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Ockham's Razor

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Ockham's razor (also known as the principle of parsimony or the principle of simplicity) encompasses a variety of possible principles, all of which regard the simplicity of a theory as a virtue. The central question about the razor is when and why parsimony is *epistemically* relevant to the evaluation of hypotheses. People find simple theories easy to understand and beautiful to behold but that does not show why simplicity is relevant to saying whether a theory is true. Ockham's razor has been used in psychology to justify behaviorism, to criticize the dreaded error of anthropomorphism, to criticize the less-dreaded error of anthropodenial, to criticize the hypothesis that chimpanzees are mind readers, and to defend the claim that they are. Philosophers and statisticians have disagreed about the status of Ockham's razor. On the philosophy side, some think it is bunk, whereas others think it is indispensable. In between these two extremes, some philosophers find justifications for some applications of Ockham's razor while being skeptical about others.

History

Ockham's razor was named for the medieval philosopher William of Ockham, who said that "plurality should not be posited without necessity" (Ockham, 1979, p. 202). He was not the first. The razor was embraced by many medieval philosophers who were influenced by Aristotle's principle, stated in *The Movements of Animals* and elsewhere, that "nature does nothing in vain." Isaac Newton used this Aristotelian phrase in his *Rules of Reasoning in Natural Philosophy*, which he added to the second edition of the *Principia* (Newton, 1713), but he gave it an entirely new meaning. Aristotle was talking about the "natures" of kinds; tigers are a kind of animal, and it is in the "nature" of tigers to have properties that are good for them (Gottlieb & Sober, 2017). Newton's nature is the whole universe of space and time, and his parsimony principle is not about what is good for the universe. In an unpublished manuscript, Newton claims that his parsimony principles are justified because God created the laws of nature (Sober, 2015).

David Hume (1739/2000) argued that all inductive inferences presuppose the principle of the uniformity of nature, by which he meant that the future will resemble the past. Hume did not say that this is a simplicity postulate, but he could have done so. He says that human beings use this principle because of "habit and custom" despite its having no rational justification. John Stuart Mill (1865/1979) asserted that there is no point in explaining an event by saying that A and B are true when A suffices. Here, the principle of parsimony is a "razor of silence," because the A hypothesis is silent about whether B is true. A "razor of denial" (which says that A and not B is preferable to A and B) is not addressed by Mill's assessment.

In the 20th century, the Bayesian statisticians Dorothy Wrinch and Harold Jeffreys (1921) suggested a simplicity postulate that covers an infinite number of equations and assigns higher prior probabilities to equations that are simpler. Karl Popper (1959) criticized this postulate, pointing out simpler theories are often less probable than theories that are more complex. Another landmark in 20th century discussions was the statistician Hirotogu Akaike's (1973) proposal that an estimate of the predictive accuracy of a model should take account of the model's fit to data and its complexity (where a model's complexity is defined as the number of adjustable parameters it contains). Akaike suggested a formula for estimating predictive accuracy that combines these two considerations and proved that the formula provides unbiased estimates of predictive accuracy. This proposal resonates with empirical scientists who realize that they can make their theory fit their data perfectly by making the theory sufficiently complex, but these complex models often fail to accurately predict new data. Simpler theories do not fit present data as well but often turn out to be more predictively accurate.

Of special historical relevance to psychology is C. Lloyd Morgan's (1903) canon that higher mental faculties should not be postulated to explain an organism's behavior if lower mental faculties suffice. Morgan's canon as he understood it does not say that you should remain silent on whether a creature has a higher faculty when a lower mental faculty suffices; rather, his canon says that you should deny that the higher faculty is present. Morgan thought that this canon was a consequence of Darwin's theory of evolution by natural selection (Clatterbuck & Sober, 2025).

The behaviorist psychologist B. F. Skinner worked in a milieu where Morgan's canon was thought to be a version of Ockham's razor (although Morgan himself denied this). You can see Ockham's razor in the background in Skinner's writings. For example, Skinner argued that claims about inner states could "throw light on the relationship" between stimulus and response but "can in no way alter it" (Skinner, 1953, p. 35). This is supposed to justify *methodological* behaviorism, which is silent on the existence of inner states; it does not deny that they exist.

Core concepts

There is no single way in which Ockham's razor is used in science. Rather, there is a family of different uses.

Common causes

An important use of Ockham's razor is inferring a common cause for two different events. The core idea is that if simultaneous events are correlated, it is (more) likely that a single event caused both. This is called the principle of the common cause (Reichenbach, 1956); however, in the causal modeling literature, it is sometimes replaced with the more general causal Markov condition (Woodward, 2003). Even if Ockham's razor is justified in postulating common causes, it should not be regarded as an ultimate principle that has no deeper justification; on the contrary, when it is plausible, it usually has a justification that depends on empirical assumptions (Sober, 2015).

Second, the existence of a common cause should be separated from facts about the nature of that cause. For example, the so-called *theory-theory* of human cognitive development says that cognitive development occurs because children change their mental models of the world, with different domains of cognition involving different specific models (Gopnik & Meltzoff, 1997) [see Cognitive Development]. Evidence for this is the correlation between changes in solving nonlinguistic problems and changes in linguistic utterances. For example, children start sorting objects spontaneously into categories around the age of 18 months, which is when they also start seeking names for everything (a *naming explosion*). Around the same time, children start passing occluded-object displacement tasks and start using the word "gone" to refer to disappearances. These correlated changes are evidence that the infant has learned new ways to represent the world and that these new representations are a common cause of the changed behavior. It is unlikely that these correlated changes can be explained by a domain-general increase in memory, attention, or processing power because changes within each domain are correlated, but changes across domains are not (Gopnik & Meltzoff, 1997). This suggests that a general increase in intelligence is not the common cause (Clatterbuck, 2018).

This explanation involves two different claims: that there is a common cause and that the common cause involves a change in representational capacity. The observed correlations provide evidence for the *existence* of common causes within pairs, but this leaves logical room to consider hypotheses other than the theory-theory about the *characteristics* those common causes have.

Phylogenetic parsimony

Appeals to Ockham's razor in cognitive science sometimes draw on a concept of parsimony that is familiar from phylogenetic biology, although it is rarely used by biologists in this way. Phylogeneticists infer the existence of common ancestors from the characteristics of present-day species, and they infer the character states of those postulated ancestors from the characteristics of their descendants. The basic idea of *cladistic* parsimony is that the best phylogenetic hypothesis is the one that requires the smallest number of changes in character states to occur in the lineages leading from ancestors to present-day organisms (Farris, 1983). Cladists infer that because all present-day birds have wings, these birds have a common ancestor, and that ancestor had wings. This is a kind of parsimony reasoning; the alternative hypothesis—that the common ancestor of birds did not have wings, and so wings evolved many different times—is less parsimonious than the alternative.

Cladistic parsimony plays an important role in comparative cognitive science. It is often used to defend anthropomorphism, that is, the claim that humans and animals behave in similar ways because they have similar mental states. For example, both humans and chimpanzees comfort their young, and humans do so because they feel empathy. From this, one might infer that the most recent common ancestor (MRCA) of chimps and humans also comforted their young and also felt empathy, so therefore, chimpanzees must also feel empathy (De Waal, 1991).

The plausibility of these arguments, however, depends on what is being claimed. Common behavior between humans and chimps may be evidence that the MRCA also behaved that way. And the fact that humans feel empathy is evidence that makes it more likely the MRCA did as well. However, that is not the same thing as saying that it is highly probable that the MRCA felt empathy or that chimpanzees do as well. The careful use of parsimony arguments distinguishes between ones that make a hypothesis more plausible in a relative sense and ones that make a hypothesis absolutely plausible (Sober, 2015).

Questions, controversies, and new developments

Ockham's razor as a cognitive mechanism

Classic philosophical discussions of Ockham's razor are normative, asking why scientists should use the principle to evaluate competing hypotheses. A complementary question is descriptive: Do humans and other organisms use something like Ockham's razor in perception, cognition, memory, and elsewhere? For example, consider the phenomenon of apparent motion. A movie consists of a sequence of two-dimensional static images from which the mind constructs a stream of perceptual experiences in which three-dimensional objects persist through time and change their characteristics. The conjecture is that Ockham's razor is part of the machinery that affects this transformation.

This descriptive use of Ockham's razor has a long history (Feldman, 2016). More recently, the predictive coding research program suggests that the mind works with a goal of minimizing the errors of its hypotheses. This research program is often implemented by using Bayesian tools (Hohwy, 2013) that have important mathematical links to parsimony [see Bayesian Models of Cognition]. An ongoing debate is whether these Bayesian tools are sufficient for capturing the sorts of hierarchical, nested models that predictive coders postulate or whether more sophisticated tools (like the Akaike Information Criterion, or AIC) might provide a better framework.

Mind reading and unification

It is sometimes difficult to tell which of two hypotheses is overall more parsimonious. Suppose theory T1 unifies two sets of observations, whereas T2 treats them as unrelated to each other. That seems to make T1 more parsimonious than T2. However, now suppose that T1 postulates a single process that is more complex than each of the simpler processes postulated by T2. This makes T2 more parsimonious than T1. The debate over whether chimpanzees are mind readers provides a useful illustration [see Theory of Mind].

Experiments in which experimenters remove food if they see or hear a chimpanzee reaching for food (Melis et al., 2006) show that chimpanzees adapt and choose behaviors that the experimenters cannot see. One interpretation of this is that chimpanzees form beliefs about what experimenters see. However, it is possible that chimpanzees merely learn to act optimally based on the experimenter's behavior, not by forming beliefs about their mental states (Penn & Povinelli, 2007; Povinelli & Vonk, 2004).

The latter alternative appears, on the face of it, to be a kind of parsimony argument; everyone thinks that chimpanzees can represent behavior, so the question is whether they also represent the minds of others. This is a use of the razor of silence, not the razor of denial; the skeptics simply deny that the data requires some further ability of mind reading.

In response, proponents of mind reading (Tomasello & Call, 2006) have argued that although any particular observation can be explained with behavior reading, the result is a patchwork of different, ad hoc explanations. Hence, the mind-reading hypothesis provides a unifying explanation of data from different experiments, whereas the behavior-reading hypotheses differ from experiment to experiment. This is also a type of parsimony argument; a single mind-reading hypothesis works across the board.

Unsurprisingly, this is a debate that persists. One important lesson from this is that different notions of parsimony can come apart. Furthermore, there is not a clean linkage between parsimony and causal notions; some common-cause models are more parsimonious than some separate-cause models, but sometimes the reverse is true [see Causal Reasoning].

Broader connections

Some version of Ockham's razor is used widely in cognitive science. Debates about chimpanzee mind reading are the tip of the iceberg. Debates about whether there are any traits that are unique to humans, especially debates about the evolution of language, are fertile grounds for the principle of parsimony [see Animal Cognition; Language Evolution; Uniquely Human Cognition]. Ockham's razor also plays a role in philosophically inflected debates over the nature and number of cognitive processes [see Cognitive Ontology].

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