Social information use and social information waste

Olivier Morin[1,2], Pierre Olivier Jacquet[3], Krist Vaesen[4], Alberto Acerbi[5]

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1. Institut Jean Nicod, DEC, ENS, EHESS, CNRS, PSL University, UMR 8129, Paris.
2. Minds and Traditions Research Group, Max Planck Institute for the Science of Human History, Jena, Germany.
3. Laboratoire de Neurosciences Cognitives et Computationnelles (LNC2), Département d'Etudes Cognitives, INSERM, Ecole Normale Supérieure, PSL Research University, Paris, France.
4. School of Innovation Sciences, Eindhoven University of Technology, Eindhoven, The Netherlands
5. Centre for Culture and Evolution, Brunel University, London, UK.

Abstract. Social information is immensely valuable. Yet we waste it. The information we get from observing other humans and from communicating with them is a cheap and reliable informational resource. It is considered the backbone of human cultural evolution. Theories and models focused on the evolution of social learning show the great adaptive benefits of evolving cognitive tools to process it. In spite of this, human adults in the experimental literature use social information quite inefficiently: they do not take it sufficiently into account. A comprehensive review of the literature on five experimental tasks documented 45 studies showing social information waste, and 4 studies showing social information being over-used. These studies cover "egocentric discounting" phenomena as studied by social psychology, but also include experimental social learning studies. Social information waste means that human adults fail to give social information its optimal weight. Both proximal explanations and accounts derived from evolutionary theory leave crucial aspects of the phenomenon unaccounted for: egocentric discounting is a pervasive effect that no single unifying explanation fully captures. Cultural evolutionary theory's insistence on the power and benefits of social influence is to be balanced against this phenomenon.

Keywords: Egocentric discounting, social learning, cultural evolution, imitation, epistemic vigilance, information cascades, conformity, advice-taking, judge-advisor-system.

1. Introduction

The human capacity to use social information is fundamental to our species' cultural evolution—arguably humankind's key adaptive asset [1–4]. It affords enormous cognitive benefits, allowing individuals to avoid the costs of individual exploration, and most importantly, to avail

themselves of collective progresses no individual could have made on their own. One is naturally tempted to infer that humans evolved both uncommon capacities for using social information, and an uncommon degree of dependence on it. Leading specialists of cultural evolution embrace this view, drawing on alleged cases of over-reliance on the example of others, such as the imitation of kamikaze suicides [5] or celebrity suicides [4,6], and the copying of prestigious models in domains where these models are clearly incompetent [7]. However, several experimental results, including from the cultural evolution research tradition, suggest that individuals (this paper focuses on human adults) use social information sub-optimally. Specifically, they do not use it enough.

Social information consists in all the things that an individual can learn from others, be it through intentional communication, demonstrations, or the mere observation of behaviours that are not necessarily meant to be seen [1,8]. We use social information whenever we let it affect our behaviour. Alongside social information, we routinely process large amounts of non-social information. Here we'll call it "individual": primary perceptions that come to us directly from the world, neither coming from nor mediated by other people. Individual information has one clear advantage over social information: it comes to us processed by no filter but our own sensory nervous system. Social information is processed or produced by others before we process it, which can cause distortions due to random error, bias, or deliberate deception.

In a social world, individual information acquires two new uses.

First, each agent’s individual information can be combined with others agents’ individual information, producing “wisdom of crowds” effects. When several agents produce two independent (i.e., not influenced by or copied from the other agent) guesses on a state of the world, and if (for binary decisions) each individual agent is more likely to be right than wrong, the combination of their guesses through majority voting or averaging usually gives a far more reliable guess than any single answer [9–11]. This well-known result only holds, however, to the extent that individual guesses are independent from each other: each guess must reflect individual information [12,13].

Second, possessing a piece of information that is not (or not yet) social may give one an edge in strategic relations with conspecifics. Disclosed to others, it enhances one's reputation as a reliable informant and valuable cooperator [14]. Kept to oneself, it makes it possible to reap rewards that elude others [15]. Both types of information (the social and the asocial) thus have their advantages and drawbacks. How much weight should we give to individual or social information, and how much effort should we spend acquiring one or the other?

Experimental evidence from several independent research traditions has evidenced a surprising discrepancy between efficiency rules for social information use, and human participants’ actual

behaviour. Contrary to what one might expect from a cultural species, participants appear to put too little weight on the information they can gather from other people's decisions or testimony. In each of the literatures we survey, the relevant findings are relatively uncontroversial: we do not claim to be discovering anything that is not already known. However, researchers in one field do not necessarily know about all the findings from other fields. As a result, the pervasiveness of egocentric discounting is not always fully realised. Furthermore, no single field possesses an integrated account of why it occurs in its multiple manifestations. The present paper precisely aims at filling this lacuna, proceeding in three steps. Part 2 synthetises the available experimental evidence for the overweighting of individual information relative to social information, surveying social psychology, cultural evolution, and experimental economics. In Part 3, we discuss the putative proximate factors that have been put forward to explain this effect: cognitive biases, task-specific demands, biases in participants sampling. In Part 4, we discuss some ultimate factors that one can derive from theories or models about social learning's evolutionary history. In conclusion (part 5), our survey reveals that no single explanation taken in isolation captures all the aspects of the phenomenon.

2. How much does social information weigh in our decisions?

The supplementary materials present a list of publications that specifically document how experimental participants (focusing exclusively on human adults) give less weight to social information when it conflicts with a belief that they hold based on previous knowledge, or with a piece of private information provided by the experimenters to them but not to others. A comprehensive list of inclusion criteria is given in Section 1 of the Supplementary Materials. These are studies in which participants are asked to perform a task, having access to both individual and social information. Pieces of information of both kinds are potentially relevant to the task, but often conflict. What counts as success in the task is clearly defined, and there are widely accepted normative frameworks that specify how agents should behave to succeed. Accurate performance, as opposed to agreement with other participants, is valued (usually incentivised). The participants are presented with social information, usually concerning the other participants' responses, freely or at a small cost.

The exact criteria for what constitutes rational or efficient use of social information vary depending on authors, protocols, or studies, but some basic criteria are shared by all. First, the opinion of two random participants should be given equal weights. Second, absent suspicions of deceptive intent or noisy transmission, other people's opinion should not be given less weight merely because they come from others. These two principles imply that the average random participant should give equal weight to her opinion and to that of a random participant from the same group [16]. This basic principle can be formalised in various ways, the most common being Bayesian updating rules [17–22] or the averaging heuristic [16,23]. This point of view is not universally shared. Hawthorne-Madell and Goodman [24] defend a somewhat more relaxed view

of what counts as a rational use of social information. Their model does not place *a priori* restrictions on the degree of competence that an agent should attribute to a random unknown agent. If an agent believes themselves to be more knowledgeable and reliable than others, it is rational for them to discount others' opinions. Indeed, under this assumption, the very fact that others disagree with the agent is evidence that their advice shouldn't be trusted [24]. This model, however, does not explain why an agent would believe themselves to be better informed and more reliable than any random agent, on a topic that neither agent is especially competent about.

We did a comprehensive search of the literature on five experimental tasks, detailed below. Overall, between 45 (counting only clear cases) and 49 (counting ambiguous cases, see Supp. Mat. Section 1 on what counts as a ambiguous case) of the studies we collected show that participants clearly fail to give enough weight to social information, showing excessive reliance on their own information, a phenomenon known as "egocentric discounting" in the advice-taking literature [25]. We re-use this label, here, to name a phenomenon that goes far beyond advice-taking experiments. In contrast, we found only 3 publications (5 if we include two ambiguous cases) showing a bias in the other direction or an absence of bias. This review is no quantitative proof, but it is in line with the consensus view in the publications we surveyed (See supplementary materials, in particular section 1 on inclusion criteria). Evidence for egocentric discounting, which consists in giving individual information greater weight than would be normatively warranted, comes from at least three independent research traditions (social psychology, cultural evolution-inspired experiments, and behavioural economics). In all three, egocentric discounting came up as a surprise discovery—at least not one that previous theorising had predicted. These studies mainly use five broad types of tasks.

The advice-taking paradigm. The standard form of this task is the "Judge-Advisor System" [26], but we also consider studies that do not use this exact paradigm, or do not explicitly do so, as well as studies from the forecast combination literature [27,28]. In a typical advice-taking task, the participant is asked to make a quantitative judgement on a factual question (e.g. "What is the height of Mount Everest?"). Having given this first answer, they are confronted with another participant's answer, and allowed to give a second answer. Accurate answers are usually (but not always) incentivized (incentives tend to decrease the egocentric discounting effect without eliminating it) [29]. The main variants involve presenting the participant with the other estimate before asking them for their own, presenting the participant with an average of the group's estimate, or allowing discussions between participants. The normative strategy in such tasks, for the second answer, is to average, i.e., to move halfway towards the other participant's guess [28], unless one has reasons to think the advisor is clearly more (or less) knowledgeable than oneself. All the studies we gathered find evidence of egocentric discounting, at least in their baseline condition: the participants' second guess modifies their first guess in the direction of the advisor's guess, but gives much more weight to the participant's first guess than to the advisor's. Table 1 in the supplementary materials shows weight of advice (WOA) values (or similar

measures) for 40 experiments across 17 publications. All 40 studies document a WOA below 0.5, consistent with egocentric discounting, in one condition at least (usually the baseline condition). Egocentric discounting can be modulated by changing the participants' confidence in their own answer and their perception of the advisor's expertise, but all this happens against a baseline of heavy discounting.

Two-armed bandit problems with social learning. In a typical task, a participant must choose between two options, A and B, one of which yields greater rewards on average. The payoff function linking A or B to the attached rewards is noisy, so that the best response can only be detected after a certain amount of exploration. Participants are typically informed about their rewards on each trial, with a piece of individual (and usually, private) information, but they are also informed about other participants' choices. This information may concern one participant, a few, or all previous participants, it may or may not include the feedback that these participants received, it may or may not be available for free. Given this variation, there is not one single optimal strategy for taking social information into account in all these tasks, and even inside a given task, what would constitute optimal use cannot always be straightforwardly determined. Nevertheless, six studies show clear cases of egocentric discounting (vs. only one showing clear evidence of the opposite effect). In [30]'s "Best Color" condition, the option that gave the best payoff for the majority of participants on the previous round is announced, yet the model that best fits the data does not include social information. In [31], participants in the "social learning" condition are not given any individual feedback on their own responses, but they are told what the majority of participants chose in another condition, where those participants were given feedback. This information is under-used, resulting in sub-optimal choices. (Specifically, 12 out of 40 participants, self-described non-conformists, ignore it altogether.) In [32] (experiment 2), participants sometimes or (for 20 participants out of 55) always refuse to view a piece of information about others' choices that is made freely available and would have improved decisions if followed. In experiment 3 of the same study, a conformist strategy (imitating what the majority of participants did on the previous rounds) is consistently optimal but not consistently followed by participants, who tend to prefer relying on their own private information. Importantly, learning based on non-social information is, in these studies, highly effective (e.g. [31]). In other words, participants have no difficulty updating their behaviour when the feedback consists in individual (rather than social) information. This suggests that general difficulties with belief updating cannot explain social information under-use in these tasks.

"Virtual arrowheads" experiments. These experiments, developed by Mesoudi and his group (e.g. [33,34]) can be seen as a many-dimensional version of a multi-armed bandit task. Participants devise, via a computer interface, arrowheads that are used for simulated "hunts", and rewarded depending on their hunts' success. Hunting success is a function of the arrowhead's properties (a range of parameters that participants determine). Although [35] found that

participants readily consulted and used social information when given the opportunity to view the choices of other players for free, requiring participants to pay for this information clearly pushes them to rely on their own feedback instead. In subsequent studies where participants must choose between getting feedback on their own hunts and seeing other people's choices of arrowhead parameters, they choose the former, even though choosing the latter is more beneficial [33,34,36].

In the last two types of tasks, a participant must guess a given state of the world on the basis of cues provided by the experimenter, and may be given, in addition to these cues, information on other participants' choices (one or more). This general description fits both the use of cue-based learning paradigms in the advice-taking and social learning literatures [37–40], and the "ball-and-urn" task used by behavioural economists to simulate cascades (e.g. [17], and see sup. mat.). In addition to the cues, participants may be given feedback regarding the accuracy of their choices, but in "ball-and-urn" studies, no feedback is given until rewards are disclosed at the end of the task.

Cue-based learning. These studies, inspired by advice-taking tasks, differ from advice-taking tasks in one essential respect. Instead of basing their guesses on general knowledge, the subjects have access to a series of experimentally controlled cues. The subject makes a first guess on the basis of these cues, then makes a second (possibly revised) guess after being exposed to social information (either an expert's guess, or a peer's guess, or a group's average guess). Once again, participants fail to update their first guess as much as they should [37–39]. Here again we only looked for positive evidence for egocentric discounting, or for the opposite effect. We do not include studies whose design may have allowed them to capture egocentric discounting, but which do not mention it among their findings, possibly because they did not look for it. Possible examples include [40,41].

Ball-and-urn tasks. In a typical *ball-and-urn task* (see sup. mat. for more information),the experiment starts with the experimenter randomly picking one out of two urns. Each urn contains balls of different colours, one urn having more balls of colour A, the other urn more balls of colour B. Participants, playing one after the other, are each given a ball drawn (with replacement) from the chosen urn. They must guess which of the two urns is being used, knowing that one urn contains more balls of colour A, the other more balls of colour B. (The ratio of A/B balls in each urn is typically known to the participants.) In addition to seeing the colour of their own ball (individual information), each participant knows the guesses made by everyone else before them. The studies in this group are the least straightforward to interpret, because of issues surrounding the normative criteria that apply to the task. To determine the weight that a participant should give to the decisions of the preceding participants, assumptions need to be made regarding their rationality, the probability that they err randomly, and the weight that they themselves put on their predecessors' decisions. Standard models, based on rational choice (in the specific sense of Bayesian updating) and game-theoretic equilibria [42,43], assume

that all agents update their beliefs in a fully normative way, and know that other agents also do. Yet experimental participants do not behave in the normative way, as these models make clearly false predictions [43,44]. Since standard models are normatively valid for an agent only if other agents behave as the model say they should, which they do not, using them as a normative benchmark is questionable. Several alternative ways to prove egocentric discounting coexist in the literature. One consists in showing that a simple "private information" model, where participants take no account whatsoever of social information and only rely on their individual information, outperforms more complex model like the Bayes-Nash model [45–47]. Another is to demonstrate that participants overweigh their private information both relative to the optimal Bayes-Nash model but also relative to more realistic models, like the Quantal Response Equilibrium model [48]. Perhaps the most concrete demonstration comes from showing how much of the possible payoff participants forego by relying on private information (an important amount, while almost no payoff is lost from following social information) [44,49]. Together, these different lines of circumstantial evidence converge to show that participants in these tasks generally underuse social information.

3. Proximate explanations for egocentric discounting

Many potential explanations have been put forward to explain egocentric discounting [3,29,50]. A generally endorsed explanation is that people put less trust in socially acquired information than in individual information [29,51]. This explanation is not trivial. It does exclude some possible causes, for instance a general inability to revise one's opinions in the face of information of whatever nature. There is a general consensus that egocentric discounting is different from, and stronger than, a simple inability to update our beliefs [27,29]. Belief updating in human adults is not optimal, but consistent evidence for a clear bias in favour of one's prior opinion is lacking [52]. In most of the "bandit" and "arrowhead" tasks, participants get private feedback on their actions, which they take into account in a near-optimal way, contrasting with their poor use of social information [31,53]. Likewise, participants in advice-taking tasks use new evidence efficiently when it is not social [16,22]. Self-confidence is a reliable predictor of egocentric discounting [29]: indeed, as Hawthorne-Madell & Goodman show, it is rational (in the authors' specific sense) for a self-confident agent to discount divergent opinions. However, simply saying that people fail to place as much trust in other informants as they place in themselves eschews the main question. Why do we not trust others as much as we ought to?

Lack of ecological validity. The value of social information may be higher in experiments than it is in real life. According to a common critique of the experimental psychology of decision-making, subjects tackle laboratory tasks with a series of heuristics adapted to real-life circumstances that need not obtain in the lab, leading to a mere appearance of irrationality [54]. Is there evidence that people fail to profit from social information optimally outside the lab?

Non-laboratory evidence that people fail to trust social information as much as would be useful for them includes studies of vaccine refusal, climate change skepticism, and resistance to mass persuasion attempts (synthesised in [55]). The experiments reviewed here represent a wide range of methodologies, some highly controlled, others much closer to everyday experience. Among the most ecologically relevant, the early experiments on forecast updating grew from ergonomic research [37,56,57] What these studies ask of their subjects is little different from what they would do in the ordinary course of their life: update an epidemiological forecast or a medical treatment forecast, based on another opinion. Experiments in the advice-taking literature also place subjects in a fairly ordinary situation, that of updating one's estimate for a date (e.g. a historical or news event), a quantity (e.g., a price), given someone else's estimate. It is not clear how these tasks depart from ordinary situations in such a systematic way as to explain pervasive egocentric discounting.

Culture. One popular explanation among cultural evolutionists explains egocentric discounting as an effect of culturally inculcated individualistic values [1,36,58]. Individualistic cultural learning is thought to be a "Western" phenomenon, absent in some cultures at least: China, Japan or Korea [1,59], or small-scale societies relying on pastoralism (according to [58]). However, clear evidence for egocentric discounting has been found in both groups. Egocentric discounting was documented in Japanese [60,61] and Chinese participants [20,36,62], and in a group of executives from 24 different nationalities [28]. While some studies find stronger rates of egocentric discounting in East Asian participants as opposed to Western ones [61], others do not [20,60]. In [36], only one sample of East Asian participants shows higher reliance on social learning, but the other two do not. Pastoralists in [58] show less discounting of social information compared to horticulturalists or city-dwellers, but they still discount it, as do the Altiplano pastoralists studied in [30]. Overall, the literature shows some evidence for cultural modulations of egocentric discounting, but does not support seeing it as a Western peculiarity. Geographical differences may also be determined by external factors (rather than culturally transmitted ideologies). For instance, experiencing economic and psychosocial adversity seems to increase reliance on social information [63].

Access to reasons. One standard explanation in the advice-taking literature holds that participants trust their own views more because they have access to their reasons for those views [16,64]. There are, however, reasons to doubt that this is a necessary condition. Results show that egocentric discounting occurs even when participants are asked to revise an estimate without being given access to the cues that motivated the estimate [65] and that egocentric discounting is also observed when participants are presented with someone else's opinion, falsely presented as their own [27,66]: they put more weight than they ought to on opinions that are presented as their own.

Task engagement. In most of the studies we reviewed, participants may be more actively involved in processing or producing individual information, than in receiving advice. Active engagement in a task promotes learning in a way that passive observation does not, arousing the participants' attention to a greater extent and allowing them to encode information in distinctive ways [67]. In "two-armed bandit" and "arrowheads" tasks, the level of engagement is often strikingly higher for individual information: the nature of the feedback that participants receive is a direct consequence of their intentional actions, whereas social information is produced by others. In some of these tasks, participants may decide whether or not they want to see others' choices, but the extent of their active involvement with social information ends there. In most advice-taking tasks, the participants actively generate their personal estimate, and are then passively exposed to someone else's. Could this explain egocentric discounting in such cases? Partly, but once again it fails to explain why egocentric discounting obtains when participants are presented with someone else's opinion falsely presented as their own [27,66]. The best argument against an account of egocentric discounting based on the participants' active involvement may come from ball-and-urn tasks, where both individual and social information consist in passively received cues. Social information remains discounted. It is worth noting, however, that in experiments where social information has to be actively requested, instead of being passively presented, subjects are prone to request too much social information [68,69], even when that information is worthless [70].

An anchoring effect in advice-taking tasks. These tasks typically ask a participant to formulate their own guess for a quantitative or numerical question, then to update it after being exposed to someone else's guess. These are favourable conditions for an anchoring effect to occur. Anchoring effects happen when a piece of information biases an estimate because all subsequent estimates are referred to it and weighed in its direction, to a greater extent than they should be, and even when the piece of information is completely irrelevant — for instance, a random number [71]. In one sense, egocentric discounting truly *is* a type of anchoring effect: the participants' initial estimate is given excessive weight, preventing them from updating their guess as much as they should. However, there are good reasons to reject the view that the general mechanisms at work in the anchoring effect explain egocentric discounting [27,29,65,72]. One reason is that an egocentric effect still obtains when participants complete a number of unrelated numerical estimation tasks between their first estimate and their last estimate, which should cancel any priming effect [27]. Furthermore, telling participants that an estimate is their own is sufficient to trigger egocentric discounting in favour of that estimate, even when the estimate is not actually their own, and is presented for the first time [27,66]. If egocentric discounting rested on a mere anchoring effect, labelling estimates as one's own or others should not matter. See [73] for an exploration of the possible role of anchoring mechanisms in advice-taking more generally.

Low exploration rates in "bandit" and "arrowhead" tasks. In these two types of tasks, participants must update their behaviour in response to feedback, in a simulated environment where the payoff associated with each response is noisy, and may change over time. In some of these experiments, environmental changes are faster than in habitual real-life situations. A failure to adjust to the rapid rates of these changes could lead to conservatism, i.e., a tendency to stick to the solution one chose on previous trials (or remain close to it) instead of changing to the (correct) solution available with social learning. Two studies show a correlation between exploratory behaviour and social learning. In the "social and individual learning condition" of [34] (Experiment 2), changes in the up-coming responses were greater for participants who opted to copy a model than for those who did not. In [74] participants in the "social learning" condition, who could see the solutions that other participants gave to the task, were more explorative than participants in the individual learning condition, who could not. The data in [34] in particular raise the possibility that participants neglected social information because of a general aversion to exploration (in [74], it is not clear whether participants under-use social information). However, neither study establishes causation. In [74], the availability of social information is experimentally manipulated and controlled, so high exploration must be a consequence of social learning—not its cause. Another study that experimentally manipulates the availability of social information, and finds that social information induces a greater level of exploration, is [50]. Here again, greater exploratiVeness cannot *cause* social learning. Both studies suggest that relations between exploration and social learning, when present, are likely to reflect an effect of social information upon exploratory behaviours, rather than the opposite. (See [75] for additional evidence against a causal link between exploratory behaviour and social information use).

4. Evolutionary explanations for egocentric discounting

The mechanisms discussed in the previous sections have to do with the specifics of experimental situations, from participant selection to task demands. We now move on to possible explanations for egocentric discounting that see it as a functional and adaptive feature of the way we deal with social information.

Epistemic vigilance. Trouche et al. [66] interpret egocentric discounting through the lens of Sperber et al.'s epistemic vigilance framework [76]. In this view, human adults have an *a priori* reluctance to believe communicated information, unless accompanied by arguments or other guarantees of reliability. This default vigilance serves as a protection against attempted manipulation [76]. A straightforward implication seems to be that social information will be less readily accepted when a source intentionally communicates it, rather than letting it leak inadvertently. Yet, it is unclear whether participants in the experiments we just reviewed usually perceive social information as being intentionally communicated to them by the source. With a

few exceptions [77], social information is merely introduced as another participant's opinion, leaving it unspecified whether the participant intended their opinion to be shown, or even knew that it would be. The same is true of most two-armed bandit tasks, arrowhead experiments, and cue-based learning tasks: social information is eavesdropped by its recipient, not openly communicated by its source. The major exception are "ball-and-urn" experiments, where participants know that their answers will be made public to all subsequent participants [17,44]. Contrary to what epistemic vigilance might imply, this seems to cause participants to trust social information *more*, not less. Participants in ball-and-urn tasks tend to answer in ways that are helpful for others (but possibly harmful for themselves). Working with a task similar in its main features to the ball-and-urn tasks, [78] argue that participants are aware of this, and show that participants are more likely to follow their predecessor's advice than to imitate their action—the opposite of what epistemic vigilance would suggest. This piece of counter-evidence is merely suggestive: testing the epistemic vigilance hypothesis would require experiments that make it clear to participants whether other participants intentionally produced social information for other participants to use.

A producer-scrounger dilemma for information use. Social information is only useful when others also gather information asocially. Cultural-evolutionary models contain a possible explanation of egocentric discounting. Rogers' influential model [79] showed that social learning may not provide any advantage over individual learning when the environment changes. The advantage of using social learning depends on the frequency of social learners in the population: if those are too numerous, social learning is useless. When there are mostly individual learners, copying is effective, because it saves the costs of individual exploration, and because the probability of copying a correct behaviour is high. However, when there are mostly social learners, the risk of copying an outdated behaviour increases and individual learners are advantaged. This means the advantages of social-learning are inversely frequency-dependent: the more other people learn socially, the less efficient it is to learn from them. The same logic is reflected, on a smaller scale, in models of information cascades, where social learning can (with a small probability) become detrimental for an individual when too many other individuals resort to it. More generally, a broad range of models converge upon the view that social information use can be likened, in terms of evolutionary game theory, to a producer-scrounger dynamic [35,75,80]. At equilibrium, these games typically yield a mixed population of producers (individual learners) and scroungers (social learners), where neither type does better than the other [81,82]. Egocentric discounting might emerge from a producer-scrounger dilemma, as a response to the devaluation of social information which may occur when too many other agents rely on social learning.

This hypothesis potentially explains several phenomena related to egocentric discounting. A frequency-dependent equilibrium could account for egocentric discounting in a subset of experimental participants [83]. These participants could be wasting social information for two

reasons, a strategic one and an altruistic one. The strategic reason starts from the premise that other participants rely excessively on social learning, making it hazardous to follow them. On a more altruistic account, egocentric discounting may be a way to help the community of participants with first-hand information [50]. Egocentric discounting, in this perspective, is altruistic: it increases the amount of information circulating in a group, at the cost of making the discounter less accurate [42]. Only two studies, to our knowledge, address the possible effect of altruistic motivations on egocentric discounting. In Eriksson & Strimling [50], subjects who scored high on a prosocial attitudes survey (Social Value Orientation scale) showed a greater propensity to acquire individual as distinct from social information, although [69] fails to find an impact of self-reported altruistic tendencies on subjects' preferences for social or private information. A "producer-scrounger equilibrium" account may also explain the widely documented inter-individual heterogeneity in propensities for social learning [53,75,84,85] since such an equilibrium is based upon the coexistence of two opposite strategies. However, this account leaves several questions unanswered, which future work might address.

- How do we explain egocentric discounting at the aggregate level? The experiments we review document egocentric discounting effects at the level of entire groups of subjects. Even though inter-individual variation, when explored, can be large, the discarding of social information is not driven by a minority, and it is not compensated, overall, by an equally strong tendency in the opposite direction. Why are there so few information scroungers?

- Do egocentric discounters expect others to over-rely on social information, and why? The producer-scrounger dilemma account appears to assume that people waste social information because they assume (consciously or not) that others are too reliant on it, making it less useful. But in most of the studies we reviewed the opposite holds true: most participants rely too little on social information, not too much.

5. Conclusion

There is little doubt that our species relies a great deal on social information, and that cultural transmission would be impossible if we did not use it [7,76,86]. This makes the well-known phenomenon of egocentric discounting all the more puzzling. This paper documented it across five different experimental paradigms (going beyond standard cases of egocentric discounting in the advice-taking literature). Several independent research traditions uncovered different aspects of the same phenomenon, a phenomenon that none of them had predicted. Combining the results of a diverse range of tasks allows for a better assessment of the most common explanations. Our review highlights the difficulty of explaining away egocentric discounting with any single-cause account, and stresses the need to study egocentric discounting through the lenses of the multiple research traditions that have investigated it. Those complement each other. Social psychology is

strong on ecological validity. Cultural evolution research seeks diverse subject pools of participants. Experimental economics is weaker on both these counts, but cascade experiments provides evidence against mechanisms that play a role in other paradigms: for instance, task engagement or epistemic vigilance.

A closer look at egocentric discounting also addresses a long-running debate in cultural evolutionary theory. A long-standing critical argument rightly stresses the artificial nature of the distinction between social and individual learning [87,88]. Social learning, as the critics point out, need not be anything but individual learning from social cues: humans require no special-purpose adaptation, no dedicated cognitive module to learn from others. We fully agree with this stance, with one subtle difference. Individual and social information may be processed by the same mechanisms, but not on an equal footing. The information that one gets on one's own engages our attention differently; it is more tractable and traceable than information that comes to us filtered through others' minds. Because it is acquired independently, it is also of more use to others than second-hand information.

Cultural evolution, alongside social psychology and experimental economics, has done much to document and explore the fact that socially acquired information may be given less weight than equivalent individual information. No extant theory predicts this phenomenon in all its dimensions or in a straightforward way. An exciting next step could consist in drawing the cultural consequences of our reluctance to incorporate information: how it impacted the evolution of social learning in our evolutionary past, and the diffusion of culture throughout our history.

Electronic Supplementary Material: Accessible at [URL to be added after peer-review]. [Appended to this submission.]

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