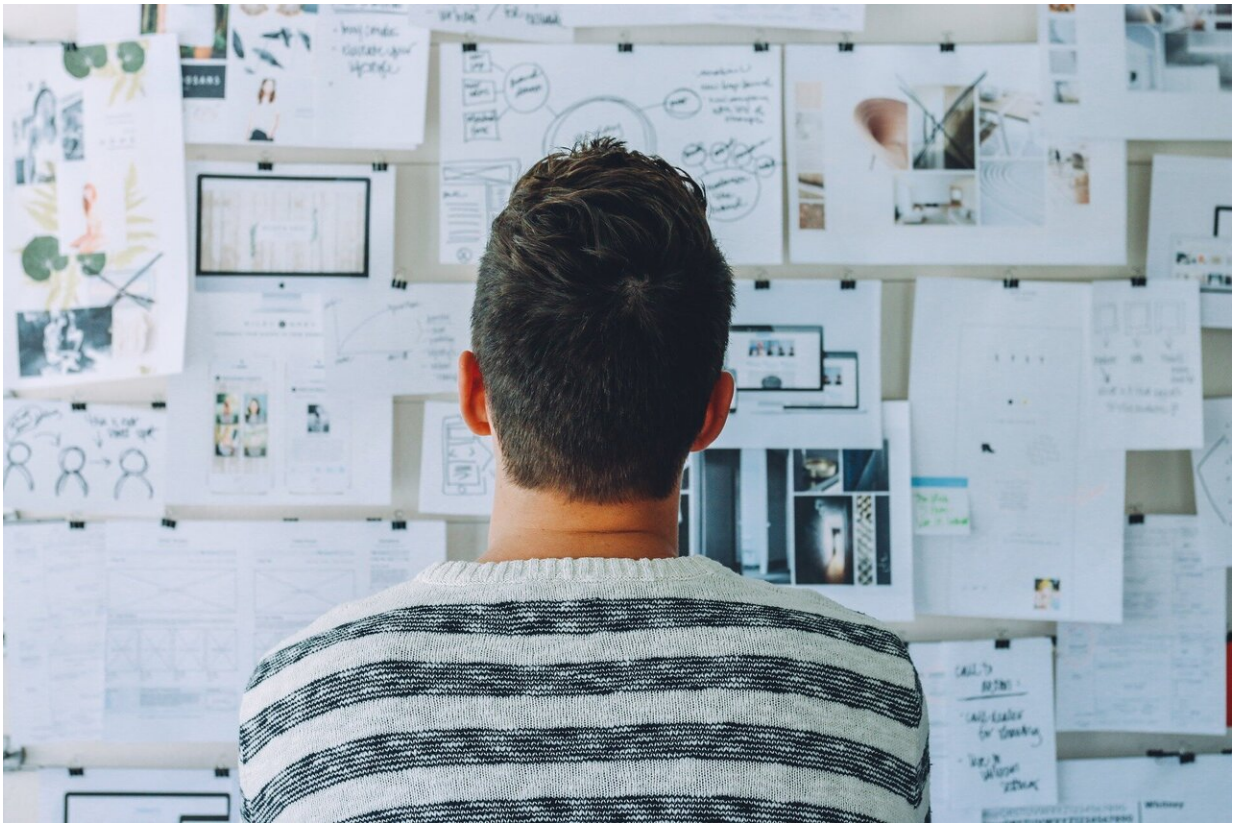
Key concepts, mathematical models, and statistical techniques for testing animal behavior rationality

November 12 2021



Credit: CC0 Public Domain

Testing rationality of decision-making and choice by evaluating the mathematical property of transitivity has a long tradition in biology,

economics, psychology, and zoology. However, this paradigm is fraught with conceptual, mathematical, and statistical pitfalls. A new article published in *The Quarterly Review of Biology* provides a tutorial review for animal scientists in testing whether animal behavior satisfies or violates rational choice theory.

In "(Ir)rationality of Animal Choice? A Guide to Testing Transitivity," authors Michel Regenwetter, Clintin P. Davis-Stober, Bart Smeulders, Bryanna Fields, and Cihang Wang review key conceptual, mathematical, and statistical insights that are prerequisites to justifiable conclusions from empirical testing of rationality. The paper focuses on the most prominent way to characterize rationality of preferences, i.e., "transitivity" of preferences.

The authors walk readers through key concepts, mathematical models, and statistical techniques for testing rationality and provide examples using the methods and data of prominent published articles on animal choice behavior as their case studies. They explain how these papers tackled the five hurdles to varying degrees of success.

The overview tackles five significant obstacles. One challenge lies in spelling out what transitivity of latent preferences says and what it implies about observable choice behavior. "This step is fraught with aggregation artifacts, in that aggregated behavior can be profoundly misleading about individual behavior," they note.

Another hurdle comes from mathematical problems associated with characterizing the properties of heterogeneous transitive populations. A third challenge is the prevalence of straw man hypotheses in this area of research, such as when different scholars rely on rejecting the same null hypothesis to support a variety of different and even mutually incompatible target hypotheses. "In our view, this happens routinely in rationality research," write the authors. The fourth difficulty is

associated with adopting appropriate statistical inference tools that correctly accommodate the idiosyncratic mathematical properties of order-constrained statistical hypotheses. Finally, the fifth hurdle arises with the role of scientific parsimony in rationality research.

"Despite seeming narrow and simple on the face of it, the transitivity paradigm requires great care with a huge range of complicated and deeply nuanced logical, mathematical, and data-analytical concepts," write the authors. They aim to endow animal scientists with the prerequisite knowledge and critical perspective to navigate these challenges. The authors note that they use "every effort to tackle a technical research question with maximally concrete examples and with as much simplicity as possible, while also unpacking and explaining the numerous errors that plague the literature in this research program." While claims of (ir)rational animal behavior in the literature have typically been insufficiently substantiated, rigorous tools are now available to better understand whether and when animal choice violates transitivity.

More information: Michel Regenwetter et al, (Ir)rationality of animal choice? A guide to testing transitivity, *The Quarterly Review of Biology* (2021). DOI: 10.1086/717165

Provided by University of Chicago