

Review of: "Comments on "The roles, challenges, and merits of the p value" by Chén et al. (Patterns, 2023, 4(12), 100878)"

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The use of p-values in hypothesis testing has been a topic of extensive discussion in the statistical community, with many articles addressing their limitations and proper interpretation. As highlighted in a 2019 special volume of *Statistical Science* dedicated to the p-value debate, numerous statisticians have argued that the reliance on p-values has led to widespread misinterpretation and misuse in scientific research. This reliance on p-values has also sparked calls for alternative methods, such as Bayesian approaches, which align more closely with the logic of probability in scientific inference.

The central criticism of p-values is their misalignment with the principles of probability, especially in the context of hypothesis testing. The p-value measures the probability of observing data as extreme or more extreme than what was actually observed, given that the null hypothesis is true. However, it does not directly provide the probability of the hypothesis itself or the probability of observing an effect in future studies. This distinction is critical because scientific inquiry often revolves around understanding the likelihood of hypotheses in light of the evidence, which is more naturally expressed in the Bayesian framework.

Bayesian methods, in contrast to p-value-based approaches, allow for the explicit incorporation of prior knowledge and provide a probabilistic statement about hypotheses. By updating prior beliefs with observed data, Bayesian analysis offers a way to quantify the evidence for or against a hypothesis directly. The language of science is inherently probabilistic, involving the degree of belief or support for various hypotheses given the data. Hence, Bayesian statistics are more aligned with the logic of scientific inference than p-values, which can sometimes obscure rather than clarify the nature of evidence.

Non-statisticians often focus on the p-value as a definitive measure of significance. However, this focus has led to misinterpretations, such as equating statistical significance with practical importance or the erroneous belief that a p-value indicates the probability that the null hypothesis is true. These misunderstandings point to the need for a paradigm shift: rather than debating p-values, researchers should be encouraged to explore Bayesian approaches. In Bayesian hypothesis testing, the outcomes are framed in terms of probabilities directly relevant to the hypotheses, providing more intuitive and actionable information for decision-making.

In summary, while p-values have played a significant role in statistical hypothesis testing, their limitations and propensity

for misuse suggest that it is time to move beyond this paradigm. Instead, adopting Bayesian approaches can offer a more coherent and scientifically meaningful framework for testing hypotheses. The real language of science is probability, and Bayesian methods provide a way to articulate and interpret this language in a manner that aligns with the goals of scientific inquiry.