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Intuitive credit attribution and the priority rule

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ABSTRACT

When a good idea is discovered, who gets credit for it? This is an important question in science, the arts, law, and everyday life. We suggest that people have intuitions about credit ownership that depend on three factors: (i) whether the idea suggests the discoverer is competent; (ii) whether the discovery elicits gratitude toward the discoverer; (iii) who the first individual to come up with the idea is. We test these intuitions in three vignette experiments with UK participants, in the context of priority disputes in science. In Experiment 1, participants find a discoverer less competent and award less credit to them for a scientific idea if they perceive that the discoverer could have plagiarized another discoverer, but attributions of credit are also shown to differ from attributions of competence. In Experiment 2, participants are more grateful toward, and award more credit to a discoverer who makes their discovery public. In Experiment 3, participants are more biased toward the first discoverer in terms of credit attribution than in terms of competence attribution or feelings of gratitude. In conclusion, we suggest that intuitions of credit ownership help explain the popularity and endurance of the priority rule in science, by which all the credit of a discovery is supposed to go to the first discoverer.

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When someone has a good idea, when they create something beautiful or useful, we give them credit for it. Gaining such credit should motivate people to come up with other impressive creations. Arguably, credit seeking fuels crucial endeavors, such as artistic or scientific creation. Here, we develop a very simple model of credit attribution, suggesting that people should be granted credit when their actions lead others both to see them as competent and to be grateful toward them. We also suggest that intuitions related to ownership might influence who gets credit in some disputed cases. We illustrate our model by applying it to an important norm of credit attribution – the priority rule in science – and, in three experiments, test the model in that context.

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The psychology of credit attribution

Earning a good reputation among one's peers is a fundamental human motivation (Cremer & Tyler, 2005; Leary, 1995). One way of earning a good reputation is to create products – physical or conceptual – that others find appealing, whether it is on esthetic or utilitarian grounds. When that happens, reputation takes the form of credit: people credit the creator, which improves the creator's reputation and, potentially, their standing in the group. Social perception in general is structured along two main axes, which have received many different monikers, but which broadly align with competence and warmth (Abele & Wojciszke, 2007; Fiske et al., 2007). We suggest that the same, broadly, goes for credit, which should be granted when someone's creation leads them to being perceived more positively on these two axes.

The first criterion, concerning competence, is the more obvious of the two. We should give people credit when they create something that requires a special skill, something that others could not easily create. Indeed, people have intuitions not only about the practical usefulness of particular ideas, but also about other qualities that might better reflect their creator's underlying skill, such as the idea's originality or cleverness. For example, people enjoy surprising explanations (Author, submitted), insightful arguments (Author, submitted), and beautiful proofs (Inglis & Aberdein, 2015; Novaes, 2019). Originality appears particularly important (de Courson et al., 2021). A contemporary high-school physics teacher has a more advanced knowledge of physics than Isaac Newton, but they get much less credit for this knowledge, since they did not create it themselves.

Consistent with this criterion, a burgeoning literature in psychology suggests that people think others deserve credit when they have created an idea themselves. Across different cultures (Mandel et al., 2020; Shaw & Olson, 2015; Yang et al., 2014), different materials (Altay et al., 2020), and starting at an early age (at least by the age of 6, Li et al., 2013; Olson & Shaw, 2011; Shaw et al., 2012), people think the original creator of an idea deserves the credit, and that plagiarism is wrong.

The second criterion of credit, related to warmth, is required as well, as demonstrated by the case of nefarious inventions. Someone who devises a particularly clever way of killing people, or a technology that generates dangerous pollutants, might be deemed competent, but people might be reluctant to give them any credit, and the positive reputation boost that comes with it.

In the case of credit, attributions of warmth to the creator might take the form of gratitude. Under the right conditions, when someone deliberately acts in a way that benefits us at a cost to themselves, we feel grateful toward them (Emmons & McCullough, 2004; McCullough et al., 2001). This should

also apply to creations: if someone has an idea or provides us with information that benefits us, we should be grateful to them. In the case of scientific discoveries, people might feel grateful toward the discoverers even if they do not personally benefit from the discovery, if they have a general perception that scientific discoveries improve humanity's lot.

Feelings of gratitude should not be sufficient, on their own, to lead to credit attribution. We can be grateful for information that does not require any particular competence (e.g., when someone reports hearsay, or something they've seen), and which thus shouldn't earn the informants much (or any) credit.

In this simple model, then, the main determinants of granting credit are whether the individual appears competent on the basis of something they've created, such as a new idea, and whether people feel grateful toward them.

There might also be a third, less important component of credit attribution, related to intuitions of ownership. People talk about ideas as they might about items they can genuinely own ("it's her idea", "this idea isn't for sale"), scholarly work refers to "idea ownership" (e.g., Shaw et al., 2012; Stark & Perfect, 2007) and, most importantly, the large legal edifice of intellectual property law relies on the concept that people can own ideas. Accordingly, intuitions people have about ownership might play a role when attributing credit for ideas.

Humans, as well as some non-human animals, have intuitions about ownership which allow them to coordinate and avoid conflicts (Gintis, 2007; Maynard Smith & Price, 1973). One of these intuitions is about first contact: the first individual who seizes an object owns it (Friedman, 2010; Friedman & Neary, 2008). This first contact intuition is modulated by other factors (e.g., whether someone recognized the value of the object), but it remains a powerful heuristic. In some contexts, people might use this intuition not only for physical objects, but also ideas, leading them to attribute the ownership of an idea to the first individual who discovers it, and, along with ownership, credit (if it fulfills the criteria of competence and gratitude).

Note that our model is mainly situated at the computational level of analysis (see, Marr, 1982). Given the goal of knowing whom to grant credit to, we believe it makes sense that the factors that lead us to attribute competence to someone, or to feel grateful to someone, should play a role in granting credit. However, we do not take a strong position on two things. First, on the representational or algorithmic level, which could be performed in different ways. On the cognitive mechanisms through which credit attribution is computed: our main claim is simply that our intuitions of credit attribution will behave similarly to intuitions to related to competence, gratitude, and ownership. This could be done in several ways. Consider the case of attributions of competence: people could perform

a single computation, on the basis of the observed behavior and of prior knowledge, which would have two separate outputs: one feeding into attributions of competence, and the other into attributions of credit; or people could perform the same computation, attribute competence, and on that basis attribute credit; or the computations could be similar for competence and for credit attribution, but performed by different cognitive mechanisms. As a result, we merely predict that (in the case of competence), attributions of competence, ownership, and feelings of gratitude, and ownership on the one hand, and of attributions of credit on the other, will be influenced by the same factors (which we manipulate in our experiments), not that the former directly causes the latter. We also do not make a strong commitment on whether intuitions of ownership are part of the computational design of attributions of credit, are the inadvertent result of operations at the algorithmic level. Indeed, the addition of intuitions of ownership to the model resulted from our initial experimental results, which forced us to consider that attributions of competence and feelings of gratitude might not be the only factors explaining credit attributions.

For the sake of transparency, we would like to point out that this model was not purely derived from a priori theorizing, but partly resulted from our initial experimental results, which forced us to consider that attributions of competence and feelings of gratitude might not be the only factors explaining credit attributions.

Credit attribution in science and the priority rule

Credit plays an important role in science. Scientists vie for the recognition of their peers – as Paul Samuelson put it: "The fame they seek . . . is fame with their peers – the other scientists whom they respect and whose respect they strive for" (Samuelson, 2009, p. 60). Studies have shown that scientists are willing to take large comparative pay cuts to choose their area of study, and to be able to publish and get recognition for their work (Stern, 2004). Science is thus an interesting context for studying credit attribution.

One of the forms that credit attribution takes in science is the priority rule, a "system of rewards which accords all credit, and so all the personal benefits that go along with credit, to the first research program to discover a particular fact or procedure, and none to other programs pursuing the same goal" (Strevens, 2003, pp. 55–56). Attention to the priority rule was first drawn by Merton (Merton, 1957), who pointed out its ubiquity since the scientific revolution and provided many examples of sometimes bitter priority disputes – fights over who discovered something first – across all disciplines of science. In contrast to science and its priority rule, reward for participation in most other collective human endeavors is apportioned in a more egalitarian manner. For instance, some reward schemes emphasize

participation – in many small-scale societies, game is divided approximately equally among the hunters, irrespective of their contribution to each individual hunt (Kaplan & Gurven, 2005). Why, in the case of science, would the first individual to make a discovery – maybe merely by luck – earn all the credit?

In some respects, the priority rule is efficient and useful, while in others it is detrimental to scientific progress (see our discussion in conclusion). Our intention is not to adjudicate on the efficiency of the priority rule, but to ask which psychological processes make that rule so compelling to both scientists and the general public.

The present framework helps explain the dynamic of credit attribution in science. Firstly, when someone claims they have made a discovery after someone else had made the same discovery, suspicions of plagiarism might be aroused. If the second discoverer is thought to have plagiarized the first, they should not be deemed particularly competent and should consequently not get any credit. Secondly, even if the rediscovery was made independently, people should feel less grateful to the second discoverer since the information was already known and did not increase the benefits gained by the first discovery. As a result, the second discoverer should be granted less credit. Thirdly, if intuitions of ownership play a role in credit attribution, they should also favor the first discoverer.

We revisit the relationship between the intuitions of credit attribution and the priority rule in the conclusion, in light of our results.

The present experiments

We present three experiments on credit attribution in the context of scientific discoveries. In these experiments, participants rate two scientists who made the same discovery, one before the other, on various traits. The details of where and how they made their discoveries are manipulated to influence the traits we expect participants to attribute to the scientists. Since some vignettes take place centuries ago, to make them more realistic and avoid potential biases, we describe all discoverers using male pronouns. For clarity, we also use this convention in the description of the experiments.

The goal of Experiment 1 is to test whether, as the current model predicts, factors other than competence explain credit attribution. We manipulate how much competence is attributed to the second discoverer, relative to the first, and test whether participants grant more credit to the first discoverer even when they do not think him more competent.

Experiment 2 turns to gratitude, testing whether credit attribution is also affected by how grateful participants feel toward the discoverers. We manipulate how grateful participants should feel toward the discoverers and test whether credit attributions track feelings of gratitude.

Finally, Experiment 3 focuses on the possible role of a first contact heuristic. In this experiment, the discoverers are described so that the second discoverer appears more competent, and more deserving of gratitude. We test whether, even in these conditions, credit attribution remains biased toward the first discoverer (relative to competence attribution and feelings of gratitude), potentially revealing the use of a first contact heuristic.

The three experiments were pre-registered, including sample sizes, data exclusion, hypotheses, and analyses. The data are available at OSF. Links to the pre-registrations (the data and scripts used for analyses are attached with the pre-registration of Experiment 3):

Experiment 1 (https://osf.io/g7t8d/?view_only=a13231cf51564250b682e81f71e3d3f7)

Experiment 2 (https://osf.io/td8zh/?view_only=b59d2e3cb03947be92a9ec11399b196f)

Experiment 3 (https://osf.io/7yau9/?view_only=177059ae56cb49cbb7c5717f5fc37415)

Several additional pre-registered studies are reported in the ESM. These are very similar to the experiments reported here, but used suboptimal wordings or pre-registered analyses. However, their results are fully congruent with the ones presented here. All reported results are confirmatory and were preregistered accordingly, unless noted otherwise.

All the experiments recruited participants in the UK using Prolific Academic who were invited to participate in an online survey published on Qualtrics. They all provided consent and demographic information, and were paid £0.25 after completing the survey. Participants also completed attention checks, and only those who passed were included in the final samples – when relevant, we report these exclusions in the methods section of each experiment. The full text of all the vignettes and the questions is available in the ESM. All the experiments used a fully between-participants design, with each participant seeing a single vignette. All statistical analyses were conducted in R (R Core Team, 2020), using R Studio (v.2022 .7.1.554; RStudio Team, 2022).

Experiment 1

The most basic reason why people would grant more credit to the first of two scientists, for the same discovery, might be that they suspect the second one to have plagiarized the first. If plagiarism is plausible, participants should perceive the second discoverer as less competent, and grant them less credit. By contrast, when plagiarism is essentially impossible, participants should perceive both discoverers as equally competent. However, if, as our model suggests, credit attribution doesn't only depend on perceived competence, then participants should grant more credit to the first discoverer even when plagiarism is impossible.

To manipulate the perceived odds of plagiarism, we created two (between-participants) conditions: a Close Country Condition (in which the discoveries took place in close and related countries, making plagiarism plausible), and a Distant Country Condition (in which discoveries took place in distant and unrelated countries, making plagiarism essentially impossible). Participants were then asked to rate the competence of the discoverers, and to judge how much credit they deserved.

Credit was measured with a combination of a direct question about "who deserves credit", and a question about who should have the discovery named after them (eponymy being an important manifestation of credit attribution in science, see Merton, 1957). A credit index was computed by aggregating the normalized responses to these two questions, scaled to a range of 0 [credit fully due to first discoverer] to 1 [credit fully due to second discoverer]. Accordingly, Experiment 1 tests the following two hypotheses:

> H1 Across both conditions, participants deem the first discoverer, relative to the second discoverer, more worthy of credit than they deem him more competent.

If H1 were verified, it would suggest that attributions of credit do not only depend on attributions of competence, as attributions of credit evince a stronger bias toward the first discoverer than attributions of competence.

> H2 Even in the Distant Country Condition, participants deem the first discoverer, relative to the second discoverer, more worthy of credit than they deem him more competent.

If H2 were verified, it would confirm that attributions of credit do not only depend on attributions of competence, as even if the two discoverers are deemed equally (or nearly equally) competent, the first is deemed more worthy of credit.

Participants

$N = 210$, 104 male, 101 female, 5 other, $M_{age} = 33.37$.

Materials and procedure

A pilot study had established that increasing the distance (and the difficulty of communication) between the country in which the first and the second discoveries took place strongly lowered the perceived odds of plagiarism. This experiment replicates and adds to the findings of E1a (see ESM). Here's an example of a vignette in both conditions:

Close Country Condition: In 1651, French scientist Paul Lesage published in France his discovery of a law governing air pressure. Later that year, English scientist Richard Knight published the same result in England. At the time, France and England were in close contact, and scholars from both countries communicated a lot.

Distant Country Condition: In 1457, Egyptian mathematician Ahmad Sa'id al-Bahili published a pamphlet in Egypt detailing his new solution for cubic equations. Later that year, Italian mathematician Enrico Pacioli published the same result in Italy. At the time, Egypt and Italy were not in close contact, and scholars from both countries barely communicated.

We used three topics (physics, mathematics, and biology). The order of the discoverers was counterbalanced, for a total of 12 vignettes (see ESM). Participants were asked three questions, in the following order:

Competence question: "Which of the two do you think is the best scientist?" 5-point Likert scale ranging from 1 ["Name of the first scientist to make the discovery" is much better] to 5 indicated ["Name of the second scientist to make the discovery" is much better].

Credit question 1: "Which of the two do you think deserves the most credit for the discovery?" 5-point Likert scale ranging from 1 ["Name of the first scientist to make the discovery" deserves all the credit] to 5 ["Name of the second scientist to make the discovery" deserves all the credit].

Credit question 2: "Whose name do you think should be given to the discovery?" 1 indicated ["Name of the first scientist to make the discovery"], 2 indicated ["Name of the first scientist to make the discovery" and "Name of the second scientist to make the discovery"], and 3 indicated ["Name of the second scientist to make the discovery"].

Results and discussion

Descriptive results for all the three experiments can be found in Figure 1. Here, and in the rest of the paper, we present the analyses with values rescaled to range between 0 and 1. As a manipulation check (which was not pre-registered) comparing the two conditions, we confirm that participants were more likely to deem the first discoverer more competent than the second ($M_{close} = 0.40$, $SD_{close} = 0.16$; $M_{distant} = 0.47$, $SD_{distant} = 0.09$; independent t-test: $t(163.06) = -3.71$, $p < .01$, *Cohen's* $d = -0.51$), and to grant him more credit ($M_{close} = 0.27$, $SD_{close} = 0.20$; $M_{distant} = 0.37$, $SD_{distant} = 0.18$; independent t-test: $t(208) = -3.82$, $p < .01$, *Cohen's* $d = -0.53$), in the Distant Country Condition (when the odds of plagiarism were essentially nil). However, the main point of Study 1 is to test whether credit attribution can be reduced to attributions of competence.

Supporting H1, there was a significant (paired t-test: $t(209) = -10.08$, $p < .01$, *Cohen's* $d = 0.70$) difference between the participants' ratings of credit and competence, such that credit was attributed preferentially to the

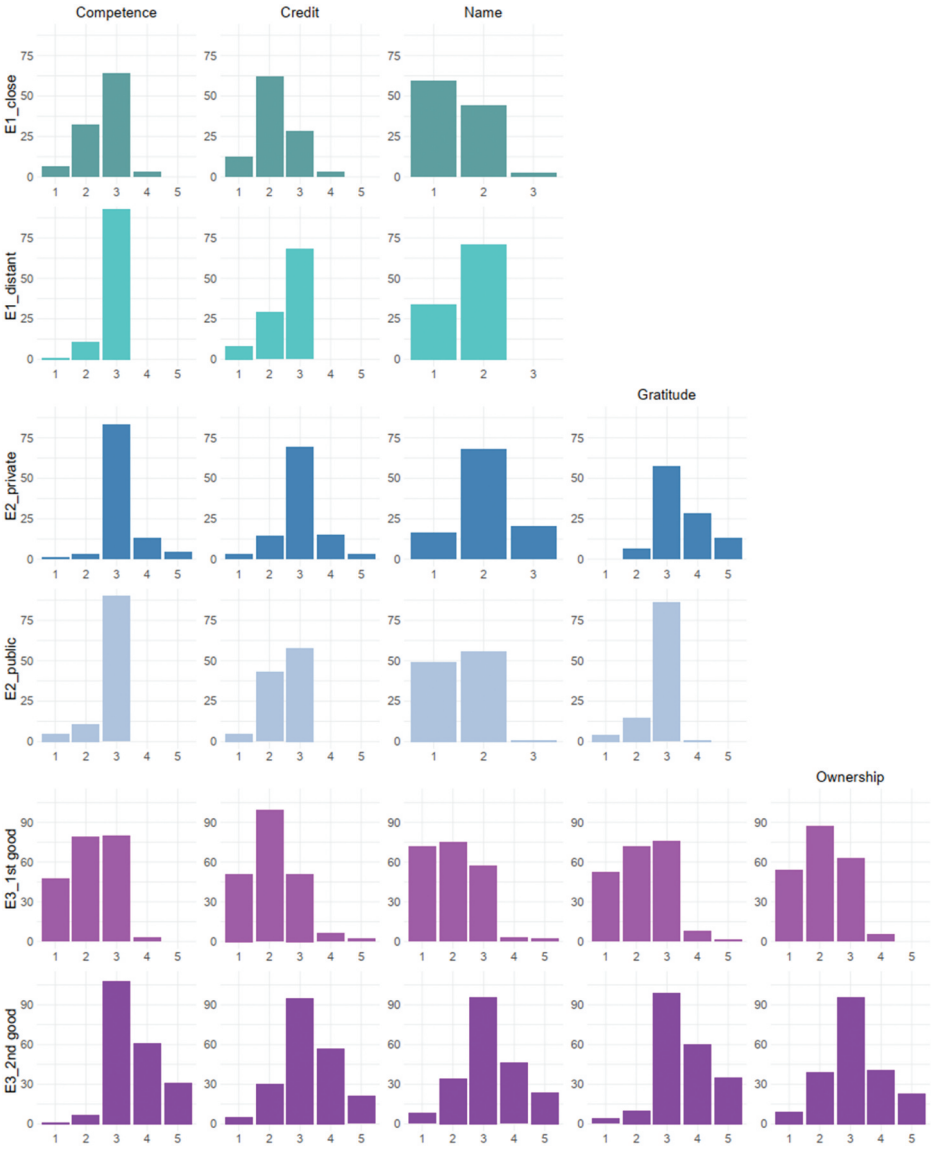

Figure 1. Frequency of each answer for each question, in each condition of all three experiments. For the 5-point scales, 1 indicates strong support for the first discoverer; 2 medium support for the first discoverer; 3 equality between the two discoverers; 4 medium support for the second discoverer; 5 strong support for the second discoverer. For the 3-point scales, 1 indicates support for the first discoverer; 2 equality between the two discoverers; 3 support for the second discoverer.

first discoverer ($M = 0.32$, $SD = 0.20$, on the scale of 0 [first discoverer] to 1 [second discoverer]), while competence was more equally attributed to both ($M = 0.44$, $SD = 0.13$).

Supporting H2, even in the Distant Country Condition, participants' ratings on the credit index ($M = 0.37$, $SD = 0.18$) were still significantly

more in favor of the first discoverer than on the competence question ($M = 0.47$, $SD = 0.09$) (paired t-test: $t(104) = -6.05$, $p < .01$, Cohen's $d = 0.59$).

Experiment 1 shows that participants are more biased in favor of the first discoverer in terms of credit attribution than in terms of competence attribution. In particular, when plagiarism is impossible, participants deem the two discoverers essentially equally competent (see Figure 1), though they still think the first discoverer deserves more credit. This suggests that credit attribution cannot be reduced to attributions of competence.

Experiment 2

The first-discoverer bias in credit attribution, demonstrated in Experiment 1, might reflect the fact that participants feel more grateful to the first discoverer, as he is the one providing genuinely new information. Gratitude, however, should mostly favor the first discoverer if they made their discovery public, rather than if they kept it private, in which case no one else could derive benefits from it.

In Experiment 2, we compare two conditions, Public and Private. The Public condition uses the same vignettes as the Distant Country condition in Experiment 1, with both discoverers making their discoveries public. In the Private condition, the first discoverer makes the discovery, but keeps it private.

By comparing these conditions, Experiment 2 tests the following hypotheses. First:

> H3 Gratitude toward the first discoverer is higher in the Public Condition than in the Private Condition.

Then, since credit is supposed to partly depend on gratitude:

> H4 The first discoverer is granted more credit in the Public Condition than in the Private Condition.

Finally, in the Public Condition, since the discoveries are independent, participants should not strongly favor the first discoverer on competence, but they should feel more grateful toward him.

> H5 In the Public Condition, participants favor the first discoverer more on gratitude than on competence.

Participants

$N = 210$, 103 male, 106 female, 1 other, $M_{age} = 38.11$

Materials and procedure

This experiment replicates Experiment 2a from the ESM, with a change to the wording of one potentially ambiguous sentence. The Distant Condition vignettes of Experiment 1 were used as the Public Condition. By contrast, here's an example of a Private Condition vignette:

> *Private Condition*: In 1651, French scientist Paul Lesage working in France, discovered a law governing air pressure. However, he never published this finding, which was only found years later, after his death, in his notes. Later in 1651, Chinese scientist Kuo Zhang made the same discovery in China, but he published his results and shared them with other scientists. At the time, France and China were not in close contact, and scholars from both countries barely communicated.

To the three questions from Experiment 1, we added:

> *Gratitude Question*: "To which of the two discoverers do you think people should be more grateful?" 5-point Likert ranging from 1 indicated, [Much more grateful to "Name of the first scientist to make the discovery"], to 5 [Much more grateful to "Name of the second scientist to make the discovery"].

The order of the questions was fixed, as in Experiment 1.

Results and discussion

Supporting H3, participants were more grateful toward the first discoverer in the Public Condition ($M = 0.45$, $SD = 0.13$) than in the Private Condition ($M = 0.62$, $SD = 0.20$) (independent t-test: $t(176.24) = 7.29$, $p < .01$, Cohen's $d = 1.01$) (all answers have been normalized from 0 [supporting the first discoverer] to 1 [supporting the second discoverer]).

Supporting H4, participants granted more credit (on the credit index created as in Experiments 1, ranging from 0 to 1) to the first discoverer in the Public Condition ($M = 0.32$, $SD = 0.18$) than in the Private Condition ($M = 0.51$, $SD = 0.32$) (independent t-test: $t(208) = 6.61$, $p < .01$, Cohen's $d = 0.91$).

Against H5, participants did not grant significantly more gratitude ($M = 0.45$, $SD = 0.13$) than competence ($M = 0.45$, $SD = 0.13$) to the first discoverer in the Public Condition (paired t-test, $t(105) = -0.24$, $p = .81$). This test is the most direct test of H5, but is not the one we had pre-registered (see ESM for the pre-registered test).

Experiment 2 shows that participants are sensitive to whether a discovery was publicized or not in deciding how grateful they feel toward the discoverers, feeling less grateful toward the first discoverer when he kept his discovery private. The results also suggest that these feelings of gratitude are related to the attribution of credit, with less credit being granted to a discoverer who did not publicize his discoveries. H5 was not verified. As

expected, the participants did not favor the first discoverer on competence, but they also did not favor him on gratitude. This latter lack of difference might be due to the fact that both discoveries are described as having taken place a long time ago, which means that our participants did not benefit from one discoverer having shared the discovery earlier than the other.

Experiment 3

Descriptively (see Figure 1), in the Private Condition of Experiment 2, participants feel much more grateful to the second discoverer, and they attribute as much competence to both discoverers. However, they do not grant the first discoverer more credit. This suggests that credit attribution might not be only a matter of competence attribution and gratitude. It is possible that participants use a first contact heuristic, by which they think the first individual to make a discovery "owns" it, and therefore deserves *some* credit – even if they are not the most competent, or the most deserving of gratitude.

To more directly track intuitions of ownership, we introduced a new question asking participants who "owns" the discovery. More importantly, we created vignettes in which one of the two discoverers was described as a "good" discoverer, that is, both more competent (they knew what they were looking for, and realized the importance of the discovery), and more deserving of gratitude (they published their discovery, and it had clear benefits for the population). This yielded a First Discoverer Good Condition and a Second Discoverer Good Condition.

Since the good discoverer is described as more competent and more deserving of gratitude, they should be rated higher on both of these traits and, in turn, deemed more deserving of credit, irrespective of whether they were first or second. However, if the first contact heuristic plays a role, this preference for the good discoverer should be modulated by the discoverers' order when it comes to the credit and ownership questions. When the good discoverer is also the first, all the factors are aligned in his favor, so the preference toward him should be very strong; by contrast, when the good discoverer is second, competence attributions and the feeling of gratitude pull in the opposite direction of the first contact heuristic, which should yield a weaker preference in favor of the good discoverer, regarding the credit and ownership questions. This leads to the following hypothesis:

> H6 When the good discoverer is the second discoverer, by contrast with when he is the first discoverer, the preference in his favor should be stronger for the competence attribution and feeling of gratitude, than for the credit and ownership attributions.

Participants

$N = 421$; 208 male, 212 female, 1 other; M age = 40.06, 4 participants excluded because they did not pass the attention check.

Materials and procedure

The vignettes were similar to those of previous experiments (three vignettes with three topics, nationality of the discoverers counterbalanced). Here's an example of a vignette in the Second Discoverer Good Condition:

> Early in 1651, French scientist Paul Lesage was being paid to write an essay on air pressure. In the process, he stumbled, by chance, on an important law governing air pressure. However, he did not realize the importance of this discovery, and he did not include it in his published essay. As a result, people only realized he had discovered that law in the 20th century when combing through his notes. Later in 1651, Chinese scientist Kuo Zhang published the same law of air pressure in China. Zhang had been researching air pressure because he thought it was fascinating, and believed that it could have positive practical consequences. Zhang fully realized the importance of his discovery. This law of air pressure allowed technological progress in China. At the time, France and China were not in close contact, and scholars from both countries barely communicated.

Vignettes in the First Discoverer Good Condition were created by swapping the attributes of the two discoverers.
We also introduced an ownership question:

> *Ownership Question*: "Who do you think 'owns' the discovery?" answers: 1 indicated [Definitely "Name of the first scientist to make the discovery"], 2 indicated [Probably "Name of the first scientist to make the discovery"] 3 indicated ["Name of the first scientist to make the discovery" and "Name of the second scientist to make the discovery"], 4 indicated [Probably "Name of the second scientist to make the discovery"] and 5 indicated [Definitely "Name of the second scientist to make the discovery"].

Additionally, we modified the answer format so that all questions required an answer on a 5-point Likert scale in order to make them more comparable. All participants answered the questions in the same order. The experiment is a direct replication of Experiment 3b from the ESM apart from the aforementioned changes and a different preregistered analysis (see ESM for details).

Results and discussion

As a manipulation check, we created a gratitude and competence index, by adding the answers to the two questions (each rescaled to range between 0 and 0.5). The index ranged from 0 (all gratitude and

competence to the first scientist to make the discovery) to 1 (all gratitude and competence to the second discoverer to make the discovery). Participants in the First Discoverer Good Condition favored the first discoverer on the competence and gratitude index ($M = 0.30$, $SD = 0.19$, one-sample t-tests comparing the answers to the scale midpoint $t(208) = -15.70$, $p < .01$, Cohen's $d = -1.09$), while participants in the Second Discoverer Good Condition favored the second discoverer ($M = 0.64$, $SD = 0.18$, $t(207) = 10.74$, $p = <.01$, Cohen's $d = 0.75$).

Our next, pre-registered, analysis tested the bias for the good discoverer in the two conditions. We first reverse-coded the data from the Second Discoverer Good condition so that lower values would represent the preference for the good discoverer in both conditions. We then calculated a new variable to represent the strength of the bias for the good discoverer by subtracting the scores on the normalized questions from 0.5 (the midpoint for all variables after they were rescaled to range between 0 and 1), i.e., the neutral answer. Hence, the higher the value of this variable, the more pronounced the bias in favor of the good discoverer on a given question. We did this in order to investigate whether the bias shown toward the good discoverer was the same across questions, and between the two conditions. Specifically, we expected interactions between condition and question, such that the first contact heuristic would produce more bias in the Good Discoverer First condition on questions relating to credit, naming and ownership, as opposed to competence or gratitude.

We ran a linear mixed-effects regression with the strength of preference as the dependent variable, participants as the random effect, and question (competence as base), condition (First Discoverer Good Condition as base) and their interaction as fixed effects (see Supplementary Table SM1 for full model output). The analysis was carried out using the lme4 package (Bates et al., 2015).

As predicted, there were significant interactions between condition and credit (*beta*=-0.09, $SE = 0.02$, $t = -4.63$, $p<.001$, 95% CIs [−0.13, −0.05]); condition and name (*beta*=-0.13, $SE = 0.02$, $t = -6.82$, $p<.001$, 95% CIs [−0.17, −0.10]), and condition and ownership (*beta*=-0.12, $SE = 0.02$, $t = -6.34$, $p < .001$, 95% CIs [−0.16, −0.09]). These interactions show that the participants' bias toward the good discoverer, when the good discoverer is second as opposed to first, is weaker for the credit, naming, and ownership questions compared to the bias on the competence question (which does not differ from gratitude). The lack of a significant interaction with gratitude suggests that the priority preference is no different when it comes to gratitude than for competence attribution (see Supplementary Table SM1, and Figure 2).

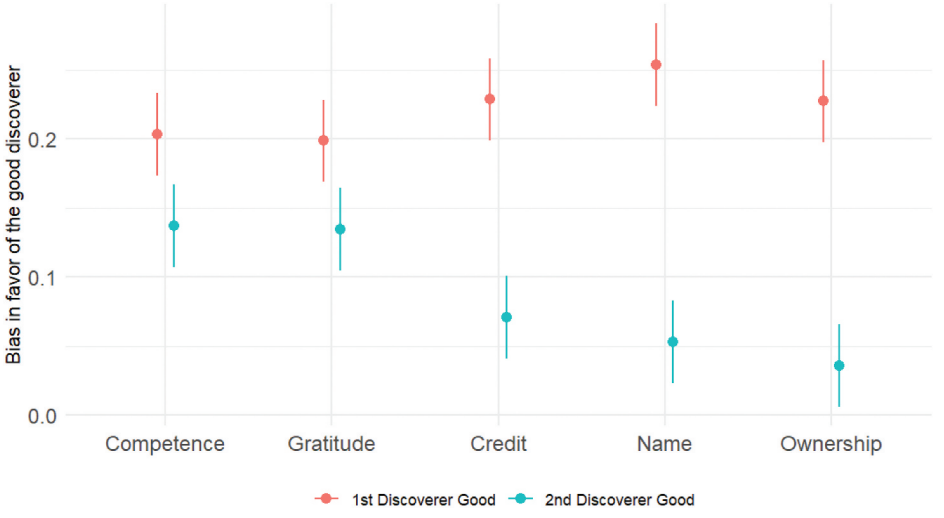

Figure 2. Predicted values of strength of bias in favor of the discoverer described as 'good' in both conditions of experiment 3, for each of the five questions.

Of interest, we also find a main effect of condition (*beta*=-0.07, *SE* = 0.02, *t*= −3.08, $p < .001$, 95% CIs [−0.11, −0.02]), which points to a weaker preference for the good discoverer in the Second Discoverer Good condition as opposed to the First Discoverer Good condition overall. Given the aforementioned significant interactions, however, this effect should be interpreted carefully.

General discussion

We developed a simple model of credit attribution, according to which the credit for creating an idea depends on (i) whether people attribute competence to the creator, (ii) whether people feel gratitude toward the creator, (iii) who had the idea first (following the intuition that first contact leads to ownership, and thus credit). In three experiments, we tested the model using materials that describe distinct scientific discoveries.

The results suggest that all three factors are relevant to credit attribution. In our experiments, participants had to judge various traits of two discoverers who made the same scientific discovery, one after the other. In Experiment 1, we manipulated whether plagiarism was possible. When this was the case, participants deemed the second discoverer less competent and thus granted him less credit, showing the importance of competence attribution for credit attribution. However, even when no plagiarism was possible, and participants essentially deemed both discoverers equally competent, they awarded more credit to the first discoverer, showing that something besides competence is at play.

In Experiment 2, one of the discoverers either made their discovery public (as in Experiment 1), or kept it private. As expected, participants felt less grateful toward the discoverer who kept his discovery private and granted that discoverer less credit, showing the role of gratitude in credit attribution. In one condition of Experiment 2, participants felt the two discoverers were equally competent, and felt much more grateful toward the second discoverer. If competence and gratitude were the only two factors of credit attribution, participants should have clearly granted more credit to the second discoverer. Instead, credit attributions were essentially split between the two discoverers, suggesting another factor was at play.

In Experiment 3, we described either the first or the second discoverer in a way that would make them appear as both more competent, and more deserving of gratitude. In spite of this, participants still exhibited a bias toward the first discoverer in credit attribution, relative to attributions of competence and gratitude. This confirmed that merely being the first to discover something leads to some credit, even if the discoverer is perceived as less competent, and elicits weaker feelings of gratitude. This bias was reflected in questions about the ownership of the discovery, suggesting that intuitions of ownership might explain the tendency to grant more credit to the first discoverer.

Conclusion

The experiments presented suggest that the attribution of credit for the creation of ideas depends on three factors: whether creating the idea is an indicator of the creator's competence; whether sharing the idea means we feel grateful toward the creator; and whether the creator was the first to come up with the idea. The first two factors create a link between the literature on credit attribution and the literature on social perception, in which it is well established that people perceive others along the main axes of competence and warmth (Abele & Wojciszke, 2007; Fiske et al., 2007). We show that, in the case of credit attribution, warmth could take the more specific form of gratitude, which points to a new avenues for research: gratitude for information – epistemic gratitude. The last factor links credit attribution to intuitions relative to ownership, in particular the intuition that the first individual to make contact with something – in the case of creations, the first individual to have an idea – owns it.

Credit attributions play an important role in many institutions, from art to law. In the case of science, one striking form that credit attribution takes is the priority rule. By contrast with other human endeavors, the first individual to make a discovery in science gets most or all of the credit – they get the prizes, the discovery is named after them, etc. Since our experiments were set in the context of priority disputes in science, we now

expand on the notion of the priority rule, and suggest that our model of credit attribution can help explain its popularity.

The priority rule means that scientists who first publish a finding can reap financial and reputational reward, including giving their name to a discovery. These rewards are, according to Merton (1957), an essential part of what motivates scientists. It has thus been suggested that the priority rule exists so as to provide incentives to scientists. This argument was further developed by Stephan (2015, p. 25). Stephan points out that once a scientist has shared their discovery with the world, they typically forfeit actual ownership of the idea: anybody can use it, built on it, etc. for free. The priority rule would be "another form of property rights", which "motivates scientists to produce and share knowledge in a timely fashion"(ibid.). This description of the priority rule also fits with the idea that intuitions about credit attribution are related to intuitions of ownership. However, if the importance of such reputational rewards for the motivation of scientists is hard to deny, these rewards can be provided by other incentive schemes, even schemes that would reward scientists for the effort provided instead of the results (see, Strevens, 2003).

Dasgupta and David (1994) offer an explanation for the stress placed on achievement over effort, that is implicit in the priority rule. They note that the results are much easier to measure than effort. Moreover, the priority rule should push scientists to make their findings public as quickly as possible. Note, however, that relaxed versions of the priority rule – for instance, rewarding the first two or three scientists who make a discovery – would provide broadly similar incentives (Strevens, 2003), but they are not common. For instance, when commenting on the priority dispute between Cavendish and Watt, the then permanent secretary of the French Academy of Sciences suggested that priority could depend "on weeks, on days, on hours, on minutes" (cited in Merton, 1957, p. 658). This, despite the fact that a scientist who publicizes a finding a few minutes after its first publication, typically made very similar choices (of research topic, methods, publication, etc.) to the prior scientist's, so that it is not clear why rewarding one over the other is the best incentive scheme.

Strevens (2003) stresses what makes science different from many other endeavors: once a discovery has been made, a later, independent discovery doesn't contribute anything to the society in which the discovery took place. Within this context, Strevens develops a mathematical model suggesting that the priority rule can represent an optimal way of allocating resources in science by incentivizing the most promising research programs.

These explanations share a functionalist assumption: the priority rule exists because it makes science more efficient. This raises two issues. The first is that functionalist explanations offer no obvious causal mechanism for the emergence and persistence of a norm,

however excellent the norm. Societies often converge instead on sub-optimal norms – at least from the point of view of their stated goal – even in domains as functionally important as medicine (Edgerton, 1992; Wootton, 2006) which means that when they do converge on a good norm, that cannot simply be explained by the advantages of the norm.

The second issue with functionalist explanations of the priority rule is that the priority rule has substantial drawbacks. We list five of these drawbacks here.

First, the priority rule can have debilitating effects on individual scientists, introducing a significant element of chance in their careers, and embroiling them in time-consuming disputes likely to be harmful to the mental health of everyone involved (see, e.g., the dispute over the discovery of anti-coagulants, see Marcum, 2000).

Second, if one of the advantages of the priority rule is to reward prompt publication of one's findings, this also incentivizes cutting corners by using less reliable methods, failing to sufficiently establish the reliability of one's findings, etc (Tiokhin et al., 2021).

Third, by creating enmity between scientists, the priority rule sometimes slows down the course of science. Absent the dispute between Leibniz and Newton over the invention of the calculus, English scholars might not have waited decades before adopting Leibniz's more efficient notation system, already adopted by continental scholars (Collins & Restivo, 1983). In their race to be the first to report new dinosaur species, paleontologists Cope and Marsh each destroyed fossils instead of giving the other a chance to take credit for them (Jaffe, 2001).

Fourth, the priority rule favors people who hold a higher position within science. This has meant, for example, that women's contributions have tended to be neglected (e.g., Maddox, 2002; Rowe & Koreuber, 2020; Swaby, 2015). Modeling shows that the priority rule can help reinforce structural disadvantages in science by accentuating inequalities between groups (Rubin & Schneider, 2021).

Last but not least, the priority rule simply often grants credit to the "wrong" (i.e., not the first) discoverer, to the point that the naming of a scientific discovery after someone who is not their first discoverer has been dubbed a law, "Stigler's law" (fittingly, Stigler's law is also an example of Stigler's law, since it was not first proposed by Stigler). If the priority rule often fails to reward the first discoverer (and especially if this is quite widely recognized), it is not clear how it can help optimally allocate resources.

These considerations are not a conclusive proof against functionalist explanations for the priority rule: its advantages could outweigh its drawbacks. Moreover, scientists could realize (or simply believe, whether it is true or not) that this is the case, and thus push for the continued use of the

priority rule for these reasons. Still, the arguments above suggest that alternatives to the functionalist hypothesis should be considered.

The model we sketched suggests that, instead of owing its popularity to its usefulness, the priority rule could owe its popularity to its fit with our psychology. In other domains, such as morality or economics, it has also been suggested that norms and institutions owe their success in part to what makes these norms and institutions seem intuitively "natural" and compelling (Boyer & Petersen, 2012; Nichols, 2002; Sperber, 1996). Here, intuitive credit attribution should favor the first discoverer for three reasons: (i) later discoverers might have been inspired by or even plagiarized the first, in which case they should be deemed less competent; (ii) we should mostly feel gratitude toward the first person who gives us a piece of information; (iii) the first discoverer is the first to have "made contact" with the idea discovered, and is thus intuited to have "ownership" of it. In particular, intuitions of first contact are triggered even if someone else made, or could have made, contact with something very shortly after the first individual to do so (Friedman, 2010). This could help explain why it has been suggested that the priority rule applies even when the priority merely depends "on weeks, on days, on hours, on minutes" (cited in Merton, 1957, p. 658).

A limitation of the present studies is that they have been conducted among laypeople, and not scientists. If scientists might be the chief architects of scientific institutions, laypeople – patrons, funders, even the general public – also play a role in shaping these institutions. Moreover, scientists and laypeople appear to reason broadly similarly, even in areas in which we might wish scientists to perform differently from laypeople—e.g., by displaying a weaker confirmation bias (Koslowski, 2012). Still, it would certainly be interesting to replicate the present experiments in a sample of scientists.

Although much work remains to be done to link the kind of experiments we presented with the priority rule as encountered in science, we believe that the psychological mechanisms studied here hold one of the keys to understanding the popularity of this institution.

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References

Abele, A. E., & Wojciszke, B. (2007). Agency and communion from the perspective of self versus others. *Journal of Personality and Social Psychology*, *93*(5), 751. https://doi.org/10.1037/0022-3514.93.5.751

Altay, S., Majima, Y., & Mercier, H. (2020). It's my idea! Reputation management and idea appropriation. *Evolution and Human Behavior*. https://doi.org/10.1016/j.evolhumbehav.2020.03.004

Author, H. (submitted).

Bates, D., Mächler, M., Bolker, B., & Walker, S. Article 1. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01.

Boyer, P., & Petersen, M. B. (2012). The naturalness of (many) social institutions: Evolved cognition as their foundation. *Journal of Institutional Economics*, *8*(1), 1–25. https://doi.org/10.1017/S1744137411000300

Collins, R., & Restivo, S. (1983). Robber barons and politicians in mathematics: A conflict model of science. *Canadian Journal of Sociology/Cahiers Canadiens de Sociologie*, *8*(2), 199–227. https://doi.org/10.2307/3340126

Cremer, D. D., & Tyler, T. R. (2005). Am I respected or not?: Inclusion and reputation as issues in group membership. *Social Justice Research*, *18*(2), 121–153. https://doi.org/10.1007/s11211-005-7366-3

Dasgupta, P., & David, P. A. (1994). Toward a new economics of science. *Research Policy*, *23*(5), 487–521. https://doi.org/10.1016/0048-7333(94)01002-1

de Courson, B., Fitouchi, L., Bouchaud, J.-P., & Benzaquen, M. (2021). Cultural diversity and wisdom of crowds are mutually beneficial and evolutionarily stable. *Scientific Reports*, *11*(1), 1–15. https://doi.org/10.1038/s41598-021-95914-7

Dutilh Novaes, C. (2019). The Beauty (?) of Mathematical Proofs. In A. Aberdein & M. Inglis (Eds.), *Advances in Experimental Philosophy of Logic and Mathematics* (pp. 63–93). London:Bloomsbury Academic.

Edgerton, R. B. (1992). *Sick societies: Challenging the myth of primitive harmony*. Free Press.

Emmons, R. A., & McCullough, M. E. (2004). *The psychology of gratitude*. Oxford University Press.

Fiske, S. T., Cuddy, A. J. C., & Glick, P. (2007). Universal dimensions of social cognition: Warmth and competence. *Trends in Cognitive Sciences*, *11*(2), 77–83. https://doi.org/10.1016/j.tics.2006.11.005

Friedman, O. (2010). Necessary for possession: How people reason about the acquisition of ownership. *Personality and Social Psychology Bulletin*, *36*(9), 1161–1169. https://doi.org/10.1177/0146167210378513

Friedman, O., & Neary, K. R. (2008). Determining who owns what: Do children infer ownership from first possession? *Cognition*, *107*(3), 829–849. https://doi.org/10.1016/j.cognition.2007.12.002

Gintis, H. (2007). The evolution of private property. *Journal of Economic Behavior & Organization*, *64*(1), 1–16. https://doi.org/10.1016/j.jebo.2006.02.002

Inglis, M., & Aberdein, A. (2015). Beauty is not simplicity: An analysis of mathematicians' proof appraisals. *Philosophia Mathematica*, *23*(1), 87–109. https://doi.org/10.1093/philmat/nku014

Jaffe, M. (2001). *The gilded dinosaur: The fossil war between ED Cope and OC marsh and the rise of American science*. Three Rivers Press.

Kaplan, H., & Gurven, M. (2005). The natural history of human food sharing and cooperation: A review and a new multi-individual approach to the negotiation of norms. In H. Gintis, S. Bowles, R. Boyd, & E. Fehr (Eds.), *Moral sentiments and material interests: The foundations of cooperation in economic life* (pp. 75–113). MIT press.

Koslowski, B. (2012). Scientific reasoning: Explanation, confirmation bias, and scientific practice. In G. Feist & E. Gorman (Eds.), *Handbook of the psychology of science*. Springer.

Leary, M. R. (1995). *Self-presentation: Impression management and interpersonal behavior*. Westview Press.

Li, V., Shaw, A., & Olson, K. R. (2013). Ideas versus labor: What do children value in artistic creation? *Cognition*, *127*(1), 38–45. https://doi.org/10.1016/j.cognition.2012.11.001

Maddox, B. (2002). *Rosalind Franklin: The dark lady of DNA*. Harper Collins.

Mandel, G. N., Olson, K. R., & Fast, A. A. (2020). Debunking intellectual property myths: Cross-cultural experiments on perceptions of property. *BYU Law Review*, *219*. https://doi.org/10.2139/ssrn.3312822

Marcum, J. A. (2000). The origin of the dispute over the discovery of heparin, HYPERLINK "https: //muse.Jhu.edu/pub/8/journal/92"Journal of the history of. *Journal of the History of Medicine and Allied Sciences*, *55*(1), 37–66. https://doi.org/10.1093/jhmas/55.1.37

Marr, D. (1982). *Vision: A computational investigation into the human representation and processing of visual information*. W. H. Freeman.

Maynard Smith, J., & Price, G. R. (1973). The logic of animal conflict. *Nature*, *246*(5427), 15–18. https://doi.org/10.1038/246015a0

McCullough, M. E., Kilpatrick, S. D., Emmons, R. A., & Larson, D. B. (2001). Is gratitude a moral affect? *Psychological Bulletin*, *127*(2), 249. https://doi.org/10.1037/0033-2909.127.2.249

Merton, R. K. (1957). Priorities in scientific discovery: A chapter in the sociology of science. *American Sociological Review*, *22*(6), 635–659. https://doi.org/10.2307/2089193

Nichols, S. (2002). On the genealogy of norms: A case for the role of emotion in cultural evolution. *Philosophy of Science*, *69*(2), 234–255. https://doi.org/10.1086/341051

Olson, K. R., & Shaw, A. (2011). 'No fair, copycat!': What children's response to plagiarism tells us about their understanding of ideas. *Developmental Science*, *14*(2), 431–439. https://doi.org/10.1111/j.1467-7687.2010.00993.x

R Core Team. (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Rowe, D. E., & Koreuber, M. (2020). *Proving it her way: Emmy Noether, a life in mathematics*. Springer International Publishing.

RStudio Team. (2022). RStudio: Integrated development for R. *RStudio*, http://www.rstudio.com/

Rubin, H., & Schneider, M. D. (2021). Priority and privilege in scientific discovery. *Studies in History & Philosophy of Science Part A*, *89*, 202–211. https://doi.org/10.1016/j.shpsa.2021.08.005

Samuelson, P. (2009). Paul Samuelson. In W. Breit & B. T. Hirsch (Eds.), *Lives of the laureates* (pp. 49–64). Twenty-three Nobel economists. MIT Press.

Shaw, A., Li, V., & Olson, K. R. (2012). Children apply principles of physical ownership to ideas. *Cognitive Science*, *36*(8), 1383–1403. https://doi.org/10.1111/j.1551-6709.2012.01265.x

Shaw, A., & Olson, K. (2015). Whose idea is it anyway? The importance of reputation in acknowledgement. *Developmental Science*, *18*(3), 502–509. https://doi.org/10.1111/desc.12234

Sperber, D. (1996). *Explaining culture: A naturalistic approach*. Blackwell: Oxford.

Stark, L.-J., & Perfect, T. J. (2007). Whose idea was that? Source monitoring for idea ownership following elaboration. *Memory*, *15*(7), 776–783. https://doi.org/10.1080/09658210701643042

Stephan, P. (2015). *How economics shapes science*. Harvard University Press.

Stern, S. (2004). Do scientists pay to be scientists? *Management Science*, *50*(6), 835–853. https://doi.org/10.1287/mnsc.1040.0241

Strevens, M. (2003). The role of the priority rule in science. *The Journal of Philosophy*, *100*(2), 55–79. https://doi.org/10.5840/jphil2003100224

Swaby, R. (2015). *Headstrong: 52 women who changed science-and the world*. Crown Publishers.

Tiokhin, L., Yan, M., & Morgan, T. J. (2021). Competition for priority harms the reliability of science, but reforms can help. *Nature Human Behaviour*, *5*(7), 857–867. https://doi.org/10.1038/s41562-020-01040-1

Wootton, D. (2006). *Bad medicine: Doctors doing harm since Hippocrates*. Oxford University Press.

Yang, F., Shaw, A., Garduno, E., & Olson, K. R. (2014). No one likes a copycat: A cross-cultural investigation of children's response to plagiarism. *Journal of Experimental Child Psychology*, *121*, 111–119. https://doi.org/10.1016/j.jecp.2013.11.008