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18 **ENQUIRE WITHIN:**  
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21 **CULTURAL EVOLUTION AND COGNITIVE SCIENCE**  
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25  
26 Cecilia Heyes

27  
28 All Souls College & Department of Experimental Psychology

29  
30 University of Oxford

31  
32 Oxford, OX1 4AL

33  
34 United Kingdom  
35  
36  
37  
38  
39

40 [orcid.org/0000-0001-9119-9913](http://orcid.org/0000-0001-9119-9913)

41 [cecilia.heyes@all-souls.ox.ac.uk](mailto:cecilia.heyes@all-souls.ox.ac.uk)  
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**Abstract**

Cultural evolution and cognitive science need each other. Cultural evolution needs cognitive science to find out whether the conditions necessary for Darwinian evolution are met in the cultural domain. Cognitive science needs cultural evolution to explain the origins of distinctively human cognitive processes. Focussing on the first question, I argue that cultural evolutionists can get empirical traction on *third-way cultural selection* by rooting the distinction between replication and reconstruction, two modes of cultural inheritance, in the distinction between System 1 and System 2 cognitive processes. This move suggests that cultural epidemiologists are right in thinking that replication has higher fidelity than reconstruction, and replication processes are not genetic adaptations for culture, but wrong to assume that replication is rare. If replication is not rare, an important requirement for third-way cultural selection, *one-shot fidelity*, is likely to be met. However, there are other requirements, overlooked by dual-inheritance theorists when they conflate strong (Darwinian) and weak (choice) senses of 'cultural selection', including: *dumb choices* and *recurrent fidelity*. In a second excursion into cognitive science, I argue that these requirements can be met by *metacognitive social learning strategies*, and trace the origins of these distinctively human cognitive processes to cultural evolution. Like other forms of cultural learning, they are not cognitive instincts but cognitive gadgets.

## 1. Introduction

Populational models - such as dual-inheritance theory and cultural epidemiology - put minds at the heart of cultural evolution. Purely historical approaches take whole cultures as their units of analysis, and ask about the forces that move these massive, mind-free entities from one condition to the next. In contrast, populational or 'kinetic' models take cultural change to be change in the frequencies of types in a population as the aggregate consequence of innumerable episodes of social learning; of episodes in which one mind acquires information from one or more other minds.

Given this spotlight on the mental, it is surprising that cognitive science rarely makes an appearance at the lively interdisciplinary party of cultural evolutionary studies. The hosts - evolutionary biology, mathematics, and anthropology - are often joined by archaeology, economics, ecology, environmental sciences, and philosophy. Psychology is certainly not excluded, but the invitations (or perhaps the acceptances) are not uniformly distributed across the discipline. They reach areas - such as comparative, developmental and social psychology - that are rooted in our common sense or 'folk psychological' understanding of the mind; in the blend of wisdom and old wives' tales that explains behaviour with reference to the thoughts and feelings, beliefs and desires, of whole agents [e.g. 6]. But the invitations rarely get through to areas of psychology that are more fully integrated with cognitive science; for example, cognitive psychology, behavioural and cognitive neuroscience, experimental psychology, and psychophysics.

The term 'cognitive science' has been used since the early 1970s to refer to research in psychology, computer science, linguistics, neuroscience and philosophy that likens the mind to a computer. It casts thinking as 'information processing', and seeks to explain behaviour at a 'sub-personal' level [7,8]. That is, in contrast with folk psychology, which takes mental states of the whole agent (e.g. beliefs and desires) to be the drivers of behaviour, cognitive science typically explains behaviour as due to the activities of parts of the mind, and of the interactions between these parts. For example: 'Stephanie said 'blue' when she saw BLUE written in red ink because two

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3 parts of her mind - one responsible for naming colours, and the other for reading words – competed  
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5 for control of Stephanie’s speech mechanisms, and the reading part won the contest.’ The sub-  
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7 personal explanations offered by cognitive science are not familiar or intuitive, but they burrow  
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9 deeper into the mind than folk psychology, and many have survived rigorous experimental tests [9].  
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12 In this article I suggest that cultural evolutionists and cognitive scientists should party  
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14 together more often because we need each other. Cultural evolution needs cognitive science for  
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16 many reasons (for example, to test hypotheses about conformist bias), but especially to get  
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18 empirical traction on a fundamental question: Are the conditions necessary for Darwinian evolution  
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20 met in the cultural domain? Cognitive science needs cultural evolution to address another  
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22 fundamental question: What are the origins of distinctively human cognitive processes? My primary  
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24 focus here will be on the first question, on what cognitive science can do for cultural evolution.  
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26 After some reflection on the question itself – on the possibility of ‘third-way cultural selection’  
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28 (section 2) – I turn to a distinction, between ‘replication’ and ‘reconstruction’, which has been used  
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30 by cultural epidemiologists to argue, against dual-inheritance theorists, that cultural change is not a  
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32 selection process. Although inspired by research in psychology, I argue that the replication /  
33  
34 reconstruction distinction is being used in a way that prevents cognitive science from informing  
35  
36 debate about third-way cultural selection (section 3). Making a first excursion into cognitive science,  
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38 I reconstruct the replication / reconstruction distinction to root it more firmly in research on the sub-  
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40 personal processes involved in social learning. This exercise suggests that cultural epidemiologists  
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42 are right in thinking that replication has higher fidelity than reconstruction, but wrong to assume  
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44 that replication is rare (section 4). If replication is not rare, an important requirement for cultural  
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46 selection – ‘one-shot fidelity’ - is likely to be met. However, there are two other requirements, often  
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48 overlooked by dual-inheritance theorists: for ‘dumb choices’ and ‘recurrent fidelity’ (section 5). A  
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50 second excursion into cognitive science suggests that these requirements can be met by  
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52 ‘metacognitive social learning strategies’ (section 6). To conclude, I offer a glimpse of the reciprocal  
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3 relationship – what cultural evolution can do for cognitive science – using the origins of  
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5 metacognitive social learning strategies as an example (section 7).  
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## 8 9 10 **2. Third-way cultural selection**

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14 The most fully developed populational account of cultural evolution is known as dual-inheritance  
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16 theory [1,2,10,11], or the ‘California school’ [5, 12]. This impressive body of work is ‘evolutionary’ in  
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18 at least three respects. First, it assumes that social learning – or, at least, the kinds of social learning  
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20 that drive large-scale changes in human populations - is built on a set of genetic adaptations; natural  
21  
22 selection acting on genetic variants has given humans psychological mechanisms - called ‘learning  
23  
24 biases’ or ‘decision rules’ - that are specialised for learning from others. Second, dual-inheritance  
25  
26 theory is very much concerned with how genetic evolution interacts with cultural change; with  
27  
28 ‘gene-culture co-evolution’. This kind of co-evolution occurs when a change in the socially learned  
29  
30 characteristics of a population provokes a change in genetically inherited characteristics, or vice  
31  
32 versa. The classic example of gene-culture co-evolution is lactose tolerance [13]. Third, dual-  
33  
34 inheritance theory is evolutionary at a methodological level: it borrows techniques from the study  
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36 of genetic evolution, applying to socially learned characteristics mathematical models that were  
37  
38 initially developed in population genetics. Thus, on the dual-inheritance view, cultural change is  
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40 evolutionary at least by virtue of its relationships of interdependence with genetic evolution:  
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42 because it is made possible by genetically inherited psychological mechanisms; in continuous  
43  
44 interaction with genetic evolution; and subject to analysis using mathematical tools developed by  
45  
46 geneticists.  
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51 But is dual-inheritance theory ‘evolutionary’ in a stronger sense? Does it claim not only that  
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53 cultural change is closely related to genetic evolution, but that the conditions required for the  
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55 occurrence of Darwinian selection – variation, heritability, and differential fitness - are present in the  
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57 cultural domain [3]? Elucidating this distinction, and building on Godfrey-Smith’s [14] analysis of  
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3 'Darwinian populations', Sterelny [5] points out that 'selective' explanations of cultural change are a  
4 subset of populational explanations. All populational explanations suggest that the frequency of  
5 types in a population at time T+N is largely determined by their frequency at time T. However,  
6 selective explanations further suggest that "the frequency of types at T+N is importantly determined  
7 by selection on those types at previous time steps, with selectively favoured types at one step  
8 increasing in frequency at the next in virtue of that success, together with some mechanism  
9 [replication or otherwise] supporting resemblance between parent and offspring" [5, p. 2]. In  
10 common with Lewens [3], Sterelny doubts that dual-inheritance theory is designed to offer selective  
11 explanations because, in his view, the members of the California school "do not seem to think of  
12 selection and fitness in causally robust ways" [5, p. 3]. For example, they rarely address *cui bono*  
13 questions [15]: when dual-inheritance theorists suggest that one cultural trait is fitter than another,  
14 they rarely specify who or what benefits from this fitness, or what is the nature of the benefit.  
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29 Sterelny and Lewens, philosophers of biology with a deep understanding of evolutionary  
30 theory and the contemporary literature on cultural evolution, may well be right about this, but my  
31 hunch is different. I think dual-inheritance theory *is* intended to provide selective explanations, *is*  
32 committed to the idea that cultural change can be Darwinian in its own right, but the California  
33 school hasn't got round to addressing the questions that would make this hypothesis "causally  
34 robust". This hunch is based, in part, on the fact that the early development of dual-inheritance  
35 theory was much influenced by Donald T. Campbell, and his view of cultural evolution was  
36 unambiguously, and indeed evangelically, selectionist [16, 17]. Also, to this day, when commenting  
37 on their project as a whole, and glossing the results of particularly models, the members of the  
38 California school write as if they are aiming for selective explanations. They emphasise the  
39 'Darwinian' character of cultural evolution, refer to 'cultural adaptations', use the term 'selection'  
40 repeatedly, and make explicit statements such as: "The logic of natural selection applies to culturally  
41 transmitted variation every bit as much as it applies to genetic variation" [10, p.76].  
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3           Only if the dual-inheritance project offers selective explanation does it have the potential to  
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5 show that there is 'third-way' in which human thought and behaviour can become adapted, can  
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7 achieve a better fit with their environments. We know from sociobiology, evolutionary psychology,  
8  
9 and human behavioural ecology that human thought and behaviour can become adapted to their  
10  
11 environments via natural selection operating on genetic variants (the first way; 18). In humans, as in  
12  
13 other animals, genetic evolution has produced behavioural propensities and cognitive processes that  
14  
15 enhance survival and reproduction. We know from Enlightenment philosophy, experimental  
16  
17 psychology and everyday experience that human thought and behaviour can come to fit their  
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19 environments through the operation of cognitive processes lodged in individual heads (the second  
20  
21 way). Some of these processes - known collectively as 'learning', 'intelligence', 'insight' or 'foresight'  
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23 - make individuals, or, as in science, groups of humans working together, smart enough to come up  
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25 with new solutions to old problems, to distinguish better from worse solutions, and selectively to  
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27 adopt the good ones. The crucial question is whether there is *another* way, a third way, in which  
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29 human thought and behaviour can become adapted; a process that selects among cultural rather  
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31 than genetic variants, and in which the adaptiveness of the selection does not depend on individuals  
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33 or groups being smart enough to design novel solutions or to recognise what works and what  
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35 doesn't [12, 19,20]. Thus, the 'third-way' question is: Are human thought and behaviour made  
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37 adaptive - made to fit their environments - not only by genetic selection and intelligence but, at  
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39 least sometimes, by cultural selection?  
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44           I believe that dual-inheritance theory offers an affirmative answer to this question, whereas  
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46 Lewens and Sterelny are not so sure. Only time (and members of the California school) can tell us  
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48 who is right, but in the meantime it is clear that the third-way question is of fundamental  
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50 importance. It is analogous to the challenge faced, and met, by Darwin. Darwin asked whether  
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52 'intelligent design' by God was the only way in which morphological characteristics could become  
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54 adapted to their environments. The third-way cultural selection question asks whether natural  
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3 selection operating on genetic variants, and 'intelligent design' by human minds, are the only ways  
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5 in which behavioural characteristics can become adapted to their environments.  
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### 8 9 **3. Replication and reconstruction**

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13 An alternative to dual-inheritance theory, 'cultural epidemiology' or the 'Paris school', has been  
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15 gaining ground since the 1990s [4,21]. Like dual-inheritance theory, cultural epidemiology is a  
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17 populational approach to cultural change. However, according to the Paris school, they disagree  
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19 with their Californian cousins on the subject of selection. Paris argues that California is committed  
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21 to third-way cultural selection – a positive answer to the third-way question – and that California  
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23 makes cultural selection appear plausible by assuming, wrongly, that cultural inheritance typically  
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25 involves 'replication'. In contrast, the Paris school denies there is a process of cultural selection  
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27 producing improvement or adaptation of cultural traits – it offers a negative answer to the third-way  
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29 question – on the grounds that, in fact, cultural inheritance typically involves 'reconstruction' rather  
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31 than 'replication' [4, 21, 22].  
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36 What is the difference between replication and reconstruction, and why does it matter? The  
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38 second of these questions has been given a much more satisfactory answer than the first. It is  
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40 widely assumed - by dual-inheritance theorists, cultural epidemiologists, and others - that the  
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42 distinction matters because replicative processes have higher fidelity products than reconstructive  
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44 processes, and high fidelity products, although not strictly necessary for selection [9, 23, 24], make  
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46 selection more likely to happen, and a more powerful generator of adaptations when it occurs. In  
47  
48 other words, and more slowly: It is assumed that replication and reconstruction are both  
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50 psychological processes, or sets of psychological processes, in which cultural entities – ideas,  
51  
52 behaviours, artefacts - play a causal role in the production of new, more-or-less similar entities. The  
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54 products of these psychological processes are high fidelity when the new entities closely resemble  
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56 the old ones; for example, when the idea you form as a result of reading my words is very similar to  
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3 the idea that inspired me to write them. High fidelity inheritance enhances the probability and the  
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5 power of third-way or 'cumulative' cultural selection – gradual improvement or adaptation of  
6  
7 cultural variants over successive generations – because it preserves small improvements (the  
8  
9 analogue of beneficial mutations), and thereby makes them available for further improvement in the  
10  
11 future [25,26].  
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14 If this is correct, the distinction between replication and reconstruction matters a great deal  
15  
16 – it is a key to answering the third-way question. To find out whether cultural selection is likely to  
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18 occur, or under what conditions it is likely to occur, we just need to work out whether the social  
19  
20 learning processes that mediate cultural inheritance are replicative or reconstructive, and that  
21  
22 seems to be an eminently tractable empirical question. Indeed, there are already a number of  
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24 laboratory experiments that appear to have made progress in answering the question [e.g.  
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26 22,27,28]. But there is a problem. Although many cultural evolutionists write confidently about  
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28 replication and reconstruction, no one has characterised the difference between them such that  
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30 replication and reconstruction could be distinguished empirically in psychological experiments *and*  
31  
32 used as indicators of the fidelity of cultural inheritance in the real world.  
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36 The word 'replication' comes from the lexicon of molecular genetics, where it refers to a  
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38 process of "splitting and reassembly" of DNA, which occurs at cell division [29]. As far as I can tell,  
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40 no one is claiming – or claiming that others are claiming – that cultural inheritance involves a precise  
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42 analogue of this kind of splitting and reassembly. Rather, replication is almost invariably defined  
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44 with reference to 'copying', but, as Godfrey-Smith [30] and Lewens [31] have noted, without an  
45  
46 accompanying explanation of what is meant by 'copying' [21,32]. Consistent with everyday usage,  
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48 and the way the term is used in research on social learning, 'copying' could be understood as any  
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50 process in which entities play a causal role in the production of new, similar entities. However, this  
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52 approach would bind the process of copying / replication too closely to its products [33]. In effect, it  
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54 would define replication in terms of its relatively high fidelity products, and thereby squander the  
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56 opportunity offered by the replication / reconstruction distinction: the opportunity to find out about  
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3 the fidelity of cultural inheritance by examining the features of the psychological processes through  
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5 which it occurs. Only if we know about the processes of cultural replication can we work out the  
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7 range of inputs over which there is a match between input and output sufficient to support cultural  
8  
9 selection.

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11 Thus, the distinction between replication and reconstruction has considerable promise when  
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13 replication and reconstruction are viewed as two different types of psychological process, one of  
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15 which, by hypothesis, yields higher fidelity cultural inheritance than the other. In this case, the likely  
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17 fidelity of cultural inheritance in a given domain across time could be assessed using data that are  
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19 readily available; data from humans alive today which tell us about the psychological processes  
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21 mediating social learning in various domains. I have argued that this promise is not being fulfilled  
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23 because replication and reconstruction are being defined not as types of psychological process - in  
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25 terms of the operations, or sequences of events, that each instantiates - but by the extent to which  
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27 their products resemble their social inputs. This approach conflates processes with products  
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29 (replication and reconstruction with high and low fidelity), makes the argument circular, and  
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31 prevents cognitive science from getting a handle on a fundamental question about cultural  
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33 evolution: does it involve third-way cultural selection?  
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#### 40 **4. A reconstruction of replication and reconstruction**

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43 I think the potential value of the replication / reconstruction distinction can be recovered by using  
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45 dual-systems theory to develop Sperber's [4,33] suggestion that replication is "stimulus-driven"  
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47 whereas reconstruction is inferential. Dual-systems models (not to be confused with dual-  
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49 inheritance theory) have provided a framework for research on cognition ever since psychology  
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51 became an empirical science [34], and they continue to inspire some of the most rigorous,  
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53 cumulative work in the field [35,36]. These models vary in detail but they are united in suggesting  
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55 that thought, and especially human thought, is controlled by two systems, or types of process, that  
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3 interact with one another. The operation of System 1 is typically characterised as bottom-up (or  
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5 stimulus-driven), fast, involuntary, parallel, unavailable to conscious awareness, and based on  
6  
7 information derived from genetic inheritance and associative learning. The operation of System 2 is  
8  
9 top-down, slow, effortful, serial, available to conscious awareness, and based on information both  
10  
11 from System 1 and generated by its own activity. System 2 acts as a more or less successful  
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13 'supervisor' or 'executive' with respect to System 1 [37]; it schedules, harnesses, and augments the  
14  
15 activities of System 1. The activities of System 1 lend themselves to characterisation at the sub-  
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17 personal level, whereas the activities of System 2 are more naturally characterised at the personal  
18  
19 level, as things that are done by the whole agent.  
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22 Viewed from the perspective of dual-systems theory, social learning is replicative to the  
23  
24 extent that information from another agent is picked up or encoded by System 1 – in a fast,  
25  
26 involuntary, and possibly unconscious way – and reconstructive to the extent that encoding of  
27  
28 information from another agent is done or supervised by System 2 – in a slow, deliberate, conscious  
29  
30 way. This is a reconstructed version of the replication / reconstruction – it is not the same as  
31  
32 Sperber's replication / reconstruction distinction – but it is consistent with his suggestion that  
33  
34 replication is stimulus-driven, and with the connotations of 'replication' that waft over from  
35  
36 genetics. It makes cultural replication into a process that occurs 'all by itself'. Like genetic  
37  
38 replication, it is not 'done by' the recipient of the ideas / alleles; it just happens. To make clear when  
39  
40 I'm using the dual-systems, reconstructed version of the replication / reconstruction distinction, I'll  
41  
42 refer to 'replication<sup>1</sup>' and 'reconstruction<sup>2</sup>'.  
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46 There is plenty of evidence of replication<sup>1</sup> in the cognitive science literature on social  
47  
48 learning in humans and other animals. For example, there are many demonstrations that, in  
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50 controlled laboratory conditions and when talking casually to others, humans engage in 'automatic  
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52 imitation' or 'mimicry'. We copy the gestures of others – the way in which parts of the body move  
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54 relative to one another – when we do not intend to copy; when copying interferes with us  
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56 discharging our intentions; and when we are apparently unaware of the other person's gestures or  
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3 our own imitation of them [38,39]. Similarly, there is compelling evidence that, like other animals,  
4 humans readily acquire preferences and aversions through ‘observational conditioning’ – a form of  
5 unsupervised associative learning, and therefore solidly part of System 1. After seeing another  
6 person’s face spontaneously wincing in presence of an object, or showing disgust in reaction to a  
7 smell, the observer becomes fearful of the object, or apt to avoid eating anything with that, now  
8 nasty, smell [40,41]. Another kind of replication<sup>1</sup>, rote learning, is evident in everyday life. Living as I  
9 do in the unusual world of an Oxford college, I have heard a particular prayer, a Latin grace, said  
10 many times by others. I don’t understand Latin, and I never intended to learn the sequence of  
11 sounds, but when the time came for me to say grace, I could utter the words ‘parrot-fashion’.

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22 The same kinds of content – sequences of body movements, aversions, sequences of sounds  
23 – can also be socially learned by reconstruction<sup>2</sup>. As a lousy tennis player, with a very limited  
24 repertoire of skilled tennis moves, I might try to copy the pro’s serve by laboriously describing it to  
25 myself while watching – trying to capture in words the topography and timing of the action  
26 components – and then rehearsing this description in my mind as I grasp the racket and try to repeat  
27 the pro’s performance. This would be an intentional, reconstructive<sup>2</sup> (and probably doomed) form  
28 of body movement imitation. Similarly, in episodes of what cultural epidemiologists call ‘ostensive  
29 communication’, I could acquire an aversion by hearing you say “touching a hot iron is painful” or  
30 “spinach is disgusting”. And, given the right education, people could certainly learn to say a Latin  
31 grace in the time-honoured, reconstructive<sup>2</sup> way: with the firm intention to learn and full command  
32 of the tongue of Ancient Rome.

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The foregoing examples support two things that cultural epidemiologists have claimed about  
replication and reconstruction, but run counter to a third. They are broadly consistent with the idea  
that replication<sup>1</sup> is typically of higher fidelity than reconstruction<sup>2</sup>; on average, System 1 social  
learning processes yield products that more closely resemble their inputs than System 2 social  
learning processes. Replicative copying of novel sequences of body movements can be very precise  
[42], but our action vocabularies are so limited that imitation-by-verbal-description is likely to be

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3 grossly inaccurate for all but the most topographically simple actions. Likewise, observational  
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5 conditioning may be more likely than verbal instruction to result in the receiver developing an  
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7 aversion to the same category of objects as the transmitter. An observationally conditioned  
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9 aversion generalises only to physically similar objects – for example, from a flat iron to a steam iron  
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11 – but an instruction such as ‘touching an iron is painful’ could be taken to mean it’s risky to contact  
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13 any tool made of iron. And if a receiver understands the language in which a formula is expressed  
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15 they are more likely to ‘correct’ a component they regard as wrong, or to produce an utterance that  
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17 means the same but sounds different, than if they learn by rote a sequence of phonemes that is, for  
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19 them, meaningless. Thus, while it may be possible to make the fidelity of reconstruction<sup>2</sup>  
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21 comparable with that of replication<sup>1</sup> – for example, through extended periods of teaching, such as  
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23 those involved in science education – it is likely that, on average, replication<sup>1</sup> is of higher fidelity than  
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25 reconstruction<sup>2</sup>.  
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29 The foregoing examples also support the cultural epidemiologists’ denial that replication,  
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31 when it occurs, depends on psychological mechanisms that are genetic adaptations for culture; that  
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33 evolved genetically *for* high fidelity cultural inheritance [21]. Imitation of body movement  
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35 topography used to be thought to depend on such a genetic adaptation, or ‘innate module’ [43].  
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37 However, the foundation of the innate module view was recently undermined by a large scale study  
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39 showing that human newborns do *not* imitate [44], and there is now a substantial body of evidence  
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41 from adults, infants and nonhuman animals indicating that, rather than being genetically inherited,  
42  
43 the imitation mechanism is constructed in the course of development through learning [45,46]. As  
44  
45 for observational conditioning and verbal instruction, the former is a species of associative learning –  
46  
47 a cognitive capacity that is far too ancient, in phylogenetic terms, to be an adaptation for culture –  
48  
49 and even those who regard language as a human-specific genetic adaptation do not claim that it  
50  
51 evolved specifically for high fidelity cultural inheritance by verbal instruction.  
52  
53

54  
55 However, the foregoing examples suggest that the Paris school is wrong in thinking that  
56  
57 replication is rare. I suspect their preoccupation with cultural traits that are transmitted via  
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3 language (e.g. religious beliefs, folk lore, fairy tales), combined with their rich Gricean view of how  
4  
5 much System 2 inference is involved in linguistic communication, has led cultural epidemiologists to  
6  
7 overlook a substantial body of research in cognitive science showing that sub-personal, System 1  
8  
9 processes can mediate the cultural inheritance of gestures, skills, preferences, and, with the  
10  
11 appropriate social support for rote learning, linguistic entities that are in an important sense  
12  
13 meaningless for those who utter them [38-42].

14  
15  
16 In summary: Reconstructing the distinction between replication and reconstruction so that it  
17  
18 is more firmly rooted in cognitive science, and does not merely define replication as high fidelity  
19  
20 transmission, suggests that the Paris school is right on two counts and wrong on a third: Replication<sup>1</sup>  
21  
22 is more likely than reconstruction<sup>2</sup> to support high fidelity inheritance - to result in the receiver  
23  
24 receiving something similar to what the sender sent (deliberately or inadvertently) - and this is not  
25  
26 because replication<sup>1</sup> mechanisms are genetic adaptations for cultural inheritance. However, there is  
27  
28 no reason to think that replication is rare. Indeed, the ease with which automatic imitation,  
29  
30 observational conditioning, and rote learning can be observed in the lab and in everyday life suggest  
31  
32 that cultural replication<sup>1</sup> is a pervasive feature of human lives.

### 33 34 35 36 37 **5. Cultural selection requires more than replication<sup>1</sup>**

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41  
42 Several commentators have recently argued that too much fuss is being made about the differences  
43  
44 between dual-inheritance theory and cultural epidemiology, and that disagreements between the  
45  
46 California and Paris schools are more apparent than real [24, 27, 47]. For example, surveying the  
47  
48 results of transmission chain experiments, Acerbi and Mesoudi [27] conclude that there is enough  
49  
50 evidence that cultural inheritance can be replicative (they use the term 'preservative'), for us to be  
51  
52 confident that, at least in some domains and at certain levels of granularity, there is selection on  
53  
54 cultural variants. This may well be true if one takes 'selection' to be no more than a synonym for  
55  
56 'choice'. In that case, to say that there has been 'selection on cultural variants' means only that the  
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3 frequency of types in a population at T+N has been influenced by learners' choices among variants  
4  
5 to copy at previous time steps. However, if one is interested in the third-way question, cultural  
6  
7 selection means more than this. In the third way context, cultural selection occurs when 1) a change  
8  
9 in the frequency of types in a population constitutes improvement or adaptation (i.e. the frequency  
10  
11 of types that do a better job, with respect to human purposes, increases more than the frequency of  
12  
13 types that do the same job less well), and 2) this improvement is *not* due solely to smart choices by  
14  
15 agents; to learners choosing to copy the better variants because they, the learners, recognise the  
16  
17 'betterness' of the better variants. If the improvement is due to smart choices by learners – for  
18  
19 example, if people use durable rather than disposable shopping bags because they understand the  
20  
21 former to be better for the environment - thought and behaviour are becoming adapted in the  
22  
23 second way, not the third way [14,19].  
24  
25

26  
27 Third-way cultural selection requires a good deal more than replication, or even replication<sup>1</sup>.  
28  
29 As the previous paragraph indicates, one additional requirement is for 'dumb', blind or trusting,  
30  
31 choices by learners, which nonetheless make better variants more likely to be copied than inferior  
32  
33 variants. These choices could be made with deliberation, and via sophisticated cognitive processes,  
34  
35 but they must *not* depend on learners detecting, individually or collectively via foresight, the  
36  
37 betterness of better variants [12]. Intelligence in the sense of insight into what will and will not  
38  
39 'work', whether uniform or highly variable within a population, is a threat to third-way cultural  
40  
41 selection; it increases the chances that adaptation will occur in the second, rather than the third  
42  
43 way.  
44  
45

46  
47 A second additional requirement is for another kind of fidelity. Replication<sup>1</sup> delivers 'one-  
48  
49 shot fidelity'; processes such as imitation, observational conditioning, and rote learning make it likely  
50  
51 that, in the course of a particular episode of social learning, the receiver will acquire an idea or  
52  
53 behaviour similar to that of the model agent. But for improvements to accumulate - for cultural  
54  
55 selection in the strong sense - 'recurrent fidelity' is also needed; the idea or behaviour must remain  
56  
57 similar to that of the model, in memory and over episodes of activation or use, until it is passed on  
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3 to one or more other learners. A little more formally: 'one-shot fidelity' is the fidelity with which a  
4 trait,  $t$ , is initially learned from an expert,  $A$ , by a novice,  $B$ . A fair degree of fidelity at this initial stage  
5 is undoubtedly necessary for cultural selection but it is radically insufficient. For improvements to  
6 accumulate, 'recurrent fidelity' is also needed:  $B$  must retain  $t$  – keep doing what  $A$  did, or keep  
7 believing what  $A$  believed – until  $C$ , a novice of the next cultural generation, acquires  $t$  from  $B$ . The  $t$   
8 needs to be insulated from loss or modification between acquisition and re-transmission [48-50].

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16 Many of the processes or 'decision rules' that dual-inheritance theory regards as integral to  
17 cultural evolution – such as 'direct bias', 'guided variation', and 'conformist bias' – are consistent  
18 with the idea that cultural change is a function of choice, but are threats to the possibility of third-  
19 way cultural selection. They militate in favour of selection in the weak sense – choice - and against  
20 selection in the strong sense. For example, direct bias is a threat to the requirement for dumb  
21 choices. In direct bias [1], later called 'content bias' [10], learners are supposed to survey all traits in  
22 the population, evaluate their efficiency relative to other traits, and, based on this evaluation,  
23 preferentially to copy the better traits. Although direct bias is clearly a selection mechanism in the  
24 weak sense – it relates to choices among cultural traits [27] – it involves (incredibly) smart choices by  
25 learners, and therefore any improvement or adaptation resulting from this bias would be due, not to  
26 third-way cultural selection, but to individual intelligence or insight. Similarly, guided variation,  
27 which occurs when cultural variants are modified by learning between acquisition and re-  
28 transmission [1], is a threat to recurrent fidelity; it reduces the chances that small improvements will  
29 be preserved as platforms for further improvement.

## 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 **6. Metacognitive social learning strategies**

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51  
52 Faced with the many requirements for third-way cultural selection, and threats against their  
53 fulfilment, cultural epidemiologists are sceptical about a third way, arguing that cultural change is  
54 rarely, if ever, a process of adaptation. In contrast, dual-inheritance theorists appear to remain  
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3 optimistic about the possibility of cultural selection, but have not explained how the requirements  
4  
5 could be met in spite of the threats [12, 23]. This may have been part of what Sterelny [5, p.3] had  
6  
7 in mind when he said that dual-inheritance theorists “do not seem to think of selection and fitness in  
8  
9 causally robust ways” (see section 2 above.) I share the optimism of the California school, and  
10  
11 believe that cognitive science can help us to think about cultural selection in more “causally robust  
12  
13 ways”; it can help us to explain how, against the odds, the requirements for third-way cultural  
14  
15 selection could be met.  
16

17  
18 Let’s take as an example the ‘decision rules’ – sometimes called ‘social learning strategies’ –  
19  
20 that are, according to dual-inheritance theory, the basis on which learners choose which cultural  
21  
22 variants to copy. These rules are a fundamental part of dual-inheritance theory, they explain  
23  
24 directional change in the frequencies of variants in the population, but they have been consistently  
25  
26 ‘blackboxed’ by the California school [51]. With some resolution, dual-inheritance theorists have  
27  
28 refused to ask what social learning strategies are ‘made of’ - how they are implemented at the  
29  
30 cognitive level. Opening the black box, and combing through research on social learning strategies  
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32 in animals, children, and adults, recently I found evidence that, from a cognitive science perspective,  
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34 two kinds of rule guide choices about when, what and who to copy [52]. The first, ‘planetary’ kind of  
35  
36 decision rule is implemented by relatively simple, taxon- and domain-general psychological  
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38 processes; mechanisms of attention and associative learning that are present in a broad range of  
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40 species, come on-line early in development, and process information from the social and inanimate  
41  
42 worlds via the same computations. For example, agents who grab more attention because they are  
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44 large, noisy, or standing close to desirable objects, are more likely to be copied than agents who  
45  
46 grab less attention. Empirical regularities of this kind can be characterised by rules – such as *copy*  
47  
48 *older individuals* (who tend to be larger), or *copy the successful* (who tend to be located near  
49  
50 desirable objects) – but these rules, like the rules of planetary motion, are in the minds of  
51  
52 researchers, not in the minds of the entities or agents the researchers are studying. The second,  
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54 ‘cook-like’ kind of decision rule is implemented by complex ‘metacognitive’ processes; System 2  
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3 psychological processes that represent 'who knows'. More specifically, System 2 metacognitive  
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5 processes represent the accuracy and reliability with which other cognitive processes, in the self and  
6  
7 in others, represent the world [53]. The evidence suggests that these metacognitive social learning  
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9 strategies are found only in humans, come online late in development, and process social  
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11 information in a domain-specific way. For example, they specify that, when building a boat, one  
12  
13 should *copy the boat builder with the largest fleet*, and when struggling with information technology,  
14  
15 one should *copy digital natives*. Metacognitive social learning strategies are full-blooded rules.  
16  
17 They are consciously represented in the minds of choosing agents, guiding their behaviour in the  
18  
19 way that a cook uses a recipe.  
20  
21

22  
23 Unlike planetary rules, metacognitive social learning strategies have the potential to meet  
24  
25 the requirements for cultural selection identified in the previous section – the need for dumb  
26  
27 choices and recurrent fidelity. i) Dumb choices. Although mediated by sophisticated psychological  
28  
29 processes, metacognitive social learning strategies are dumb in the sense that is important for third-  
30  
31 way cultural selection: they bias an agent towards copying better variants without the agent being  
32  
33 smart enough to know which variants are better and which are worse. They are alternatives to  
34  
35 direct / content bias that leave room for cultural selection, rather than individual intelligence, to do  
36  
37 the adaptive work. If I *copy the boat-builder with the biggest fleet*, there's a good chance I'll copy a  
38  
39 design that is especially successful. This is because fleets remain large when they are made up of  
40  
41 boats that are unlikely to sink. But, crucially, I don't need to know this in order to make the right –  
42  
43 the adaptive – choice of which boat design to copy. I don't need to be smart enough to know what  
44  
45 makes a good boat good, or to have any theory about why the builder with the biggest fleet knows  
46  
47 best. As long as I, along with other novices, slavishly follow the rule *copy the boat-builder with the*  
48  
49 *biggest fleet*, adaptive innovations are likely to become more widespread and to form the basis for  
50  
51 further improvements in boat design.  
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54  
55 ii) Recurrent fidelity. Metacognitive social learning strategies can guide learners towards  
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57 knowledgeable models with great precision, specifying the individual or type of person to copy in  
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3 each of a range of task domains. As a result, they create conditions conducive to the development  
4  
5 and evolution of processes that promote high fidelity cultural inheritance. When there is a good  
6  
7 chance that you're going to copy an adaptive variant, it is worthwhile investing time and energy in  
8  
9 copying accurately and in detail. The processes that promote one-shot fidelity, replication<sup>1</sup>  
10  
11 processes, include automatic imitation and rote learning (section 4). The processes that promote  
12  
13 recurrent fidelity are those that discourage guided variation, i.e. changing a cultural variant in the  
14  
15 light of further experience between acquisition and re-transmission. As far as I am aware, no one  
16  
17 has studied these processes from a cognitive science perspective. My guess is that they involve a  
18  
19 variety of low-level processes (System 1) supervised by culturally inherited beliefs (System 2) about  
20  
21 the importance of conserving cultural traits for group identity, or more specifically, about who is and  
22  
23 who is not allowed to innovate in particular domains. As an example of the former: I inherited from  
24  
25 my mother the belief that Maids of Kent (women born to the east of the river Medway in the English  
26  
27 county of Kent) decorate their apple pies with pastry in the shapes of oak, ash and elm leaves. In  
28  
29 superstitious fear of being mistaken for a Kentish Maid (born to the west of the Medway), an  
30  
31 identity with no practical consequences in my lifetime, this belief has prevented me from deviation.  
32  
33 Every apple pie I have ever made has been decorated with an oak, an ash and an elm leaf.  
34  
35 Consequently there has been no opportunity for me discover through reinforcement learning (also  
36  
37 known as 'trial-and-error') that alternatives are quicker to assemble, more pleasing to the eye, or  
38  
39 garner more compliments. And had I failed in childhood to suppress my System 1 inclination to  
40  
41 innovate, no doubt my mother or grandmother would have restored recurrent fidelity by punishing  
42  
43 my tinkering with a pained expression and a pastry knife.  
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48  
49 Thus, thinking about social learning strategies from a cognitive science perspective reveals  
50  
51 that there are two kinds of decision rules, and the metacognitive kind, found only in humans, has the  
52  
53 potential to overcome many of the threats to third-way cultural selection identified by the California  
54  
55 and Paris schools. Of course, this analysis begs the question of where metacognitive social learning  
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3 strategies come from, and how they get to be so wise – questions I will take up in the latter part of  
4  
5 the next section.  
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7

## 9 **7. Cultural evolution of cognitive processes**

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14 So far this article has considered only what cognitive science can do for cultural evolution. Now I  
15  
16 want to consider, albeit briefly, the reciprocal relationship: what cultural evolution can do for  
17  
18 cognitive science. This topic has been the focus of my work for the last few years [54]. I suggest that  
19  
20 cognitive science needs cultural evolutionary theory to explain the origins and adaptiveness of  
21  
22 distinctively human cognitive mechanisms – mechanisms such as causal understanding, imitation,  
23  
24 language, and mindreading (or ‘theory of mind’), that are present in mature adult humans, but  
25  
26 absent, or found only in nascent form, in other animals.  
27

28  
29 Evolutionary psychology – or, at least, the Santa Barbara school of evolutionary psychology  
30  
31 [55] – suggests that genetic evolution is the architect of the human mind. According to this  
32  
33 ‘cognitive instinct’ view, distinctively human ways of thinking are inborn. A human baby does not  
34  
35 enter the world understanding causality, able to imitate any action she sees, talking in complete  
36  
37 sentences, and understanding all about other minds, but she contains in her genes very specific  
38  
39 programmes for the development of these capacities; programmes that are capable of building  
40  
41 distinctively human, domain-specific cognitive mechanisms with minimal help from learning. The  
42  
43 environment in which a child grows up is seen as merely ‘triggering’ or ‘evoking’ cognitive  
44  
45 development.  
46  
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48  
49 The cognitive instinct view had some plausibility when it was introduced more than 20 years  
50  
51 ago. For example, at that time there seemed to be compelling evidence that human newborns can  
52  
53 imitate [56]; Chomsky’s ‘universal grammar’ account of language was still dominant among linguists  
54  
55 [57]; and it was widely accepted that autistic individuals have difficulty ascribing thoughts and  
56  
57 feelings because they lack an innate module for theory of mind [58]. But in the ensuing years, and  
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3 partly through the emergence of social cognitive neuroscience – a potent blend of social psychology,  
4  
5 cognitive psychology, and brain imaging - the cognitive instinct hypothesis has become less and less  
6  
7 plausible. We now know that human newborns do not imitate [44]; ‘universal grammar’ has been  
8  
9 pared down to the point where Chomsky’s claim is either untestable or indistinguishable from the  
10  
11 alternative, pragmatic or constructivist, view of language [59, 60]; and there is evidence that autistic  
12  
13 individuals have many cognitive impairments, some of them, like ‘weak central coherence’ and  
14  
15 problems with executive function, that are much more domain-general than theory of mind [61].

16  
17  
18 But if distinctively human cognitive mechanisms are not products of genetic evolution,  
19  
20 where do they come from? No doubt ‘learning’, broadly construed, is a large part of the answer to  
21  
22 this question, but it can’t possibly be the whole answer. People grow up in a broad range of  
23  
24 environments. Therefore, if each developing human built his or her own specialised cognitive  
25  
26 mechanisms through experience, it would be a staggering coincidence to find, as we do, that most  
27  
28 people – at least, most people within any given culture - end up with the same set of mechanisms;  
29  
30 for example, with mechanisms of causal understanding, language, and theory of mind, each of which  
31  
32 functions in much the same way as it does in other adults of the same social group. Furthermore,  
33  
34 the ‘learning’ answer, by itself, does not explained why these shared cognitive mechanisms do their  
35  
36 jobs reasonably well – why causal understanding gives us some insight into the workings of the  
37  
38 inanimate world; language enables us to communicate fairly effectively; and theory of mind allows  
39  
40 us to predict what others are going to do. Learning alone cannot explain why, in this sense,  
41  
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43  
44 distinctively human cognitive mechanisms are adaptive.

45  
46  
47 To explain why distinctively human cognitive mechanisms are both shared and adaptive  
48  
49 cognitive science needs cultural evolutionary theory. Until now, cultural evolutionary analysis has  
50  
51 been applied only to ‘grist’; it has been used to explain variation in, and the adaptiveness of, the  
52  
53 products of thought - behaviour, skills and artefacts. I am proposing that it should also be applied to  
54  
55 ‘mills’; to the mechanisms of thought – like causal understanding, language, and mindreading - that  
56  
57 control behaviour, mediate skills, and, through those skills, produce artefacts. This kind of analysis,  
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3 'cultural evolutionary psychology', embraces the now plentiful evidence that the development of  
4  
5 distinctively human cognitive mechanisms depends crucially, not merely on learning, but on social  
6  
7 learning. Humans have a genetic starter-kit consisting of enhanced social motivation, attentional  
8  
9 biases (e.g. to faces and voices), and souped-up domain-general mechanisms of learning and  
10  
11 memory. This starter kit allows complex, domain-specific 'modules' to be constructed in the course  
12  
13 of development through social interaction. Distinctively human cognitive mechanisms are, not  
14  
15 merely learned, but culturally inherited from members of the child's social group. They are shared  
16  
17 within social groups because members 'catch' them from one another, and to the extent that they  
18  
19 are adaptive – do their jobs well – it is because variant cognitive mechanisms have been winnowed  
20  
21 by third-way cultural selection [54].  
22  
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24  
25 This kind of cultural evolutionary analysis can explain why, by hypothesis, there are  
26  
27 metacognitive social learning strategies that promote third-way cultural selection of grist. The  
28  
29 picture is of a population of social groups – groups of people defined, not by the genes they carry,  
30  
31 but by geography and/or cultural characteristics such as language. The members of each social  
32  
33 group subscribe to a common set of metacognitive social learning strategies. The decision rules are  
34  
35 shared within groups because their inheritance is 'distributed', i.e. the rules are learned not only  
36  
37 from biological parents (vertical transmission) and unrelated members of the parental generation  
38  
39 (oblique transmission), but also from peers (horizontal transmission). Different social groups  
40  
41 subscribe to different sets of metacognitive decision rules [62-65]. For example, group A's set of  
42  
43 rules might differentiate more finely among task domains, or among potential models within each  
44  
45 domain, than group B's set of rules. To the extent that the more precise rules really identify 'who  
46  
47 knows' – the right people to copy in each domain – group A will be better able than group B to  
48  
49 preserve adaptive innovations in the task domains for which they have more precise rules, and this  
50  
51 will enable group A to develop, through third-way cultural selection, better boats, fish hooks, or  
52  
53 methods of baking bread. The resulting benefits to group A's living conditions make group A more  
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55 likely than group B to persist, to expand through biological reproduction and immigration, and  
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3 consequently to 'bud', producing offspring groups with the similar metacognitive social learning  
4  
5 strategies. Thus, group A is fitter than group B, where the fitness of a social group can be  
6  
7 understood in relation to the number of descendant individuals (Type 1 fitness), or descendent  
8  
9 groups (Type 2 fitness) that inherit the group's metacognitive social learning strategies [66].  
10

11 Many metacognitive social learning strategies are sources of what dual-inheritance theorists  
12 call "indirect bias" [1]. They instruct learners to decide what to copy, not by evaluation of the traits  
13 themselves (direct / content bias) – e.g. how swiftly a boat moves through the water – but on the  
14 basis of model characteristics – e.g. which potential model agent has the largest number of boats,  
15 cows, or publications. Compared with direct / content bias and guided variation, indirect bias is  
16 certainly a friend of third-way cultural selection. It involves choices that are dumb in the relevant  
17 sense, and it does not militate against recurrent fidelity. However, indirect bias has been found, not  
18 only in humans, but in a broad range of other species for which there is no evidence of cumulative or  
19 adaptive cultural change. For example, vervet monkeys are more inclined to copy females, the  
20 philopatric sex, than males [67]. Therefore, by itself, the occurrence of indirect bias in human  
21 populations is not sufficient grounds for optimism about cultural selection. It is only when we focus  
22 on cognitive mechanisms – recognise that, in humans, indirect bias can be implemented by System  
23 2, cook-like rules, as well as by System 1, planetary rules – that we begin to see how indirect bias can  
24 support cultural selection. Planetary social learning strategies can change as a function of the user's  
25 own, recent experience; for example, if a monkey finds that information from females has yielded  
26 higher payoffs recently, it will turn its attention from males to females. By contrast, because they  
27 can be expressed in language and thereby culturally inherited, metacognitive social learning  
28 strategies can distil the experience of many agents over an extended period of time. In other words,  
29 metacognitive social learning strategies tend to be 'wise' (see section 7), to promote third-way  
30 cultural selection of behaviour, skills and artefacts, not merely because they implement indirect bias,  
31 but because they are themselves products of third-way cultural selection [51,52].  
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## 8. Conclusion

I have argued that conflict between populational models of cultural evolution – between dual-inheritance theory and cultural epidemiology - is important to the extent that it concerns the third-way question: Are human thought and behaviour made adaptive, not only by genetic selection and intelligence, but by cultural selection? Where this is the question at issue, easy attempts to reconcile California and Paris – by suggesting that California has quietly given up on third-way cultural selection, or by conflating weak and strong senses of ‘selection’ – are in danger of drawing attention away from a fundamental question about cultural change. I have also suggested that cognitive science, and especially the kind of psychology that concerns itself with sub-personal mechanisms, can help cultural evolutionary theory to address the third-way question by i) refining the distinction between replication and reconstruction, so that it can be used more effectively to assess the one-shot fidelity of cultural inheritance, and 2) by casting a spotlight on metacognitive social learning strategies. These decision rules, unlike their planetary counter-parts, have the potential to meet the dumb choice and recurrent fidelity requirements for third-way cultural selection. In a coda I suggested that cognitive science needs cultural evolution at least as much as cultural evolution needs cognitive science: to explain the origins and adaptiveness of distinctively human cognitive processes. If that is correct, third-way cultural selection is much less likely to have been crowded out by natural selection on genetic variants, by the ‘first way’, than the Paris school assumes in its discussions of cultural attraction. But that’s another story, to be told at another interdisciplinary party. Thanks for the invitation.

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