Transmission biases in the cultural evolution of language: towards an explanatory framework

N. J. Enfield

31.1 Introduction

In any natural, causal account of linguistic and other cultural transmission, an important role is played by the biases that regulate the process at various levels. These biases ultimately regulate the historical, cumulative transmission of culture. One reason for wanting to understand these biases is that they are phenomena of interest in themselves. In addition, while the discussion here presupposes the prior evolution of a capacity for cumulative culture in our species, our interest in transmission biases should ideally also give us some insight into that initial phylogenetic transition. In this chapter I discuss some of the biases that have been described in previous work relating to cultural change, including the historical evolution of language, and I will point to the need for a framework within which to explain just why we observe the biases we observe. After sketching a proposal for such an explanatory framework, I conclude by pointing toward some lines of research that this opens up.

31.2 Cultural epidemiology

In the cultural evolution of language, that is, the diffusion, maintenance, and change of linguistic practices in historical communities, it is often assumed or implied that the unit of analysis is the language system as a whole. But the replication and transmission of whole language systems is not causally conducted at the system level. It is an aggregate outcome of a massive set of much simpler and much smaller concrete speech events that operate on the elements which form *part* of any language, such as a word or a piece of grammar (Hudson 1996). Language systems only exist because populations of linguistic items replicate and circulate in human communities, where these items are directly observable as elements of spoken utterances (Croft 2000; Enfield 2003; Enfield 2008). A causal account of language evolution focusing on the transmission of linguistic items can be termed an epidemiological view of language change, following Sperber (1985; 1996), and in a similar spirit to Keller (1994) and Croft (2000). In an item-based account, the pieces of a language or other cultural system can change independently from other pieces, and they can be plucked out and borrowed from one system to another, as for example when we borrow a word. Of course, the notion of 'item' is an abstraction. An item in the sense intended here does not refer to a bounded physical object. Even when such objects are implied (e.g., a cultural tool like a hammer), the

item is always defined by sets of relations. Thus, a hammer is only a cultural item when we include not just the object but its relation to the human body, and the functions it is designed for fulfilling (e.g., banging in nails). So, even the simplest items must be understood to be packages of relations. And of course all packages of relations are embedded in further such packages, and again in further such packages, and so on seemingly without limit, as any ethnographer or grammarian well knows. This is why an item-based account must also ultimately be able to handle the special properties of higher-level linguistic systems or grammars. But we must avoid a temptation to treat these robustly coherent systems as if they were organisms with bodies. Cultural systems are not organisms. They are observed aggregates of behaviour, distributed in patterns of cognition, action, and material structure in the form of cultural items and the interrelations between those items. While ultimately we need a causal account for why it sometimes seems like we *can* treat languages as if they were organism-like systems (e.g., when we write grammars), it is first necessary to define the basic underlying causal anatomy of item-based language transmission. Here I outline the basics of a 'transmission biases' approach to the historical evolution of languages.

31.3 Biased transmission

The diffusion of cultural items is best understood in terms of a *biased transmission* model of the distribution of cultural knowledge and practice within human populations and across generations, following a general framework of cultural epidemiology (Sperber 1985; Sperber 1996; Boyd and Richerson 1985; Boyd and Richerson 2005; Enfield 2003; Enfield 2008). In a biased transmission model, the question of whether fashions of cultural practice in a population spread, decline, transform, or remain as they are will be determined the cumulative effect of a range of biases which ultimately serve as accelerants or decelerants on cultural practices in a competition for social uptake.

Linguistic and other cultural items are not confined to the mind, or to perceptible performance, but are simultaneously manifest in mental and material domains, *and* in relations between these domains. At any given moment, a human population is abuzz with a virtual mesh of ongoing causal chains that constitute continuous trajectories of production and comprehension of item-level patterns of behaviour. I am referring to all of the situated courses of behaviour in which people carry out goal-directed action by means of words, tools, body movements, and other cultural items. These trajectories of behaviour are the contexts in which the natural histories of

cultural and linguistic items are played out. They constitute

causal chains with links from mind (I know a word, I

understand a tool) to usage (I utter the word in a

communicative act, I use the tool for a purpose), to mind (my

addressee learns or recognizes the word, an onlooker builds or

confirms an understanding of the tool's function, attributing a

goal to my behaviour), to usage, to mind, to usage, to mind, to

usage, and on. We may call this type of causal trajectory a

chain of *iterated practice*, or a cognitive causal chain (Sperber

2006). See Fig. 31.1 for a simplified illustration.

FIG. 31.1 ABOUT HERE

Fig. 31.1 is not the same as the 'iterated learning' chains

presented by Kirby and colleagues (2004; 2008), Christiansen

and Chater (2008), among others (see below). Those iterated

learning depictions resemble Fig. 31.1, but they are not the

same. In iterated learning, each arrow from public to private

may represent an entire learning process such as a child's

learning of a language. Each link in the chain is effectively a

single macro-level 'state change' in ontogeny (e.g., the move

from not knowing the language to knowing the language). This

is shorthand for a great number of small events and small

associated state changes. Learning a language involves not one

event but many iterations of exposure and reproduction, and in

each occasion of exposure and reproduction there is feedback that comes from others' reactions to our usage of words for communicative goals in context. This feedback plays an essential role in learning. The iterated learning model abstracts away from these details (not without practical reason), while the iterated practice model in Fig. 31.1 attempts to capture them directly and explicitly. While iterated learning focuses on the ontogenetic or biographical timescale, iterated practice focuses on the *enchronic* timescale, that is, the timescale of moves and counter-moves in sequences of human interaction (Enfield 2009:10; Enfield 2011:285-291, 2013 Ch. 4). In Fig. 31.1, each link in the chain from private-public-private does not represent a generation of individuals in a human population (by contrast with the comparable figure in Christiansen and Chater 2008). It represents a generation of individuals in a population of *items*, that is, one local cycle of instantiation of a practice, such as a single use of a word, a single performance of a ritual, or a single occasion of making bacon and eggs for breakfast.

The schema in Fig. 31.1 draws our attention to a set of little bridges that a bit of culture has to cross if it is to survive a cycled of iterated practice. What are the forces that facilitate the passage across those bridges, and what are the forces that inhibit it? These forces are called transmission biases (following Boyd and Richerson (1985; 2005). This kind of

account assumes a standard model of Darwinian evolution (variation of heritable characters in a population), but where the variation is 'guided' in a specific way. As Boyd and Richerson (1985) formulate it, variation of cultural items is guided by the properties of human agents. If, for example, a certain way of doing something is easier to learn than some other functionally equivalent way (e.g., doing maths on an abacus versus a calculator), then this greater ease is likely to increase the frequency of the easier variant in the population, and, all things being equal, this variant will also in turn increase in frequency simply because it is already higher in frequency. Christiansen and Chater (2008) use this idea in arguing that the properties of the human brain, e.g., for language learning and processing, favour certain linguistic variants over others, leading to the view that language is the way it is because it is 'shaped by the brain', and thus not because the evolution of a language faculty has caused the human brain to change in some fundamental way because of how language is.

Assuming this model of guided variation, the question then becomes: What are the forces that serve to guide variation in this way, and that operate upon different variants within a population, ultimately determining whether they become, or remain, conventional in a population? We now consider some of the known biases.

31.4 Some previously described transmission biases

Variants of cultural behaviour compete for adoption by individuals in human populations. Different researchers have described different biases, sometimes in quite specific terms, sometimes in broader terms. For example, Chater and Christiansen (2009) describe four factors that mostly have to do with properties of the individual human body, especially the brain: (1) perceptuo-motor factors, (2) cognitive limitations on learning and processing, (3) constraints from mental representations, (4) pragmatic constraints. These factors can affect the likelihood that one linguistic variant is selected over another, though the social mechanisms that are also a necessary part of the process are left implicit by these authors. By contrast, Boyd and Richerson (1985) introduce distinctions that are broader in kind. They illustrate with an example from table tennis. For the function of hitting the ball, one may choose between holding the bat with a pencil grip or a handle grip. Choosing one of these variants necessary precludes choosing the other. They discuss different biases that might cause a person to select one grip over the other. A *direct bias* concerns the relationship between the variant and the adopter, and thus it concerns affordances (Gibson 1979). An individual should choose variant A if it is somehow more advantageous than

variant B for a proximate function in a given context. Thus, by a direct bias we should choose the grip that is easier, more effective, feels better, gives better results. An *indirect bias* works with reference to a notion of social identity, assuming that the variant a person selects will be seen by others and that this will lend a certain status to both the adopter (as the kind of person who adopts that variant) and the variant (as a variant that is adopted by that person or someone like that). We adopt variants of behaviours not only for their proximate efficacy but also with some notion of how we will be seen by others when we make that choice. So by an indirect bias we should choose the same grip as people who we identify with, or want to emulate. Finally, a *frequency-dependent bias* favours variants that are more frequent.

Similar biases have been described in a vast literature in sociology on the diffusion of innovations (Rogers 1995). Here, we can discern three sets of conditioning or causal factors in the success or failure of a practice. First, *sociometric factors* concern the network structure of demographic groups. Different individuals are differently socially connected, especially in terms of the number of their points of connection to others in a social network, as well as the quality (e.g., intensity) of these connections. A practice is more likely to spread if it is being modelled by someone who is widely

connected in a network, simply because he or she will expose a greater number of people to the practice. Gladwell (2000) refers to this as the law of the few. Second, *personality factors* concern differences between individuals in the population that can have consequences for the success or failure of an innovation. Some people are more willing than others to innovate and to adopt others' innovations (early adopters versus laggards). And these differences may correlate with social categories such as age, class, and sub-culture. Some people are better known or better admired in their social milieu and may thus be more likely to be imitated. Third, there is the sheer *utility* of an innovation, more or less what Boyd and Richerson (1985) mean by direct bias, outlined above. The innovation will take off if it is more advantageous to potential adopters.

The biases that we have just reviewed might be seen as a somewhat unstructured, ad hoc list. It is clear that they each play an important role in the mechanisms of transmission that drive the circulation of bits of culture in human populations. But how to explain them? Where do these biases come from and how are they related to each other? How can we limit this possibility space? Can we motivate these biases by locating them directly in the causal anatomy of transmission? What predictions are possible?

One way to motivate and constrain the possibility space of transmission biases is to develop an explanatory framework that is grounded in the basic structure of iterated practice shown in Fig. 31.1. Let us now see how this structure gives us a way of locating and characterizing the biases. If we examine the elements of transmission illustrated in Fig. 31.1, we see at the heart of it a repeating, four-stroke cycle of transmission consisting of the following steps:

(1) **Exposure**, a process of going from public to private, made possible by a mind and body coming into contact with, and perceiving/engaging with, the public instantiation of a bit of culture;

(2) **Representation**, the storing and organizing of a private construct based on (1), and the private product of this process;

(3) **Reproduction**, a process of going from private to public, made possible in part by an individual's motivation to cause the same public event as in (1).

(4) **Material**, the material instantiation of the result of an event of reproduction of a cultural item.

(5) Stages (3-4) can then lead to another round by exposing

      another person to the cultural item in question (feeding

      into a new stage (1)).

FIG. 31.2 ABOUT HERE

Each of the four steps is a bridge or existential threshold for any bit of culture to succeed or fail in the competition for uptake in a human population. If people aren't exposed to it, it will die. If it is difficult to represent mentally, or if in the course of mental representation it is radically altered, it will die, or effectively die. If people aren't motivated to reproduce it, no further exposure will happen, and with the biological death of those individuals with mental representations of the practice in question will come the historical death of the practice, as happens for example with language extinction. And if the material realization of the practice is not available to the perception of others, the transmission process will stall. Failure on any of these four links causes a break in the chain and may cause the variant to no longer exist.

It is important not to get the impression that a single such chain represents the entire historical trajectory of a cultural item. It is only the tiniest strand. This is because at any

moment, there is a veritable thicket of equivalent chains of iterated practice that keep a practice alive and evolving in the kind of sizable human population that would constitute a historical cultural community.

As discussed above, the key question that a biased transmission approach to linguistic epidemiology seeks to answer is: What are the filters, pumps, and transformers in an item's career? On the present proposal, we can posit four functionally-defined groups of biases. Each group of biases is defined by the function it serves in accelerating, braking, or transforming the transmission of practices in human populations through social-cultural interaction (i.e., at an enchronic level). While there may be a long, if not open list of possible biases, each should fall into one of the four categories, exhaustively defined by the basic causal structure represented in Fig. 31.1 and 31.2 above: exposure biases (relating to the world-to-mind transition), representation biases (relating to mind structure), reproduction biases (relating to the mind-to-world transition), and material biases (relating to world structure). Within each functionally-defined class of bias (1-4), different specific biases may affect the transmission of a practice in qualitatively different ways. As sketched above, some of these biases will have to do with facts about social networks, some with individual personality traits, some with

properties of human perception, attention and memory, some with the shape of the human body, some with the culture-specific means and ends that come with culturally evolved structures of activity, some with the organization of complex information in cognition. Let us now briefly consider how some of the previously described specific biases fit within the framework of these macro-categories of transmission bias.

31.4.1 **Exposure biases** (relating to the world-to-mind transition); anything that affects the likelihood that a person will come into contact with, and pay attention to, the practice.

Connectedness. All people are situated in social networks, but they are situated in different ways. One type of difference between people concerns the number of other people we come into contact with. So-called connectors have a large number of social ties (Granovetter 1973), and so are more likely to be involved in an encounter with an innovation. Those who have few social network connections will have a lower chance of being exposed to a given practice.

Salience. Once one is in the presence of a behaviour or kind of innovation one may or may not pay attention to it. Things that stand out are more likely to be attended to. The definition of 'stand out' is clearly a matter of perception in the

classical sense of affordances, that is, a matter of the relationship between a person and the practice. Some things are more likely to be noticed because of the nature of our perceptual apparatus in relation to the world. Other things are more salient to us because we are on the lookout for them, often because our language or culture encourages or requires it; this is a kind of *active salience*. More than one property of a thing will contribute to its salience. It may be especially prominent in a part of our perceptual field, it may be especially persistent.

Identity. Who is the person carrying out the practice when it is encountered? If it is somebody who I want to 'be like' in some way, then I am more likely to pay attention to what the person is doing and how. If it is someone I have no affinity with, or desire to imitate, I will be less likely to inspect their behaviour. In this way, social identity can play a role in exposure biases, by affecting the extent to which someone will attend, or carefully attend, to the practice when encountered.

31.4.2 **Representation biases** (relating to mind structure); anything that affects the likelihood that, or the manner in which, a practice will be learnt or stored by a person, or how the psychological or otherwise private component of a practice will be structured.

Once we have come into contact and at least noticed a practice, we can learn it. We form a representation of it, attributing to it some meaning or function, and we incorporate that representation in a framework of existing representations or knowledge. Some innovations are more memorable than others. Of two things we may notice, one will be more easily internalized. The reasons for this difference concern cognitive propensities that are either known from psychological science or that are on that research agenda. There are other differences in how things are learnt. The modality of an input (seen, heard, felt, or some combination of these) can have consequences for how a thing is interpreted, learnt and understood (Enfield 2005). This then affects in turn how the knowledge is used in practice (e.g., it may account for how an agent decides that a practice is an appropriate means for certain ends in a particular context).

There are effects of the psychological context into which a practice is embedded. Practices are partly constituted by knowledge; knowledge that is caused by, and in turn causes, public behaviour and associated states of affairs. Like any structured domain, knowledge is characterized by structured patterns that include part-whole relations, hierarchical relations, and other sorts of dependency among items in a system. When

we learn something we relate it to other things we know, at the very least because it was related to other things in the context in which we learnt it. As an example, if I learn a new word such as *unfriend*, I relate it to other words I already know, both in terms of similarity (*untie, undo, unfold*) and association (e.g., the fact the *unfriend* is a verb and can be used only with specific grammatical roles in English sentences). Or if I learn about the possibility of downloadable ringtones I will naturally contextualize this in terms of my existing knowledge of mobile phones and Internet access. Through this *context bias* I am more readily able to learn and psychologically represent those things that have an existing 'place'.

In language, items are structured into conceptual frames, systems of categorization, semplates, conceptual metaphors, structural paradigms and syntagms. There is good reason to think that these systems will tend toward symmetry, consistency, and simplicity, though of course this does not mean that they will be symmetrical, consistent, and simple. Change is always taking place, and because of the nature of systems, when something happens in one place it will have effects in another place. In the densely structured linguistic systems of lexicon and grammar, such system-internal relational perturbations sometimes give rise to a degree of 'psychological shakiness', as Sapir (1921) put it, which can

lead to significant reorganization of a system, in the private, mental realm, and then potentially in the public realm.

In the broadest sense of meaning, capturing everything from the arbitrary meanings of words in languages to the affordance-grounded functions of tools (Kockelman 2006), we are helped by what can be called natural meaning. If a word or grammatical expression is compatible with other information, for example by having iconic properties, it is better learnt and remembered. Similarly for technology, if there is a good match between functions and affordances, then we are more likely to understand the practice, it will be easier to learn, and indeed what needs to be stored representationally is reduced because the relevant information can stored materially (Norman 1991). This kind of *content bias* pertains to learning, storage, and reduction of load on cognition, thus illustrating some ways in which 'representation' is a functional rubric for transmission biases.

31.4.3 **Reproduction biases** (relating to the mind-to-world transition); anything that affects the likelihood that a person will employ the practice themselves.

One way to think of this sense of reproduction is whatever causes a person to turn the private representation of a

practice into action whose production and effects are then perceptible by others.

What motivates us to turn knowledge into action? On a commonsense view, daily life consists of courses of goal-directed behaviour that are motivated by our beliefs and desires (see e.g., Davidson 2006; Searle 1983; Fodor 1987). When we act, we have reasons. Typically these reasons are grounded in our beliefs and oriented toward our goals. Thus, a typical reason for reproducing a practice is as a means to an end. I may want to get something done for which I need someone else's cooperation. One way to do this is to produce an utterance using words and grammatical constructions. So I am motivated to choose words. Depending on my specific goals, I will select certain words and will thereby select against all the other words I could have chosen. This is the competition among words and grammatical forms referred to in Darwin's (1859)(1871:60) quote of Max Müller (1870): 'A struggle for life is constantly going on amongst the words and grammatical forms in each language'. The competition among different cultural practices operates in the same way. I have a goal, I have certain beliefs about how it can be attained, I have certain knowledge that allows me to set courses of action in motion where certain effects are foreseen. All this points to a powerful bias under the

reproduction rubric, concerning functional needs, and means to ends.

Boyd and Richerson's *content bias* fits partly under this rubric. As discussed above, a content bias favours a practice that is more beneficial in some way to the one selecting it. As Boyd and Richerson point out, some aspects of these biases are 'direct', others are 'indirect'. A direct bias is in operation when the benefit concerns the greater functional payoff, or reduced cost, of the practice, in terms of the primary effects it brings about. In the table tennis example, a direct bias would favour the pencil grip if the pencil grip were lower in cost or greater in benefit than the handle grip, that is, in terms of its efficacy for getting the ball back over the net and, ultimately, winning matches. An indirect bias is in operation when the perceived cost or benefit involved concerns not the direct effects of the practice on things in the world (e.g., efficacy in getting the ball back over the net) but concerns how, by virtue of you having made that choice, other people will regard you because of *who else* makes that same choice. The indirect bias is about the effects of whom you identify with (or against) by virtue of choosing a practice.

In language, there is an extensive literature on this phenomenon in the field of sociolinguistics. Speaking English,

I might say *guy* in one context and *bloke* in another. It may be that there is a slight meaning difference between these two words (thus invoking a direct content bias), but these differences may be minimal compared to the effect of identifying myself with certain sub-cultural groups by virtue of this choice between different word forms with near-identical meanings. Clearer examples concern pronunciation: whether I choose to say *working* or *workin'* has more to do with who I identify with (an indirect bias) rather than what meaning I convey (a direct bias). In the cultural realm, both a Rolex and a Tagheuer will tell the time for a high price but the choice may depend on whether you want to identify with Roger Federer versus Tiger Woods (or, indeed, tennis versus golf). And there is perhaps most often some combination of the two. Do I choose to drink this brand of beer over all the rest because it tastes better (a irect bias) or because by doing so I identify with some person or group of people (an indirect bias)? It could be both. In any case, the mechanisms at play will serve to bias a person's motivation for selecting one practice over all the others that he thereby does not select.

The indirect bias is also sometimes described as a *model bias*. There is an important distinction to be made here depending on the age of the person concerned. Infants and children, who cannot yet be considered full members of a

culture, are engaged in an intensive project of socialization.
The process involves constant and large-scale adoption of
cultural practices, in which the child attends to certain practices
(often because their attention is drawn to them by adults and
peers, other times because they are naturally motivated), and
reproduces them in their own behaviour as means to ends. How
does a child select which variants of a practice to adopt? A
conformity bias favours those practices that 'everyone else'
adopts (Boyd and Richerson 1985; Gergely and Csibra 2006).
Another term for this bias is docility (Simon 1990), that is, an
adaptive propensity to adopt more or less unquestioningly the
practices of your group. For the infant this group will tend also
to consist of the people to whom one is genetically most closely
related. The effect is that cultural practices tend to (but need
not) have similar histories as genes.

As a person becomes socialized to the point that they
are regarded a full member of a cultural group, they will
encounter a greater range and number of cultural items (i.e.,
they continue learning), and they may find themselves therefore
with new choices. This may be because they encounter other
ways of doing things than the way 'my people' do things,
through their contacts with other groups, for instance in trading,
ritual and other kinds of inter-group social interaction.
Different people will have different degrees of mobility,

sometimes differing because of personality, sometimes

differing more predictably depending on things like gender

(men often travel more widely than women), age or sub-

culture. At a later age, there is a greater degree of choice and

therefore greater competition between choices. We may or may

not consciously deliberate about such choices. But as adults we

may be more aware of the meanings of the different options.

Here's where the indirect bias looks more like the model bias

exploited in advertising and also active in any other diffusional

process as a low-level favouring of those practices that are

modelled by more admired or charismatic people.

31.4.4 **Material biases** (relating to world structure); anything

that affects the manner in which a practice will be physically

instantiated in the perceptible world.

Material biases concern the affordances of a cultural

item for exposure and reproduction. Material biases can affect

exposure biases in some obvious ways. Speech, for instance, as

a result of a particular reproduction process (vocalization), has

the property of being instantiated in fleeting form. A fact about

the material of speech is that it is perceptible at the time of

production but then it is gone. But when a reproduction process

involving language is carried out through writing, this

evanescence is dramatically lessened, and the dynamics of

transmission are significantly affected. Outside of language, we see similar contrasts. Forms of activity such as adopting a certain grip for table tennis are temporally fleeting and are only available for exposure simultaneously with the reproduction process that potentially constitutes the transmission event (photos, etc., aside). The table tennis bat itself, however, has a more persistent physical existence. Material biases concern the specific nature of the 'publication' of cultural practices such that they may continue to play a role in the exposure-reproduction cycle described above under the rubric of iterated practice.

31.5 Conclusion

The purpose of this chapter has been to address the need for an explanatory framework in the study of transmission biases in cultural epidemiology, focussing on the case of language. A proper account of the cultural evolution of language must be explicit about the causal anatomy of the process. Previous work has usefully identified and described transmission biases, but one might ask: Why these biases? What others might we predict are possible? How many might there be? I submit that we can answer these questions with reference to the basic causal anatomy of social transmission in human populations. Cultural epidemiology is powered by a four-stroke engine, a

causal chain from exposure to representation to replication to material instantiation, back to exposure and round again. When we talk about transmission biases, we mean any force that is responsible for causing this engine to accelerate, or to falter and stall, by virtue of its effects on any of the links in this potentially open-ended chain of iterated practice.

Subsequent research should now turn to the tasks of, firstly, seeing if we can account for all of the currently known and understood biases within this 'four-stroke engine' framework, and secondly, articulating predictions made by the framework such that we may empirically test them. In addition, such research should ultimately connect to research on the initial evolution in our species of the capacity for cumulative culture, a capacity that is so strongly pronounced in humans and so weak if present at all in our closest relatives the other apes. A first place to look for clues here would be to consider the known biases in connection with what is known about the cognition and social structure of other species. While we can readily assume that other animals are engaged in goal-directed courses of action, and that they select from among different means for certain ends in both the social and material realms, their selection of means for ends is relatively less flexible than that of humans. We might assume that a chimpanzee, say, will be guided in its selection of a behavioural strategy by a strong

content bias, incorporating a basic min-max payoff logic. But if their repertoire of strategies is, on the whole, not being learnt from others, then the transmission biases will have little traction. That said, a topic for research could be to look and see the extent to which other apes possess the cognitive prerequisites. While the biggest differences between us and them are known to be in social cognition, they are nevertheless intensely social species with textured social worlds. Many of the key cognitive and sociometric ingredients for biased transmission may have been in place before the evolution of our species, allowing the processes to kick in as soon as culture was being transmitted at all.

References

Boyd, Robert, and Peter J. Richerson. 1985. *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

———. 2005. *The Origin and Evolution of Cultures*. New York: Oxford University Press.

Chater, Nick, and Morten H. Christiansen. 2009. "Language Acquisition Meets Language Evolution." *Cognitive Science*: 1–27.

Christiansen, Morten H., and Nick Chater. 2008. "Language as Shaped by the Brain." *Behavioral and Brain Sciences* 31 (5): 489–509.

Croft, William. 2000. *Explaining Language Change: An Evolutionary Approach*. Harlow: Longman.

Darwin, Charles. 1859. *On the Origin of Species by Means of Natural Selection*. London: John Murray.

Davidson, Donald. 2006. *The Essential Davidson*. Oxford: Clarendon.

Enfield, N. J. 2003. *Linguistic Epidemiology: Semantics and Grammar of Language Contact in Mainland Southeast Asia*. London: RoutledgeCurzon.

———. 2005. "The Body as a Cognitive Artifact in Kinship Representations. Hand Gesture Diagrams by Speakers of Lao." *Current Anthropology* 46 (1): 51–81.

———. 2008. "Transmission Biases in Linguistic Epidemiology." *Journal of Language Contact* THEMA 2: 295–306.

———. 2009. *The Anatomy of Meaning: Speech, Gesture, and Composite Utterances*. Cambridge: Cambridge University Press.

———. 2012. *Relationship Thinking: Enchrony, Agency, and Human Sociality*. Typescript, MPI Nijmegen.

Fodor, Jerry A. 1987. *Psychosemantics*. Cambridge, MA: MIT Press.

Gergely, György, and Gergely Csibra. 2006. "Sylvia's Recipe: The Role of Imitation and Pedagogy in the Transmission of Cultural Knowledge." In *Roots of Human Sociality: Culture, Cognition, and Interaction*, ed. N. J. Enfield and Stephen C. Levinson, 229–255. London: Berg.

Gibson, James J. 1979. *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.

Gladwell, Malcolm. 2000. *The Tipping Point: How Little Things Can Make a Big Difference*. Boston: Little and Brown.

Granovetter, Mark. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78: 1360–1380.

Hudson, R. A. 1996. *Sociolinguistics (Second Edition)*. Cambridge: Cambridge University Press.

Keller, Rudi. 1994. *On Language Change: The Invisible Hand in Language.* London/New York: Routledge.

Kirby, Simon, Hannah Cornish, and Kenny Smith. 2008. "Cumulative Cultural Evolution in the Laboratory: An Experimental Approach to the Origins of Structure in Human Language." *Proceedings of the National Academy of Sciences of America* 105 (31): 10681–10686.

Kirby, Simon, Kenny Smith, and Henry Brighton. 2004. "From UG to Universals: Linguistic Adaptation Through Iterated Learning." *Studies in Language* 28 (3): 587–607. doi:10.1075/sl.28.3.09kir.

Kockelman, Paul. 2006. "Residence in the World: Affordances, Instruments, Actions, Roles, and Identities." *Semiotica* 162 (1-4): 19–71.

Norman, Donald A. 1991. "Cognitive Artifacts." In *Designing Interaction: Psychology at the Human-computer Interface*, ed. John M. Carroll, 17–38. Cambridge: Cambridge University Press.

Rogers, Everett M. 1995. *Diffusion of Innovations.* Vol. (Fourth edition.). New York: The Free Press.

Sapir, Edward. 1921. *Language: An Introduction to the Study of Speech.* Orlando/San Diego/New York/London: Harcourt Brace Jovanovich.

Searle, John R. 1983. *Intentionality: An Essay in the Philosophy of Mind*. Cambridge: Cambridge University Press.

Simon, Herbert A. 1990. "A Mechanism for Social Selection and Successful Altruism." *Science* 250: 1665–1668.

Sperber, Dan. 1985. "Anthropology and Psychology: Towards an Epidemiology of Representations." *Man* 20: 73–89.

———. 1996. *Explaining Culture: a Naturalistic Approach*. London: Blackwell.

———. 2006. "Why a Deep Understanding of Cultural Evolution Is Incompatible with Shallow Psychology." In *Roots of Human Sociality: Culture, Cognition, and Interaction*, ed. N. J. Enfield and Stephen C. Levinson, 431–449. Oxford: Berg.

Figure captions

Fig. 31.1. Simplified illustration of iterated practice, or a social

cognitive causal chain (Sperber 2006:438).

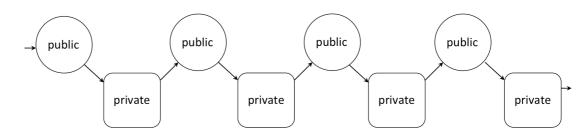Fig. 31.2. Elements of transmission; a 'four-stroke engine'

model.

Fig 31.1

Fig. 31.2