

## Human communication as niche construction

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in press, Shennan volume

Cultural transmission is essentially the idea that beliefs and values are passed from generation to generation. The question I would like to address in this paper is how does this happen? In particular, what is the mechanism? In the absence of a deep understanding of the process by which people come to have similar ideas, a variety of metaphors have been used. The purpose of this paper is to outline the options for understanding cultural transmission as a process and to analyse their consistency with what we know about cultural change and communication more generally. I conclude with a view which I hope is an advance over the existing alternatives. My proposal makes clearer the role of artefacts in mediating many kinds of communication, and takes account of the recent evolution of evolutionary technology – networks of machines which exhibit the qualities of information inheritance, selection and mutation – as an important phenomenon that interacts with cultural change.

Communication is the process of exchanging information via a common system of symbols, signs or behaviour (Merriam-Webster dictionary; Encyclopedia Britannica). A more technical definition, based in information theory, is a process in which information is transmitted from a sender to a receiver by means of a message that moves through a channel (Shannon and Weaver 1963). Communication is supposed to result in ‘shared information’ – that is, information of similar content in two minds. The common inference is that one individual or agent has acquired this information through a process of information transfer: information moves from one place to another, where it gets stored in some form. As many have noted, this transfer establishes an information inheritance relation between these agents. Others have suggested that chains of communication events might exhibit all the requirements of Darwinian evolution, summarized by the phrase ‘descent with modification’: mutation, selection and inheritance (Cavalli-Sforza and Feldman 1981; Boyd and Richerson 1985; Durham 1991). Cultural change could then be described as the population-level consequence of many communication chains over a period of time, leading to changes in the relative frequency of cultural variants (Croft 2002).

Even if this is true, the Darwinian approach is wonderfully agnostic about the means by which transfers of information from agent to agent are achieved. This makes the theory very powerful -- it can be applied to many processes, including genes and culture -- but it also leaves scientists with work to do in finding out how the information transfer occurs in any given instance. In the absence of clear knowledge, researchers in the social and psychological sciences have been creative in their use of metaphor to describe the process.

### ***The ‘no dynamic’ metaphor***

Some culture theorists don’t accept the basic premise that transmission is an important process in cultural change. This can be taken as a kind of default position. Such a position typically argues that ‘culture’ is just the consequence of individual learning. For example, this ‘no-

dynamic' alternative is characteristic of some behavioural ecologists who, while they may acknowledge that some social learning occurs in humans, play down its importance in explaining group-level differences in behaviour. There is no specific evolutionary dynamic to the ideas which human groups exhibit beside individual-level learning from the environment. At least some suggest that so-called 'culture' is just another phenotypic trait – a quality of an individual, not a group (e.g. Flinn and Alexander 1982). If transmission does happen, it is argued not to have significant independent effects due to the social diffusion of knowledge: individuals still maximize their inclusive fitness in ways expected by standard evolutionary theory; no new phenomena or dynamics are involved in culture. These theorists take advantage of a kind of 'phenotypic gambit' (Grafen 1982), arguing that transmission happens in such a way that culture -- and any effects it might have on the distribution of knowledge, and hence behaviour, within a population -- can be ignored. Human behaviour can be explained as the interaction of individuals with their environments and there is little need to invoke other causes underlying behaviour such as cultural beliefs and values. Humans learn to respond adaptively to environmental cues without paying much attention to their conspecifics. For example, one prominent behaviour ecologist admits that "I, personally, find 'culture' unnecessary" (Betzig 1999: 17).

However, over the past couple of hundred years, some human groups have achieved amazing power over their environments through technological advances while others continue to eke out a meagre subsistence with no economic surpluses. It would be extremely difficult to explain this difference without making reference to differences in group-specific traits and activities, such as engineering principles for constructing superstructures and large-scale infrastructures such as electricity webs and computer networks. The existence of these must be due to socially-learned traits. This fact tends to be ignored by human behaviour ecologists, who have in large part preferred to study subsistence-level societies (Smith et al. 2000).

### ***The 'jukebox' metaphor***

Evolutionary psychology, with its notion of 'evoked' culture, partakes of a variant of this individual learning model. It argues that learning, whether individual or social, is less important in determining so-called 'cultural' behaviours than information stored in evolved mental structures. The transmission of information is occurring not from other people during an individual's lifetime, but at the point of birth, in the form of genes. 'Culture' (which is not culture at all, because it is not socially transmitted information, the whole point of the culture concept) is put into people's heads by a long-term process of natural selection for ideas that worked in the past to produce adaptive behaviour, given the ecological conditions of the species during its evolutionary history (Cosmides and Tooby 1992). 'We call similarities triggered by local circumstances *evoked culture*... Observations of similarities and differences do not establish that the substance of human life is created by social learning. In any specific case, we need to map our evolved psychological architecture to know which elements (if any) are provided by transmission' (Cosmides and Tooby 1992: 210). In this case, a mechanism is implied (although not always explicitly mentioned): culture piggy-backs on genetic inheritance, with cultural information being inscribed (somehow) in genes. Presumably cultural information could be incorporated into the genome via a Baldwinian process (Baldwin 1896) or through genetic assimilation (Waddington 1953), so that what has been individually learned becomes at least partly genetic in causation as mutations which support propensities to engage in environmentally appropriate behaviour evolve and gradually take over responsibility for producing the behaviour.

However, it is unlikely that such a slow process can provide brains with the ability to choose the correct alternative in any cultural context, since culturally appropriate behaviour can be sensitive to many novel stimuli (Richerson and Boyd 2004). Of course the evolutionary psychologists respond that, for new aspects of human environments, no adaptive solution can be expected to have evolved, accounting for the maladaptive nature of many culturally sensitive behaviours in modern societies (such as the demographic transition).

The more significant difficulty for this genetic or 'individual learning only' position is to explain how groups maintain distinct bodies of knowledge and practice that are not correlated with the ecological experience of the individuals in those groups. Many examples exist of distinct boundaries in cultural behaviour between groups living side-by-side in similar ecological niches (Richerson and Boyd 2004). These differences can only be explained by a group-level process of knowledge retention, presumably through social learning among group members. Transmission, and its effects on the distribution of knowledge, cannot be ignored when human culture is to be explained.

### ***The 'magic' metaphor***

Used in the enculturation literature (primarily found in social psychology and anthropology), this metaphor argues that each generation, as it matures and develops, begins to exhibit the cultural traits of the previous generation. The young acquire these traits by an undisclosed means, and thus by 'magic'. For example, enculturation is an individual's 'internalization of all aspects of their culture' (DeFleur and Ball-Rokeach 1989: 209).

A somewhat more specific account suggests that one generation 'enculturates' the next generation, en masse, by passing on their traits, although again the mechanism for achieving this transformation of the younger generation is typically unspecified. Thus, enculturation is 'a partly conscious and partly unconscious learning experience whereby the older generation invites, induces, and compels the younger generation to adopt traditional ways of thinking and behaving' (Harris 1987: 7) According to etymologists, enculturation is 'the process by which human infants learn their culture'; it happens 'when culture is passed along from one generation to the next'.

Not all socialization theorists would argue that no mechanism of transmission exists; only that we currently lack knowledge of how transmission occurs. However, such metaphors also tend to rely on a perceived quality of information which itself is magical and appears not to require a mechanism at all. This is the belief that 'culture-stuff' can be in one person's head, but passed to another while retaining it as well: information is the one resource that you can give away and still keep yourself (e.g. Pinker 1997). The problem with the idea of costless gift-giving or the spontaneous generation of cultural information in naïve individuals is that it does not specify the physical substrate of cultural objects; at the same time it requires the causeless duplication of information. The metaphor thus suggests 'action at a distance' – the metaphysical notion that activity in one time and place affects a situation at some remove without a physical causal connection. The metaphor also seems to involve the duplication of a physical entity – a quantity of information – at no cost and thus violates the laws of conservation of mass and energy.<sup>1</sup> A science of communication cannot be built on these metaphysical foundations, so an alternative to the metaphor of communication-as-magic must be found.

### ***The 'sneeze' metaphor***

An interesting feature of culture is the often rapid replacement of one practice with another: a new way of doing something, or a new game or clothes fashion, can spread through a population seemingly overnight. These practices or beliefs often seem to be mindless variations on previous trivial or frivolous behaviour. These features suggest that at least some cultural change is rather different from the slow, progressive change of genes. The spread of fashions and fads is often likened to the diffusion of a pathogen-based epidemic, making use of a 'culture-as-virus' metaphor. This epidemiological approach places emphasis on the rapid spread of a particular idea or practice through a population, typically without considering the possibility of mutation or variation. The idea is that when a person speaks, ideas pass through the air, and can enter other people's bodies. The communication of information is thus like sneezing: an agent which can produce 'symptoms' (i.e. influence behaviour) makes the passage from one person to another by moving through the air. Ideas, then, are like viruses. The field of memetics has largely grown up around this metaphor (Dawkins 1976; Blackmore 1999; Aunger 2001, 2002). For example, Dennett (1990: 131) suggests that 'memes now spread around the world at the speed of light, and replicate at rates that make even fruit flies and yeast cells look glacial in comparison. They leap promiscuously from [evolutionary] vehicle to vehicle, and from medium to medium, and are proving to be virtually unquarantinable.' The diffusion of innovation literature (Rogers 1995) also applies this metaphor to the transmission of cultural practices and new technology through a population, producing 'epidemics' of new varieties of corn seed (Ryan and Gross 1943) or the use of novel antibiotics among rural American doctors (Coleman et al. 1966).

Pathogens, the foundation of biological epidemics, grow and multiply either within the host or a vector species, and then disperse to the next host or vector. However, it is rarely assumed that ideas duplicate themselves within one mind prior to being ejected into the external environment (e.g., in the form of speech); this aspect of the analogy does not transfer from the disease domain to the new domain of culture (the magical duplication of information is supposed to occur again). However, it is crucial to make this assumption for the analogy to be relevant and physically plausible; otherwise, transmission must involve the loss of information during communication: people would have to sneeze away the only copy of the idea they have. If this was true, cultural transmission would become a zero sum game, with a fixed set of cultural elements being exchanged back and forth through social 'learning'. The consequence would be that the accumulation of culture so obvious in recent human history would become difficult to explain.

Alternatively, one can think of the expression of ideas as the phenotype of a mental genotype. Speech in this case is the product of an idea that never leaves the individual's mind (the 'genotype' of an idea presumably being instantiated as a unit of neural memory). However, in this case, the communication-as-infection process becomes Lamarckian because it is the phenotype (speech) which is copied by the 'infected' individual. The duplicate of the idea in the receiver's mind is a phenocopy, being derived from the phenotype rather than directly from the genotype. In this sense, communication becomes an instance of the inheritance of acquired variation (Aunger 2002). If the rate of mutation in ideas is low, and inheritance exact, such transmission could lead to a loss of variation on which cultural selection could work (the 'Fleeming Jenkins' effect). Since we generally see a proliferation rather than reduction in cultural variation around us (at least as a long-term trend at the global scale), this type of model seems unlikely.

### ***The 'telephone' metaphor***

Derived from mathematical communication theory (Shannon and Weaver 1963), the idea here is that 'bits' of information are sent through a physical channel from sender to receiver. (Shannon's approach also has a probabilistic interpretation in terms of the reduction of uncertainty deriving from receiving a bit of information, but I am concerned here with the communication model that derives from the theory.) This metaphor at least makes explicit the need for a channel, and for 'things' that move through it from one place to another. In this respect, the model is fine -- as far as it goes. It also allows for the possibility of randomized mutation in the message, as a result of the action of environmental noise. But it is not fully evolutionary in nature (being designed to explain information flow through telephone networks), because there is no role for selection of messages; that is, the sender and receiver are not conceived as strategic (i.e., biological) agents, but as physical mechanisms. This makes the model difficult to apply to biological agents. (Thus, the notion of communication as coded-decoded transfer of information from one party to another also is too broad. Instead, communication should be seen as intrinsically strategic.) In effect, the model doesn't explain how messages are constructed, selected or adopted by human beings, nor how the relationship between sender and receiver might influence the choice of message nor the likelihood of its adoption. The 'telephone' metaphor is, in the end, too physical, too oriented on the transmission component itself. We still lack information about what happens both before and after a message is transmitted 'down the line'.

All of these metaphors remain abstract in one sense or another: they are insufficiently realistic in their description of how human communication happens. Communication must be, first, a process with physical causes and consequences, and, second, a process of strategic engagement between agents with potentially conflicting interests. These facts restrict the kinds of models one can legitimately make of the communication process, and eliminate those considered so far.

### ***The 'construction' metaphor***

In earlier work (Aunger 2002), I developed a model of cultural transmission which avoids these problems. In this model, communication is not seen as the exchange of symbolic objects or abstract 'information'. It is rather an attempt to manipulate others in the social group using signals or signs (as originally suggested by Dawkins and Krebs 1978).<sup>2</sup> The goal of communication in this case is get others to engage in behaviours that assist the communicator's efforts to maximize inclusive fitness.

In this view, communication – the process underlying cultural change -- is not fundamentally about the transmission of anything in particular. (By comparison, gene evolution is not really about transmission either, but rather the 'hand-to-hand' construction of offspring DNA strings.) Instead, communication can be defined as *an instance of niche construction using signs, signals or artefacts which is targeted at changing the behaviour of conspecifics.*

The specification of targeting in this definition distinguishes communication from incidental signal production – such as footprints in the sand – which conveys information to others without the intention (or evolved function) of making them behave differently. Accidental transfers of information may occur, but they are assumed not to regularly result in behaviour which improves the signaller's biological fortunes. Communication is thus a narrower concept than social learning, which can involve the inadvertent construction of an environment or situation

from which other organisms can better extract information, such as social facilitation. (Boysen and Himes 1999)

Social learning thus often occurs without intentionality. In fact, the preponderance of information transmission probably cannot be called communication because it is unintentional. Animals often observe the behaviour of conspecifics to pick up cues about what is important about a place or context, as well as to see how certain kinds of potentially complex skills are best performed. It can be assumed that there is no intention to manipulate conspecifics in this case of 'naturalistic' observation, so presumably the model (or accidental demonstrator) is engaging in the most appropriate and relevant practice. It is also easier to evolve culture through this kind of inadvertent social learning than through dedicated dyadic interaction (Panchanathan and Boyd 2004). Even in humans, most skills are learned without formal teaching, but rather through observation of cultural practices (Rogoff 2003). The inadvertent transmission of information may therefore be the dominant mode of culture learning. However, I argue that it is also the case that there is an adaptation for intentional transmission – the phenomenon I am calling 'communication' in this paper.

Any activity that has the desired effect on others' behaviour will do as an instance of communication. In humans and other big-brained species (particularly primates), the process of signalling others can be accomplished through various means which make the process more or less indirect. The most direct (and hence simplest) form of communication involves the production of signals such as vocalizations or movements of the body (signs) which can be directly perceived by others. A more complex form of communicative manipulation of the environment involves the production of artefacts which can modify environmental energy forms (such as photon streams), producing signals. In this case, an agent rearranges or manipulates the environment in ways that cause others who interact with that aspect of the environment to receive messages. This is social manipulation without communication or 'social learning' in the strict sense. An example is the production of a book, which includes pieces of paper imprinted with ink, creating physical surfaces that reflect modified patterns of photons which can be perceived and interpreted through reading. In this case, artefacts serve as stores of symbolically coded messages which serve as templates (or even more actively, transmit) signals to others on your behalf. An even more complex form of communication utilizes artefacts as the communication channel as well – for example when a page of a book is displayed over the Internet on a computer screen, or when reading an 'e-book'.

Communication in this view is a type of environmental manipulation. It involves primary, secondary and tertiary goals, all of which result in niche construction (*sensu* Odling-Smee et al. 2004), albeit in different forms. The first objective is to modify the environment by constructing either a signal (i.e., a short-lived perturbation of a medium such as air or water, created through e.g., speech or gesturing), or a signal template (i.e., the production or modification of an artefact which stores signal-related information, such as writing a letter or typing into a computer, which produces changes in the state of RAM to store an email). Both signals and artefacts are aspects of the individual's niche, so communication begins as an instance of niche construction by the communicator. The secondary goal is to get conspecifics to 'consume' the signals produced directly by the sender (e.g., through speech) or by the artefact in which information has been stored (e.g., by watching a computer screen displaying received email). This view suggests that other minds are the equivalent of artefacts: something to be constructed (albeit indirectly) by an organism's activity. In this instance, the secondary constructive target of communication is *mental* (re)construction by the message receiver. (Of course, the receiver will evolve psychological filters to minimize the infiltration of potentially

damaging information, such as attention, categorization and assessment processes.) The tertiary goal of communicative activity is to eventually influence the behaviour of conspecifics, presumably as a result of this (potentially indirect) information transfer to the receiver's mind. This tertiary goal of communication is to get *conspecifics* to engage in ecological niche constructive activity which is either beyond the ability of, or could only be done at greater cost by, the communicator. For example, convincing a more senior colleague to approach the head of the firm where one works with a criticism of business operations. It could also be the case that the tertiary goal is to encourage the message receiver to collaborate with the communicator (or third parties) on some cooperative endeavour that achieves an evolutionarily advantageous end-state. In any case, the end result is behaviour by a conspecific which modifies the communicator's niche in a way which tends to increase the communicator's inclusive fitness.

The traditional view of communication as the face-to-face exchange of spoken words makes it difficult to deal with the complications introduced by artefacts. It might be argued that the role of artefacts is irrelevant, that communication of the same message is still achieved (as when Blackmore [1999] suggests that reading is just imitation). However, such a position would ignore the very large literature on the effects of mediation on the interpretation of messages (Thompson 1996). Marshall McLuhan went too far when he said that the 'medium is the message', but certainly a whole discipline -- known as media studies -- has arisen to study the phenomenon of how technological mediation influences the consequences of communication. Further, artefacts are becoming increasingly like agents themselves, playing significant roles in determining who knows what. This means that their influence must be taken into account when attempting to explain or predict cultural change. (Aunger 2002) It therefore seems foolish to ignore -- or minimize -- the complexities of how information moves through modern technological societies.

It is worth noting that if the goal of communication is to influence one's environment (particularly the behaviour of others), then communication may not lead to the replication of information (as some communication theorists would have it -- e.g., the Shannon and Weaver tradition). In particular, communication is not designed to create mind viruses, as memetics would suggest (Dawkins 1976). If the goal of communication is not to copy information, then it is unlikely that selection would have caused the evolution of high fidelity inheritance mechanisms (i.e., meme replication devices) to support information replication. <sup>3</sup>

As Sperber and Wilson emphasize, a listener's objective is not to copy what is in the speaker's mind, but to learn what might be of use to them -- what is *relevant* to their evolutionary interests at the time.<sup>4</sup> It is also the case that any given instance of mental reconstruction is likely to reflect the influence of prior reconstruction. Hence, we all have brains shaped by culture, and cultural filters determine any further shaping of our brains by experience.

Take the example of gossip, which is a major topic of human conversation (Dunbar 2004). One could think of it as trying to create shared opinions about third parties, as coming to an agreed assessment of the character of others not present. One may not create the same opinion of a third party in the listener, but merely influence their opinion upwards or downwards. In any case, why invest so much time trying to convince someone of the trustworthiness of others? Presumably to boost one's own relative social standing (as the source of valuable information) and/or to cause the listener to engage in -- or refrain from engaging in -- a variety of behaviours, either with oneself or the subjects of gossip.

Human communication is unlike that of other species because we are not interested in decoding the meaning of what has been said. In a sense, we don't care about content. At least the chain of inferences prompted by the perception of social signals doesn't stop there. We proceed to figuring out what the speaker was trying to achieve by communicating that content, to us, in that situation (in essence, Grice's notion of 'implicature'). This is why pragmatics, or the study of language in use, must complement semantics, or the study of meaning, to understand human communication. Communication is about changing the minds of others, not transferring informational content (Sperber and Wilson 1995; Taillard 2005).

### **Discussion**

A variety of positions can be, and have been, taken with respect to the nature of information transmission in cultural change. Most contemporary scholars see some form of social learning as central to cultural change (contra the 'innatists' who argue that culture is just another aspect of genetic phenotype). However, the mechanism by which social learning occurs remains more or less vague in most accounts. This leads to problems when the objective is to describe or predict the consequences of social learning: cultural change.

While I do not provide new insight here into the mechanisms of social learning underlying cultural change, I have been concerned with the role of communication, as a form of social niche construction, in cultural change. Because the various positions outlined above are typically not explicit about the means of transmission, it is difficult to evaluate whether their claims about cultural dynamics involve intentional communication or whether they could be restricted to inadvertent transmission pathways. I will therefore leave this issue aside, and only pursue the question of what cultural dynamics would be like if based in communicative events.

Communication is typically seen as fairly instantaneous message-passing, with little role given to the environment (except in the form of a channel). However, with the advent of technology, it is possible for the environment to store information for later acquisition by human beings. I have suggested that social learning needs to be placed in a broader context when dealing with humans, due to their ability to involve artefacts in the learning process. Transmission in the sense of the active, simultaneous exchange of information between sender and receiver is therefore not a sufficiently general model of communication to sustain investigations into cultural change. It places the emphasis in the wrong place: on the context of individual message transfers. To be interesting, culture should be thought of as the consequence of many chains of communication, resulting in a population of stored messages.

The advantage of this 'cultural constructionist' position is that it then becomes possible to deal with communication in modern societies using the same model as applied to 'standard' face-to-face communication. It also illuminates the fact that even non-technological communication is a niche constructive activity. This is because communication is *always* 'mediated' by signalling, even in the simplest species. Signals are physical things. The social insects, for example, use a variety of chemicals to communicate with one another.

Leaving pheromone trails may not be the image most social scientists have in mind when considering cultural transmission, but neither is typing an email into one computer and having the message being read days later by someone half a world away. The standard model of transmission – speech in the context of a face-to-face interaction – may be a rather rare form of communication when viewed from a phylogenetic perspective, and from a human historical perspective as well. In future, it is likely to become even less familiar as a mode of human



communication, as technologically-mediated communication becomes even more prevalent than it is today.

To understand culture, we have to be able to follow messages as they wend their way through various forms between sending and receiving people. Nowadays, information is spending more and more of its time in artefacts. Indeed, cultural change is being increasingly influenced by a progressive trend in the nature of communicative processes: mediation by artefacts. The use of artefacts to mediate communication has a long history. For example, chimpanzees use 'leaf clipping' (a particularly loud means of ripping leaves with the fingers or mouth) to communicate various kinds of messages. In some groups, leaf clipping signals a desire for a mating; in others it indicates an individual's frustration with the current situation; in yet others it is absent, suggesting the same use of an artefact (the leaf transformed into artefact by ripping) has culturally-specific meanings in each group. (Whiten et al. 1999) Humans have obviously taken such practices to much greater lengths. Indeed, much of human behaviour has been sucked into artefacts used as communication channels. Perhaps the most extreme contemporary example is on-line virtual worlds like Second Life, in which people can spend their time supervising avatars as they engage in all significant human activities (including economic and sexual exchanges) with the avatars of other players in a synthetic environment visualized via computer terminals. By allowing people to come together in synthetic environments or in common spaces such as Friends Reunited, Myspace or Facebook (various social networking websites), who knows whom is no longer determined by physical proximity, but rather by shared interests. This constitutes a fundamental reorganisation of social structures which surely has an impact on the dynamics of cultural change.

Whether to count the information stored in the environment as part of culture 'proper' becomes a major question in this case. I have previously argued that it should not. (Aunger 2002) The practical reason is that it makes it harder to conceptualize or measure cultural 'alleles' and their frequencies because the population must be defined in terms of people-plus-artefacts rather than just people. A theoretical reason is that if information inheritance is occurring *within* the technological domain, this will influence any dynamics that might be investigated in culture, and the dynamic interaction between mind-based culture and technological culture will itself coevolve over time. My argument is that this potentially independent dynamics of information inheritance, mutation and selection in artefact populations/networks, and its coevolutionary dynamic with mental culture, should be explicitly dealt with in cultural evolutionary studies – at least where there is significant involvement of symbolic artefacts in a society's culture (Aunger 2002, 2006).

We have, in a way, returned to the position of the evolutionary psychologists here: transmission *per se* is not an adequate model of cultural change. Instead, attention must be paid to other possible sources of information besides social learning. However, there are two significant differences between my position and that of the evolutionary psychologists. First, what can be called 'cultural constructionism' emphasizes that much of individual learning is with respect to artefacts produced by others, rather than an exogenous environment, so it remains social learning, if only in an indirect sense. Second, constructionism stresses the importance of population-level consequences from repeated chains of transmission events, which evolutionary psychologists and behavioural ecologists tend to down-play. The cause of cultural stability is not genetic assimilation as the evolutionary psychologists would have it, but rather the stabilizing influence of enduring informational infrastructures in modern societies which play a significant role in mediating human interactions, cultural and otherwise.

In the end, use of the word 'transmission' to describe this complex process of technologically mediated social learning may be counterproductive. Transmission is linked to the idea of information, which tends to have a rather abstract, disembodied quality. It also allows one to be sloppy about specifying a mechanism. Perhaps the word 'transfer' is preferable, as it suggests the existence of a physical object which must be moved from one place to another. It also reduces the possibility of thinking that information is something with no mass or energy which can be conveyed to naïve individuals without loss of the original 'message' or cost in the transfer. In fact, work must be done to cause the duplication of information, just like anything else. This effortful activity will only take place when it is in the evolutionary interest of the communicator.

I have argued this interest in communication is most likely to be reflected in the goal to make conspecifics change behaviour in specific ways which are advantageous to the communicator. Such communicative intentions are likely to be effective when the interests of the receiver overlap with those of the communicator, as is the case within families (e.g., skill transfer) – a context likely to have been significant in evolutionary terms.

Communication can be achieved through the creation of signal templates or data which is stored in artefacts for later connection to receivers. In any case, communication requires construction. Models of the communication process which ignore the physical requirements of information transfer are inadequate, and approaches to cultural evolution which ignore the possibilities of information storage, inheritance, and mutation through machine networks are also incomplete. Cultural evolution is best studied as a coevolutionary, *co-constructive* process in both organic and inorganic lineages.

Cultural constructionism has a number of advantages over the other metaphors used to describe cultural change described here. It is strategic in its treatment of communicative agents; it is physicalist in the sense that it specifies the activities associated with communication, rather than thinking of communication as an abstract, or 'magical' process; it explicitly acknowledges the role of technology in communicative acts; it is evolutionary and therefore allows culture to accumulate. Perhaps most importantly, it unifies the treatment of all forms of human communication under a single model, as a process of signal production, consumption and consequent behaviour.

## ACKNOWLEDGEMENTS

Thanks to an anonymous referee, Kevin Laland, Joseph Henrich and Stephen Shennan for critical readings of an earlier version of this paper, and to the audience at the conference for their excellent questions.

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<sup>1</sup> Information is not typically considered to be subject to the constraints of matter and energy conservation; however the physics of information suggest that information is a kind of form and cannot be created without energy; information always has a physical substrate and its creation is a negentropic act (Landauer 1991; Bennett 1995).

<sup>2</sup> Teaching or other forms of instruction are designed to reproduce information, ideas or beliefs. However, this is a specialized kind of communication. Education of the young *is* a cooperative endeavour, traditionally engaged in by kin, who share genetic interests. But more generally, communication is manipulative in nature due to the conflicts of interest between the senders and receivers of signals or messages.

<sup>3</sup> However, if most cultural transmission occurs outside the context of communication, and hence is inadvertent, then mechanisms of imitation could be favoured by selection. In this case, memes might exist, they just wouldn't replicate through intentional communication, as most memeticists insist (Blackmore 1999; Dawkins 1976).

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<sup>4</sup> This is not to deny that high-quality replication doesn't sometimes occur as a result of communication; only that it is not the evolved function of such acts, and so therefore may not occur often.