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A (Simple) Experimental Demonstration that Cultural Evolution is not Replicative, but Reconstructive — and an Explanation of Why this Difference Matters

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Abstract

Two complementary approaches to a naturalistic theory of culture are, on the one hand, mainstream cultural evolution research, and, on the other, work done under the banners of cultural attraction and the epidemiology of representations. There is much agreement between these two schools of thought, including in particular a commitment to population thinking. Both schools also acknowledge that the propagation of culture is not simply a matter of replication, but rather one of reconstruction. However, the two schools of thought differ on the relative importance of this point. The cultural attraction school believes it to be fundamental to genuinely causal explanations of culture. In contrast, most mainstream cultural evolution thinking abstracts away from it. In this paper I make flesh a simple thought experiment (first proposed by Dan Sperber) that directly contrasts the effects that replication and reconstruction have on cultural items. Results demonstrate, in a simple and graphic way, that (i) normal cultural propagation is not replicative, but reconstructive, and (ii) that these two different modes of propagation afford two qualitatively different explanations of stability. If propagation is replicative, as it is in biology, then stability arises from the fidelity of that replication, and hence an explanation of stability comes from an explanation of how and why this high-fidelity is achieved. If, on the other hand, propagation is reconstructive (as it is in culture), then stability arises from the fact that a subclass of cultural types are easily re-producible, while others are not, and hence an explanation of stability comes from a description of what types are easily re-producible, and an explanation of why they are. I discuss two implications of this result for research at the intersection of evolution, cognition, and culture.

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Keywords

culture – cultural attraction – cultural evolution – evolutionary psychology

1 Introduction

Cultural items — be they mental representations (knowledge, beliefs, desires, etc.) or their public expressions (words, behaviour, artefacts, etc.) — often exhibit a great deal of uniformity across time and space. Languages, for instance, change only slowly, certainly slowly enough for individuals of different generations to retain mutual comprehensibility. Cultural artefacts sometimes exhibit a remarkably consistency that spans many biological generations. A famous example is the Acheulean hand-axe, the canonical form of which remained unchanged for hundreds of thousands of years. This degree of stability is extreme, but it is nevertheless the case that cultural items — not only languages or material artefacts, but also moral beliefs, categories of kinship, and numerous others — sometimes exhibit a long-term stability that demands explanation. Indeed, a degree of stability can be part of what makes these things cultural in the first place. As such, any scientific explanation of culture must address the generation and maintenance of cultural stability (Sperber and Hirschfeld, 2004).

One possibility is that the very existence of cultural stability is evidence of psychological mechanisms capable of high-fidelity copying, which operate as a form of inheritance, and hence that an explanation of the biological evolution of these mechanisms in turn provides an explanation of cultural stability. This view has some intuitive appeal, and it is implicit in a great deal of research on the evolution of culture. Indeed, the cultural evolution literature is greatly inspired by the analogy with biological evolution, where the digital quality of DNA ensures that genetic information is transmitted from one generation to the next in a preservative way, at levels of fidelity that are high enough to secure a significant degree of stability. It is often tacitly assumed that the psychological mechanisms that facilitate cultural propagation perform a similar function for culture. For instance: "human beings 'transmit' ontogenetically acquired behavior and information, both within and across generations, with a much higher degree of fidelity than other animal species. The learning processes that ensure this fidelity serve to prevent information loss . . . [and] form the basis for cultural evolution" (Tomasello et al., 1993: p.495); "cultural transmission mechanisms with their different degrees of conservativeness, determine the stability of cultural traits" (Guglielmino et al., 1995: p.7589); "In order

for a behaviour to become traditional, it must be transmitted . . . without any significant loss of fidelity" (Mesoudi, 2011: p.193).

One school of thought has consistently argued against this assumption that high-fidelity copying is necessary to explain cultural stability (Sperber, 1996; Boyer, 1998; Atran, 2001; Claidière and André, 2012; Claidière et al., 2014). The core of the counter-argument can be illustrated with a simple example. Consider a lecturer's notes, written on the board. These notes are then copied by a student, but with a spelling error. A second student, a friend of the first, then copies these notes for herself and, in the process of doing so, corrects the spelling error, such that her notes match what the lecturer wrote on the board. Note that neither instance of copying took place with complete fidelity. Instead, by making use of their various inferential and other cognitive abilities, the students re-constructed the spellings (the second one correctly, the first one not so). Consequently, cultural stability is maintained, but not by high-fidelity replication. Instead, cultural stability is maintained, in the end, by the factors that allow individuals to recognise tokens of a particular type of cultural item, and to re-construct, or re-produce, a further token of that type. In this simple case, one important such factor is the fact that all the protagonists are literate. Other cases will be more complex, and identification of the relevant causal factors will be less trivial.

Does the distinction between replication and reconstruction matter? Much cultural evolution research readily acknowledges — often using the label 'guided variation' — that cultural items can change in the process of propagation as a consequence of the proper functioning of the cognitive mechanisms involved (Boyd and Richerson, 1985; Henrich et al., 2008; Mesoudi, 2011; Acerbi and Mesoudi, 2015). Furthermore, the fact that repeated iterations of guided variation can result in stable traditions has been experimentally shown several times (the clearest and most elegant demonstration is Kalish et al., 2007). Several researchers have therefore argued that while the above summarised arguments are a useful corrective to naive views of cultural evolution, they do not fundamentally alter mainstream approaches: "In our view, there is no real conflict [here] . . . besides a focus on different aspects of cultural evolution" (Acerbi and Mesoudi, 2015: p.483); "it is quite likely that the general picture painted by Sperber, Boyer, and Atran is correct — cultural transmission does not involve the accurate replication of discrete, gene-like entities. Nonetheless, we also believe that models which assume discrete replicators that evolve under the influence of natural-selection-*like* forces can be useful" (Henrich et al., 2008: p.121, italics in original). Scientific theories often make simplifications in order to gain corresponding benefits in generality (as indeed they should do, where appropriate), and perhaps this is such a case.

No existing experiment directly contrasts reconstruction and replication as two different modes of cultural propagation. This paper therefore presents (i) a simple transmission chain experiment that demonstrates that reconstruction and replication have different effects on cultural stability and (ii) a corresponding explanation of why this difference really does matter. The design of the experiment draws directly on a thought experiment that has previously been used to argue against the assumption that cultural propagation is replicative (Sperber, 2000). Thus, the experiment is not designed to yield surprising new findings, and nor does it. The motivation is instead to use experimental methods to illustrate, in a simple and graphic way, that cultural propagation is reconstructive (not replicative), and why this fact is of critical importance for any naturalistic, evolutionarily-informed theory of culture.

2 Methods

2.1 *Participants and Ethics*

All participants came from the undergraduate community at Durham University. The study received ethical approval from the ethical board of the Department of Anthropology, Durham University.

2.2 *General Methods*

Transmission chain experiments are similar to the children's game 'Chinese Whispers' (also called 'Broken telephone') (see Mesoudi and Whiten, 2008 for a review). The first participant reads or hears some material (called a 'seed'), and is then asked to reproduce it. This reproduced information is then given to the second participant, who reads/hears it, and attempts to reproduce it. This process is repeated over for several 'generations'. In this study each chain was run in one of four experimental conditions, in a 2×2 design: two different seeds (see Stimuli, below) were crossed with two different modes of reproduction (see Modes of Reproduction, below). Each condition had two chains, and each chain had seven generations.

2.3 *Stimuli*

I seeded transmission chains with one of two different images (Figure 1). One was the letters 'ABC'. Call this the Attractor stimulus. The other had the same lines as those that make up the letters 'ABC', but rearranged in a random way, so that it had no resemblance to any of the letters 'ABC', or indeed to anything in particular. Call this the Non-Attractor stimulus.

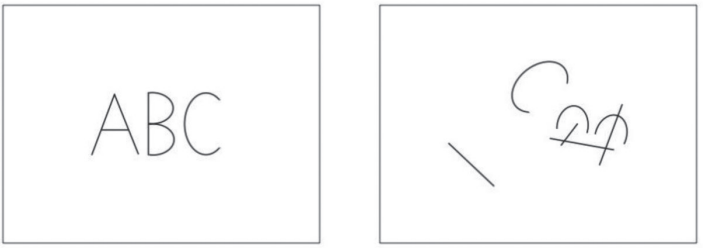

FIGURE 1 *Experimental stimuli. The transmission chains were seeded with one of these two images. Both images contain the same individual lines as each other. As can be seen, one image is a token of a familiar type (the first three letters of the Roman alphabet), while the other is not.*

2.4 *Modes of Reproduction*

The participants were asked to reproduce the stimuli in one of two different ways, according to condition. In the Reconstruction condition, they were given an A6 piece of blank paper, and a pen. They were told that they would shortly be shown an image on another piece of paper for two seconds, after which the image would be removed. Their only task was to draw on their own piece of paper the image they had just seen. In the Replication conditions, they were also given a A6 piece of blank paper and a pen, but in this case, they were asked to trace the image. In both cases, the first participant in each chain was shown one of the two images in Figure 1. The second participant in each chain was shown the image drawn by the first participant; the third participant was shown the image drawn by the second participant; and so on, until seven generations were completed.

2.5 *Predictions*

Drawing on the above discussed literature, which emphasises how cultural items are re-constructed at each time step, I made three specific predictions. The first is that *while the Attractor image will be copied with almost complete fidelity in the Replication condition (i.e., will be close to a facsimile), in the Reconstruction condition each new image will be only a token of the same type of image, and not a facsimile*. If correct, this would show these two different modes of propagation do *not* function in equivalent ways, at least not in general. The second prediction is that *in the Reconstruction conditions, the Attractor image will retain its essential form (i.e., later versions will be recognisable as tokens of the same type as the starting image), but the Non-Attractor will not (it will instead gravitate*

to some simpler form, which might in turn show some consistency). If correct, this too would show that cultural propagation is not functionally equivalent to replication — since if it was, the string of repeated reconstructions should have affected the two different stimuli in broadly similar ways. The third prediction is that *in the Replication condition, unlike the Reconstruction condition, the two initial stimuli will both exhibit a large degree of stability* (since differences that do appear will be random deviations introduced through copying error, and these deviations should be small). If correct, this would show that, in addition to not being functionally equivalent to one another, replication and reproduction have different causal consequences for the dynamics of cultural change, and hence for explanations of cultural stability.

3 Results

The full set of drawings is shown in Figure 2. There are no surprises here, and no quantitative analysis is necessary, since visual inspection alone clearly shows that all the experimental predictions are borne out. In the Reconstruction conditions, the 'ABC' image is not copied with complete fidelity, but does retain its essential form. In contrast, the random lines show no similar consistency, and indeed gravitate towards forms that, it is uncontroversial to say, are simpler and more memorable than the starting image. There is no similar difference in the Replication conditions. There, both images retain their original forms, with some minor variations introduced by copying error (for instance, by the end of the second chain of the 'ABC' images, the legs of the letter A have become short).

4 Why this Matters

Intuitively, these results, which show a clear functional distinction between replication and reconstruction, should not themselves be a surprise (see also Tamariz and Kirby, 2014 for a similar set of results, from a study with a similar but still different experimental design). Nevertheless, there is some debate in the present literature about whether this fact has any substantive implications for explanations of culture (see Introduction). I will now explain why it is in fact of critical importance (see also Claidière and André, 2012).

This study is the first to experimentally isolate the different effects that replication and reconstruction have upon cultural propagation. The results show that the fact that humans are able to copy some items with high-fidelity does not on its own explain cultural stability. To see this most clearly, compare the

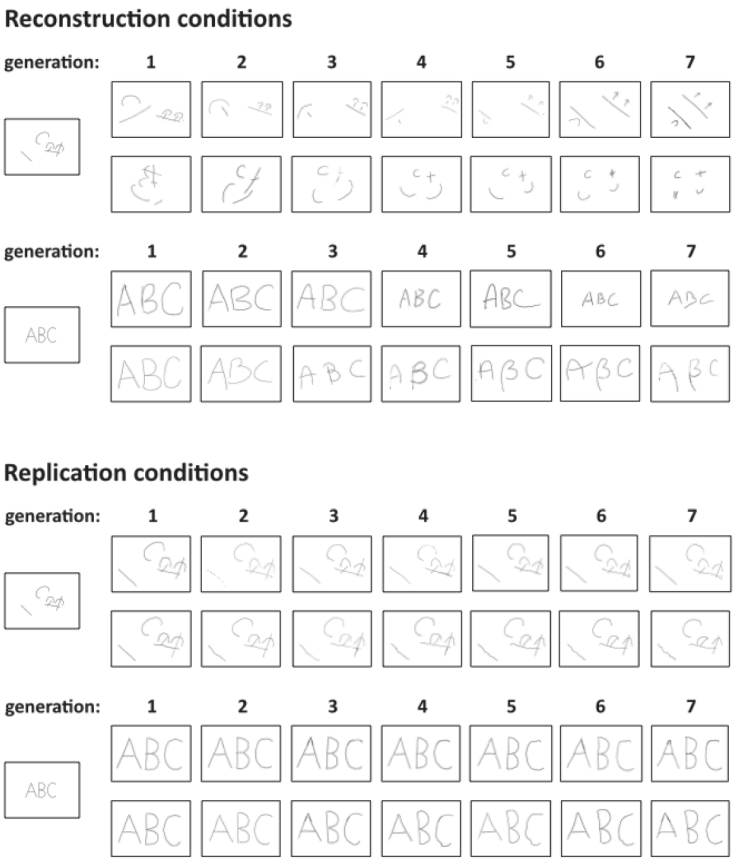

FIGURE 2 *Experimental results. Each condition had two chains, with seven generations per chain. As can be seen, only the 'ABC' stimuli were stable in the Reconstruction conditions. In contrast, both types of stimuli were stable in the Replication conditions. Moreover, the type of stability was different across the two different Modes of Transmission (replicates in the Replication condition; tokens of the same type in the Reconstruction condition). See the main text for discussion of the importance of these results. Note: to add legibility, many of these images have been scaled up in size. Please contact the author for the original scans.*

behaviour of the two images in the Reconstruction condition. Although the two figures were composed of the same parts, only the 'ABC' image remained stable. The other degenerates in form, into something simpler. Thus, the fact that individuals are able to copy with high-fidelity does not on its own explain cultural stability — since if it did, then the two images should have

demonstrated comparable levels of stability. What is also needed is an explanation of why some stimuli (in this case, the 'ABC' image) are reproduced with high-fidelity, while others (in this case, the randomly arranged lines) are not.

The reasons why an item can (or cannot) be straight-forwardly reproduced will be different in each case, and will typically involve a combination of factors, both cognitive and ecological (Sperber, 1996; Claidière et al., 2014). In this particular case, a key factor is familiarity with the Roman alphabet. Other cases are not so obvious as this, often much less so. For each case identification of the relevant factors is critical to explaining both the generation and maintenance of cultural stability.

An example is language structure, where multiple factors interact with one another (Scott-Phillips, 2014). A marriage of computational models and laboratory experiments suggests that two especially important factors are (i) learnability and (ii) expressivity (Christiansen and Chater, 2008; Kirby et al., 2015). If a language is learnable but not expressive (i.e., unable to express a wide range of meanings), or if it is expressive but not learnable (i.e., lots of distinct words, with no use of combinatorics), then the language is not stable in a world in which the language must be both used for communication, and learned anew by new users (*ibid.*). It is work such as this, which identifies the factors that allow a given cultural item to be re-produced time and time again, as tokens of the same type, that provides genuine explanations of cultural stability. This is a direct consequence of the fact that cultural propagation is not replicative, but reconstructive.

In short, the difference between replication and reconstruction matters because (among other things) *it changes how stability arises, and hence how it can be causally explained* (this point applies also, *mutatis mutandis*, to cultural change as well as to cultural stability). If propagation is replicative, then stability arises from the fidelity of that replication, and hence a casual explanation of stability comes from an explanation of how and why this high-fidelity is achieved. This is why the discovery of the structure of DNA, among other findings, was so important for evolutionary biology. If, on the other hand, propagation is reconstructive, then stability arises from the fact that a subclass of cultural types are easily re-producible, while others are not, and hence a casual explanation of stability comes from an explanation of *why* some types are easily re-producible (and why they are re-produced), while others are not. What differentiates the reproducible from the unreproducible?

There are many case studies where this focus on why certain items (and not others) are reproducible has been directly and profitably applied. A great deal of explanation in anthropology can be read in this way, but here I will just highlight some examples from the recent literature on evolution and

culture: the structure of languages (for which see above); the structure of social institutions, such as markets (Boyer and Petersen, 2012); the cultural history of gaze direction in portraiture (Morin, 2013); the cross-cultural popularity and persistence of bloodletting, despite medical inefficiency (Miton et al., 2015); and the persistence of pseudoscience in the face of scientific discoveries (Boudry et al., 2015).

5 Implications

The point that the distinction between reconstruction and replication changes how stability can be explained has implications for a number of research agendas at the intersection of biology and culture. One example is research on the similarities and differences between animal and human cultures. A prominent question in this literature is whether or not any non-human species are capable of high-fidelity copying (see Whiten et al., 2009 for a review). One reason for this prominence is that this question is especially important if we assume or believe that the fidelity of copying is what explains cultural stability. If, however, we recognise that cultural propagation is reconstructive, then the most critical question becomes: Which cultural items are easily reconstructed by a given species, and why these items, and not others? One species for which the first of these questions is presently being addressed is chimpanzees, and current data suggest that chimpanzees can in fact only reconstruct behaviours that already sit within what is called the 'Zone of Latent Solutions': the range of behaviours that, under the right circumstances, they might be able to invent anew even if they did not see others use them (Tennie et al., 2009). Whether or not this empirical claim stands the test of time, the key point to make here is that it attempts to meet the important challenge of identifying which cultural items are easily re-producible for a given species, and which are not. The next, critical step is to identify the various factors, cognitive or otherwise, that determine why it is these items, and not others, that are easily re-producible. Because of the reconstructive character of cultural propagation, it is answers to these questions that will provide genuinely causal explanations cultural stability.

A second area where the reconstruction/replication distinction has important implications is the formal modelling of cultural evolution (Claidière and André, 2012; Claidière et al., 2014). The majority of cultural evolution models have idealised away the reconstructive character of cultural propagation. This is not a problem in and of itself. Models necessarily abstract away from various factors, as indeed they should, since the *modus operandi* of all models is to gain clarity about the causal roles of various factors of interest by abstracting away

from other factors. Abstracting away from the reconstructive character of cultural propagation has yielded many worthwhile insights. However, given the critical role of reconstruction for explaining cultural dynamics, it is important to develop complementary models that directly study how reconstruction interacts with other factors of importance. There is a small collection of models that attempt to do this (Henrich and Boyd, 2002; Claidière and Sperber, 2007; Kalish et al., 2007; Griffiths et al., 2008; Claidière et al., 2014), but the topic remains in its infancy. The development of further, more general models of this sort is an urgent problem.

References

Acerbi, A. and Mesoudi, A. (2015). If we are all cultural Darwinians what's the fuss about? Clarifying recent disagreements in the field of cultural evolution. *Biology and Philosophy* 30, 481–503.

Atran, S. (2001). The trouble with memes. *Human Nature* 12, 351–381.

Boudry, M., Blancke, S. and Pigliucci, M. (2015). What makes weird beliefs thrive? The epidemiology of pseudoscience. *Philosophical Psychology* 28, 1177–1198.

Boyd, R. and Richerson, P. (1985). *Culture and the Evolutionary Process*. University of Chicago Press, Chicago, IL.

Boyer, P. (1998). Cognitive tracks of cultural inheritance: How evolved intuitive ontology governs cultural transmission. *American Anthropologist* 100, 876–889.

Boyer, P. and Petersen, M. (2012) The naturalness of (many) social institutions: Evolved cognition as their foundation. *Journal of Institutional Economics* 8, 1–25.

Christiansen, M. H. and Chater, N. (2008). Language as shaped by the brain. *Behavioral and Brain Sciences* 31, 489–509.

Claidière, N. and André, J. B. (2012). The transmission of genes and culture: A questionable analogy. *Evolutionary Biology, 39*(1), 12–24.

Claidière, N. and Sperber, D. (2007). The role of attraction in cultural evolution. *Journal of Cognition and Culture* 7, 89–111.

Claidière, N. and Sperber, D. (2009). Imitation explains the propagation, not the stability of animal culture. *Proceedings of the Royal Society of London Series B: Biological Sciences* 277, 651–659.

Claidière, N., Scott-Phillips, T.C. and Sperber, D. (2014). How Darwinian is cultural evolution? *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences* 369, 20130368.

Griffiths, T.L., Kalish, M. L. and Lewandowsky, S. (2008). Theoretical and empirical evidence for the impact of inductive biases on cultural evolution. *Philosophical Transactions of the Royal Society Series B: Biological Sciences* 363, 3503–3514.

Guglielmino, C.R., Viganotti, C., Hewlett, B. and Cavalli-Sforza, L.L. (1995). Cultural variation in Africa: Role of mechanisms of transmission and adaptation. *Proceedings of the National Academy of Sciences of the United States of America* 92, 7585–7589.

Henrich, J. and Boyd, R. (2002). On modeling cognition and culture: Why cultural evolution does not require replication of representations. *Journal of Cognition and Culture* 2, 87–112.

Henrich, J., Boyd, R. and Richerson, P. (2008). Five misunderstandings about cultural evolution. *Human Nature* 19, 119–137.

Kalish, M.L., Griffiths, T.L. and Lewandowsky, S. (2007). Iterated learning: Intergenerational knowledge transmission reveals inductive biases. *Psychonomic Bulletin and Review* 14, 288–294.

Kirby, S., Tamariz, M., Cornish, H. and Smith, K. (2015). Compression and communication in the cultural evolution of linguistic structure. *Cognition* 141, 87–102.

Mesoudi, A. (2011). *Cultural Evolution: How Darwinian Theory Can Explain Human Culture and Synthesize the Social Sciences*. University of Chicago Press, Chicago, IL.

Mesoudi, A. and Whiten, A. (2008). The multiple roles of cultural transmission experiments in understanding human cultural evolution. *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences* 363, 3489–3501.

Miton, H., Claidière, N. and Mercier, H. (2015). Universal cognitive mechanisms explain the cultural success of bloodletting. *Evolution and Human Behavior* 36, 303–312.

Morin, O. (2013). How portraits turned their eyes upon us: Visual preferences and demographic change in cultural evolution. *Evolution and Human Behavior* 34, 222–229.

Scott-Phillips, T.C. (2014). *Speaking Our Minds*. Palgrave Macmillan, London.

Sperber, D. (1996). *Explaining Culture*. Blackwell, Oxford.

Sperber, D. (2000). An objection to the memetic approach to culture. In: Aunger, R. (Ed.), *Darwinizing Culture: The Status of Memetics as a Science*, pp. 163–173. Cambridge University Press, Cambridge.

Sperber, D. and Hirschfeld, L.A. (2004). The cognitive foundations of cultural stability and diversity. *Trends in Cognitive Sciences* 8, 40–46.

Tamariz, M. and Kirby, S. (2014). Culture: Copying, compression, and conventionality. *Cognitive Science* 39, 171–183.

Tennie, C., Call, J. and Tomasello, M. (2009). Ratcheting up the ratchet: On the evolution of cumulative culture. *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences* 364, 2405–2415.

Tomasello, M., Kruger, A.C. and Ratner, H.H. (1993). Cultural learning. *Behavioral and Brain Sciences* 16, 495–511.

Whiten, A., McGuigan, N., Marshall-Pescini, S. and Hopper, L.M. (2009). Emulation, imitation, over-imitation and the scope of culture for child and chimpanzee. *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences* 364, 2417–2428.