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CRITICAL POINTS IN CURRENT THEORY OF CONFORMIST SOCIAL LEARNING

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Abstract. Existing mathematical models suggest that gene-culture coevolution favours a conformist bias in social learning, that is, a psychological mechanism to preferentially acquire the most common cultural variants. Here we show that this conclusion relies on specific assumptions that seem unrealistic, such as that all cultural variants are known to every individual. We present two models that remove these assumptions, showing that: 1) the rate of cultural evolution and the adaptive value of culture are higher in a population in which individuals pick cultural variants at random (*Random* strategy) rather than picking the most common one (*Conform* strategy); 2) in genetic evolution the *Random* strategy out-competes the *Conform* strategy, unless cultural evolution is very slow, in which case *Conform* and *Random* usually coexist; 3) the individuals' ability to evaluate cultural variants is a more important determinant of the adaptive value of culture than frequency-based choice strategies. We also review existing empirical literature and game-theoretic arguments for conformity, finding neither strong empirical evidence nor a strong theoretical expectation for a general conformist bias. Our own vignette study of social learning shows that people may indeed use different social learning strategies depending on context.

Keywords: social learning, conformist transmission, gene-culture coevolution

1. INTRODUCTION

Social learning, the non-genetic transmission of traits from a model individual to a naive individual, is a crucial element of cultural evolution. Since humans live in groups, there are usually many potential models around. If they all use the same

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cultural variant, then social learning will result simply in the transmission of that variant. Human populations, however, are rarely culturally homogeneous. Thus the following questions are central to understand cultural evolution: How do individuals choose among cultural variants? What determines such rules of choice? How do they influence cultural evolution?

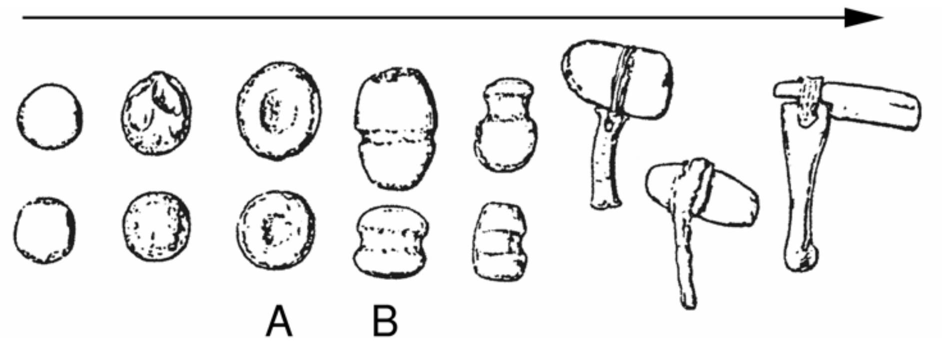


Figure 1. Historical variants of hammers. The arrow indicates increasing efficiency. Adapted from Basalla (1988)

As an example, consider different variants of hammers (*Figure 1*). Suppose a naive individual observes that many use hammer A and few hammer B. What hammer will she use? Many possible choice rules come to mind. She might try out both hammers to see which works best; she may stick with the first hammer she finds; she may choose the design that appeals to her most, regardless of how well it works; she may choose the hammer that is used by the best hammer-wielder; she may choose the hammer that seems to be most popular, and so on. The choice rule is important because hammers are not all equally good for their purpose. Hammer B, for instance, is better than hammer A. With a better hammer, the wielder can work more efficiently than individuals with worse hammers. In general, an individual's choice of cultural variants can often affect the individual's reproductive success. If the mechanisms to choose among cultural variants have a genetic basis, we expect natural selection to favour mechanisms that tend to result in the acquisition of superior cultural variants. Two types of strategies for choosing among variants have been considered.

The first suggestion is that individuals evaluate on their own the available cultural variants and choose the best one (BOYD and RICHERSON 1985, 1995). This strategy, it has been suggested, may be the basis of adaptive culture (ENQUIST et al. 2007). However, it may not always be possible to accurately evaluate all variants, e.g., if effects can only be seen in the long term, or if they have a large stochastic component. The second suggestion is to rely on social information, i.e., information on what variants are used by others. It has been suggested that we have evolved special psychological biases that result, on average, in the acquisition of adaptive cultural variants (LUMSDEN and WILSON 1980, 1981). One influential idea is that we have a strong bias for imitating common variants vs. rare ones, referred to as *conformist bias*. The rationale is that "once adaptive processes cause the best variants to be most common, those who imitate the most common variant are less likely to acquire inappropriate beliefs than those who imitate at random" (RICHERSON and BOYD 2005, p.~121). We may thus expect natural selection to favour a genetically based conformist bias. This interesting idea has had some impact on theoretical research on cultural evolution. For example, conformist bias has been proposed as essential to the maintenance of adaptive culture, and as a driving force for the emergence of cultural phenomena such as stable between-group differences and altruistic punishment (BOYD and RICHERSON 1985; HENRICH and BOYD 1998, 2001; RICHERSON and BOYD 2005). The idea, however, has also been criticized, for instance on the ground that a conformist bias would slow down the spread of adaptive innovations (HENRICH and BOYD 1998; MAMELI 2007).

Here we try to contribute to this theoretical debate with several arguments. In section 2 we describe the conformist bias idea and the theoretical models that show how such a bias would be adaptive in a population living in a changing environment (BOYD and RICHERSON 1985; HENRICH and BOYD 1998). We point out that these models implicitly assume that individuals have access to all possible cultural variants – what we call the *accessibility* assumption. We believe this assumption is not appropriate to describe culture: variants are not known until they are invented by someone, and then they are known only to the inventor or to individuals who learn it from the inventor or from others. In section 3 we modify the model of HENRICH and BOYD (1998) relaxing the accessibility assumption. The result is that a conformist biased population can now be invaded by an unbiased genotype. In other words, conformist bias is not evolutionarily stable in this model. In section 4 we develop a new model of cultural evolution, relaxing the oft-made assumption that exactly two variants of a trait exist at any one time, and allowing for unbounded cumulation of inventions (e.g., a series of inventions increasing in efficiency, *Fig. 1*). In this model a conformist bias performs even worse. A conformist biased population is at a severe disadvantage compared to an unbiased group because of its inability to adopt new, adaptive cultural variants.

These theoretical results cast doubt on the adaptive value of a conformist bias, but ultimately its existence in humans is an empirical question. In section 5 we review the empirical evidence, which we find scarce and apparently not supportive of the conformist bias hypothesis. In section 6 we report results of a vignette study of social learning in two different contexts, food choice and punishment of social defectors. Our rationale is that, from a game-theoretic point of view, there is little justification to expect that conforming to the majority should always be the best strategy. We might thus expect to see different social learning strategies according to the specific problem at hand. Our study indeed suggests that newcomers in an environment are more likely to adopt common behaviours in the domain of food choice than in the domain of punishment of social defectors.

2. CURRENT THEORY OF CONFORMIST BIAS

We are aware of two models showing that a genetically based conformist bias can evolve, one in BOYD and RICHERSON (1985) and the other in HENRICH and BOYD (1998). It has also been suggested that a genetically based conformist bias could coevolve with a "success bias" (a tendency to imitate successful individuals, BOYD and RICHERSON 1985; RICHERSON and BOYD 2005), and that these biases may be socially learned rather than innate, but we are not aware of any formal studies of these ideas (see MAMELI 2007 for discussion).

The models in BOYD and RICHERSON (1985) and in HENRICH and BOYD (1998) are similar in that individuals choose between two cultural variants, each of which is favoured in one of two possible environmental states. Both models also feature a number of local populations in different environmental states, linked by moderate migration. The model in BOYD and RICHERSON (1985) combines two processes. Parents with the best variant have more children, causing natural selection on both genetic and cultural traits, including strategies for social learning. Children learn from their parents, but if they migrate to another habitat they may either copy the most common variant (conformist bias) or copy at random. The basic finding was that genetic evolution favoured a conformist bias.

It was later recognized that the result of BOYD and RICHERSON (1985) might not hold if the environment can change with time, since a conformist bias might prevent individuals from adapting to change. Thus a new model was proposed where each habitat stochastically and independently switches between the two different environmental states (HENRICH and BOYD, 1998). Another new feature of this model is the central role played by individual learning. Agents are assumed to first try to evaluate the two variants on their own, relying upon social information from the previous generation only when individual learning yields no decisive results. In this model there is no natural selection of cultural variants and cultural parents are drawn at random. Another difference is that all learning, social or individual, occurs before migration. Thus a conformist bias plays no role in adapting the individual to a new environment after migration. The model was too complex for mathematical analysis, but based on simulations the authors concluded that a conformist bias should be favoured under a very broad range of parameter values – though *not* when individual learning is completely ineffective.

Why does conformist bias evolve in these models? Genetic evolution always favours a conformist strategy *when the best cultural variant is also the most common variant*. Thus, it is central to know how cultural variants of different fitness are distributed, both in theoretical models and in reality. We know of no studies of the latter. In the model of BOYD and RICHERSON (1985) only individuals migrating to another subpopulation could have a conformist bias. Non-migrating individuals, the majority, acquired the cultural variant of their parents, and parents with the best variant had more children. Thus eventually most individuals in each subpopulation will use the best variant for their habitat, favouring a conformist bias among migrating individuals.

In the model of HENRICH and BOYD (1998) there is no natural selection of cultural variants, as cultural parents are drawn at random. Another mechanism, individual learning, ensures that the most common variant is usually the best. All individuals are assumed to have *a priori* knowledge of both variants, hence plain guessing leads to a 50% chance of picking the best variant. If individuals can sometimes discover by individual learning which variant is best, and if social learning is faithful enough, then the frequency of the superior variant will soon be above 50% even after an environmental change, which makes a conformist bias adaptive.

How general are the conclusions from these two models? In this paper we investigate the consequence of relaxing two assumptions. We call them the *two variant assumption*, meaning that individuals must choose between only two cultural variants, and the *accessibility assumption*, meaning that individuals know *a priori* what the available variants are. As we argued in the introduction, we believe that these assumptions are not realistic. Thus it is important to understand how they impact model results. We will focus on two questions:

1. When does natural selection promote a conformist bias over unbiased choice?
2. When does a conformist-biased population have higher average fitness than an unbiased population?

3. A MODEL WITH TWO CULTURAL VARIANTS ACCESSIBLE THROUGH INVENTION AND SOCIAL LEARNING

We have tried to design a simple model that preserves all important features of the model by HENRICH and BOYD (1998) and allow us to both replicate their result and to explore the consequence of relaxing the accessibility assumption. We consider a single population of N individuals that must choose between just two cultural variants. Depending on the environmental state, one of them is superior to the other. With a probability p_{switch} the environment switches state so that the other variant becomes superior in the next generation. A naive individual tries to find out the best cultural variant based both on social information from n individuals from the previous generation (her cultural parents) and on her own effort to evaluate variants. We consider two decision processes, one which removes the accessibility assumption and one which maintains it.

Removing the accessibility assumptions, we assume that an individual knows about a variant only if she has seen it among her cultural parents. If she has seen only one variant, then she adopts it. Otherwise, she tries to find out which variant is best. The evaluation is either correct or leaves the individual uncertain. The latter occurs with a probability $p_{\text{uncertain}}$, in which case the individual uses social information to choose a variant. We contrast two genetically based choice rules:

- Conform: Choose the most common variant among cultural models.
- Random: Choose a cultural model at random and adopt her variant (equivalently: adopt a variant with a probability equal to its frequency among cultural models).

Lastly, we assume that an individual that is not using the best variant after the above decision process has a small probability, p_{invent}, of inventing it on her own.

The second decision process we consider keeps the accessibility assumption, i.e., an individual is assumed to always know about both variants, even if one was absent among her cultural parents. Then the decision process goes on as above.

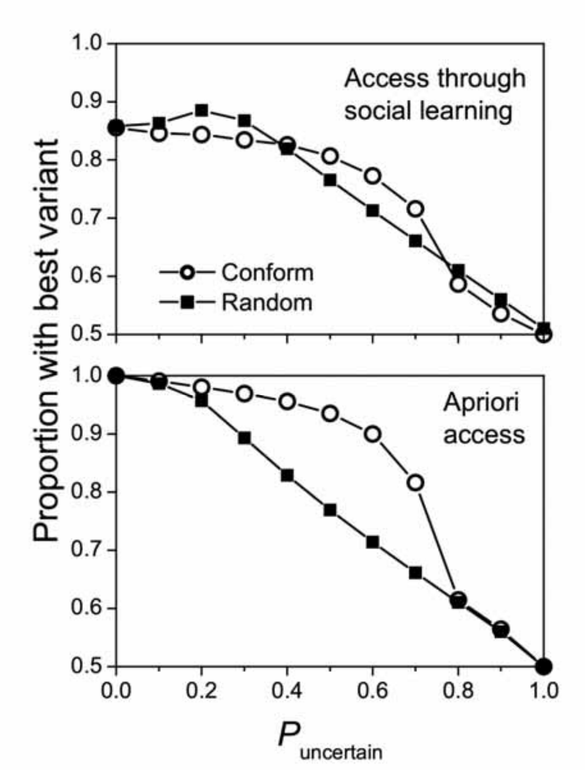


Figure 2. The frequency of individuals with best variant in populations of either the *Conform* or the *Random* strategy under two assumptions about access to variants obtained for varying $p_{\text{uncertain}}$. Each data point is the average of 5000 generations of simulation

We have run a large number of simulations of this model. In the following example, which is representative, the invention rate is $p_{\text{invent}} = 0.01$, the population size $N = 10000$, and each naive individual observes $n = 10$ cultural models. The environmental instability is $p_{\text{switch}} = 0.1$. We first study whether a conformist-biased population has a higher average fitness than an unbiased population. *Fig. 2* shows the frequency of individuals with the superior variant as a function of $p_{\text{uncertain}}$ in populations where all individuals follow the same social learning strategy. *Conform* is able to maintain a higher frequency of the superior variant only when individuals have *a priori* access to both variants (lower panel). When individuals must know about the variants by social learning, *Random* does as well as *Conform* (upper panel).

3.1. Genetic evolution

The above results have no direct bearing on genetic evolution. In this section we let the *Conform* and *Random* social learning strategies compete with each other in a gene-culture coevolutionary process. We are interested in whether there is a selection pressure for or against conformity and whether the *Conform* strategy is evolutionarily stable. Hence we start our simulations from a homogeneous population of *Conform*, as well as from random mixtures of the two strategies, and introduce a small probability of genetic mutation in each generation. We use the same parameters as above. In addition, we assume that individuals with the best variant have fitness two times higher than individuals with the inferior variant. We model genetic evolution with random drift as follows. Each new generation of *N* individuals is created by sampling the previous generation *N* times; every time, the probability for an individual of being chosen is proportional to her fitness. On average this process yields reproduction proportional to fitness. The probability of a strategy being changed to the other one by mutation is $p_{\text{mutation}} = 0.0001$.

We first show that we can replicate the result of Henrich and Boyd (1998) by assuming that each individual always has access to both variants. As shown in *Fig. 3*, the *Conform* strategy seems to be an ESS unless $p_{\text{uncertain}}$ is close to 1. Dropping the accessibility assumption the result is different. *Fig. 3* illustrates that a conformist population can always be invaded in this case. No strategy is consistently superior, although for most values of $p_{\text{uncertain}}$ the *Conform* strategy is somewhat more frequent on average than *Random*. A detailed examination of the simulations reveals that periods in which *Conform* does better alternate with periods in which *Random* does better. This follows from the pattern of environmental changes. After a long time without an environmental change the best strategy is established in the population and conformity is favoured. However, when a change occurs very few, if any, individuals have the best variant and unbiased choice is favoured as long as the best variant is in the minority.

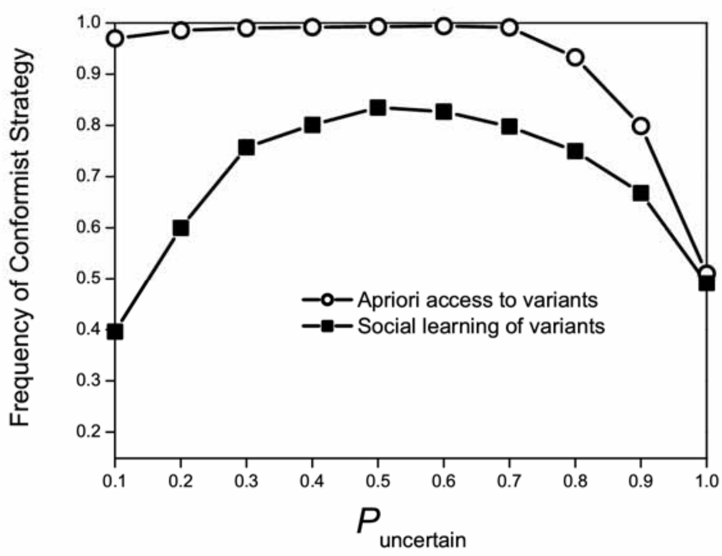


Figure 3. The frequency of the *Conform* strategy as a function of $p_{\text{uncertain}}$ for two different assumptions about individuals' access to cultural variants. Each data point is the average of 5000 generations of simulation, starting from a *Conform* population

3.2. Conclusions

In conclusion, we have shown that the accessibility assumption is crucial to the evolution of a conformist bias. When the assumption is dropped, a conformist bias is not consistently superior to unbiased choice. The reason is that when individuals have always access to all cultural variants they can adapt more quickly to environmental change. This translates into a higher frequency of individuals with the superior variant, which in turn tends to favour conformism in social learning. When individuals need to see the variants before they can compare them, on the other hand, adaptation to environmental change is slower, fewer individuals end up with the superior variant and conformism is not consistently favoured.

Lastly, note that the most important parameter for the adaptive value of culture in this model is the individual's uncertainty of evaluation, $p_{\text{uncertain}}$, not which rule she applies when uncertain (*Fig. 2*). The logic behind this is straightforward: If perfect evaluation is possible, then no individual will ever need to use any other choice rule. On the other hand, if no evaluation at all is possible, then no choice rule based only on the frequency of variants can be adaptive both when the superior variant is uncommon and when it is common.

4. AN INFINITE-STEP MODEL OF CULTURAL CUMULATION

In the previous model, evolution was driven by environmental change. However, a variable environment is not necessary for cultural evolution. We describe now a model with a stable environment, in which culture has unlimited potential for change through an unbounded sequence of possible inventions. As a mental image, think of an infinite cultural ladder where each step represents an improvement. For instance, the hammer types in *Fig. 1* are arranged in order of increasing efficiency. Thus the present model is obtained from the previous one through four modifications:

- Instead of just two cultural variants, we assume an infinite number of variants arranged in a sequence of increasing efficiency, referred to as a cultural ladder.
- There is no environmental change. Cultural variants, however, can become suboptimal because superior variants are invented.
- The ability to distinguish which of two variants is best may depend on how different the variants are (i.e., the number of steps that separate them on the cultural ladder).
- After an individual has obtained a cultural variant through social learning, she has a probability p_{invent} of improving it through invention; improvements result in a variant that is one step further on the cultural ladder.

As before, the *Conform* and the *Random* strategy specify what individuals do when they cannot reach a conclusion about which variant is best. We study two cases reflecting two different assumptions about how these choice rules are applied. In the first case, the individual is uncertain about all the observed variants; in the second case, it is only uncertain about the best and the second best variants (i.e., it is easy to discard clearly inferior variants).

4.1. Conformist bias inhibits cumulation of culture

We first study how the two choice rules influence the cumulation of culture. We measure the performance of the different choice rules by measuring the speed at which they climb the cultural ladder, i.e., the speed at which the efficiency of cultural variants increases. In the examples below we use a population size of $N = 1000$. Each individual observes $n = 10$ cultural models, and the probability of inventing a superior variant is $p_{\mathrm{invent}} = 0.01$. *Fig. 4* shows the average cultural level reached after fifty generations, for varying values of $p_{\mathrm{uncertain}}$. The figure illustrates two results. First, *Random* almost always results in a more efficient cultural variant than *Conform*. When $p_{\mathrm{uncertain}}$ is small the difference is absent or small, but as individual evaluation becomes more uncertain the difference grows. When $p_{\mathrm{uncertain}}$ is close to one, a population adopting *Conform* has a remarkable disadvantage. Second, climbing up the cultural ladder is faster when the individual's uncertainty of evaluation is limited to the two best variants.

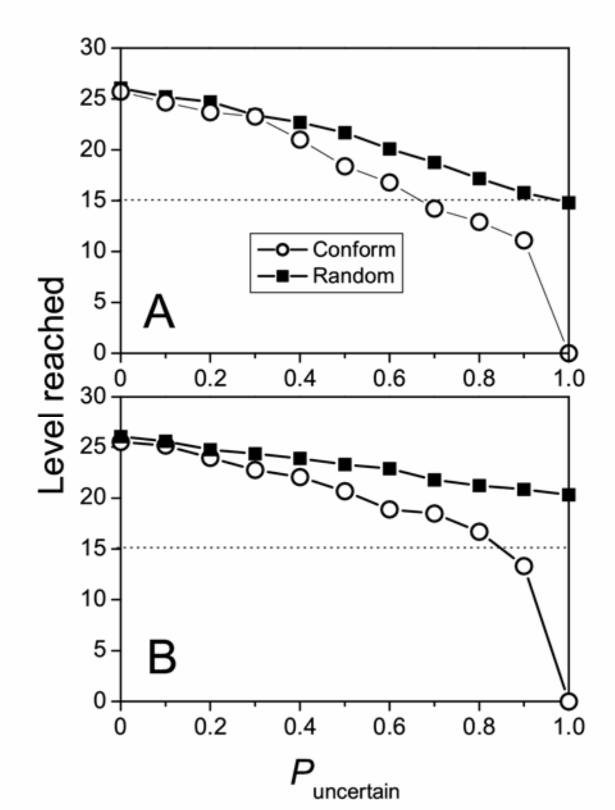


Figure 4. The level reached after 50 generations of cultural evolution in homogeneous populations of each of the two choice rules *Conform* and *Random* as a function of $p_{\mathrm{uncertain}}$. In panel A the individual is uncertain about all observed variants, in panel B the uncertainty includes only the two best variants. The values given are the average of 25 runs

These results can be understood by considering the distribution of cultural variants in the population, which individuals sample through social observation. As generations pass the cultural ladder is progressively climbed, so there is no typical distribution in the absolute sense. However, what matters is the distribution of variants in relation to each other. *Fig. 5* illustrates such distributions and shows that *Conform* and *Random* are favoured under different circumstances. Note also that when $p_{\text{uncertain}}$ or p_{invent} increase, the importance of the choice rule used decreases, just as in the model studied in section 3.

Figure 5. Hypothetical efficiency distributions of cultural variants. The fitness of a social learning strategy is proportional to the probability of picking the most efficient variant. Thus for a symmetrical distribution *Random* and *Conform* fare equally well, while for distributions with a left (right) skew *Random* (*Conform*) performs better. If individuals are uncertain only about the most efficient variants (shaded areas) then *Conform* fares worse than both *Random* and a strategy that always picks the rarest variant

4.2 Conformist bias is often selected against

We now consider the genetic evolution of choice rules by letting them compete with each other in simulations, as in section 3. We use a mutation rate of $p_{\text{mutation}} = 0.001$. and start with a homogeneous population using the *Conform* strategy (other starting points yield the same result) and find that it is often out-competed by the *Random* strategy. *Fig. 6* shows the proportions of the two strategies reached after five hundred generations, for varying values of $p_{\text{uncertain}}$. The *Random* strategy is particularly successful when the individual is uncertain only about which one of the two best variants is the best.

In *Fig. 6*, panel A, the *Random* strategy is not dominating when $p_{\text{uncertain}}$ is less than 0.5. This is associated with the distribution of cultural variants being more symmetric or skewed toward better variants. The reason is that with low $p_{\text{uncertain}}$ individuals are better at evaluating alternative variants and the best variant becomes common more rapidly. A decrease in the probability of invention p_{invent} also favours *Conform*, because also in this case the best variant is more likely to be the most common. *Fig. 7* illustrates a case with $p_{\text{uncertain}}. = 0.5$ and individuals only being uncertain about which one of the two best variants is the best. To get some intuition for these values, note that $p_{\text{invent}} = 0.01$ leads to a level around 20 after 50 generations while $p_{\text{invent}} = 0.001$ leads to a level around 9.

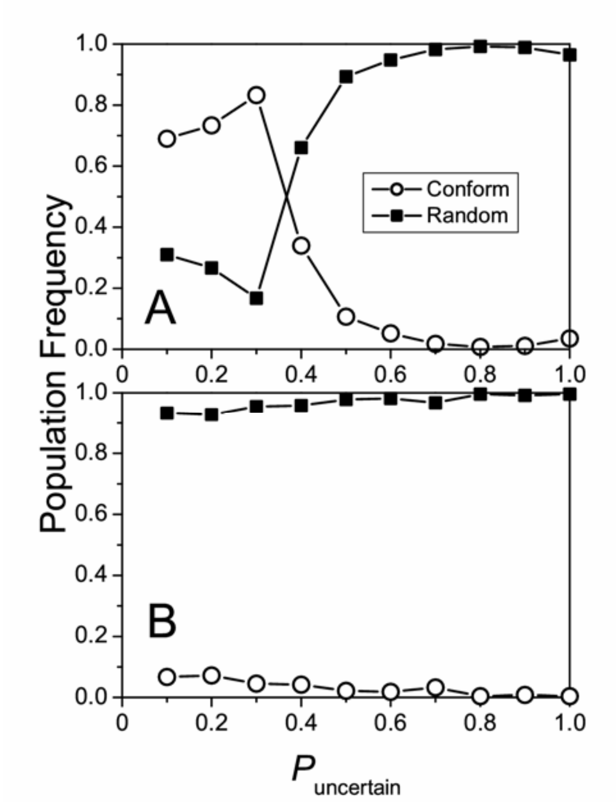


Figure 6. The frequency of the *Conform* and *Random* strategy after 1000 generations of gene-cultural coevolution, as a function of $p_{\text{uncertain}}$. In panel A the individual is uncertain about all observed variants, in panel B the uncertainty includes only the two best variants. The values given are the average of 25 runs

Note that genetic evolution is slow in some of the considered cases. For instance, when $p_{\text{uncertain}}$ is small the choice rule is seldom used, because individuals can make up their mind on their own. Thus there the choice rule has only a small effect on fitness, while random factors such as drift and the random sampling of cultural parents become relatively more important. For this reason it was necessary to run simulations for 1000 generations to observe a clear pattern.

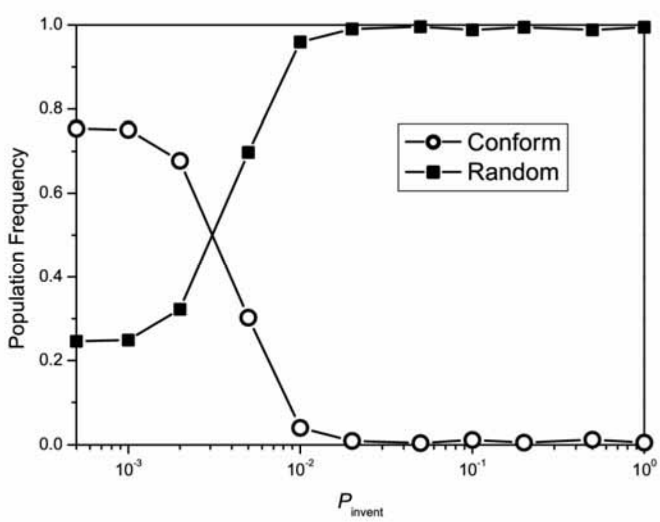


Figure 7. Equilibrium frequencies of the *Conform* and *Random* strategies as a function of the probability that an individual invents a more efficient cultural variant, p_{invent}

4.3 Conclusions

We have shown that the *Random* strategy allows faster cumulation of adaptive innovations than the *Conform* strategy. Adaptive cultural evolution is also faster when the individuals are better at discriminating between alternative strategies (lower $p_{uncertain}$) and better at inventing more efficient cultural variants (higher p_{invent}). In genetic evolution, *Random* social learning dominates the *Conform* strategy under most conditions, unless cultural evolution is very slow (e.g., low p_{invent}), in which case the two strategies can coexist.

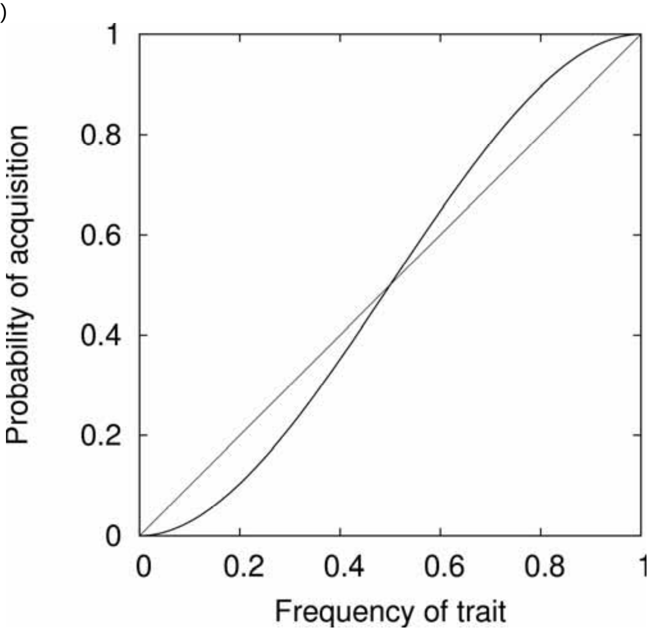
5. EMPIRICAL STUDIES OF CONFORMISM

The interpretation of empirical studies of conformism is difficult for two main reasons. First, a tendency to do as the majority is not necessarily a result of an innate psychological bias – an argument we develop in the next section. Second, researchers themselves use the term "conformism" to refer to the outcome of processes unrelated to "conformist bias" in the present sense. For instance, in an archaeological study of ceramic styles in villages in New Mexico (around AD 1300), KOHLER et al. (2004) found less diversity than expected from pre-village data. The authors do argue for an explanation in terms of conformist social transmission of styles between potters, but they attribute it to a conscious desire to signal group identity at a time when tensions between groups were significant, rather than to a psychological bias to conform. Another example is social psychology, where the term conformity is used for an individual's tendency to follow group beliefs or norms, which is not the same as a "conformist bias''. The latter refers to choice of behaviour when there is variability within a group, rather than an established group norm, and is unrelated to issues such as peer pressure or group identification.

Even setting aside problems of interpretation, the evidence for a conformist bias seems scarce. Several empirical studies of social learning have shown that people do use information about others' choices as a guideline to their own choices, but in a way that was often at odds with existing theory of conformist bias (MCELREATH et al. 2005; EFFERSON et al. 2007). The best evidence comes, perhaps, from studies in which people had to choose between just two possible variants. Before discussing such evidence, note that in the case of two variants a choice rule can be visualized as a curve that relates the observed frequency of a variant to the probability of adopting that variant (*Fig. 8A*). Unbiased choice is thus represented by a straight line: a variant is adopted with a probability equal to its observed frequency. A conformist bias is instead represented by an S-shaped curve (BOYD and RICHERSON 1985). The reason is that the slope (i.e., the marginal effect of adding one more cultural model bearing on a certain variant) should be highest in the middle, because here a difference of just a few percent in observed frequency can determine whether a variant is in majority or not. On the other hand, when a variant is clearly very common or very rare a conformist-biased individual would be less sensitive to one cultural model more or less. The S curve will be vertically compressed if there is a direct bias favouring one of the two variants, but it will remain S-shaped.

Existing evidence, while certainly not definitive, runs contrary to an S-shape for the effect of observed frequency on choice. For instance, in the classical experiments of ASCH (1952), the impact of the group decreased dramatically if just one of the confederates agreed with the participant. On the other hand, according to the conformist bias hypothesis the difference between unanimity and near-unanimity would be negligible since in both cases the same variant is clearly the most common one. Inspired by conformist transmission theory, COULTAS (2004) performed the following two experiments. In the first one, she monitored whether newcomers to a communal computer room would adopt an odd way of placing the computer keyboard cover, namely to balance it on the computer monitor, as a function of the proportion of people in the room that were already doing so. In a second study she considered two ways of writing the date, a short form like 18/5/04 (estimated to be the more common at ~80% frequency), and a long form like 18 May 2004. People were asked to sign on a participant list for a psychology experiment that had been manipulated in order to contain variable proportions of

A)



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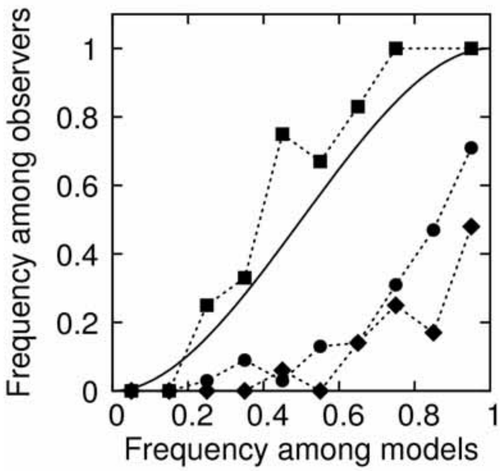

Figure 8. A) Unbiased social learning yields a linear relationship between the frequency of one (out of two) cultural variants and the probability for a naive individual of acquiring this variant through social learning. Conformist bias gives an S-shaped curve. The form of the bias is the one in BOYD and RICHERSON (1985), HENRICH and BOYD (1998). B) Data from COULTAS (2004). Circles: data from the computer room experiment. Squares and diamonds: data from the date writing experiment. See text for details. The continuous line is again the example of conformist bias plotted in the A) panel

the two date writing styles, to see whether they would change their own style to conform to the one that was most used on the list. COULTAS'S (2004) results are summarized in *Fig. 8B*. One set of data, from the date writing experiment (closed squares, relative to people switching from the rare to the common form), matches the expectation of conformist bias theory while two data sets do not, one from the computer room experiment and one from the date experiment (relative to people switching from the common to the rare form).

6. WHEN SHOULD ONE CONFORM?

6.1 A game theoretical perspective

One difficulty in testing the hypothesis of an innate conformist bias in social learning is that there may be several reasons to conform (or not conform) to the majority. For instance, there might be a direct advantage in doing what the majority does. Individuals may thus choose to conform as a strategic choice (*direct frequency-bias* in BOYD and RICHERSON 1985). In game theory, this occurs in so-called *coordination games* (COOPER 1999). In such a game, agents benefit from choosing the same strategy as everyone else, as in many instances of concerted effort. Obviously, conformity is the game-theoretic prediction for the outcome of coordination games quite independent of a conformist bias in social learning. It is also clear from game-theoretic considerations that conforming is not always the best thing to do. In *complementarity games*, for instance, individuals have an incentive to be different from others (MATSUYAMA 2002). Typically, complementarity games model situations where there are specializations and benefits of exchange. For instance, if there are already many bakers one might do better as a butcher. In a complementarity game, the equilibrium has behavioural diversity. Even situations that are not strategic in themselves are often transformed into coordination games or complementarity games by other mechanisms. For example, even if the functionality of a certain clothing style is not affected by how other people choose their clothes, forces like peer pressure or desire of group identification add a need for coordination, whereas trend-setter prestige gives to the same situation elements of a complementarity game.

It is also worth noting that conformist or non-conformist behaviour can arise from information asymmetries. For instance, a newcomer who wants to know what is good to eat at an unfamiliar place will likely assume that more experienced individuals sit on superior information worth having. In contrast, an individual who has found out she gets sick from a certain type of food will likely avoid it even if the majority eats it.

6.2 A demonstration of context-specific choice rules

In summary, from a game-theoretic perspective it is clear that we should not expect a general conformist bias. At most, we might expect a conformist bias in coordination games and in situations where we expect the majority of people to have valuable information. We have carried out a simple vignette study to test whether people's tendency to conform depends on the nature of the behaviour considered. According to the argument above, food choice is an example of a domain where we expect newcomers to conform, since they have reason to believe veterans have better information but similar preferences.

An important example of a domain where we do not expect newcomers to conform is in punishment of social defectors. We base this hypothesis on the following theoretical considerations. First, punishing can be conceived as a complementarity game in the sense that if you want anti-social behaviour to be punished, but punishment is costly, then the more other punishers around the less reason for you to punish. Second, if anti-social behaviour is common despite many punishers, then a rational agent may start doubting the effect of punishment; on the other hand, if anti-social behaviour is rare, then there will be little actual punishing to imitate.

The case of punishment is particularly interesting since it has been proposed that costly punishment of social defectors can be maintained by conformist transmission of the punishing behaviour, hence solving the problem of how pro-social behaviour can evolve (HENRICH and BOYD 2001).

6.2.1 Method. Nine different types of vignettes were designed (see Appendix). Each vignette describes a situation where the respondent comes, as an exchange student, to a college club. Three of the vignettes describe a party where the exchange student had a choice between two unknown and unrecognizable dishes (a light-brown stew and a dark-brown stew). These vignettes differed in the proportion of people ahead in line who chose the light-brown stew (10%, 50% or 90%). The remaining six vignettes instead described how some people at the club are social defectors (using the communal printer for large jobs), and how some people engage in costly punishment (telling the defectors to stop, despite their getting angry). Vignettes came in six different versions depending on the proportion of punishers (10%, 50% or 90%) and whether or not there were other people around in the situation when the respondent had an opportunity to punish a defector.

Each vignette ended with a single question: "How likely is it that you in this situation would choose the light-brown stew" or "How likely is it that you in this situation would tell the person to stop his printing job?" Responses were on a seven-point Likert scale (1 = *would definitely do it*, 7 = *would definitely not do it*). Since the effects were expected to be large for food choice and much smaller for punishment, we decided to collect fewer responses to food choice vignettes than to punishment vignettes.

250 participants (230 males, 20 females; average age 22 years) were recruited among computer science students at two Swedish universities. Each participant was given one vignette, drawn at random from a pile consisting of 50 copies of each version of the punishment vignettes, and 15 copies of each version of the food choice vignettes. The numbers of drawn copies of each version are reported in *Fig. 9.*

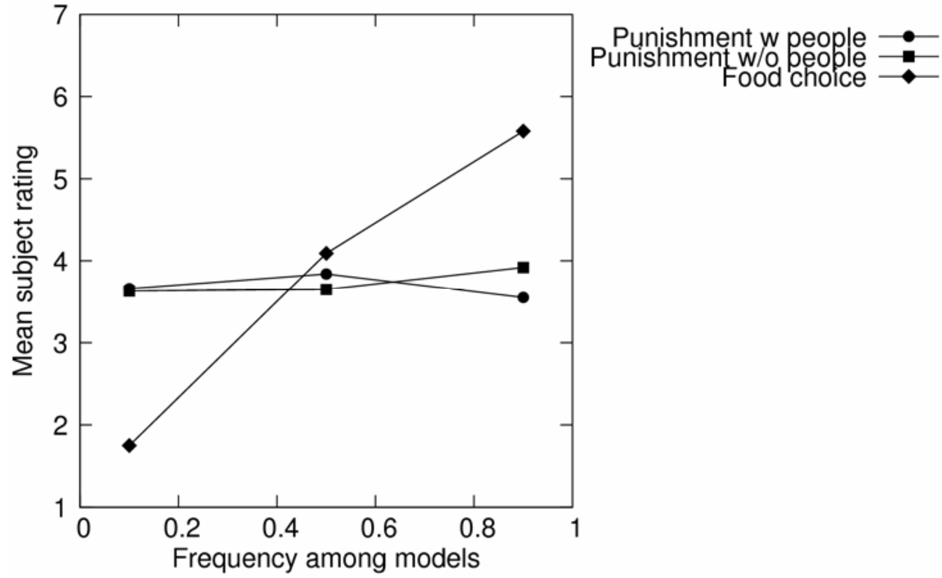

Figure 9. Results from a vignette study of frequency-dependent social learning. The study asked people to rate on a seven point Likert scale the likelihood of adopting one of two particular behaviours, manipulating the frequency of the two behaviours among cultural models. Only when the choice was about which food to eat we could see an effect of the frequency of the two variants, but not when the choice was about whether to punish or not a social defector (in the presence or absence of other people). Standard deviations ranged between about 0.8 and 1.9

6.2.2 Results. *Fig. 9* shows our result as mean likelihood ratings for the nine vignette types. The data on responses to food-choice vignettes show a clear effect of the frequency of models using the behaviour, in the expected direction (conformity). In contrast, there is no discernible effect of the frequency of punishers, either in the scenario with other people around or in the alternative scenario. An ANOVA with mean rating as dependent variable and frequency of cultural models and context as independent variables shows a strong interaction between frequency and context ($F(244.2) = 11.63$, $p < 0.0001$) and a main effect of frequency ($F(244.1) = 5.12$, $p < 0.005$).

7. DISCUSSION

We have investigated the popular idea of a so-called conformist bias in human social learning, i.e., an evolved psychological bias to imitate the most common cultural variant among cultural models. We have highlighted two simplifying assumptions of existing models: the accessibility assumption, postulating that individuals have *a priori* knowledge about existing cultural variants, and the assumption that individuals must choose between just two cultural variants. We have studied two models that replace these assumptions with more realistic ones, namely, that an individual only knows about those cultural variants she experiences and that invention can produce an unlimited number of cultural variants varying in efficiency. Simulations of both models show that conformist-biased social learning is not, in general, evolutionarily stable, and often leads to lower fitness than unbiased social learning. The models also show that an individuals' ability to discriminate between cultural variants (referred to as *adaptive filtering* by ENQUIST and GHIRLANDA 2007; see also ENQUIST et al. 2007) seems more important, for the cumulation of adaptive culture, than frequency-based choice rules.

We also found no strong empirical tests of conformist-biased social learning. Most empirical findings are open to alternative interpretations, are at odds with the predictions of models of conformist bias, or are simply not an adequate test of the theory. Our own vignette study indicates that people may use different choice rules in different domains of experience, namely food choice and punishment of social defectors, which undermines the notion of a generalized conformist bias. This study was suggested to us by strategic (game-theoretic) considerations, that clearly show how conforming to the majority may be a good strategy in some cases but not in others.

Our overall conclusion is that, although transmission patterns and social learning strategies are probably essential in shaping human cultural evolution, a conformist bias is not a catch-all solution to adaptive problems. Based on our theoretical arguments and simulations, we do not expect any strong selection pressure for a conformist bias, and we found no satisfactory evidence that such a bias actually exists within human psychology.

APPENDIX

We reproduce here the text for the vignette study presented in Section 6. Alternative text used in different conditions is here highlighted in boldface, but was presented as normal text to the subjects.

Punishment vignette

Imagine coming as an exchange student to a university with alien customs. The students of your class have a common-room the costs of which are shared equally by everyone in the class through a class-fee. This room has a printer with the sign: "Print no more than a few pages, please!!" Your first time in this room, someone seems to be printing out an entire book. In surprise you point to the sign. The person becomes angry with you, and you find the situation unpleasant. After a while, though, the person stops his printing job and disappears. You tell another student about the incident, and he is not surprised at all:

"Some students use the printer to avoid paying the cost of textbooks. It is very expensive for us, so we must soon raise the class-fee."

"I'm afraid so. Well, nobody here thinks bad of you if you don't intervene."

"So how many here are prepared to intervene anyway?"

"Oh, I'd say about **[10 / 50 / 90]%** do it."

Next time you pass the printer, you see that once again there is a student printing an entire book. **[There are no other people around. / There are two other persons close by.]** Would you tell him to stop? Answer on a seven-point scale (1 = yes, definitely, 7 = definitely not).

Food vignette

Imagine coming as an exchange student to a university with alien customs. The students of your class have a common-room the costs of which are shared equally by everyone in the class through a class-fee. This room has a sign saying: "It's back! SILENT PUB here tonight!" When you arrive to the pub you realize that it's really silent. Lots of people are on the dance-floor, and they seem to enjoy themselves immensely, despite (or perhaps due to) the fact that there is no music. Other people are playing cards, arm-wrestling, playing dart, kissing, gesticulating wildly ... but no one says a word! Behind a simple counter there are two dishes served: a light-brown stew and a dark-brown stew. You have no clue what's in the stews or how they taste. There is no sign, and of course you cannot ask anyone since everyone must be silent. People ahead of you in line choose their dish through pointing. About **[10 / 50 / 90]%** choose the light-brown stew. Would you choose the light-brown stew? Answer on a seven-point scale (1 = yes, definitely, 7 = definitely not).

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REFERENCES

ASCH, S. E. (1952): *Social Psychology*. Prentice-Hall.

BOYD, R. and RICHERSON, P. J. (1985): *Culture and the Evolutionary Process*. University of Chicago Press.

COOPER, R. W. (1999): *Coordination Games*. Cambridge University Press.

COULTAS, J. C. (2004): When in Rome. An evolutionary perspective on conformity. *Group Processes and Intergroup Relations*, 7: 317−331

EFFERSON, C., RICHERSON, P. J., MCELREATH, R., LUBELL, M., EDSTEN, E., WARING, T. M., PACIOTTI, B. and BAUM, W. (2007): Learning, productivity, and noise: An experimental study of cultural transmission on the Bolivian Altiplano. *Evolution and Human Behavior,* 28: 11−17.

ENQUIST M. and GHIRLANDA, S. (2007): Evolution of imitation does not explain the origin of human cumulative culture. *Journal of Theoretical Biology*, 246: 129−135.

ENQUIST M., ERIKSSON, K., and GHIRLANDA, S. (2007): Critical social learning: A solution to Rogers' paradox of non-adaptive culture. *American Anthropologist*, in press.

HENRICH, J. and BOYD, R. (1998): The evolution of conformist transmission and between-group differences. *Evolution and Human Behavior*, 19: 215−242.

HENRICH, J. and BOYD, R. (2001): Why people punish defectors: conformist transmission stabilizes costly enforcement of norms in cooperative dilemmas. *Journal of Theoretical Biology*, 208: 79−89.

KOHLER, T. A., VAN BUSKIRK, S. and RUSCAVAGE-BARZ, S. (2004): Vessels and villages: evidence for conformist transmission in early village aggregations on the Pajarito Plateau, New Mexico. *Journal of Anthropological Archaeology,* 23: 100–118.

MAMELI, M. (2007): Understanding culture: a commentary on RICHERSON and BOYD'S not by genes alone. *Biology and Philosophy,* in press.

MATSUYAMA, K. (2002): Explaining diversity: Symmetry-breaking in complementarity games. *American Economic Review,* 92: 241–246.

MCELREATH, R., LUBELL, M., RICHERSON, P. J., WARING, T. M., BAUM, W., EDSTEN, E., EFFERSON, C. and PACIOTTI, B. (2005): Applying evolutionary models to the laboratory study of social learning. *Evolution and Human Behavior*, 26: 483−508.

RICHERSON, P. J. and BOYD, R. (2005): *Not by Genes Alone*. University of Chicago Press.