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Confirmation: What's in the evidence?

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ABSTRACT

The difference between accommodated evidence (i.e., when evidence is known first and then a hypothesis is proposed to explain and fit the observations) and predicted evidence (i.e., when evidence verifies the prediction of a hypothesis formulated before observing the evidence) is investigated in this article. According to the purely logical approach of Bayesian confirmation theory, accommodated and predicted evidence constitute equally strong confirmation. Using a survey experiment on a sample of students, however, it is shown that predicted evidence is perceived to constitute stronger confirmation than accommodated evidence. The results show that predictions work as a signal about the scientists' (the proposer of the hypothesis) knowledge which in turn provides stronger confirmation.

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1. Introduction

Is it relevant for scientific confirmation whether evidence is known first and a hypothesis is proposed later to explain and fit it (henceforth called accommodation), or evidence verifies predictions from a hypothesis formulated before observing the evidence?[1] Bayesian confirmation theory implies that whether evidence is predicted or accommodated is irrelevant. A hypothesis is confirmed if the posterior is greater than the prior, and this occurs if evidence supports the hypothesis independent of the timing of the empirical claim, i.e., whether the hypothesis is stated before or after the data has been observed. This view, also known as the purely logical approach to confirmation, holds that the timing of the empirical claim is irrelevant for scientific confirmation.

Musgrave (1974) discusses the possibility of how to move away from the purely logical approach to confirmation by giving a detailed review of three different views of the historical approach. The historical approach takes into account the historical setting in which the theory was proposed when judging the evidence. It holds that predicted evidence is more important than accommodated evidence unless special circumstances prevail. The first and most extreme perspective, the strictly temporal view of background knowledge, holds that facts known before a hypothesis is proposed cannot confirm the hypothesis since they are already part of background knowledge. But for many this view is too conservative.[2] The second, heuristic view of background knowledge claims that an old fact can confirm and be novel to a new theory, provided the theory has not been constructed to explain the fact but is still in the process of explaining it. Finally, the third view of background knowledge holds that old facts can confirm and be novel to the new theory if and only if its prediction is unique such that it cannot be explained by or contradict the old theory.

While scientific confirmation has been debated heavily in philosophy for over 400 years, it has gained well-deserved attention in economics only relatively recently. Kahn et al. (1996) developed a model that focuses on different scientific methods. In their decision theoretical framework, it is shown that if the scientists have different abilities to propose truthful theories and can choose either to predict the evidence or construct a theory that accommodates it, an observer will have a stronger belief in the truthfulness of the theory if the theory is proposed before the evidence has been considered. The observer, assumingly unaware of the

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[1] In the case of prediction, the hypothesis is usually partly based on existing observations. However, a prediction requires the empirical claim to be verified by at least some observations that are made after the empirical claim (Lipton, 2005).

[2] A famous historical example is that Einstein showed that general relativity agrees closely with the observed amount of perihelion shift, which was not the case with Newtonian physics. Although the motion of the perihelion of Mercury was known long before Einstein proposed his theory, the evidence was considered to support the theory and to be a powerful argument motivating the adoption of general relativity.

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scientist's abilities, updates the probability that the consistent theory is proposed by a scientist with greater ability to propose truthful theories if evidence supports the theory, thus providing stronger confirmation. If the scientist constructs a theory that accommodates evidence, however, nothing is learned about the scientist's type and no updating takes place. While Bayesian epistemology traditionally avoids the relationship between evidence and personal or psychological attributes, which can be considered to impose undesirable subjectivity and arbitrariness on questions of evidential support, Kahn et al. (1996) focus on this link.[3] In the present paper we empirically examine the perception of evidence. Our main findings are that predicted evidence constitutes stronger confirmation than accommodated evidence and that prediction works as a convincing signal about the scientist's knowledge.

The remainder of the *paper is organized as follows*. Section 2 begins with a general discussion on the importance of understanding how evidence is perceived. We then move on to discuss scientific methodology considering the age-old question of whether a theory can be confirmed or only refuted, and how it relates to the classical approach to inference. While the main focus of this paper is on Bayesian confirmation, the aim of Section 2 is to put the question in a broader context by discussing some non-Bayesian perspectives and relate it to contemporary classical inference methods.[4] In Section 3, we turn to the Bayesian perspective and formulate simple Bayesian models of confirmation, and hypotheses are formulated based on the predictions of our models. In Section 4, we explain the experimental design, and the results are presented in Section 5. Section 6 concludes the paper.

2. Background

2.1. The perception of evidence

What is evidence? One view is that evidence is knowledge acquired by means of the senses. But there are several other accounts of what constitutes evidence as well. For example, evidence is suggested to be information, or evidence is what is fully believed, or evidence is something that is observed and justifies some beliefs. Williamson (2015) argues that the view that evidence is any of these four suggestions has serious concerns. Instead he argues that evidence is what is rationally granted. This is in line with the intuition that you cannot reason your way to something without presuming something else. While the epistemological analysis of what evidence really is may be interesting, it is beyond the context of our enquiry, which relies on folk intuition of what constitutes evidence. Folk intuition of evidence is of course likely to be less rigorously defined than the epistemological understanding of evidence.

We test whether people take a purely logical stand on confirmation (i.e., hold that the timing of the empirical claim is irrelevant for scientific confirmation) or whether they believe in a research hypothesis that predicts evidence more than they believe in one that accommodates it. Subsequently, we test whether prediction constitutes stronger confirmation than accommodation because the observer infers that scientists are more knowledgeable when they have provided a correct prediction (e.g., Kahn et al., 1996). Hence, we investigate whether it is the fit between the hypothesis and the evidence that affects beliefs about whether or not a hypothesis is true, or if beliefs about the mental ability of the scientist also affect people when judging whether or not a hypothesis is true together with the evidence. As far as we know, there are no empirical studies that address these questions. Yet, it seems essential for our understanding of how scientific results are perceived. This is true not only for results produced in economics but in general for all empirical sciences. For example, for the science of climate changes it could be essential to understand how people judge scientific evidence and how to credibly communicate scientific results. While many climate science studies show evidence that a long-term change (to year 2100) in the average atmospheric temperature could occur, a non-negligible share of the public persist in distrusting the results. Could short-term predictions reduce the gap in beliefs between scientists and the public and diminish the persistent rejection of what we know about global warming and its human causes by part of the public? This is a question that partly inspired this paper. Notably, understanding the complex models climate scientists use and the validity of these models is beyond most people's knowledge. In contrast, whether the predictions the scientists make at one point of time are verified at a later point in time or not could be easier for people to understand. To the extent we assume that changing people's beliefs about the state of the world can change their behavior, the understanding of how people actually judge evidence is essential. Before discussing confirmation from a Bayesian perspective, which is the main focus of this study, we will in the next section briefly address some non-Bayesian and contemporary perspectives. Hence, empirical hypotheses can be assessed in terms of some philosophical model of confirmation, e.g., either Bayesian confirmation, or in terms of falsification (e.g., Popperian falsification), which we will explore in greater detail in the next section.

2.2.. Evidence – non-Bayesian perspective(s)

According to Popper's view, science is distinguishable from pseudoscience based on the simple criterion that scientific theories are falsifiable and non-scientific theories are not. If a theory doesn't make a falsifiable prediction, it isn't science. Popper's views were in contrast to earlier views which generally held that empirical verifiability is the criterion that distinguishes scientific theories from pseudo statements. Popper (just like Hume) rejected the concept of induction (i.e., the process of inferring a general law or principle from the observation of particular instances) and argued that we cannot logically with certainty demonstrate the truth of general scientific theories using inductive inference. Popper argued that while empirical observations cannot prove scientific theories, they could very well refute (falsify) them. Hence, scientific theories cannot be confirmed by more and more positive empirical evidence. Notably, while confirmation is inductive inference, refuting can be based on deductive inference (reasoning from general to particular), which is what Popper propagates for empirical sciences (for example, suppose it is hypothesized that all swans are white, and A is a swan; by deduction, we conclude that A is white, and if A is observed to be black, the hypothesis is falsified).

There are two prominent approaches for statistical inference: the Bayesian and the classical. While the Bayesian approach is obviously in conflict with Popper's view that hypotheses cannot be confirmed, the question of how the classical approach relates to the Popperian view is more complicated, as will be discussed in the subsequent section.

In the classical framework, data is subjected to random variation, and a null hypothesis is a conjecture about the distribution of the random variable. A statistical test defines the rule for when to reject the conjecture. In a single hypothesis test, an acceptable

[3] A reason to avoid such a link is that norms in science value "universalism," which means that a person's attributes and social background is irrelevant to the scientific value of a person's ideas. I.e., *scientific* findings must be judged by *impersonal* criteria.

[4] Many economists seem to be aware of the conflict between the Popperian "conjectures and refutations" approach and Bayesian confirmation but less aware of the complicated relationship between classical inference and the Popperian approach, which we discuss in section 2.

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