skills, maps, images, and so on.) This information is materially realized in the *mental representations* of the people, and in their *public productions*, that is, their cognitively guided behaviors and the enduring material traces of these behaviors. Mentally represented information is transmitted from individuals to individuals through public productions. *Public representations* such as speech, gestures, writing, or pictures are a special type of public productions, the function of which is to communicate a content. Public representations play a major role in information transmission. Much information, however, is communicated implicitly, that is, without being publicly represented. Information can also be transmitted without being properly speaking communicated, not even implicitly, as when one individual acquires a skill by observing and imitating the behavior of others.

Most information transmitted among humans is about local and transient circumstances, and is not transmitted beyond these. Some information of more general relevance, however, is repeatedly transmitted, and propagates throughout the group. Talk of "culture" (whatever the preferred definition or theory of culture) is about this widely distributed information and about its material realizations inside people's mind and in their common environment (see Sperber 1996).

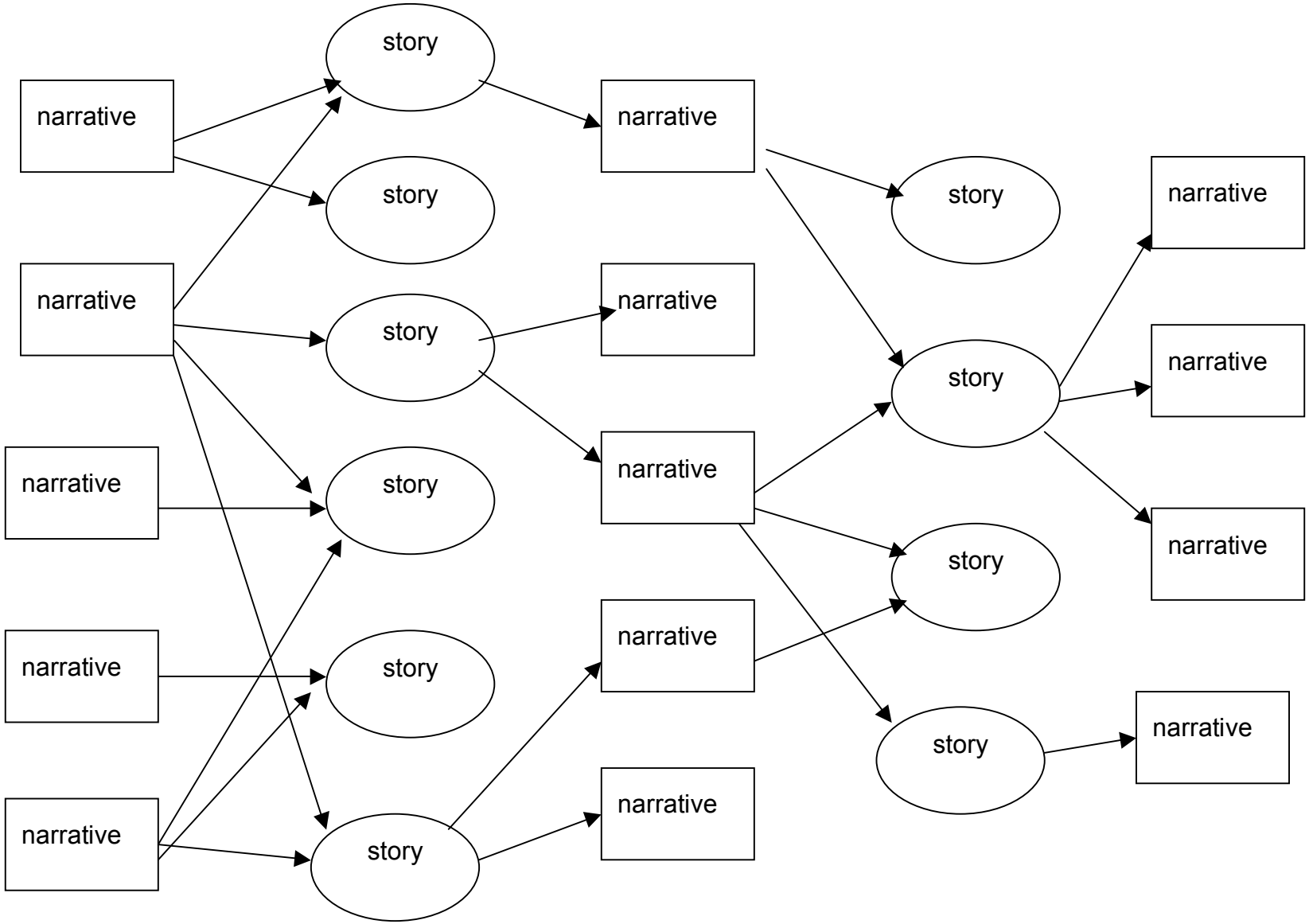
One can study cultural phenomena in two main ways. One can interpret them, that is, try and make their contents intelligible to people of another culture, or more intelligible to members of the culture in which these phenomena occurs, as do anthropologists and historians. One may also try and explain causally how these cultural phenomena emerge, stabilize and evolve. Both approaches are, of course, legitimate and complementary. Can they be pursued independently of one another? Sperber (1985) has argued that while it is possible—and indeed common—to adopt an interpretive stance with little or no concern for causal explanation, it is impossible to adopt a causal-explanatory stance that does not rely to some degree on interpretation: the characterization of cultural phenomena cannot be achieved without interpreting them,

that is without attending to the mental and public representations of the people involved. The same behavior, say eating a certain meat, can be a ritual action, a breach of religious prescriptions, or an ordinary meal, according to people's representations, and, in each case, the causal explanation of the behavior should be different.

To interpret a cultural phenomenon, and in particular a cultural representation, it may be enough to study its contents without paying much attention to its material realizations. Thus a religious dogma, a law, or a folktale can be paraphrased, summarized, or submitted to exegesis without studying the processes involved in its public communication or in its mental representation. Not so however when the goal is to explain the causes and effects of cultural phenomena, for only material realizations have causal powers. Different material realizations of the same content (for instance oral vs. written transmission of a folktale) go together with different patterns of social distribution hence different cultural status, and, in the end, tend to favor different evolutions of the content itself.

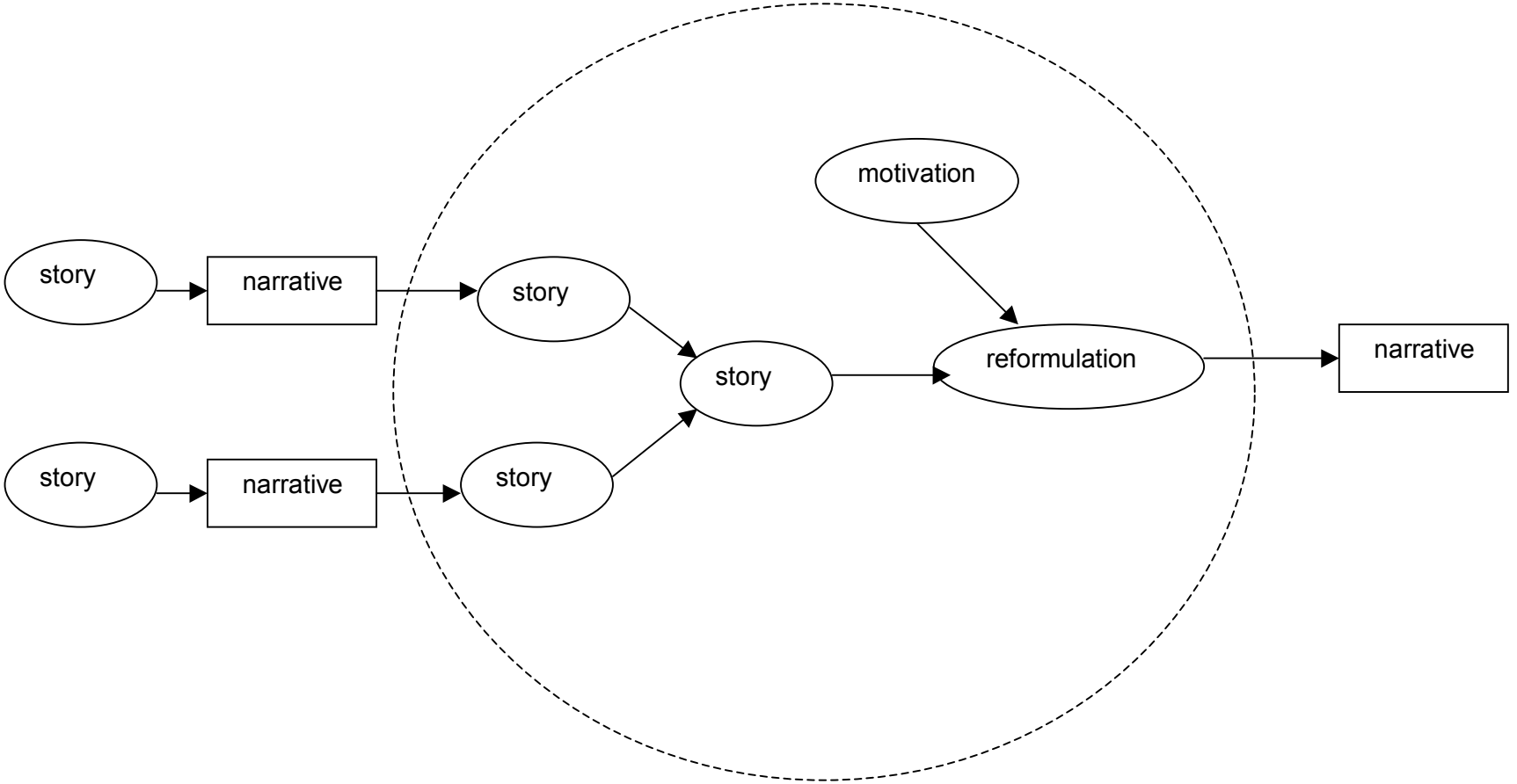
If one wants to explain, for example, why an oral tradition tale such as Tom Thumb has propagated throughout Europe, generation after generation, while so many other stories (told for instance by one mother for the edification of her children) failed to generate any tradition, one must consider the very process of oral transmission, which is made of a vast number of public and mental micro-events. An oral tradition tale corresponds to a causal chaining of public narratives and remembered mental stories, a fragment of which can be schematically represented as in figure 1. (In this figure as in the three following ones, oval boxes represent mental episodes, rectangular boxes represent public episodes, and arrows represent cause-effect relationships among these episodes.) What makes Tom Thumb a folktale is the fact that, in a long and spread-out causal chain, almost every public representation of the tale has engendered mental representations and a sufficient proportion of these mental representations have in turn engendered public representations, or else the tale would never have reached a cultural level of distribution.

Figure 1: Fragment of the causal chain of a tale



In order better to understand the process, links in this causal chain can be magnified, as in figure 2. Every individual having played a role in the propagation of the tale (such as the individual represented by the dotted circle) must have been able to understand and remember in a synthetic form the content of several narratives; she must have been able to reformulate the memorized story in the form of a new but closely similar narrative, and, of course, she must have been motivated to do so, for instance by a request from her listeners ("Please, Granny, tell us the story of Tom Thumb!).

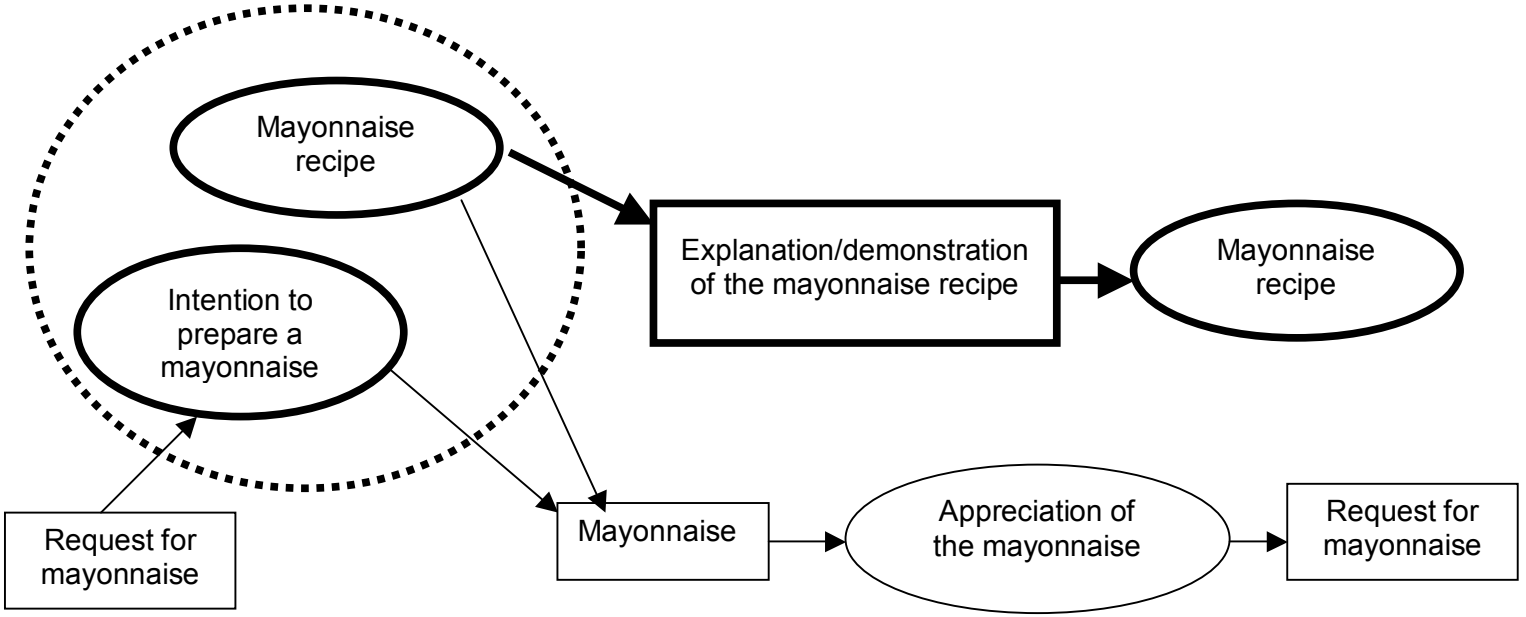
Figure 2: A causal link in the causal chain of a tale



To explain the success of a tale, at least during the period where this success exclusively depended on oral transmission, one must describe what made it particularly easy to understand, to remember, and to tell. Different types of explanatory factors will have to be invoked. Some pertain to the local conditions in which the tale was transmitted; others pertain to more general cognitive or motivational dispositions of the human mind (see Rubin 1995). Given the diversity of social and cultural contexts where, through countries and centuries, a tale like Tom Thumb prospered, one may surmise that general factors will be of particular explanatory importance in this case. Other oral tradition narratives such as the founding myths of particular dynasties have a distribution more linked to local factors.

A folktale is a particularly simple case of cultural phenomenon since the causal chains that distribute its versions are made just of an alternation of mental and public representations of the tale itself. Few cultural phenomena are that simple. The case of an elementary know-how, such as that involved in the domestic preparation of the mayonnaise sauce, already involves a more complex causal chaining, a very simplified fragment of which is represented in figure 3. We have here two interconnected causal chains. One (in thick lines) transmits the mayonnaise know-how from cooks to cooks; the other (in thin lines) perpetuates the demand for mayonnaise that ordinary consumers address to cooks (explicitly or implicitly, by showing their appreciation). On the mental side, there are at least three types of representations: descriptive/normative representations of the mayonnaise itself (its composition, its taste, its texture, its aspect), more or less explicit representations of the recipe, and representations of mayonnaise tokens (e.g. intentions to prepare a mayonnaise, or appreciation of a mayonnaise). On the public side, there are actual mayonnaises, requests for mayonnaise, and tokens of the recipe. Recipes can be transmitted orally or in writing, with or without demonstration of the procedure. Each of these mental and public types of episodes is articulated with other types (many of which are not included in the figure, e.g. public and mental representations of appropriate uses of the mayonnaise) and contributes to the cultural success of the mayonnaise. Most cultural phenomena involve still much more complex causal chainings (and so does the mayonnaise itself when one takes into consideration not just its home made, but also its commercial versions).

Figure 3: Fragment of the causal chain of the mayonnaise

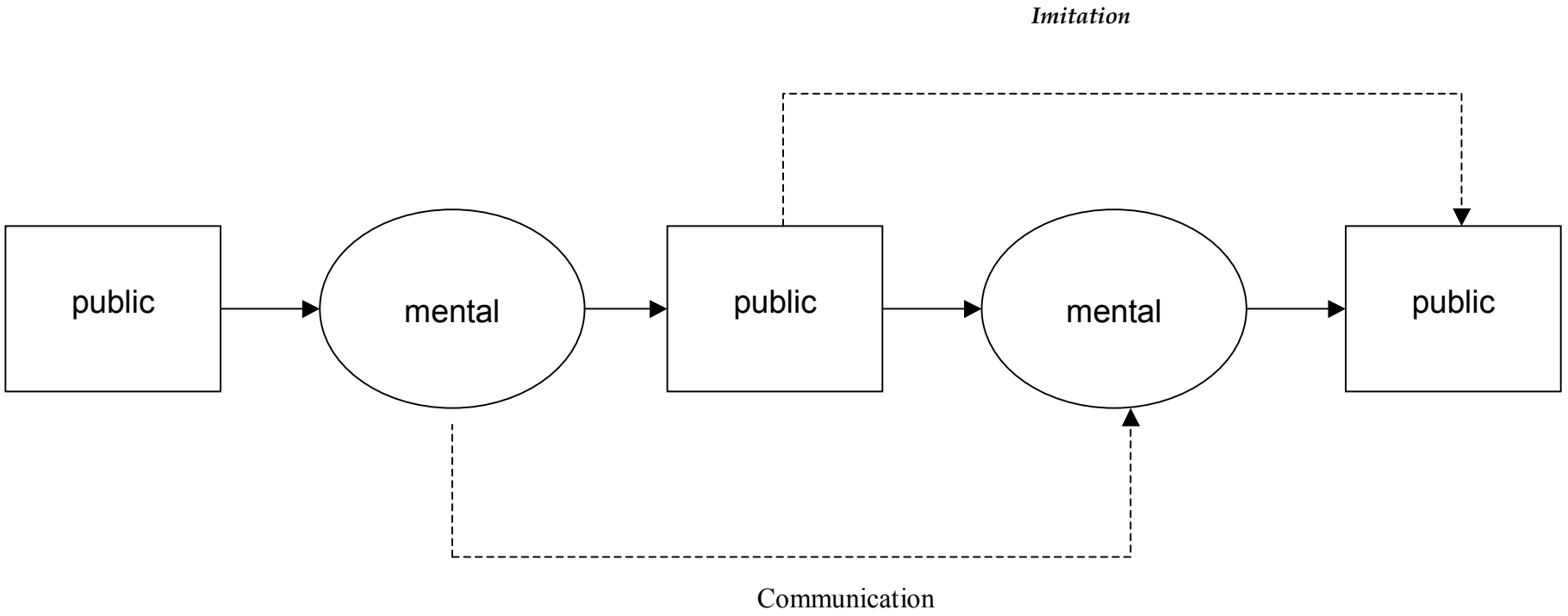


Whatever its complexity, the causal explanation of any cultural phenomenon has to invoke, as in the cases of Tom Thumb or the mayonnaise, two kind of episodes, mental and public ones; it has to spell out how each kind of episode triggers the episodes that follow in the causal chain; for this, the explanation will have to rely on a combination of local and general factors. Local factors are involved in the explanation of cultural variations. General factors are involved in the explanation of the very possibility of culture and of its variability.

The microprocesses of cultural transmission

The basic structure of the causal chains of culture consists, as just illustrated, in an alternation of mental and public episodes. How can such an alternation secure the stability of the contents transmitted? Two main types of processes have been invoked: imitation and communication (see figure 4). Imitation decomposes into a process of observation and a process of re-production of the behavior or of the artifact observed. In between these two processes, there must be a third, mental one, that converts observation into action. Communication decomposes into a process of public expression of a mental representation and a process of mental interpretation of the public representation. Between these two processes, there must be a third environmental process whereby the action of the communicator impinges on the sensory organs of the interpreter. Ideally, imitation secures the reproduction of public productions (behaviors or artifacts) while communication secures the reproduction of mental representations. Imitation and communication may overlap or interlock when the imitator acquires a mental representation similar to that guided the behavior imitated, or when the interpreter reproduces the public representation interpreted.

Figure 4: imitation and communication



Actually, recent work on imitation (e.g. Heyes & Galef 1966, Whiten & Ham 1992, Tomasello et al. 1993, Blackmore 1998, Hurley, S. and Chater, N. in press) and communication (e.g. Sperber & Wilson 1995) tend to show that their power and role, even if crucial, have been overestimated. To begin with, imitation and communication are not strict copying mechanisms. The imitator or the interpreter constructs a version rather than a replica of what she imitates or interprets. They do so not just because the mechanisms of imitation and communication are imperfect—which they are—, but also, and more importantly, because even if a strict copy could be produced, this is not what the imitator or interpreter is generally aiming at: imitation or interpretation is a means to an end rather than an end in itself. With rare exceptions (such as the forging of a signature), the goal of imitators and interpreters is served well enough, or even better, by an approximation or an adapted version of the model. Moreover, the production of behaviors and thoughts informed by the behaviors of thoughts of others typically involves processes that are more constructive than is assumed by common accounts of imitation or communication. An imitator often takes inspiration from the model rather than copies it (and this is imitation only in a loose sense). An interpreter develops her own thoughts with the help of those of the communicator without necessarily adopting these and, for that matter, without being concerned with the strict accuracy of her interpretation.

To illustrate how imitation has been overestimated, let us make a detour—but is it really a detour?—through the case of animal cultures. Very often quoted as an example of cultural transmission among non-human animals is the case of the English tit and the milk bottle. At the time when, every morning, milk bottles with aluminum foil caps were delivered in front of every English house, these birds had learned to peck a hole in the cap and to enjoy the cream at the top of the bottle. In a matter of years, this skill had spread among tits throughout England. Unless one stipulates that "cultural" applies only to humans, this is a clear case of cultural transmission: a skill shared by a whole population and transmitted not genetically but through interactions among individuals.

If we mention this example, it is because it has undergone an interesting reinterpretation (see Sherry & Galef 1984, Galef 1988). According to its classical description, each novice tit was observing the way in which expert tits procured cream by piercing the milk bottle tap, and reproducing this action to achieve the same goal. According to the more parsimonious, now generally accepted description, tits have an instinctive disposition to peck at objects made salient by the pecking behavior of other tits. Hence a tit observing another tit pecking at a bottle cap will be inclined to do likewise. It will then discover on its own the benefit to be gained from such a behavior and be reinforced to repeat it when the occasion arises. According to this redescription, we are not, in fact, dealing with the imitation of a complex action the structure and endpoint of which would be understood by the imitator. The observation of other tits pecking at bottle caps makes bottle caps more peckable objects, and the disposition to do what has proved beneficial determines the adoption of pecking at milk bottles' caps as a regular type of behavior. The acquisition of the skill is triggered by the observation of the behavior of others, but it consists not in an imitation but in a new individual acquisition of the routine. It draws mostly on psychomotor resources already present in the individual, on stable features of the environment. Rather than of imitation, one speaks in such cases of stimulus enhancement. Other cases of the spread of a type of behavior in a population involve "emulation" rather than imitation: one animal observing another animal achieving some result rediscovers a means, identical or not, of achieving this same goal.

One may, in such well-documented cases of the spreading of a skill in animal populations, speak of properly cultural phenomena (see Whiten et al. 1999). Still, there is a major difference between these and human culture. Some animals have cultural practices, but, apart from these, their social life is culture-free. Human life, on the other hand,—and not just social activities but also individual activities and thought—is soaked in culture from infancy. It would be mistaken however to infer from this that human cultural transmission relies more on strict copying and less on processes of individual construction stimulated by the observation of others.

Explaining both cultural diversity and stability

Anthropologists have been justly fascinated by the richness and variety of the cultures they have described and tried to explain. They have relied on an image of the human mind as a "blank slate," or, less metaphorically, as a learning system without limits or biases, equally open to any kind of cultural content (see Sperber 1985, Pinker 2002). To most developmental psychologists, this view has become unacceptable. They see rather the acquisition of knowledge and competencies as a process guided by innate learning dispositions that allow the child to approach different domains with schemas that are, at least in part, domain-specific (Hirschfeld & Gelman 1994, Sperber, Premack & Premack 1995). The issue then is to articulate the diversity of cultures as documented in anthropology with our best understanding cognitive development.

Not only the diversity of cultures, but also their relative stability calls for an explanation. The contents of cultural representations and practices must remain stable enough throughout a community for its members to see themselves as performing the same ritual, sharing the same belief, eating the same dish, and understanding the same proverb in the same way. We are not denying, of course—in fact we are insisting—that culture is in constant flux and that its stability is often exaggerated. Still, without some degree of stability, nothing cultural would be discernible in human thought and behavior. In fact, a wide variety of representations, practices, and artifacts exhibit a sufficient degree of stability at the population scale to be recognizably cultural. It is tempting then to assume that this stability is secured by processes of faithful reproduction at the level of micro-transmissions. Otherwise, it seems, the cumulative effect of even small "copy errors" would jeopardize the stability and hence the properly cultural character of the contents transmitted. Anthropologists (and, today, also "memeticists" developing the suggestions of Richard Dawkins 1976, 1982) take generally for granted that human imitation, communication, and memory abilities are sufficiently reliable to secure a faithful enough reproduction of contents through communities and generations. "Faithful enough" does not mean absolutely faithful, of course; it means faithful enough at the micro level to explain the relative stability we observe at the macro level.

This *a priori* argument to show that cultural items are truly replicated in the micro-episodes of their transmission does not withstand even a cursory examination of the facts of the matter. Variations are the norm rather than the exception at the level of individual episodes of imitation, communication, and memory storage and retrieval. Neither memory, nor the micro-mechanisms of transmission come near the level or reliability that would explain cultural macro-stability. But how then can this relative stability be explained at all?

Just as we must articulate cultural diversity as evidenced by anthropology with the complexity of innate cognitive dispositions discovered by developmental psychologists, we must articulate the relative stability demonstrated by the very existence of culture with the observation of

the transformations in content involved in most micro-transmissions. Our claim is that these two tasks not only can but must be carried out together.

To try and explain the diversity of cultures by assuming, as anthropologists have done, that the human mind is indefinitely malleable—inasmuch as the idea makes any psychological sense—, is to deprive oneself of the means to explain cultural stability. Beings with an indefinitely malleable mind would, at every turn, adopt the last opinion, the last practice, the last goal encountered. They could never achieve this deep and largely unconscious allegiance to the ways of their cultural group that is so characteristic of human existence. Cultural ways themselves would not stabilize in such conditions. If one imagines that, as clay drying, the malleable mind rigidifies as soon as it has acquired a given shape—let us forget for a moment the psychological poverty of these metaphors—then it is the adaptability individually demonstrated by humans throughout their lives that becomes unexplainable.

One might be tempted to explain cultural stability by a human predisposition to acquire culture, a generalization so to speak of the language faculty as seen by Chomsky. It is from such a perspective for instance that Susan Blackmore (1999) attributes to humans a disposition to imitate that transforms them into "meme machines." Nothing however in developmental psychology or in neuropsychology confirms the existence of such a general "culture faculty" (based on imitation or anything else). The acquisition of different types of cultural competencies (language, mathematics, dancing, the sense of honor, for example) follows quite different patterns. Cultural competences can be selectively impaired through brain damage. What this suggests is that cultural information is based not on an integrated and specific culture acquisition mechanism, but rather on the interaction of several cognitive mechanisms with different specialization.

Incidentally, postulating a "culture faculty" would raise the following problem. While modern humans have emerged some two hundred thousand years ago, the existence of an omnipresent richly symbolic culture is well-evidenced only in the last forty thousand years or so. It is likely, of course, that currently available archeological data fails to do justice to the cultural wealth of earlier homo sapiens, but, even so, it is quite possible that, for a large part of its history, homo sapiens had only rudiments of culture, a richer version of what is found among other primates rather than a simpler version of the all-encompassing culture we are familiar with. More generally, there is nothing implausible in the idea that there could be an intelligent species with high communicative abilities but communicating only about local and transient states of affairs and stabilizing only rudiments of culture. It could be that, for much of its history, Homo sapiens was such a species.

Modules and their domains

One hypothesis we would like to invoke here to help explain both cultural diversity and cultural stability is that of a modular organization of the mind/brain—and we stress "*help* explain," since this is not meant to be more than an important component of the overall explanation (with other important component involving, for instance, history and ecology). According to the massive modularity hypothesis (see Carruthers 2003; Cosmides & Tooby 1994; Samuels 1998, 2000; Sperber 1996, 2001), the mind is to a large extent made up of a variety of domain- or task-specific cognitive mechanisms or "modules". It might seem that massive modularity would imply a level of cognitive rigidity hardly compatible with cultural diversity. We want to argue, on the contrary, that massive modularity properly understood is a crucial component in the explanation of this diversity.

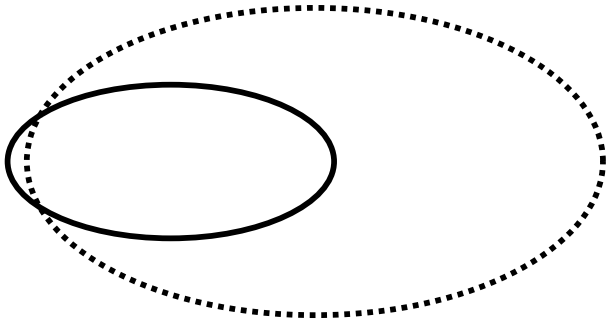
A cognitive module is an autonomous mind/brain device characterized by specific inputs from which it derives specific outputs through its own procedures. A module is autonomous not only in the way it functions, but also in its phylogenetic and ontogenetic development, which are distinct from that of other modules, and also in its failures that can be quite diagnostic.

Most innate human modules are learning modules (in the broad common sense of "learning," not in that of "learning theory"). Most modules in the mature human cognitive system are generated by these learning modules through an epigenetic process and hence are not innate but do have an innate basis. While infants show fear of height without any previous experience—presumably a truly innate module—, the capacities of the face recognition module develop with each face it learns to recognize: here the module requires the acquisition of, at least, a dedicated data basis. Linguistic competence in a given language such as Tagalog or English has, we would argue, the form of a language-specific module produced by a language acquisition module through a process where not just specific data, but also of specific procedures have to be acquired.

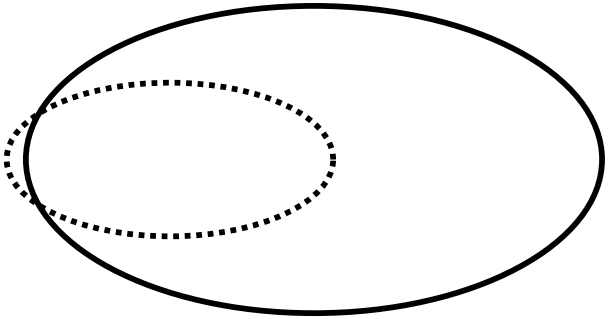
There is then a continuum of cases between properly innate modules and more or less structured dispositions to modularize specific types of cognitive and motor competencies (including some cultural competencies such as reading that are too recent to have has a noticeable effect on the evolution of the genome – see Dehaene 2003). What we are suggesting, in other terms, is that we both distinguish and closely connect the notion of a module and that of a direct biological adaptation. Innate learning modules are biological adaptations that perform their functions by drawing on cognitive inputs to generate acquired modules. Acquired modules have an innate basis and have derived biological functions (in the sense of Millikan 1984) and direct cultural functions (Origgi & Sperber 2000). With cognitive adaptations and modules articulated in this manner rather than equated, the massive modularity thesis should become much more plausible and acceptable.

To explain the role played by modules in cultural diversity and stability, Sperber (1996) introduced the notion of the "domain of a module." A cognitive module—for instance a snake detector, a face-recognition device, a language acquisition device—has as its function to process a given type of stimuli or inputs—for instance snakes, human faces, or linguistic utterances. These inputs constitute the *proper domain* of the module. To recognize inputs belonging to its proper domain, a module uses formal conditions that an input has to meet in order to be accepted and processed. All inputs meeting the input conditions of a module constitute its *actual domain*. These inputs conditions can never be perfectly adequate. Some items belonging to the proper domain of the module may fail to satisfy them—a snake may look like a piece of wood. Some items not belonging to the proper domain of a module may nevertheless satisfy its input conditions—a piece of wood may look like a snake. If only because cognition is a probabilistic activity, the actual and the proper domain of a module are unlikely ever to be strictly co-extensive. There will be false negatives, i.e. items belonging to the proper domain but not to the actual domain, and false positives, i.e. items belonging to the actual but not to the proper domain. When false negatives are much more costly than false positives, as in the case of a snake detector—better mistake a piece of wood for a snake than a snake for a piece of wood—, it can be expected that the actual domain will be larger than the proper domain and will almost entirely include it (fig 5a). When false positive are much more costly than false negatives, as in the case of a berries detector—better miss a few berries than swallow a poisoned fruit—, it can be expected that the actual domain will much smaller than the proper domain and will almost entirely be included in it (fig 5b).

Figure 5: Proper and actual domains of a module



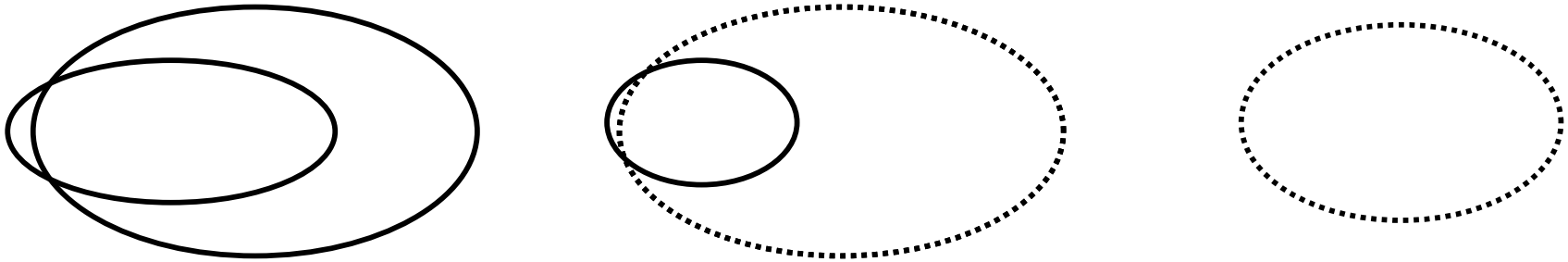
(5a) Proper domain (full line) et actual domain (dotted line) of a venomous snake detector



(5b) Proper domain (full line) et actual domain (dotted line) of a berry detector

The way in which the proper and the actual domain of a module overlap may also depend on the history of the environment in which the module has been operating. Imagine for instance a venomous-snake detector selected at a time in the history of the species where most snakes present on some island were venomous. The function of this module is to help organisms endowed with it avoid these venomous snakes. However its input conditions are met by all snakes and not just venomous ones. In such conditions, the actual domain, which contains all perceptible snakes, was, from the start, significantly larger than its proper domain, which contains only venomous snakes, even if the latter was large enough to cause the evolution of the detector (figure 6a). In a later period, the environment had changed. There were still as many snakes activating the module, but most were harmless. In other terms, the proper domain dwindled while the actual domain remained as large as before (figure 6b). Today, there are fewer snakes on the island, and they are all harmless. The perception of a snake still activates the venomous-snake detector, but its proper domain is now empty (figure 6c). Given that there is no benefit to compensate for the costs of this activation, there is selective pressure for the elimination of the module.

Figure 6: What happens to the proper and actual domain of a venomous snake detector when these snakes become extinct.



(6a) Initially, there are plenty of venomous snakes belonging to the proper domain (full line).

(6b) Later, there are much fewer venomous snakes belonging to the proper domain (full line).

(6c) Finally, venomous snakes are gone. The proper domain is empty. The actual domain (dotted line) is reduced.

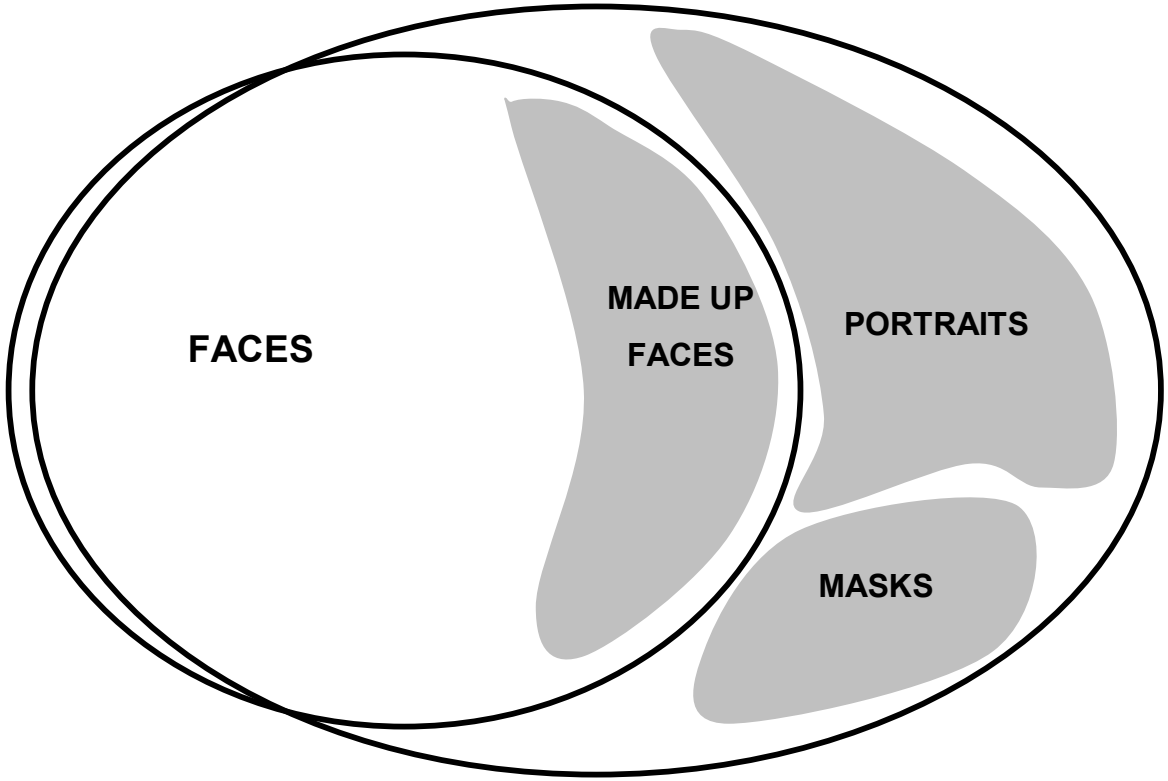
In some cases of particular interest here, the mismatch between the proper and the actual domain of a module results in part from the exploitation of the module by other organisms. Striking illustrations are provided by animal mimicry. Many insectivorous birds for instance have the ability to detect wasps, which are dangerous to eat. Hover flies, which are good food for these birds, have evolved black and yellow stripes on their abdomen that mimic the appearance of wasps and activate the birds' wasp detecting module. These hover flies have invaded the actual domain of the birds' wasp detector where they trigger false positives to their own advantage. Camouflage is another form of exploitation of the relative rigidity of modular detectors. While mimicry consists in the invasion of the actual domain of a detector by

organisms that don't belong to its proper domain, camouflage consists, on the part of organisms belonging to the proper domain of a detector in eliminating, or at least attenuating the features that would make them belong to its actual domain, resulting in false negative that are advantageous to them.

The manipulation of the cognitive modules of another organism can occur not only in interspecific relationships (as in animal mimicry and camouflage) but also in intra-specific interaction (for instance in cases involving sexual selection). This takes place to a unique extent among humans. Humans seek to influence one another in many ways, and hence need to both attract and direct the attention of others. A reliable way to attract attention is to produce information that falls within the actual domain of modules, whether or not it also falls within their proper domain. Moreover, given the rigid patterns of modular processing, the direction in which such information is likely to be processed is relatively easy to predict.

A great variety of cultural artifacts are aimed at specific modules. For instance, face recognition modules found in primates accepts as input simple visual patterns that in a natural environment are almost exclusively produced by actual faces. In the human cultural environment, many artifacts are aimed at the face recognition module. They include portraits, caricatures, masks, and made up faces. The effectiveness of these cultural artifacts is in part to be explained by the fact that they rely on and exploit a natural disposition. Often, they exaggerate crucial features, as in caricature or in make up, and constitute what ethologists call "superstimuli." The effectiveness of these artifacts in turn helps explain their cultural recurrence. More generally, the actual domain of human mental modules is invaded and inflated by culturally produced information. When some specific type of information is culturally produced in order to activate a module, it can be described as a cultural domain of the module. For instance portraits, caricatures, masks, and made up faces are cultural domains of the actual domain of the face recognition module (figure 7). Cultural domains are likely to be outside of the proper domain of the module, as is the case with portraits, caricatures, or masks. They may also fall within the proper domain as in the case of made up faces: these are genuine faces, and therefore it is the function of the face recognition module to analyze them; however they are faces that have been artificially transformed so as to be interpreted for instance as younger or healthier than they really are.

Figure 7: Proper domain (full line), actual domain (dotted line) and three cultural domains (shaded) of the face recognition module



We illustrate this approach with three types of cultural phenomena: folkbiology, folksociology, and supernaturalism.

The case of folkbiology: All animals interact with a variety of other animals and plants and must organize knowledge about them to guide their own behavior and interpret the properties and behaviors of other species (e.g. aggression from predators or sweet taste from ripe fruits). In the human case, categorization of living kinds is complex, comprehensive, and cultural (see Berlin 1992). In different cultural traditions plants and animals play diverse roles (e.g., in activities ranging from foraging and agriculture to totemism). Nevertheless, folk taxonomies the world over are remarkable in the degree to which they structurally resemble each other and in the extent to which they match scientific taxonomies.

Sorting plants and animals into categories is largely guided by regularities in perceptual discontinuities in morphology in local ecologies. However, reasoning about living things is not principally based on inductive processes. Developmental findings provide evidence for a special-purpose module for folk or naive biology. Despite often fragmentary and limited experience, young children's inferences and expectations about the nature of living things are like adults': they are based on the fact that category membership supports very rich and varied inferences (Atran 1995). These inferences obey a naïve form of inference according to which each living kind has an unseen essence. These implicit species-specific essences are treated as having causal effects on the appearance and behavior of members of the kind (Gelman & Hirschfeld 1999). Young children, for example, privilege common folk category identity over similarity in appearance when inferring whether different living things share biologically-relevant properties. Young children also understand that a living thing's category membership is fixed; both with respect to developmental changes organisms may naturally undergo and with respect to the imperviousness of species-typical properties. Cross-cultural evidence is scant, but what little exists indicates that both expectations do not vary culturally (e.g. Atran. et al. 2001; Sousa et al. 2002).

The unique importance of animals and plants in ancestral environments and the fact that they afford domain-specific patterns of classification and inference suggest that a dedicated module might have evolved that governed the categorization of living kinds and reasoning about them. The similarities of folk-taxonomies across cultures and the regularities in the acquisition and deployment of these taxonomies confirm this hypothesis (see Atran 1990). The proper domain of the living-kinds module would have been the local plants and animals with which the individual had to interact. However, the fact that inputs to this module come not just from direct experience of the living creatures to be categorized but also, and crucially, from communication with other people allows expanding the actual domain of the module well beyond its proper domain and the limits of local ecology. Using verbal descriptions and pictures as inputs, the module may build representations of many species with whom the individual is unlikely ever to interact —including extinct species such as the dinosaurs, or imaginary species such as dragons.

The module may enrich its categories with information about both familiar and unfamiliar species, information the relevance of which is often cultural rather than practical. Indeed, folkbiology strikingly illustrates how the existence of evolved modular dispositions to attend to and organize information in a domain-specific way lends itself to a massive cultural exploitation. For example, in modern societies, wolves are encountered, if at all, only in zoos. However a culturally transmitted representation of wolves as dangerous predators of humans (which they are not) is among children's earliest acquisitions. This representation is a strong attention catcher, a source of recurrent metaphors, and it plays an important role in folklore and children's literature (see Zipes 1993) and, recently, in an American presidential election campaign. Culturally reinterpreted wolves have become superstimuli. Modular processing of information about living kinds is similarly the basis for the variety of cultural exploitations lumped together in classical anthropological theory under the label of "totemism" (Lévi-Strauss 1963).

The case of folksociology: All social animals face the challenge of coordinating behavior with members of their own and other social groups. They are likely to have, for this, dedicated cognitive abilities involving in particular the ability to categories conspecifics as members of different social categories or groups. Among primates, it has been argued that the increasingly complex forms of group living have triggered the evolution of a higher-order cognitive capacity to attribute mental state to others. Such a naïve psychology capacity may play a major role in cooperation, communication, deception and its detection, coalition formation, and social competence generally (see Whiten & Byrne 1997). However, there is no reason to assume that, in some primates and in particularly in humans, it replaces, rather than complements, forms of social competence found in social species without naïve psychology. Primates (human and nonhuman) simultaneously belong to many social groupings (based on territory, intragroup status, sex, biological relatedness, and transient or opportunistic coalitions), membership in any of which provides a basis for predicting and interpreting the behavior of others (Hirschfeld 2001). The cognitive demands of such inference are sufficiently specific and complex to suggest the possibility of a special-purpose modular competence in naïve or folksociology quite distinct from folk psychology, and of probably much greater ancestry.

Unlike the social lives of nonhuman primates, human social life is thoroughly cultural. All forms of social organization, from biological-sounding "kinship" to such artificial groupings as monastic orders and political parties, vary culturally and rely on culturally transmitted, partly explicit institutional rules. The distinction between the proper and actual domains of a cognitive module makes it possible to understand this cultural diversity as a function of the evolution of abilities found in other primates. The proper domain of primate and ancestral naïve sociology modules consisted in the group affiliation of conspecifics. The actual domain of these modules was determined by whatever (in an individual's bodily appearance, behavior, or the reaction of others to them) provided evidence of their group memberships (e.g., chimpanzee strategies of facial phenotypic matching used in kin recognition—see Parr & de Waal, 1999).

The culturalization of social groupings must initially have consisted in the elaboration of these cues of group membership. For instance, to natural sexual dimorphism was added a cultural gender dimorphism. Thus existing mechanisms for social cognition were presented with culturally contrived superstimuli (just as in the case of face recognition superstimulated with make up). Cognitively, groups are characterized by whatever cues makes it possible to identify their members and by the inferences this identification affords. In an ancestral environment these cues were natural, but why (and how) could there have been anything in the ancestral module that precluded the

possibility of culturally enhanced or constructed cues.

Indeed, just as living kinds are categorized not only on the basis of direct experience, but also, and crucially, on the basis of communication, the recognition of social groups draws heavily on verbal labels and clichés and other expressions of group membership and of attitude to other groups. The displacement of natural signs of group membership by more salient cultural signs together with communication about the consequences of group membership made possible the construction of novel social groupings, a process which has a self-realizing character (see Hacking 1995). If a culture recognizes, say, castes as genuine social categories with distinctive consequences for their members, then they are genuine social categories (although their actual sociological character may be misrepresented in the folksociology). Whatever culturally constructed social groupings happen, at a given time and place, to fill the actual domain of a social competence module also falls within its proper domain.

The case of supernaturalism: Folkbiology and folksociology are cultural systems of representations that, we argued, may be each grounded in a specific evolved cognitive mechanism. However, not every system of cultural representations matches a distinct cognitive disposition. It is implausible for instance that representations of supernatural beings and events of the type found in all religions (and also in folklore, art, and literature) are grounded in an ad hoc cognitive mechanism. After all, supernatural beings, unlike living kinds or social groups, were not part of the environment in which humans evolved. It has, nevertheless, often been argued that religion responds to a basic human need, be it a need for answers to fundamental questions, a need for transcendence, a need for comfort and reassurance, or a need for superior authority. From a point of view informed both by cognitive science and evolutionary biology, the existence of such needs and the ability of religion to satisfy them are quite questionable. Typically religious beliefs raise more questions than they answer, and cause anxiety as much as they comfort (there is, say, a promise of eternal life after death, but it might be spent in Hell). Explaining religion by a religious disposition lacks insight and plausibility (see Boyer 2003).

The ubiquity and salience of cultural representations of supernatural beings may be accounted for in terms of a modular cognitive architecture without assuming that there is a modular disposition to represent such beings or to look for supernatural explanations. Representations of supernatural beings do not just depart from what is taken to be natural or ordinary. A zebra with red and blue stripes or a person who, like Borges's character Funes, remembers everything, however out of the ordinary and in practice impossible, are unlikely ever to become culturally recognized supernatural beings. Supernatural beings are not just impossible in nature. They blatantly violate the kind of basic expectations that are delivered by domain-specific cognitive mechanisms. In direct clash with naive physics, some are able to be in several places at the same time or to pass through solid objects. In direct clash with naive biology, some belong to several species at the same time or can change from one species into another. In direct clash with naïve psychology, some can literally see all past and future events. Despite these striking departures from intuitive knowledge the appearance and behavior of supernatural beings is otherwise what intuition would expect of natural beings. That is, they have enough of the characteristic features of plants, animals, people, topographic entities or celestial bodies to fall squarely in the actual domain of cognitive modules. Supernatural animals have, apart from their supernatural features, a regular biology. Supernatural agents have a belief-desire psychology. As argued by Boyer, it is this combination of a few striking violations with otherwise conformity to ordinary expectations that makes supernatural beings attention arresting and memorable, and rich in inferential

potential (see Boyer 2001).

Representations of supernatural beings, we suggest, spread and stabilize in different cultures because they act for one or several cognitive modules as superstimuli. Unlike other superstimuli, which have some features exaggerated while essential features are maintained, these cultural superstimuli typically combine exaggerated and paradoxical features with ordinary and essential ones. One way in which they may be paradoxical is in falling simultaneously in the actual domain of two different modules. For instance, a sacred tree may be attributed agency: its appearance activates a naive botany module, whereas what is said of it and the way it is treated activates a mindreading module. Representations belonging to a complex system such as a religion (which involves not only representations but also practices, artifacts and institutions with a much more complex epidemiology) need not be all anchored in one and the same cognitive module. On the contrary, multiple anchoring in several cognitive mechanisms may contribute to the cultural system's stability (Atran 2002).

Conclusion

The propagation, stabilization, and evolution of cultural representations have a variety of causes. They are helped or hindered by demographic and other ecological conditions, in particular by human-made features of the environment, and by educational, political, and religious institutions. We agree with standard social science that culture is not human psychology writ large and that it would make little sense to seek a psychological reductionist explanation of culture. We believe, however, that psychological factors play an essential role in culture. Among these psychological factors, the modular organization of human cognitive abilities favors the recurrence, cross-cultural variability, and local stability of a wide range of cultural representations.[1]

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[1] This chapter integrates and expands elements from Sperber 2003 and Sperber & Hirschfeld 2004.

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