Are people really conformist-biased? An empirical test and a new mathematical model

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Abstract: According to an influential theory in cultural evolution, within-group similarity of culture is explained by a human 'conformist-bias', which is a hypothesized evolved predisposition to preferentially follow a member of the majority when acquiring ideas and behaviours. However, this notion has little support from social psychological research. In fact, a major theory in social psychology (Latané and Wolf, 1981) argues for what is in effect a 'nonconformist-bias': by analogy to standard psychophysics they predict minority sources of influence to have relatively greater impact than majority sources. Here we present a new mathematical model and an experiment on social influence, both specifically designed to test these competing predictions. The results are in line with nonconformism. Finally, we discuss within-group similarity and suggest that it is not a general phenomenon but must be studied trait by trait.

Key words: Cultural evolution, conformist bias, social impact theory, minority influence

Introduction

In this paper we report the first direct experimental test of two competing hypotheses about the frequency-dependence of acquisition of a cultural trait in the absence of other biases. The competing hypotheses, often named "conformist" and "non-conformist" bias, were formulated by Boyd and Richerson (1985). They apply to the situation where social learners acquire one out of two, or more, alternative cultural variants. Typical examples include opinions (e.g., whether love is important), customs (e.g., whether you attend religious service), and skills (e.g., whether you speak English).

Now imagine a social learner, Indy, who learns a variant from a cultural parent selected from the population at random with uniform probability. This means that the probability that Indy will acquire a certain variant, say A, equals the frequency of variant A in the population. In contrast, two other social learners, Confy and Nonco, select cultural parents with non-uniform probabilities. Confy's selection procedure gives higher weight to people who have more common variants, whereas Nonco 's gives higher weight to people with uncommon variants. In the terminology of Boyd and Richerson, Indy is frequency-independent while the others exhibit different types of frequency-based bias: Confy is conformist-biased, Nonco is nonconformist-biased. Figure 1 shows, for each of the three types, how the probability of acquiring variant A depends on the frequency of A in the population (in the special case of exactly two possible variants).

FIGURE 1 HERE

The hypothesis that human social learning is, on the whole, (non)conformist-biased will henceforth be called the (Non)Conformist Hypothesis. The main reason for the interest in the Conformist Hypothesis is that, over time, conformist-biased social learning as in Figure 1 would quickly lead to within-group similarity of culture. This can then be taken as the basis for theories of cultural group selection. In contrast, under the Nonconformist Hypothesis the outcome of social learning models would be within-group diversity. For a review of the arguments behind these conclusions, see Efferson et al (2008). In the present paper we are interested in which of the two hypotheses, if any, is correct.

Models of gene-culture co-evolution have indicated how a conformist-bias could be adaptive (Boyd & Richerson, 1985; Henrich & Boyd, 1998). However, a recent model showed that a conformist-bias may actually be maladaptive in a species like humans where culture evolves cumulatively (Eriksson et al, 2007). On theoretical grounds, the question of whether humans are conformist-biased is far from settled — although one can easily obtain this impression from some of the literature in the area of cultural evolution. Researchers who rely on the Conformist Hypothesis for subsequent theoretical work usually treat it as an uncontroversial assumption (cf. Henrich & Boyd, 2001; Henrich, 2004; Richerson & Boyd, 2005) while review articles on evolution and human behaviour often present conformist-bias as if it were an established fact (cf. Cohen, 2001; Norenzayan & Heine, 2005; Gintis 2007).

Of course, social influence and conformity have been extensively studied in social psychology, without reference to evolution. Most of this work does not at all address the question of frequency-dependence, that is, the relative social influence of a minority member compared to a majority member. However, a specific prediction about this comes out from Social Impact Theory (Latané, 1981; Latané & Wolf, 1981; see also Tanford and Penrod, 1984). In brief, Social Impact Theory predicts that the social influence of a group is positively related to its numerosity, immediacy and strength. The importance of all three variables has been confirmed (Markovsky and Thye, 2001, 2002). The variable of interest for our present purposes is the *numerosity* of the group, for which Social Impact Theory predicts *decreasing marginal impact* (e.g., a group of six has less than twice the impact of a group of three). This prediction is based on two arguments. First, classic experiments on conformity show that the impact of the influencing group levels off as the group size increases. Second, a decreasing impact of additional social stimuli is in line with the psychophysical laws that govern the subjective impact of physical stimuli such as light and sound (Latané 1981; Latané & Wolf

1981). Thus, when people are influenced by a group in which several competing cultural variants are represented, Social Impact Theory predicts the minority group to have stronger impact relative its size. In effect, this is equivalent to saying that the people under influence are nonconformist-biased. Nevertheless, it should be noted that the acquisition probability of a common cultural variant is still higher than that of a rare variant under non-conformist bias.

There have been a number of experiments in social psychology related to this prediction with results that are generally supportive of decreasing marginal impact of numerosity (reviewed in Tanford and Penrod, 1984; see also Clark and Maass, 1990). However, these studies have not been specifically designed to test frequency-dependence. For one thing, they usually vary group sizes in a way that does not cover any significant portion of the range (0-100%) of possible frequencies (with the exception of Coultas, 2004). Furthermore, conformity research typically studies choices where it is clear which variant subjects would choose in the absence of social influence. In other words, the choice between the cultural variants is intrinsically biased, and this must lead to other shapes of acquisition graphs than the classic ones shown in Figure 1. To begin with, some subjects will choose a given variant even when no one else chooses it, so the graph will be compressed (acquisition probabilities starting at a level above 0% and ending at a level below 100%). Further, unless the choice between the two possible variants is perfectly neutral the acquisition graph must deviate from the perfect symmetry exhibited by both graphs in Figure 1. Our first contribution in this paper is to develop a new mathematical model that takes these aspects into account.

In this experiment, we let participants make binary choices to express their opinions on various matters, a dozen in all. For each choice, some participants made the choice without any source of social influence present; in this way we can ascertain whether the variants are neutral (i.e. roughly half make either choice). Remaining participants made their choice when aware of how nine other persons had, ostensibly, answered the same question; we manipulated this source of social influence so that the frequencies range from 0% to 100%. The decision to use nine 'models' of the behaviour was based on previous research (Asch, 1951; Mann, 1977; Coultas, 2004).

The results of our study support the prediction of Social Impact Theory ($p<0.05$, one-tailed) and hence we reject the Conformist Hypothesis. This leaves open the question of the source of within-group similarity. We turn to this issue in the concluding section, where we find that within-group similarity seems to be limited to specific cultural traits for which a variety of specific homogenizing mechanisms operate.

A new mathematical model of 'acquisition graphs'

The social impact on a group of targets is usually measured as the proportion of targets that are swayed by the social influence. By analogy to the psychophysical laws of intensity of perception, Social Impact Theory assumes decreasing marginal impact of the number of sources of social influence. This seems plausible, but there is a missing link in the chain from social influence (which is the input to individuals) to social impact (which is the proportion of behaviours in a group). We must explain how social influence is translated into individuals' choices of behaviour in a way that is consistent with the social impact measured on the level of the group. The simplest way to do this is to assume that individuals behave non-deterministically, with probabilities that depend on the social influence. Below we develop a mathematical model for these probabilities.

Consider an individual in a binary decision-making situation where one option is A. In the social environment some sources of influence favor A and others disfavor A, and we quantify this by the proportion s of sources that favor A[1]. The deviation of s from 50% is a measure of the *social bias*[2] in this choice. Thus, if $s = 0.5$ there is no social bias (a neutral social environment). If $s > 0.5$ the social bias is toward A, and if $s < 0.5$ the social bias is against A.

[1] This is reasonable only under the assumption that sources are roughly identical in their potential to influence, which is the case that we study here. If sources differ in, say, prestige then some weights must be assigned.

[2] Observe that social bias is not the same as a transmission bias (Boyd & Richerson 1985).

For a given choice, we now want to model the probability that an individual chooses option A as a function $f(s)$. There is a suggestion made in the literature (Boyd & Richerson, 1985):

$$f_1(s)=s + Ds(1-s)(2s-1)$$

For $D = -1, 0, 1$, this is the model used to generate the acquisition graphs shown in Figure 1. The parameter D measures the degree of conformist-bias. Positive values of D give S-shaped graphs, negative values give inverse S-shapes.[3]

The problem with the function $f_1(s)$ is that it is too constrained. Whatever the value of D, this function always predicts unchanging probabilities of choosing A in the three cases when s=0, 1/2, and 1, the fixed probabilities being $f_1(0)=0$, $f_1(1/2)=1/2$ and $f_1(1)=1$. These constraints are clearly unrealistic (e.g., see the data presented in Coultas, 2004). We want our model to incorporate the following three parameters:

p_{neutral}: probability that the individual's decision is A in the absence of social influence. (The deviation of p from 50% is a measure of the *intrinsic bias* in this choice.)

p_0: probability that the individual's decision is A when s=0, i.e., all sources of influence are against A. Call $p_0 = f(0)$ the *left baseline.*

p_1: probability that the individual's decision is A when s=1, i.e., all sources of influence are for A. Call $p_1 = f(0)$ the *right baseline.*

Further, we want our model function f to satisfy two conditions that seem logically reasonable.

Condition 1. When the choice is symmetric (no intrinsic bias, symmetric baselines) the acquisition graph is symmetric between the options A and non-A. Mathematically, this means that

if p_{neutral}=1/2 and if $p_1 = 1 - p_0$, then the derivative $f'(s)$ is symmetric around s=1/2.

Condition 2. If there is no social bias, the probability that an individual will choose A is the same as in the absence of social influence. Mathematically, this means that the function f must satisfy

$$f(1/2) = p_{\text{neutral}}$$

[3] Boyd and Richerson's model is a special case of more general model discussed by Efferson et al (2008). This more general model shares the fundamental properties of the polynomial considered here, i.e., $f(0)=0$, $f(1/2)=1/2$ and $f(1)=1$, but it is based on a binomial sum and is therefore less tractable.

We will now generalize the function $f_1(s)$ to satisfy all these conditions:

$$f(s)= p_0 + (p_1-p_0)s - 2(p_0+ p_1- 2p_{\text{neutral}})s(1-s) + Ds(1-s)(2s-1) \qquad \text{(eq. 1)}$$

This is a general cubic polynomial, constrained only by the natural constraints on the parameters. It is straightforward to verify that $f(0)= p_0$, $f(1)= p_1$, and $f(1/2) = p_{\text{neutral}}$. To check Condition 1, we assume that p_{neutral}=1/2 and $p_1 = 1- p_0$ and compute the derivative

$$f'(s)= 1-2p_0 + D(1/2-6(s-1/2)^2),$$

which is clearly symmetric around s=1/2.

Figure 2 shows how the graph of Figure 1b can change when baselines and intrinsic bias are incorporated.[4]

FIGURE 2 HERE

A null hypothesis. To summarize, we have developed a function $f(s)$ to model the probability of making a certain binary choice under a given level of social bias. This model is parameterized by the intrinsic bias and the left and right baselines, as well as by the degree D of conformist-bias. We obtain our null hypothesis for the statistic analysis by setting D=0:

$$f_{\text{null}}(s)= p_0 + (p_1-p_0)s - 2(p_0+ p_1- 2p_{\text{neutral}})s(1-s),$$

that is, the null hypothesis is a quadratic polynomial.

In our empirical study we will obtain data for four equidistant values of s: 0, 1/3, 2/3, and 1. The canonical way to obtain a measure D^* of deviations from the null hypothesis is then to compute the expression

$$D^* = 9/4 \times [f(0) - 3f(1/3) + 3f(2/3) - f(1)],$$

[4] It is worth noting that the graph that used to be shaped as an inverted S becomes roughly convex for large intrinsic bias. A change of shape is unavoidable, because intrinsic bias means precisely that the midpoint of the graph is moved downward or upward. A similarly convex shape was found in an experiment on biased choice between signing with either a short or a long form of date (Coultas, 2004; see discussion in Eriksson et al. 2007).

because it is easy to verify that this is the unique (up to scaling) linear combination of these four function values that is zero whenever f is a quadratic polynomial. Indeed, computing D^* for our mathematical model (eq. 1) yields

$$D^* = D$$

Thus, the measure D^* estimates the degree of conformist-bias as it is represented in our model.

Method

Main Study: One hundred and twenty participants (54% female, age range 14 to 85 years) were recruited in shopping malls to take part in a study looking at people's preferences/opinions. This type of data collection takes into account recent suggestions (Mesoudi, 2007) that the external validity of experimental methods can be increased by the use of a more diverse sample of participants i.e. non students.

Pilot Studies: The first pilot (N = 65) established the most 'neutral' opinions to be used in the main study. We started with 50 potentially neutral opinions and using a five-point likert scale established the 6 most neutral e.g. "Pigeons spread disease", and "Married people should always wear rings". The second pilot was a test run.

Materials and experimental design: Participants were presented with a set of twelve forms each containing two columns. The forms presented yes/no questions from three domains: six neutral attitudinal items (e.g. "DIY instructions should have images rather than text"), three binary choices of the most attractive face (2 sets of female, 1 set of male), and three judgments of whether a face showed any sign of a certain emotion (disgust/anger/fear). The three faces used in the judgment of emotion part of the task were created using Smartmorph software (Kemmis, Hall, Kingston and Morgan, 2007). Each picture was obtained by morphing of a face showing the focus emotion (weight 30%) with a neutral face (weight 70 %) to give a face where the original emotion was difficult to recognize. The original faces were taken from Ekman and Friesen (1976). The questions are presented in Table 1.

TABLE 1 HERE

Each opinion or preference was presented in one of five conditions: (1) no social information, or (2) with nine previous answers shown on the same form, distributed in either of four ways: (a) 0 yes/9 no, (b) 3 yes/6 no, (c) 6 yes/3 no, or (d) 9 yes/0 no. The yes/no were counterbalanced on the forms (for each proportion) and the order of presentation of the forms was counterbalanced (for each participant). For each participant there was random assignment of conditions across questions.

For the three binary choices of the most attractive face there was an option to write ‘yes’ in either the left or right hand column i.e. under either of the two faces. Unlike the other nine questions the coding for these was ‘yes (right column)’ and ‘yes (left column)’ rather than yes/no.

Procedure: Participants were asked to complete 12 opinion/face preference forms. Subterfuge was used in the explanation for why some forms already had nine answers (9 out of the 12 forms presented to each participant). Some participants chose not to answer some questions (so out of 1440 forms in total there were 1402 completed). After completing the forms participants were asked about whether they (1) tended to choose the majority choice (2) tended to choose the minority choice (3) were not influenced by other people’s decisions. Those who chose (1) were categorised as conformists or social learners and those who chose (3) as mavericks (cf. Efferson et al. 2008). There were very few who indicated that they were influenced by the minority (2). Participants were debriefed when the study was completed.

Analysis. For each question we want to call one of the choices ‘A’. We make the arbitrary choice that A stands for ‘yes (left column)’ in questions Q7-9, and that A stands for ‘no’ in all other questions. For every question we compute the percentage of A-choices in each of the five treatments: r_{neutral} is the percentage in the treatment with no social information, while r_0 , $r_{1/3}$, $r_{2/3}$, r_1 are the percentages in the treatments where the social information had the proportion s=0, 1/3, 2/3 resp. 1 of A-votes.

For every question we then estimate the degree of conformist-bias as discussed in the modeling section: $D^* = 9/4 \times (r_0 - 3r_{1/3} + 3r_{2/3} - r_1)$. We also calculate the measure D^* for the entire data set (i.e., pooling the data from all twelve questions). The prediction of Social Impact Theory is that D values are negative, so that D^* measures will tend to be negative.

The statistical analysis proceeds as follows. For every question we compute the quadratic polynomial that best fits the data[5]; this quadratic polynomial will be our null model $f_{\text{null}}(s)$. For each question, we now compute the four relevant probabilities from the null model:

$$p_s = f_{\text{null}}(s) \text{ for } s = 0,\ 1/3,\ 2/3, \text{ and } 1.$$

To check whether we can reject the Conformist hypothesis that D is positive, we then compute the probability that the null model ($D = 0$) would generate data yielding a value of D^* (for the pooled data) that is at least as negative as the measure found in the actual data. We do this by simulation, in each run generating a simulated data point corresponding to each of our actual data points, with the probability of an A-choice given by the null model for that particular question and treatment.[6] We run 1,000,000 simulations and count the proportion of runs that give values of D^* that are at least as extreme as in the actual data.

[5] Best fit was defined in terms of least squares. In line with our model assumptions, we assume that the data in the treatment with no social information can be treated as if they were data for $s = 1/2$. However, almost exactly the same results are obtained if these data are not included in the analysis (in particular, we then obtain p=0.038 instead of 0.040 in Table 3).

[6] We here assume independence of data points generated by the same individual. Assuming some dependence, such that individuals were to have some consistency in answers across questions, would only strengthen our results (in the limiting case of maximal dependence, we obtain p=0.018 instead of 0.040 in Table 3). The reason is that individuals who make independent choices in the null model will create greater variance in the D value, since their contributions to the shape of the simulated acquisition curve will be more varied than the contributions of more consistent individuals.

Results

Table 2 shows the results in terms of the percentage of respondents who made the A-choice given different treatments. For each question the table also presents the measure *D** that estimates the conformist-bias parameter *D* in our model. Recall that our prediction from Social Impact Theory is that *D* be negative values. The estimate *D** varies considerably between questions, ranging from −2.138 to 0.405. However, nine of twelve questions have a negative value of *D*,* and for the pooled data set we have *D** = −0.720.

TABLE 2 HERE

Table 3 shows for each question the null model and the result of the ensuing statistical analysis obtained through the procedure described in the Methods section. The aggregated estimate of *D* (−0.720) is significantly less than zero (p<0.05, one tailed). We therefore reject the null hypothesis and, a fortiori, the Conformist hypothesis.

TABLE 3 HERE

Figure 3 shows the acquisition graphs for the pooled data, and for each of the three categories of questions. Figure 4 shows the difference between the null model and the cubic model.

FIGURE 3 HERE

FIGURE 4 HERE

Self-reported susceptibility to social influence. Following Efferson et al (2008), we classified as ‘conformists’ those participants (N = 23) who reported that they tend to choose the majority choice, and as ‘mavericks’ (N = 80) those who reported that they are not influenced by other people’s decisions. There were no statistically significant differences between ‘conformists’ and ‘mavericks’.

Discussion of results

Our results suggest a general tendency of decreasing marginal impact of the numerosity of sources of social influence, in line with Social Impact Theory and counter to the Conformist Hypothesis. In addition to this general tendency our study also suggests that there is variation between different domains in the degree to which people show (non)conformist-bias. Analysis of this variation may be a fruitful area of future research.

Since our results support the Nonconformist Hypothesis of social influence, we will discuss how our study compares with two other types of studies that seem to make the opposite finding (Martin et al, 2002; Efferson et al 2008).

Martin et al (2002) examined the impact on participants of reading an article titled *‘Majority (82% or 52%) [or Minority (48% or 18%)] of students against voluntary euthanasia’,* and found that the large difference in effect was between 52% and 48%, i.e., the important message was which was the majority opinion. This would seem to support the Conformist Hypothesis. However, it is well known that the brain processes different types of information differently. Specifically, Social Impact Theory assumes that the decreasing marginal impact of additional social stimuli is simply an effect of psychophysical laws of perception, which seem biologically primary; in contrast, understanding of percentage numbers is a biologically secondary skill that is acquired only through teaching (Geary, 1995). Therefore, it is perfectly reasonable that social information presented as percentages has a different type of impact than when each social source is presented separately. In an evolutionary perspective, however, only the latter situation seems to be of importance.

Conformist effects are also sometimes found in economic 'two-armed bandit' game studies (cf. Efferson et al 2008). In these studies, participants repeatedly choose between drawing cards with values (later converted to money) from one of two decks of cards, which have values randomly drawn from distributions with different means. Hence, in the long run it is better to use only the deck with the highest mean, but from just a few draws it is difficult to know which deck is best and therefore it is rational to take into account also what choices other people are making, thereby pooling information from many sources. In other words, conformist-bias is not necessary to explain why participants tend to follow the majority among other people that they can observe in this game; instead this is most parsimoniously explained by rationality.

Conclusions: What about within-group similarity?

Our empirical results support Social Impact Theory and the Nonconformist Hypothesis. Where does that leave the question of within-group similarity? According to one researcher, "without a conformist component to create 'cultural clumps', social learning models predict (incorrectly) that populations should be a smear of ideas, beliefs, values and behaviours, and that group differences should only reflect local environmental differences" (Henrich, 2004, p.23). However, it is not self-evident that groups are culturally homogeneous in general. In fact, the abundance and importance of within-group *diversity* has been stressed both in the classic social psychology literature on minority influence (cf. Nemeth 1986) and by many others, as shown by the following quotes from a feminist scholar, a community psychologist and two cultural psychologists:

> "Furthermore, there is tremendous within-group diversity. One can never assume common sets of meanings within any grouping - not even all middle-class, middle-aged, White, English-descent, heterosexual, feminist, East Coast men share common meanings about gender (or, for that matter, anything else)." (Laird, 1998, p. 27)
>
> "in research with Chilean immigrants it was evident that there was a general sense that all members of the community shared a history and cultural background, but within the community it seemed there were strong differences" (Sonn, p. 216)
>
> "any study of ethnic groups runs the risk of overgeneralization, because labels tend to focus on the similarity between sets of people while neglecting variability that occurs within those sets (e.g., among subgroups)." (Coon & Kemmelmeier, p. 351)

Thus, we can turn the argument around: with a conformist component, social learning models predict, incorrectly, that populations should be culturally homogeneous. In this light, it is not surprising that the evidence from social psychology does not support the Conformist Hypothesis.

In the following, we will make our own speculations about the nature of cultural similarity of diversity within groups. It is undoubtedly true that groups are culturally homogeneous in *some* respects. For instance, consider Swedes. Almost all Swedes speak both Swedish and some English, and when they wave a flag it tends to be the blue-and-yellow flag of Sweden. However, there seem to be different specific mechanisms that explain the homogeneity of these cultural traits. For example, since Swedish is already the common language for communication, newborns will learn it automatically from its surroundings while most immigrants will find it useful to make the effort to learn the local language. In contrast, the main reason that Swedes generally speak some English is that it is taught as a compulsory subject in school during ten years or more. The reason for waving the Swedish flag, on the other hand, seems to be to signal group membership. These examples suggest to us that it would be possible and interesting to investigate what set of properties distinguishes ideas and behaviours that exhibit within-group diversity from those that exhibit within-group similarity (and the various mechanisms behind). However, we have found no psychological or sociological research directed specifically at this question.

In order to obtain a first impression, we have gone through "Swedish Trends 1986-2005" (Holmberg & Weibull, 2006), a report of a yearly questionnaire sent out to many thousands of Swedes. Among other types of items, the questionnaire includes around a hundred questions about habits and opinions for which binary results are reported. If defined as at least 85 % consensus among Swedes[7], within-group similarity was exhibited in only a few of these hundred items: Swedes (a) do not attend religious service, (b) do not snuff tobacco, (c) do not support legalization of the use of cannabis, (d) do not think Sweden should go in more for coal or oil as energy sources, (e) rate health and honesty as very important things but do not rate wealth or salvation or power as very important things. The remaining items in this survey, the overwhelming majority, exhibit lack of consensus among Swedes. A similar analysis of a report on Swedish youth (Nordström, 2001) adds only one nontrivial item to the list: (f) Swedes do not spank their children.

[7] Less than 15 % of the Swedish population is born outside Sweden.

If the "Swedish trends" sample is at all representative, it seems that human creativity and non-conformism typically leads to diverse ideas and habits in populations. The few examples of cultural homogeneity in this sample seem to have different explanations. Only item (d) can readily be explained by the Swedish environment[8]. Non-attendance to religious service is likely caused by competition between activities on people's time, and in Sweden there is no pressure on people to participate in religious activities. The absence of spanking is likely the effect of an enforced social norm (spanking is both illegal and generally condemned in Sweden). It is a challenge to explain why Swedes are almost unanimous in opposing cannabis legalization or rating health as very important and wealth as not, but any temptation to invoke conformist-bias ought to be quelled by the fact that the survey found no unanimity on the importance of twenty other values like love, justice, true friendship, happiness, etc.

In conclusion, cultural variation within a population is much more subtle than the Conformist Hypothesis can account for. As a further illumination of this point, consider items (a) and (b) more carefully. Sweden is extremely secular compared to other countries in the world, so it is reasonable to think of non-religiosity as a Swedish cultural trait. In contrast, it would be bizarre to count non-snuffing as a Swedish cultural trait; to the contrary, snuffing is particularly Swedish! Snuff was banned in the European Union in 1992, but Sweden managed to obtain an exception. The rate of 13 % snuffers in Sweden is likely the highest in the world, illustrating that culture is not necessarily manifested by the behaviour of the majority.

Theorists of cultural group selection need to pass up the free ride offered by the Conformist Hypothesis. The evidence speaks against the existence of such a general mechanism leading to within-group similarity. Instead, cultural group selectionists must argue case-by-case why the particular behaviour they are studying is likely to be one where sufficient within-group similarity will emerge.

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[8] Sweden's lack of natural sources of oil and coal may be responsible for the lack of enthusiasm for these energy sources.

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References

Asch, S. (1951) Effects of group pressure upon the modification and distortion of judgements. In Guetzkow, H (Ed), *Groups, Leadership and Men,* pp 177 – 190 New York Russell and Russell Inc.

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

Clark, R.D., and Maass, A. (1990) The effects of majority size on minority influence. *European Journal of Social Psychology*, 20: 99-117.

Cohen, D. (2001) Cultural variation: Considerations and implications. *Psychological Bulletin*, 127: 451-471.

Coon, H.M., and Kemmelmeier, M. (2001) Cultural Orientations in the United States: (Re)Examining Differences among Ethnic Groups, *Journal of Cross-Cultural Psychology* 32: 348-364.

Coultas, J. C. (2004) When in Rome ... An evolutionary perspective on conformity. *Group Processes and Intergroup Relations* 7: (4) 317 - 331

Efferson, C., Lalive, R., Richerson, P.J., McElreath, R., and Lubell, M. (2008) Conformists and mavericks: the empirics of frequency-dependent cultural transmission, *Evolution and Human Behavior* 29: 56–64.

Eriksson, K., Enquist, M. and Ghirlanda, S. (2007) Critical points in current theory of conformist social learning, *Journal of Evolutionary Psychology*. 5: 67-87

Ekman, P. and Friesen, W. (1976) *Pictures of facial expression.* Consulting Psychologist Press,

Palo Alto, CA

Gintis, H. (2007) A framework for the unification of the behavioral sciences *Behavioral and Brain*

Sciences 30: 1–61

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

Henrich, J. (2004) Cultural Group Selection, Coevolutionary Processes and Large-scale Cooperation. Target article in *Journal of Economic Behavior and Organization,* 53: 3-35 and 127-143.

Holmberg, S. and Weibull, L. (2006), *Swedish Trends 1986-2005*. The SOM-institute, Göteborg University.

Kemmis, L., Hall, J. K., Kingston, B. and Morgan, M. J. (2007) Fear recogntion in regular recreational cocaine users *Psychopharmacology*, 194: 151-159

Laird, J. (1998). Theorizing culture: Narrative ideas and practice principles, In M. McGoldrick, (Ed.), *Re-visioning family therapy,* pp. 20–36. New York: Guilford.

Latané, B. (1981) The psychology of social impact. *American Psychologist* 36: 343 –356.

Latané B., and Wolf, S. (1981) The social impact of majorities and minorities. *Psychological Review*, 88: 438-453.

Mackie, D. M. (1987). Systematic and nonsystematic processing of majority and minority persuasive communications. *Journal of Personality and Social Psychology*, 53: 41-52.

Mann, L. (1977) The effect of stimulus queues on queue joining behaviour. *Journal of personality and social psychology,* 6: 437 - 442

Markovsky, B., and Thye, S.R. (2001). Social influence on paranormal beliefs. Sociological Perspectives, 44: 21-44.

Markovsky, B., and Thye. S.R. (2002). Social influence and the power of the pyramid. *Skeptic* 9: 36-41.

Martin, R., Gardikiotis, A., and Hewstone, M. (2002). Levels of consensus and majority and minority influence. *European Journal of Social Psychology,* 32: 645-665.

Mesoudi, A. (2007) Using the methods of experimental social psychology to study cultural evolution. *Journal of Social, Evolutionary, and Cultural Psychology,* 1: 35-58.

Nemeth, C.J. (1986) Differential contributions of majority and minority influence. *Psychological Review*, 93: 23-32.

Nordström, Å., ed. (2001). *Up to the Age of 18*. Barnombudsmannen, Stockholm. Available from http://www.bo.se.

Norenzayan A., and Heine, S.J. (2005) Psychological Universals: What Are They and How Can We Know? *Psychological Bulletin* 131: 763–784.

Richerson, P. J. and Boyd, R. (2005) *Not by Genes Alone: How Culture Transformed Human Evolution.* London: The University of Chicago Press

Sonn, C.C. (2002) Immigrant adaptation: Understanding the process through sense of community. In A.T. Fisher, C.C. Sonn, & B.J. Bishop (Eds.), *Psychological sense of community: Research, applications, and implications,* pp. 205–222. New York: Kluwer Academic Plenum Publishers.

Tanford, S., and Penrod, S. (1984) Social influence model: A formal integration of research on majority and minority influence processes. *Psychological Bulletin*, 95: 189-225.

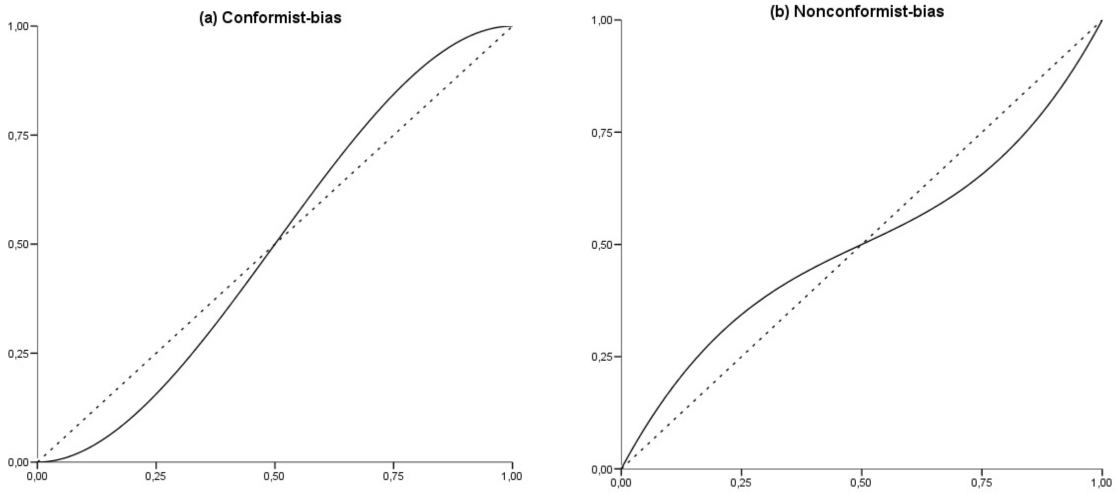

Figure 1. The acquisition probability of a cultural variant as a function of the frequency of the variant in the population: Frequency-independent learning yields a linear acquisition graph (dotted lines). Conformist-bias yields an S-shaped graph (a). Nonconformist-bias yields an inverted S-shape (b).

Q1	Married people should always wear rings.
Q2	Eating garlic protects you from catching a cold.
Q3	DIY instructions should have images rather than text.
Q4	Pigeons spread disease.
Q5	Volvic bottled water is better than Evian bottled water.
Q6	Thornton's chocolates are better than Green and Black's.
Q7	Which face do you find most attractive? [Male faces]
Q8	Which face do you find most attractive? [Female faces]
Q9	Which face do you find most attractive? [Female faces]
Q10	Does this face show any sign of disgust?
Q11	Does this face show any sign of anger?
Q12	Does this face show any sign of fear?

Table 1. The twelve questions.

	r_{neutral}	N	r_0	N	$r_{1/3}$	N	$r_{2/3}$	N	r_1	N	TOTAL	N	D^*
Q1	*48%*	27	*19%*	21	*35%*	23	*42%*	26	*52%*	23	*40%*	120	-0.270
Q2	*65%*	23	*26%*	27	*60%*	25	*50%*	22	*91%*	22	*57%*	119	-2.138
Q3	*18%*	22	*22%*	23	*24%*	21	*27%*	26	*44%*	25	*27%*	117	-0.293
Q4	*21%*	24	*12%*	26	*21%*	24	*39%*	23	*48%*	21	*27%*	118	0.405
Q5	*68%*	19	*72%*	25	*88%*	24	*95%*	22	*92%*	26	*84%*	116	0.022
Q6	*48%*	23	*47%*	19	*42%*	24	*50%*	24	*78%*	23	*53%*	113	-0.158
Q7	*53%*	45	*29%*	17	*50%*	20	*47%*	17	*74%*	19	*52%*	118	-1.215
Q8	*35%*	23	*12%*	25	*35%*	23	*26%*	27	*53%*	19	*31%*	117	-1.530
Q9	*79%*	24	*65%*	23	*74%*	35	*83%*	18	*74%*	19	*75%*	119	0.405
Q10	*32%*	19	*27%*	22	*48%*	23	*32%*	25	*52%*	27	*39%*	116	-1.643
Q11	*31%*	26	*65%*	20	*39%*	23	*45%*	22	*87%*	23	*53%*	114	-0.090
Q12	*55%*	31	*41%*	27	*48%*	23	*54%*	13	*71%*	21	*53%*	115	-0.270
TOTAL	*47%*	306	*36%*	275	*48%*	288	*48%*	265	*68%*	268	*49%*	1402	-0.720

Table 2. Percentage of A-choice by question and treatment. r_{neutral} is the percentage in the treatment with no social information. r_0 is the percentage in the treatment where the social information had the proportion s=0 of A-votes, etc. D^* is the estimate of D given by the expression $9/4 \times (r_0 - 3r_{1/3} + 3r_{2/3} - r_1)$.

	p_0	p_1	$p_{neutral}$	D^*	p
Q1	0.193	0.512	0.427	-0.270	0.392
Q2	0.297	0.855	0.593	-2.138	0.016
Q3	0.226	0.437	0.219	-0.293	0.368
Q4	0.110	0.490	0.263	0.405	0.671
Q5	0.727	0.931	0.842	0.022	0.511
Q6	0.475	0.778	0.453	-0.158	0.437
Q7	0.319	0.709	0.516	-1.215	0.147
Q8	0.151	0.480	0.313	-1.530	0.051
Q9	0.643	0.748	0.790	0.405	0.675
Q10	0.314	0.489	0.368	-1.643	0.049
Q11	0.655	0.871	0.350	-0.090	0.464
Q12	0.409	0.709	0.529	-0.270	0.409
ALL DATA				-0.720	0.040

Table 3. For each question, the table shows the parameter values p_0, p_1 and p_{neutral} for the best fitting quadratic polynomial, to be used as null model; the value of D^* from Table 1; and the probability that the null model generates data with a value of D^* that is at least this small. The last row shows the D^* for the pooled data from Table 1, and the probability that the dataset generated by pooling data from the twelve models above gives a value of D^* less than or equal to -0.720.

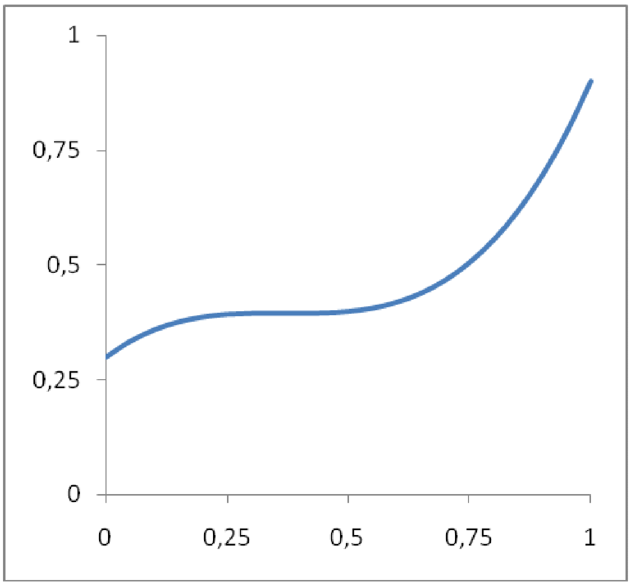

Figure 2. The acquisition graph of our model for nonconformist bias $D = -1$ and with parameters $p_0 = 0.3$, $p_{neutral} = 0.4$, and $p_1 = 0.9$. Compare with Figure 1b, which shows the inverted S-shape obtained with the same value of D but with $p_0 = 0$, $p_{neutral} = 0.5$, and $p_1 = 1$.

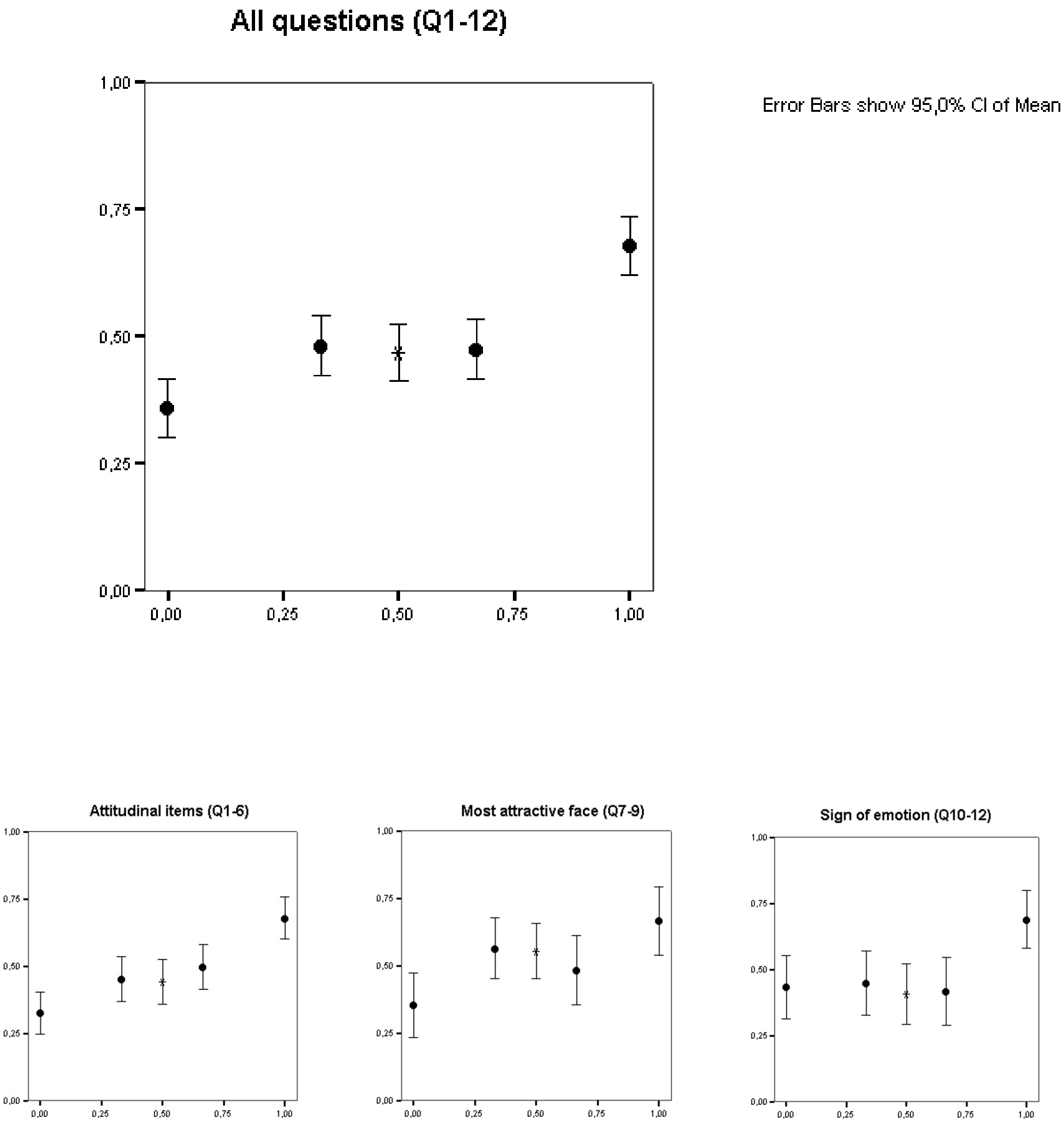

Figure 3. Empirical acquisition graphs depicting the proportion of A-choices as a function of the frequency of A-votes in the social information. The star (*) is the case of no social information, here presented as if it represented a frequency of 50% A-votes. The top graph shows the results aggregated over all questions. The bottom graphs show the same results separated on the three categories of questions.

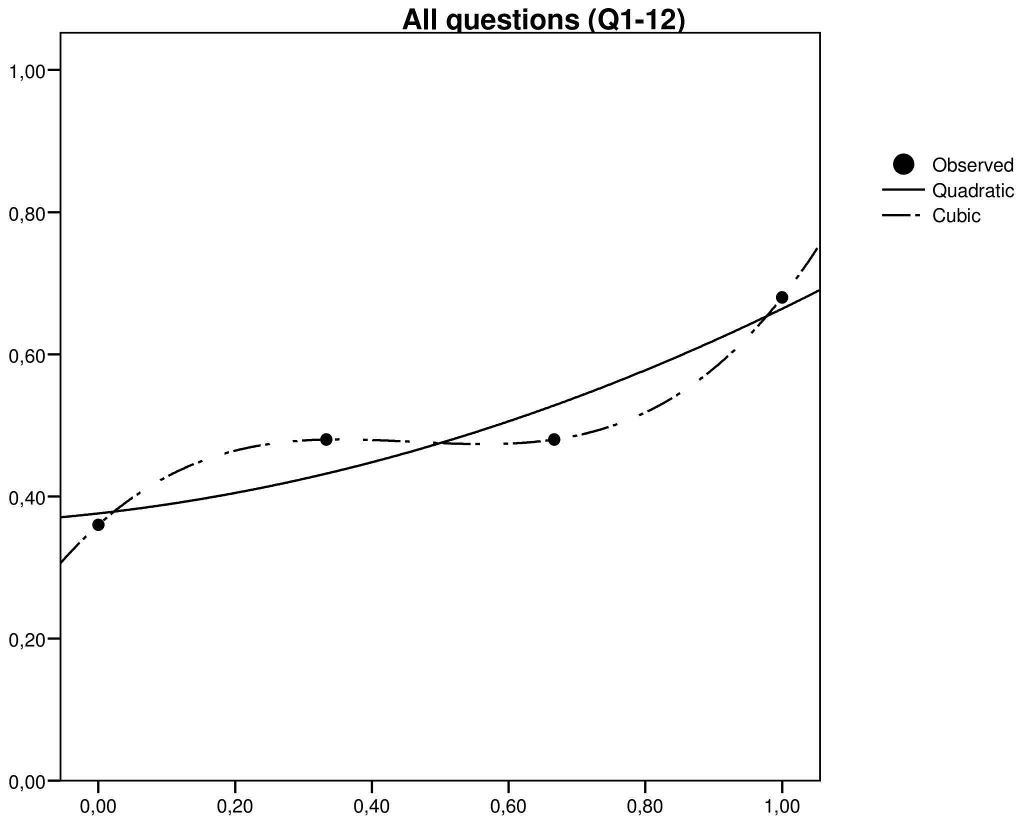

Figure 4. Illustration of the difference between the quadratic (null) and cubic models that best fit the pooled data.