



A bias for social information in human cultural transmission

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Evolutionary theories concerning the origins of human intelligence suggest that cultural transmission might be biased toward social over non-social information. This was tested by passing social and non-social information along multiple chains of participants. Experiment 1 found that gossip, defined as information about intense third-party social relationships, was transmitted with significantly greater accuracy and in significantly greater quantity than equivalent non-social information concerning individual behaviour or the physical environment. Experiment 2 replicated this finding controlling for narrative coherence, and additionally found that information concerning everyday non-gossip social interactions was transmitted just as well as the intense gossip interactions. It was therefore concluded that human cultural transmission is biased toward information concerning social interactions over equivalent non-social information.

In seeking to investigate the social nature of memory, Bartlett (1932) formulated the 'transmission chain method', in which material, typically a text, is passed through a chain of participants, in a manner similar to the children's game 'Chinese whispers' or 'broken telephone'. The first participant reads the material, and is later asked to recall it. The resultant recall is then given to the second participant to reproduce, whose recall is in turn given to the third, and so on along the chain. Using this method, Bartlett demonstrated that traditional folk tales were transmitted more fully than a range of other stimuli, such as a newspaper report, a description of a scene and a scientific text. In the following two decades, a series of transmission chain studies were published in the *British Journal of Psychology* investigating various hypotheses and participant groups (Hall, 1951; Klugman, 1944; Maxwell, 1936; Northway, 1936; Ward, 1949).

Following this initial period of research activity, the transmission chain method fell from favour within psychology, perhaps due to the rise of behaviourism, and then of cognitive psychology, both of which have tended to ignore social processes. However, a handful of recent studies have sought to reintroduce the transmission chain method,

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updating it according to modern standards of experimental psychology by reporting standardized instructions, using multiple parallel chains and introducing the statistical analysis of quantifiable data.

For example, Bangerter (2000) found that a description of conception from a biology textbook was gradually distorted according to the participants' gender stereotypes, with the sperm cell given an active role and the ovum a passive role in the reproduced descriptions. Kashima (2000a) found that when a description of male and female behaviour was transmitted, stereotype-inconsistent behaviour was reproduced more than stereotype-consistent behaviour by the first few generations, while later generations reversed this trend and recalled more stereotype-consistent behaviour. Finally, Mesoudi and Whiten (2004) found that descriptions of everyday routine events, such as getting up or going shopping, were gradually transformed from low-level details into high-level global propositions, consistent with hierarchical script models of event knowledge representation.

These recent studies demonstrate that the transmission chain method can be uniquely effective in revealing cumulative and systematic biases in recall that affect cultural transmission. The present study used this method to investigate the cultural transmission of information regarding third party social relationships, including what is commonly called *gossip*. As acknowledged by Emler (2001), there has been very little social psychological theory developed in this area, and even less systematic hypothesis testing. In contrast, we have approached the topic from an evolutionary and comparative perspective, in which there is a large body of work devoted to the social function of human intelligence. We believe that such an approach can add theoretical rigour to a traditionally underdeveloped and under-researched topic.

The Machiavellian intelligencesocial brain hypothesis

The *Machiavellian intelligence* (Byrne & Whiten, 1988; Whiten, 1999b; Whiten & Byrne, 1997) or *social brain* (Dunbar, 1998, 2003) hypothesis asserts that primate intelligence evolved primarily to deal with complex social problems, rather than non-social ecological or technological problems such as locating food, extractive foraging or using tools. Support for the hypothesis comes from correlational analyses of a number of primate species showing a link between a proxy of intelligence, the ratio of neocortex to the rest of the brain and various measures of social complexity, such as group size (Barton & Dunbar, 1997), frequency of tactical deception (Byrne & Corp, 2004) and frequency of social play (Lewis, 2001). Measures of non-social complexity, such as range size or foraging style, show no such correlation with neocortex ratio (Dunbar, 1995).

Although such analyses encompass the entire primate order, the Machiavellian intelligence hypothesis should not be taken as excluding the evolution of human intelligence, and the studies cited above include data from several ancestral hominid species (as well as modern humans). Indeed, Whiten (1999a) outlines how social factors may have shaped cognition during human evolution to produce what he terms a *deep social mind*, exhibiting faculties such as mind-reading and coordinated cooperation. Dunbar's (1993, 1996) *social gossip theory* argues that language evolved in humans in response to social selection pressures, in order to track complex social relationships and ensure their coherence in the unusually large social groups characteristic of modern humans.

The Machiavellian intelligence hypothesis can also be taken to imply that, as a result of selection pressures in the past favouring social cognitive complexity, the cognition of modern-day humans should exhibit certain specializations to deal with social problems (Whiten, 2000). If modern-day human cognition is indeed moulded to deal with social problems, then people should preferentially attend to, recall and transmit social information over equivalent non-social information. Observational evidence consistent with this claim was provided by Dunbar, Duncan, and Marriott (1997), who found that freely forming conversational groups spent approximately two-thirds of their time discussing social topics (personal relationships, personal experiences or social activities) – more than work, leisure, politics and the arts combined.

To date, there has been no equivalent *experimental* test of the Machiavellian intelligence hypothesis with regard to cultural transmission. However, an earlier memory study by Owens, Bower, and Black (1979), while not intended to be such a test, can be considered relevant. Participants in Owens *et al.*'s (1979) study read and recalled descriptions of a female student involved in five everyday events: making a cup of coffee, going to the doctor's, buying some milk, attending a lecture and going to a party. The experimental group, but not the control group, was also told of a motive for the character (that she is pregnant by her professor) that could be used to make sense of and connect the five episodes, in effect turning the neutral events into gossip. The result was that the experimental group recalled significantly more episodes than the control group.

The present study

The aim of the present study was to extend Owens *et al.*'s (1979) findings in two ways, in order to provide an explicit test of the Machiavellian intelligence hypothesis with regard to human cultural transmission. First, rather than having single participants reading and recalling experimental material (i.e. social and non-social material), here we used Bartlett's (1932) transmission chain method to pass the material along chains of participants, in order to investigate the longer-term persistence of any 'social bias' in cultural transmission. If an effect can be demonstrated to have a degree of stability or persistence along chains of multiple participants, we can more confidently extrapolate from this necessarily simplified experimental setting to a larger group or population level and draw wider conclusions regarding human culture as a whole.

Second, we explicitly draw on the Machiavellian intelligence hypothesis in order to provide precise definitions of *social* and *non-social* information, as shown in Table 1. The Machiavellian intelligence hypothesis holds that it is not merely being 'social' in the sense of 'living in groups' that has been a key factor in the evolution of primate intelligence, but rather the degree of social *complexity*, characterized by frequently changing coalitions and alliances (Whiten, 1999b). Hence, we define *social* information as information concerning interactions and relationships between a number of third parties. This social category is subdivided according to the quality of those interactions or relationships: *gossip* involves particularly intense and salient social interactions and relationships, such as the illicit affair and the pregnancy of Owens *et al.*'s (1979) material, while *social non-gossip* involves more everyday interactions and relationships. This *social* category is contrasted with *non-social* information, which we divide into information concerning a single individual's interactions with the physical environment (*individual*) and information solely concerning that physical environment (*physical*).

Table 1. Definitions of each category of information tested in this study, with the theory that predicts the information to be favoured during transmission

Information	Definition	Predicted by
Social	Gossip	Machiavellian intelligence hypothesis/ exploitative theories of language evolution
	Social non-gossip	Machiavellian intelligence hypothesis
Non-social	Individual	Ecological hypotheses
	Physical	Ecological hypotheses

Hypotheses

The Machiavellian intelligence hypothesis would predict that social information (both gossip and social non-gossip) would be transmitted in greater quantity and with greater accuracy than the non-social information (both individual and physical). Ecological hypotheses of the evolution of primate intelligence (e.g. Clutton-Brock & Harvey, 1980) might predict in contrast that the individual information (how to do things) and the physical information (about the non-social environment) would be transmitted at least as well as the social information. A stronger version of the Machiavellian intelligence hypothesis might additionally predict that social interactions, which are more intensely 'Machiavellian' and gossip-like, featuring exploitative behaviour such as deception or infidelity, would elicit a stronger appeal than commonplace everyday social interactions. This stronger form would thus additionally predict that the gossip information would be transmitted in greater quantity and with greater accuracy than the social non-gossip information.

This additional difference between the gossip and the social non-gossip information might also be predicted by theories which argue that the function of gossiping is to transmit information about other people's antisocial behaviour, in order to learn about their reputation and protect against exploitation. Enquist and Leimar (1993) argued that gossiping is a behavioural adaptation to protect against potential free-riders by spreading information about their past behaviour, preventing the free-riders from moving from population to population in order to find and exploit naïve individuals. Meanwhile, Wilson, Wilczynski, Wells, and Weiser (2000) argued that gossiping acts as a means of preventing behaviour that acts to promote individual gain at the expense of the group. This argument was backed up by a series of experiments in which participants rated speakers of self-serving gossip more negatively than speakers of group-serving gossip. If these theories are correct, information about exploitative or antisocial behaviour such as deception and infidelity (the gossip material) should be favoured over simple everyday social interactions (the social non-gossip material).

Note that these predictions are only intended to apply to information that is equivalent in dimensions other than the social/non-social comparison. The word *equivalent* here is intended to exclude non-social information that is particularly salient or significant to people for other specific reasons: we do not claim that *all* social information is *always* transmitted better than *all* non-social information, but rather that when the only difference between two pieces of information is the social component, then the social will be preferred over the non-social.

EXPERIMENT 1

In line with the theoretical predictions outlined above and in Table 1, in Experiment 1, three paragraphs matched for number of words, sentences and propositions were constructed, each constituting a different class of information. The gossip information featured an illicit affair and pregnancy (following Owens *et al.*, 1979), the individual information comprised simple facts about a single character such as their age and occupation and physical information described the geography, history and commerce of a city. (Note that the social category is represented here solely by the gossip material; a distinction between gossip and social non-gossip information is made in Experiment 2). These paragraphs were then transmitted along multiple chains of participants using the methodology developed by Bartlett (1932).

Materials and methods

Design

A within-chain transmission chain design was adopted, in which the first participant in each of 10 replicate chains was given material containing information representing all three categories (gossip, individual and physical). Each of the 10 chains comprised four participants, or 'generations'. This within-chain design was intended to reduce random between-chain variation, and afford better detection of any differences between the material types.

The independent variable was the transmission generation, of which there were four (F1-F4). The dependent variables were the total number of propositions recalled (recall quantity), and the number of propositions that were present in the original material (recall accuracy), as detailed in the Coding section below. It was predicted that gossip would be transmitted in greater quantity and with greater accuracy than both the individual and the physical material.

Note that each chain of four participants was here treated as an independent unit of analysis, rather than each participant. This is because the focus of interest is the material and how that material changes as it passes through the chain, rather than any single participant's memory performance. Furthermore, the recall of second, third and fourth generation participants is constrained by each previous generation's recall, with anything omitted in one generation unavailable to subsequent generations to recall. Hence, the recalls of each participant within a single chain are not statistically independent of one another, and in the ANOVAs reported below, each chain is treated as an independent unit of analysis, rather than each participant (e.g. 'between-groups' implies 'between-chains' rather than 'between-subjects').

It was judged that four participants constituted an optimum chain length – in other words, that this number was long enough to capture the long-term cumulative effects of cultural transmission, yet short enough to be practical in terms of recruiting participants and performing replications. Previous transmission chain studies (Bangerter, 2000; Mesoudi & Whiten, 2004) have successfully demonstrated transmission effects using four participants per chain.

Material

The original material given to the first participant in each chain was composed of three paragraphs, each paragraph representing one of the three types of information: gossip, individual and physical (although these labels were not given to the participants). These paragraphs are reproduced in Appendix A. Each of the paragraphs was matched for number of words, sentences and propositions.

The original material contained the three paragraphs in a fixed order: individual, then gossip, then physical. The order was not counterbalanced, as it was felt that the material as a whole would make less sense to the participant if, for example, the physical material came first. Pilot studies suggested that order of presentation has no effect on recall, and in any case, any primacy or recency effect would favour either the individual or the physical material, *against* the main experimental hypothesis.

Participants

There were 40 participants of mean age 20.98 years ($SD = 3.30$) who performed the experiment. Seven of the chains were composed of female participants ($N = 28$) and three of the chains were composed of male participants ($N = 12$) to check for possible

gender differences, although based on the results of Owens *et al.* (1979) and Dunbar *et al.* (1997), none were predicted. All participants were students, participated voluntarily, were unpaid and had normal reading and writing ability.

Procedure

The procedure adopted here involved the experimenter physically passing the material from individual to individual (as in Bartlett, 1932), rather than the participants directly transmitting the material. This allowed for greater control over transmission, and removed the need to gather groups of participants together. Participants were thus run in groups of between one and five.

A booklet was produced that contained on the first page the instruction, 'please read the following text through once. When you have finished turn the page', followed by the material. The second page contained the instruction, 'now, without turning back, please write out as best you can the text you just read. Be as accurate as possible, but don't worry if you can't remember it all. When you have finished turn the page', followed by a blank space for recall. A final sheet solicited the age and gender of the participant, and thanked them for participating, whereupon the experimenter debriefed them as to the nature of the study. The recall was then typed up and inserted into the next participant's booklet as appropriate.

No distractor task was performed, and no time limit was set. At no point in the procedure did either the printed instructions or the experimenter state that the experiment was a memory test, that the material had come from another participant, or that their recall would be passed on to another participant.

Coding

A propositional analysis (Kintsch, 1974) was performed on each participant's recall. The text was divided into separate propositions, a proposition defined as a predicate plus a series of ordered arguments. A predicate is a verb, adjective or other relational term, while an argument is the complementary noun(s). For example, the sentence

'Nancy enjoys swimming'

would be represented in terms of propositions as

(ENJOY, NANCY, SWIMMING)

where the verb 'to enjoy' is the predicate and takes two arguments, the subject (Nancy) and the object of her enjoyment (swimming). Because the precise wording of the proposition as written in Standard English is unimportant for the propositional representation, the proposition above could equally represent other equivalent sentences such as 'Nancy enjoys going swimming' or 'Nancy gets enjoyment from swimming'. Propositional analysis was developed to represent meaning in texts, and the number of propositions contained in a text has been shown by Kintsch (1974) to determine reading times and subsequent comprehension. As such, it might be considered a more meaningful measure of recall than the number of words or sentences.

This propositional analysis was used to calculate the total number of propositions recalled, a measure of *recall quantity*. The second recall measure, that of *recall accuracy*, was obtained by comparing the propositions recalled by each participant with the propositions contained in the original material. This yielded the number of correctly recalled propositions. Note that recall in each generation was always compared with the

original (F0) material, not the previous generation's recall, as it is the gross cumulative changes that are important rather than any single individual's memory achievement.

To assess inter-rater reliability, an independent coder, blind to the hypothesis and to the material type, coded two of the chains from Experiment 1 and three of the chains from Experiment 2 (the same propositional analysis was used in both experiments). The coding of the blind second coder and the first author was highly consistent, with a Pearson's correlation coefficient of .97.

Results

Recall quantity

A mixed $2 \times 3 \times 4$ ANOVA with gender as a between-groups factor and material and generation as within-groups factors showed an overall effect of material, $F(2, 16) = 63.71, p < .01$, and of generation, $F(3, 24) = 26.49, p < .01$, but no effect of gender, $F(1, 8) = 2.37, ns$. Planned comparisons were made between each pair of material types, using 2×4 within-groups ANOVAs at a Bonferroni corrected significance level of $\alpha^* = \alpha/N$ where N = number of comparisons (hence $\alpha^* = .05/3 = .017$). Significant differences were found between gossip and individual, $F(1, 9) = 131.44, p < .01$, and between gossip and physical material, $F(1, 9) = 112.46, p < .01$, although there was no significant difference between individual and physical, $F(1, 9) = 3.80, ns$. The prediction that a larger quantity of the gossip material is transmitted than the other material is therefore supported, and can be observed in Fig. 1, with a larger quantity of the gossip material transmitted in every generation than of the individual and physical material.

Recall accuracy

Figure 2 suggests a similar pattern for the measure of recall accuracy to that shown in Fig. 1 for recall quantity. A mixed $2 \times 3 \times 4$ ANOVA with gender as a between-groups factor and material and generation as within-groups factors showed an overall effect of

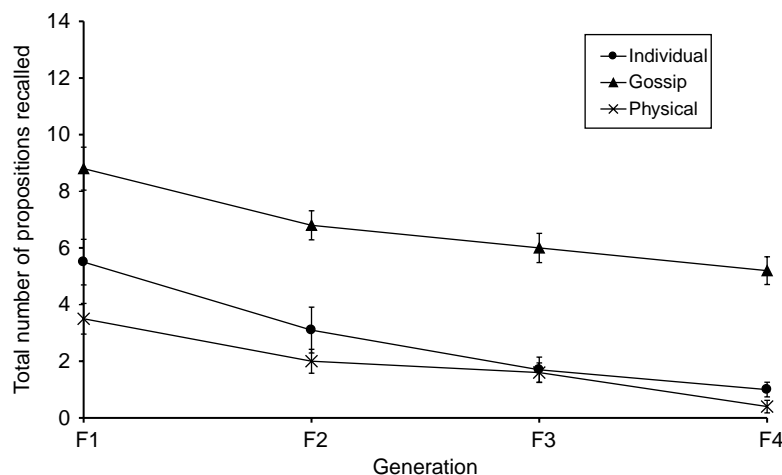


Figure 1. The total number of propositions recalled by each generation of Experiment 1 (irrespective of accuracy). Error bars show standard errors.

material, $F(2, 16) = 73.55$, $p < .01$, and of generation, $F(3, 24) = 26.91$, $p < .01$, but no effect of gender, $F(1, 8) = 2.90$, *ns*. Planned comparisons showed significant differences between gossip and individual material, $F(1, 9) = 151.22$, $p < .01$, and between gossip and physical material, $F(1, 9) = 117.36$, $p < .01$, and no significant difference between individual and physical material, $F(1, 9) = 8.05$, *ns*. The prediction that gossip is transmitted with greater accuracy than the other material is therefore supported.

There was a significant material \times generation interaction, $F(6, 48) = 2.81$, $p < .05$, probably due to the individual and physical materials exhibiting an initial difference in recall but then converging on a minimum baseline value (Fig. 2). This was indicated by simple effects showing a significant difference between individual and physical material at generation F1, $F(1, 9) = 7.31$, $p < .05$, but not at generations F2, $F(1, 9) = 5.06$, *ns*, F3, $F(1, 9) = 1.55$, *ns*, or F4, $F(1, 9) = 3.12$, *ns*.

The gossip versus physical planned comparison additionally showed a significant material \times generation interaction, $F(3, 27) = 4.38$, $p < .017$. This is most likely because the gossip material showed the steepest decline and the physical material the shallowest, causing the magnitude of the difference between these two material types to change with generation (although simple effects of gossip versus physical were significant at every generation). Partial correlation coefficients showed no effect of age on overall recall ($r_p = .09$, $N = 40$, *ns*), controlling for generation, and none of the tests above violated the assumption of sphericity.

Discussion

The results of Experiment 1 support the hypothesis that the gossip material would be transmitted in greater quantity and with greater accuracy than the non-social material (either individual or physical). However, a concern is that as well as differing in informational content, the three paragraphs could also be seen as differing in coherence. That is, the gossip material may form a coherent narrative, with the

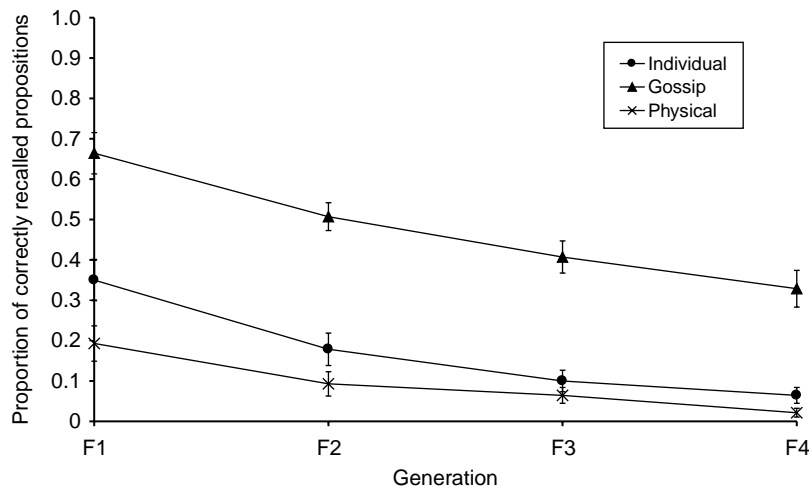


Figure 2. The proportion of propositions that were correctly recalled by each generation of Experiment 1. Error bars show standard errors.

character's affair and pregnancy integrating the entire paragraph. The other two paragraphs perhaps showed a less coherent narrative, lacking an integrating theme and reading more like a list of unconnected facts. The reason that the gossip was transmitted with greater accuracy than the other two types of material could therefore have been due to its coherence, rather than the fact that it had gossip-like content. This issue was addressed in Experiment 2.

EXPERIMENT 2

In Experiment 2, we aimed to equate conditions with respect to the integrating theme or coherent narrative. What, however, should count as an 'integrating theme' or 'coherent narrative?' Mandler and Johnson (1977), Thorndyke (1977) and Rumelhart (1977) developed the idea, originally put forward by Bartlett (1932), that stories are particularly easy to remember because they form coherent narratives that can be represented by a hierarchical schema structure. It is unlikely, however, that a paragraph of approximately 60 words would have such a complex hierarchical structure, beyond a simple linear chain of events linked causally and temporally. For example, the pregnancy causes the professor to refuse to see Nancy, which then causes Nancy to threaten to tell his wife about the affair. In contrast, a chain that is linked temporally but not causally would simply be a list of unconnected events and lack coherence, while a chain that is linked causally but not temporally would not form a narrative. Each type of material used in Experiment 2 was therefore designed to constitute a comparable linear chain of events linked causally and temporally, so that superior recall of the gossip material can be more definitely attributed to its gossip-like content rather than its greater structural coherence, as was possible in Experiment 1.

In Experiment 2, we also featured the fourth type of material from Table 1, distinguished as social non-gossip information (henceforth simply *social*). This material contained the same number of social interactions and social agents as the gossip but with interactions that would not be considered as intense or salient. So we now test firstly the prediction of the broad Machiavellian intelligence hypothesis that both the social and gossip material would be transmitted in greater quantity and with greater accuracy than the non-social individual and physical material, and secondly the additional prediction of the strong Machiavellian intelligence hypothesis that the gossip material would be transmitted better than the social material.

Materials and Methods

The design of Experiment 2 was largely identical to that of Experiment 1, with 10 chains each comprising four participants again transmitting all types of material. There were three minor differences: first, there were four types of material (gossip, social, individual and physical) rather than three; second, the order in which this material was presented was now counterbalanced; and third, five of the chains were female, and five were male. None of the participants tested here took part in, or had any knowledge of, Experiment 1. All 40 participants were students, participated voluntarily, were unpaid and had normal reading and writing ability. Their mean age was 21.40 years ($SD = 3.83$).

The original material given to the first participant in each chain is reproduced in Appendix B. The *gossip* information again featured an affair and pregnancy as its theme, although the information that Nancy is lying to her friends did not fit into the single

linear chain, so was replaced with extra information at the end concerning the professor's wife leaving the professor. The *social* (non-gossip) information comprised a causal and temporal chain consisting of a series of social interactions and containing the same number of agents as the gossip, but without gossip-like content such as deception, infidelity and pregnancy. *Individual* information featured a chain consisting of interactions between a single character and the inanimate world. Finally, *physical* information contained no intentional agents in the chain, consisting entirely of interactions within a physical system.

To test whether each of the four types of material were comparable on dimensions other than the desired experimental manipulation of social content, 10 additional participants not involved in the experiment proper were given the four paragraphs (gossip, social, individual and physical) and asked to rate each of them on a 7-point scale for *coherence*, *familiarity* and *realism*. No significant differences were found between the paragraphs on any of these dimensions, suggesting that any differences found in Experiment 2 are unlikely to be due to differences in coherence, familiarity or realism, which had been a concern in Experiment 1.

Results and Discussion

Recall quantity

A mixed $2 \times 4 \times 4$ ANOVA with gender as a between-groups factor and material and generation as within-groups factors showed an overall effect of material, $F(3, 24) = 15.29$, $p < .01$, and of generation, $F(2, 15) = 36.76$, $p < .01$ (Greenhouse-Geisser corrected), but no effect of gender, $F(1, 8) = 0.11$, *ns*. Planned comparisons were again made between the pairs of material types predicted to differ, using 2×4 within-groups ANOVAs at a Bonferroni corrected significance level of $\alpha^* = \alpha/N$ where N = number of comparisons (there are now five comparisons, hence $\alpha^* = .05/5 = .01$). There were significant differences between gossip and individual, $F(1, 9) = 25.72$, $p < .01$, and gossip and physical, $F(1, 9) = 28.23$, $p < .01$, demonstrating that a larger quantity of gossip material was transmitted than of either the individual or the physical material, as was predicted. Also as predicted, a significantly larger quantity of the social material was transmitted than of the non-social materials, as shown by significant differences between social and individual, $F(1, 9) = 15.43$, $p < .01$, and social and physical, $F(1, 9) = 21.49$, $p < .01$. There was, however, no significant difference between gossip and social, $F(1, 9) = 0.16$, *ns*. These effects are illustrated in Fig. 3.

Recall accuracy

Figure 4 suggests that the gossip and the social material were likewise transmitted with greater accuracy than the individual and physical material. Compared with the measure of quantity shown in Fig. 3, however, there is a larger difference between gossip and social, with the latter transmitted with slightly poorer accuracy than the former, especially at generations F2 and F4. A mixed $2 \times 4 \times 4$ ANOVA with gender as a between-groups factor and material and generation as within-groups factors showed an overall effect of material, $F(3, 24) = 12.99$, $p < .01$, and of generation, $F(2, 15) = 38.78$, $p < .01$ (Greenhouse-Geisser corrected), but no effect of gender, $F(1, 8) = 0.08$, *ns*.

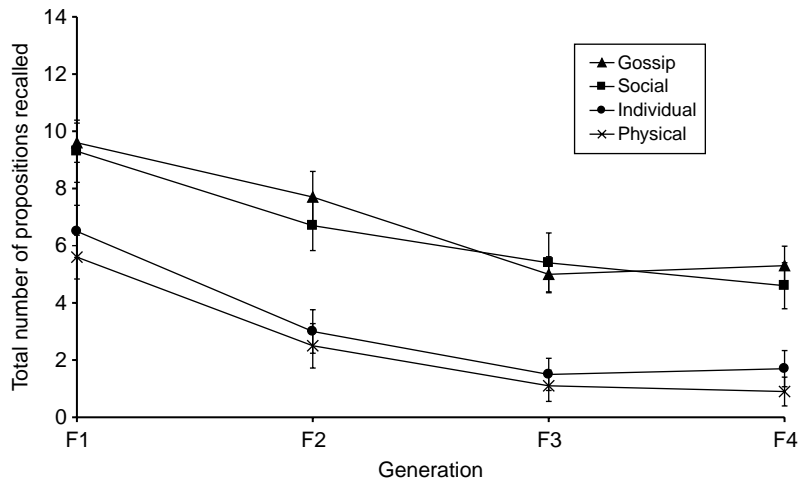


Figure 3. The total number of propositions recalled by each generation of Experiment 2 (irrespective of accuracy). Error bars show standard error.

Planned comparisons showed significant differences between gossip and individual, $F(1, 9) = 43.34, p < .01$, and gossip and physical, $F(1, 9) = 18.89, p < .01$. The gossip material was therefore transmitted with greater accuracy than the two non-social types of material, as was predicted. The comparisons between social and individual, $F(1, 9) = 10.19, p = .011$, and social and physical, $F(1, 9) = 10.30, p = .011$, were both extremely close to significance at the Bonferroni corrected significance level of .01, and so will be treated as such. This confirms the second part of the hypothesis that the social material would also be transmitted with greater accuracy than the two non-social material types (individual and physical).

The additional prediction that the gossip would be transmitted with greater accuracy than the social was not supported. There was no significant difference between the

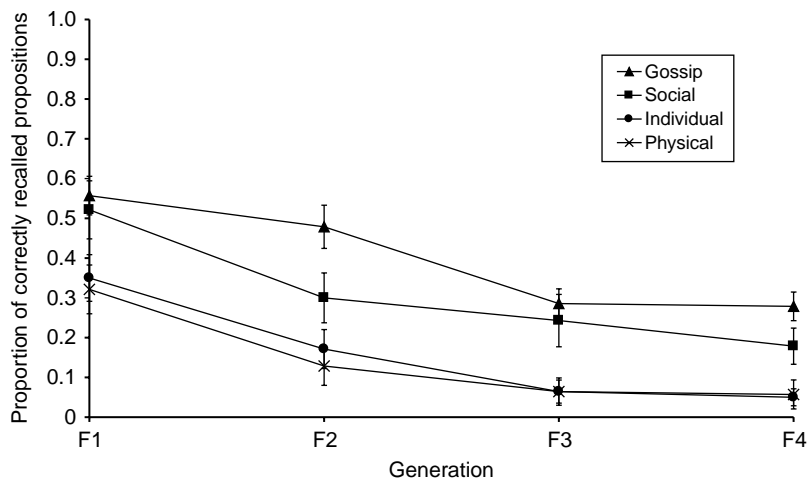


Figure 4. The proportion of propositions that were correctly recalled by each generation of Experiment 2. Error bars show standard errors.

gossip material and the social material, $F(1, 9) = 2.40$, *ns*. However, as can be seen in Fig. 4, there is a trend towards the gossip being transmitted with greater accuracy than the social material, and at generation F2 this difference is indeed significant, $F(1, 9) = 7.98$, $p < .05$. This difference is not strong, however, and there is no theoretical reason why generation F2 would be any more likely to show a difference than the other generations. Thus, while we note a trend for the gossip to be transmitted with greater accuracy than the social, with the results certainly not as clear cut as for the measure of recall quantity, the hypothesis that the gossip material is transmitted with greater accuracy than the social material cannot be accepted.

Partial correlation coefficients showed no effect of age on overall recall ($r_p = .08$, $N = 40$, *ns*), controlling for generation. None of the statistical tests described above featured any interactions, and none violated the assumption of sphericity (except where the Greenhouse-Geisser corrected significance level is given).

Conclusions

The aim of the present study was to investigate whether there is a bias for social information in human cultural transmission, as predicted by evolutionary theories that posit a social origin for human intelligence. Experiment 1 found evidence that gossip-like social information is transmitted with significantly greater accuracy and in greater quantity than non-social information. Experiment 2 replicated this finding using material equivalent in narrative coherence, demonstrating that coherence was not responsible for the superior recall of the gossip. Experiment 2 also found that information concerning social interactions that would not be described as gossip was transmitted with an accuracy and in a quantity not significantly different from the gossip itself. That is, the gossip-like content of infidelity, deception and pregnancy was relatively unimportant; what mattered for superior transmission was that there were a number of third party social agents interacting with one another.

These results are therefore consistent with the Machiavellian intelligence (Byrne & Whiten, 1988; Whiten, 1999b; Whiten & Byrne, 1997) or the social brain (Dunbar, 1998, 2003) hypothesis that primate intelligence evolved primarily to deal with social, rather than ecological, information. Here, this is reflected in a social bias in cultural transmission. The results are also consistent with Dunbar's (1993, 1996) social gossip theory of language evolution that language evolved to exchange social information. A stronger form of the Machiavellian intelligence hypothesis, and theories that argue for a more negative, exploitative function of language (Enquist & Leimar, 1993; Wilson *et al.*, 2000), were not supported, in that information commonly considered gossip-like in content was transmitted no better than equivalent non-gossip social information. Theories that argue that primate intelligence is the result of ecological selection pressures were also not supported, with information concerning the non-social environment transmitted poorly.

One possible objection to our interpretation of the results might be that the social material used in Experiment 2 (asking directions from strangers) was not 'social' in the sense of the Machiavellian intelligence hypothesis. That is, the relationships between the characters were not very meaningful and the characters were not exchanging information about themselves or other people. The broad Machiavellian intelligence hypothesis, however, predicts that *any* social interactions should be memorable, whatever their content or quality. There are still many potentially important social cues

present, such as the personality of the character (e.g. their helpfulness) or the reliability of the information they give. This information can then be stored and used to negotiate future social interactions, which may be more complex. In any case, information which is intermediate between the social and the gossip material, featuring interactions more strongly Machiavellian than the social material (but not as strong or negative as the gossip material), would presumably be transmitted just as well as these two were in Experiment 2.

It might be argued that rather than being the result of a biologically evolved predisposition, the social bias seen here is the result of some related property of the material, such as its emotional impact or attentional salience. Various findings from the social psychological literature concerning memory might be used to account for some of our findings, such as that people have better recall for descriptions of behaviour that violates social norms (Wyer, Budesheim, Lambert, & Swan, 1994) for information that is incongruent with social expectations (Stangor & McMillan, 1992) and for negative self-discrepant in-group behaviour (Gramzow, Gaertner, & Sedikides, 2001). We do not, however, see these two types of explanation as in opposition. Properties such as *arousing*, *salient* or *memorable* represent the proximate mechanisms by which an evolved bias may operate. The two levels of explanation, ultimate and proximate, should be seen as separate and complementary (Tinbergen, 1963). Indeed, a full account of human cognition and behaviour requires empirical evidence from all explanatory levels.

It might also be argued that information about social relationships becomes particularly salient during development, causing such a bias to be learned. Again, however, this does not contradict an ultimate evolutionary argument for a biologically evolved predisposition or bias to learn and transmit certain types of information. To the contrary, the comparative evidence for the social brain hypothesis (Dunbar, 1995; Joffe, 1997) makes it likely that such a bias does indeed have an evolutionary basis at some stage of development. Nevertheless, developmental investigations would be useful in further clarifying the nature and origin of the social bias observed here.

A final objection might be that the transmission aspect of our study adds little to the findings of Owens *et al.* (1979) concerning recall at the individual level. Such an effect was already apparent in our first generation recall, where single participants recalled social information better than non-social information. However, a bias in memory or recall and a bias in transmission are not alternative or opposing phenomena. The long-term transmission bias does of course reflect a memory bias, but its significance is that it uniquely documents the cumulative operation of that memory bias in successive participants, providing an experimental microcosm for the study of cultural, as opposed to merely cognitive (memory) processes. Furthermore, the assumption that a consistent effect will be observed along an extended chain is just that – an assumption – which should be empirically tested. Indeed, previous transmission chain studies (e.g. Kashima, 2000a; Mesoudi & Whiten, 2004) have demonstrated crossover effects in which later generations reverse a trend exhibited by earlier generations.

Data on persistence consequently allow us to draw conclusions regarding the wider effect of a social bias on human culture in general. As noted by Kashima (2000b), Bartlett (1932) was interested not only in cultural *transmission*, but also large-scale cultural *change*, and Kashima suggests that the transmission chain method ‘provides one way of examining how micro-processes contribute to a macro-phenomenon such as the maintenance of culture’ (p. 394). We may speculate that the bias for social information found here can be extrapolated to the population level, to explain the popularity of

socially oriented mass media such as gossip magazines and television soap operas over non-social or factual journals and television documentaries. There are a number of theoretical frameworks that might be used to make this link more formally, such as Moscovici's (1984) social representation theory, Sperber's (1996) epidemiological model of cultural change and theories of cultural evolution (Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981; Mesoudi, Whiten, & Laland, 2004, in press). Space does not permit us to examine these in any detail here.

As noted by Emler (2001), there has been very little experimental work on gossip in the past. Hence, this study was intended to be an initial investigation of the phenomenon under very simplified conditions. There are undoubtedly a number of factors not examined here that probably play an important role in the transmission of social information in the real world, and we hope that future work will systematically examine such factors. For example, our participants were not instructed that the experiment was a memory test, that the material had come from another participant, or that their recall would be passed on to another participant. The third parties described in the material were also not known to the participants. Given that it is well established that people often tailor their messages to suit the intended receiver (Sperber & Wilson, 1986), providing such information may well affect the content or accuracy of recall. Similarly, transmitting the material face-to-face rather than via anonymous written text would allow the investigation of interpersonal factors such as intonation of voice or non-verbal cues.

The conclusions drawn here are dependent on the specific material used, and there is a need to replicate the study with alternative examples of the different types of information. In Experiment 2, we strove to ensure that the four material types contained equivalent underlying causal and temporal chains so that differences in transmission could be more confidently attributed to differences in content. However, this underlying structure was still somewhat informal, and future studies might use more advanced models of causal links in narratives (e.g. Trabasso & Sperry's 1985 causal network representation model) to more precisely equate the underlying structure of the different material. There may also be an effect of varying the number of social agents or interactions. The gossip and social material in Experiment 2 featured three people, which is within the typical upper bound of four found in natural conversational groups (Dunbar, Duncan, & Nettle, 1995). Perhaps material featuring interactions between more than four people would be transmitted less well.

Finally, there is a need to replicate the study cross-culturally. Although condition-dependent biases might modulate outcomes according to ecological variations, the evolutionary theories outlined above would predict that people in many different societies would show the social bias found here. However, the sample used in the present study is particularly useful in one respect in challenging the stereotypical and historical view of 'a gossip' as poorly educated, of low intelligence and female (Emler, 2001, pp. 318-319). Here, we found that highly educated and intelligent young people of both sexes exhibit a bias for gossip over non-social ('factual') information.

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Appendix A

Material for experiment 1

The first participant of each chain in Experiment 1 read the following three paragraphs. The bracketed labels, indicating the type of material and the numbers of words, sentences and propositions, were not presented to the participants.

[Individual]

Nancy is a 22-year-old college student studying history at the University of Denver. Her father works as an accountant and her mother is a teacher. At weekends, she works part-time in a book-store. When she finishes her studies, Nancy plans to travel abroad before pursuing a career as either a novelist or a journalist.

[58 words, four sentences, 14 propositions]

[Gossip]

Nancy is having an affair with her married college professor. She has been lying to her friends about seeing him. Nancy recently became pregnant with the professor's child. The professor promised Nancy that he would leave his wife, but since she told him she was pregnant, the professor has refused to see her. Nancy is threatening to tell his wife about the affair.

[63 words, five sentences, 14 propositions]

[Physical]

Denver is the state capital of Colorado, located in the western United States near the Rocky Mountains. An early stopping place for Indians, Denver was settled permanently after the gold rush of 1859. Its main industry is agriculture. Denver is a major centre for winter sports, and also contains a branch of the US mint, which produces most of America's coinage.

[61 words, four sentences, 14 propositions]

Appendix B

Material for experiment 2

The first participant of each chain in Experiment 2 read the following four paragraphs. The bracketed labels, indicating the type of material and the numbers of words, sentences and propositions, were not presented to the participants.

[Gossip]

Nancy is having an affair with her married college professor. Nancy recently became pregnant with the professor's child. The professor promised Nancy that he would leave his wife, but since Nancy told him she was pregnant, the professor refused to see her. So Nancy told the professor's wife about the affair. The professor's wife was so upset that she left the professor.

[62 words, five sentences, 14 propositions]

[Social]

Nancy enjoys swimming. Nancy was going to the swimming pool but got lost, so she asked an old man waiting at a bus stop for directions. The old man could not

give her directions. A bus arrived at the bus stop and the old man asked the driver for directions. The driver gave Nancy directions to the swimming pool, so Nancy was able to go swimming.

[66 words, five sentences, 14 propositions]

[Individual]

One morning, Nancy's alarm clock broke and she overslept. When she woke up, she realized that she was late for an important lecture. She got dressed as quickly as she could, left the house and ran to the lecture theatre. When she got there, the lecture theatre was empty. Nancy had missed the lecture.

[54 words, five sentences, 14 propositions]

[Physical]

The weather in Colorado gets hot and dry in the summer. This removes moisture from the soil and dries out the plants that grow there. The dry vegetation catches fire easily, leading to frequent forest fires. These fires release smoke containing carbon monoxide into the atmosphere. This smoke contributes to global warming, increasing temperatures further.

[55 words, five sentences, 14 propositions]