

The Subadditivity Effect

Most of the topics in this series concern memory. This one concerns judgment, the way people estimate how probable something is, because that estimation is woven through legal fact-finding, from a juror's sense of how likely an alternative explanation is to an expert's testimony about risk. The subadditivity effect is a robust quirk of probability judgment: people judge the probability of a whole category to be less than the sum of the probabilities they assign to its parts. Put the other way around, breaking a possibility into its specific components, "unpacking" it, makes that possibility seem more probable than describing it as a single undivided whole. The same underlying reality can therefore be made to seem more or less likely depending only on how it is described.

A standard illustration comes from judgments about causes of death. Asked for the probability that a person dies of a natural cause, people give an estimate, in one study about 58 percent. Asked separately for the probabilities of death from cancer, from heart attack, and from other natural causes, the same kind of respondents give numbers that add up to far more, about 73 percent, even though those three categories are exactly what "natural causes" means (Tversky & Koehler, 1994). Nothing about the world changed; only the description did. This paper explains the effect, why it occurs, where it breaks down, and why a court should care about it.

What the Effect Is

The effect was formalized by Tversky and Koehler (1994) in what they called support theory. Its central and somewhat startling claim is that subjective probability does not attach to events in the world but to descriptions of events. A more explicit, detailed, or unpacked description calls to mind more of the evidence and reasons, the "support", for that possibility, and so receives a higher probability judgment than a compact description of the very same possibility. Because unpacking a category into its components consistently raises the total judged probability, probability judgments are systematically subadditive: the parts, judged separately, sum to more than the whole judged as one. Later work confirmed that this subadditivity is the rule rather than the exception in human probability judgment (Rottenstreich & Tversky, 1997).

Why It Happens

Support theory explains the effect through attention and availability: spelling out the components of a category brings specific instances and supporting evidence to mind that a general label leaves dormant, and each component contributes its own remembered or imagined support to the total. A complementary and simpler account holds that much of the pattern can be produced by ordinary noise in the conversion of evidence into numerical estimates, without any special reasoning bias at all (Hilbert, 2012). A closely related and long-known phenomenon sharpens the practical point: what is left out of an explicit list tends to be underweighted, as if out of sight were out of mind. In a classic demonstration, people shown a diagram of the possible causes of a car's failure to start badly underestimated the importance of the causes that the diagram omitted, treating the explicit list as more complete than it was (Fischhoff, Slovic, & Lichtenstein, 1978). Whether the mechanism is the recruitment of support, simple noise, or the neglect of the unmentioned, the consequence for judgment is the same: explicit, itemized possibilities loom larger than packed or omitted ones.

Where the Effect Breaks Down

An accurate account must note that unpacking does not always increase judged probability, so the effect is not a simple lever to be pulled at will. When a category is unpacked into atypical or implausible components, drawing attention to far-fetched members, the judged probability of the

whole can actually decrease, producing superadditivity instead (Sloman, Rottenstreich, Wisniewski, Hadjichristidis, & Fox, 2004). The components used to unpack a possibility matter: typical, plausible instances inflate it, while odd or unconvincing ones can deflate it. There are also diminishing returns. In a study of mock jurors, naming one plausible alternative suspect sharply reduced guilty verdicts, but naming two or three did little more than naming one (Tenney, Cleary, & Spellman, 2009). Unpacking is therefore a real and powerful influence on probability judgment, but a bounded one whose direction and size depend on the plausibility and number of the parts brought into view.

Subadditivity in the Courtroom

Legal fact-finding is saturated with probability judgments, and many of them are description-dependent in exactly the way support theory predicts. The most direct demonstration concerns reasonable doubt. When a defense gives the abstract possibility that "someone else did it" a concrete face, describing a specific plausible alternative perpetrator and how that person could have committed the crime, mock jurors became substantially less likely to convict than when the alternative was left as an unspecified whole (Tenney, Cleary, & Spellman, 2009). The same mechanism operates wherever a case asks a fact-finder to weigh likelihoods: a list of specific ways an accident could have happened will seem collectively more probable than the general category of "accident"; an itemized set of innocent explanations will carry more weight than a vague reference to innocent explanations; and a risk or causation estimate can be moved up or down by how finely the possibilities are divided. Two cautions keep the point neutral. First, subadditivity is a feature of normal human judgment that affects jurors, judges, lawyers, and experts alike, and both parties' framings exploit it, so it favors no side; the unpacking that helps a defendant raise doubt is the same process by which a prosecutor's detailed itemization of a theory can make it feel more probable. Second, the effect concerns how a possibility is described, not whether it is true; recognizing it is a reason to ask whether a probability judgment is being driven by the framing of the alternatives rather than by the evidence, a question that the trier of fact, properly informed, is well placed to weigh.

Special Issues in Legal Practice

The principles described above apply with equal force to every party in a legal proceeding. Memory operates the same way regardless of who is asking the questions, and the science summarized here favors no side. What differs between the parties is not the science but the vantage point — the particular places where memory issues tend to surface, and the particular errors each party is best positioned to guard against. The two summaries below identify those recurring issues. They are offered for orientation, not as litigation strategy; in every case the controlling question is what the evidence in that case will, and will not, support, and the expert's role is to inform the trier of fact rather than to advocate for either side.

Special Issues for Prosecutors

For the State, subadditivity bears on how the likelihood of competing accounts is framed for the fact-finder. The prosecution should understand that an itemized, concrete alternative-perpetrator or alternative-cause theory can be made to seem more probable than the bare possibility it represents, simply by virtue of being unpacked into specific plausible parts (Tenney, Cleary, & Spellman, 2009). Recognizing this is not a license to repackage a genuine alternative out of the jury's sight, since the evidence, not the framing, must control; rather, it equips the State to point out when an alternative's apparent strength rests on vivid itemization rather than on proof, and to note that the unmentioned and the merely possible deserve weight only to the extent the evidence supports them. The error to guard against is the same description-dependence working in the State's own favor: an elaborately subdivided presentation of the prosecution theory can inflate its felt

probability, and the sound course is to anchor the case in evidence rather than in the persuasive arithmetic of unpacking.

Special Issues for Defense

For the defense, subadditivity illuminates why a concrete alternative account can legitimately raise reasonable doubt: giving the jury a specific, plausible way the events could have happened other than as charged makes that possibility salient and harder to dismiss than an abstract denial (Tenney, Cleary, & Spellman, 2009). The defense is well positioned to ensure that genuine alternatives supported by the evidence are presented in concrete rather than abstract terms. The corresponding error to guard against is overreach. The effect has real limits, implausible or excessively multiplied alternatives can backfire and even reduce the perceived probability of the defense theory (Sloman et al., 2004), and a framing advantage is not a substitute for evidence. Responsible advocacy and expert testimony should use an understanding of subadditivity to present well-supported alternatives clearly and to help the trier of fact see when a probability judgment is tracking description rather than proof, not to manufacture doubt from possibilities the evidence does not sustain.

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