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How Alike Is It Versus How Likely Is It: A Disjunction Fallacy in Probability Judgments

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One event cannot be more probable than another that includes it. Judging P(A & B) to be higher than P(A) has been called the *conjunction fallacy.* This study examined a *disjunction fallacy.* Ss received brief case descriptions and ordered 7 categories according to 1 of 4 criteria: (a) probability of membership, (b) willingness to bet on membership, (c) inclination to predict membership, and (d) suitability for membership. The list included nested pairs of categories (e.g., Brazil–South America). Ranking a category more probable than its superordinate, or betting on it rather than its superordinate, is fallacious. Prediction, however, may be guided by maximizing informativeness, and suitability need conform to no formal rule. Hence, for these 2 criteria, such a ranking pattern is not fallacious. Yet ranking of categories higher than their superordinates was equally common on all 4 criteria. The results support representativeness against alternative interpretations.

The extension rule in probability theory states that if A is a subset of B, then the probability of A cannot exceed that of B. A special case of the extension rule is the conjunction rule, which states that the probability of A&B can exceed the probability of neither A nor B, since it is contained in both.

Tversky and Kahneman (1983) demonstrated that, under certain circumstances, people predictably and systematically violate the conjunction rule. In one study, they gave subjects the fol ng description:

> ıda is 31 years old, single, outspoken, and very bright. She ma- ed in philosophy. As a student, she was deeply concerned with ıes of discrimination and social justice, and also participated in :i-nuclear demonstrations. (p. 297)

This was followed by a list of eight possible outcomes, each describing possible activities of Linda at the present time (her job, her interests, or both). Subjects were asked to rank order the outcomes by the probability that they describe Linda's current activities. Of the eight, one was representative of Linda ("Linda is active in the feminist movement"), one was unrepresentative of Linda ("Linda is a bank teller"), and one was a conjunction of these two ("Linda is a bank teller and is active in the feminist movement"). A large majority of the subjects (85%) rated the conjunctive outcome, "Linda is a bank teller and is active in the feminist movement," more probable than "Linda is a bank teller."

This result was predicted from the representativeness hypothesis: "Representativeness is an assessment of the degree of correspondence between a sample and a population, an instance and a category, an act and an actor or, more generally, between an outcome and a model" (Tversky & Kahneman, 1983, p. 295). Kahneman and Tversky (1972, 1973) provided much evidence that people often judge the probability of an outcome given a model by the extent to which the outcome represents the model. In addition, Tversky (1977) showed that adding to an outcome (O) a feature (F) that matches a model (M) enhances the match between the outcome and the model. In other words, the match of O&F to M can be greater than the match of O to M. Hence, insofar as people judge the probability of outcomes by their representativeness, being a bank teller and active in the feminist movement would be judged more likely an outcome for Linda than being a bank teller, due to the addition of a feature that is representative of Linda (feminism) to her unrepresentative job. Whereas there is nothing logically wrong with the judgment that being a feminist bank teller is more *representative* of Linda than being a bank teller, judging the conjunctive outcome to be more *probable* than its constituent violates the logically necessary conjunction rule.

Another special case of the extension rule is the disjunction rule, according to which the probability of A-or-B can be smaller than neither the probability of A nor the probability of B, since it contains both. Formally speaking, there is no difference between the three rules (conjunction, disjunction, and extension), because for any pair of events A and B in which B is a subset of A, A can always be represented as a disjunction, one of whose constituents is B, and B can always be represented as a conjunction, one of whose constituents is A. For example, one can argue that the set of bank tellers is a disjunction—of bank tellers who are active feminists with bank tellers who are not. Viewed in this way, Tversky and Kahneman's (1983) results could just as well have been labeled the *disjunction fallacy.* Why then are they regarded as a *conjunction fallacy?* Is this just a matter of arbitrary choice?

Formally speaking, the answer is yes, but psychological considerations favor one view over another. Consider the category *parent* and its subcategory *mother.* One can just as well choose to view *mother* as the conjunction of *parent* with *female* as to

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view *parent* as the disjunction of *mother* with *father.* In contrast, the category *bank teller* does not naturally evoke a representation as a union, and certainly not as a union of bank tellers who are active feminists with bank tellers who are not. At the same time, the subcategory of bank tellers who are active feminists can hardly be described except by resort to the conjunction of these two constituents. Indeed, the language does not even contain a single-word label to designate this category. In that sense, the categories *bank teller* and *bank teller and active feminist* are more naturally viewed, respectively, as a unitary category and a conjunction of two categories, than as a disjunction of two categories and a unitary category.

How, then, might one create a category that would be naturally viewed as disjunctive? The simplest possibility to come to mind is to replace the connective *and* used to create conjunctive categories with the connective *or.* This idea must be implemented with caution, however, because the English words *and* and *or* do not always quite correspond to the logical connectives *and* and *or.* First, the English *or* is often understood in its exclusive sense of "A or B but not both," as in "The party will take place next week or the week after." Second, the English *and* can be used to create a union as well as an intersection—the sentences "She invited colleagues *or* relatives" and "She invited colleagues *and* relatives" could be used to describe the same guest list. Third, and most pertinent to present concerns, not all categories that can be meaningfully joined by one of these connectives lend themselves to as meaningful a joining by the other. For example, whereas putting *and* between *bank teller* and *active in the feminist movement* creates a meaningful category, putting *or* between these two category names creates a rather odd one. Similarly, whereas the question, "Is Linda more likely to be a bank teller, or a bank teller and active in the feminist movement?" makes some sense, the question, "Is Linda more likely to be a bank teller, or a bank teller or active in the feminist movement?" sounds to us rather confusing.

Nonetheless, this was precisely the approach taken by all previous attempts to study a disjunction fallacy. In the first attempt to extend the conjunction fallacy to a disjunction fallacy, Morier and Borgida (1984) gave subjects Linda's description and asked them to estimate the probability that (a) Linda is a bank teller, (b) Linda is active in the feminist movement, (c) Linda is a bank teller and is active in the feminist movement, and (d) Linda is a bank teller or is active in the feminist movement.

Wells (1985) took a similar approach. He also gave subjects personality descriptions and asked them for the probabilities of four events: two individual events, their conjunction, and their disjunction. Wells, however, took two precautions to make the resulting disjunction more natural. First, both of the individual events were attitudes toward some national issues, making them of a kind that sounds quite natural when joined by *or.* Second, Wells explicitly added *or both,* to highlight that the *or* was nonexclusive. For example, after describing Jim, subjects were asked for the probability that Jim (a) "favors . . . a U.S. buildup in military strength," (b) "favors the decriminalization of marijuana," (c) "favors [the first] *and* [the second]," and (d) "favors [the first], or [the second], or both." Yet, in spite of these precautions, Wells himself remained concerned "that these subjects misunderstood the union request (e.g., interpreted "or" as a conjunction)" (p. 277).

Biela (1986) took a slightly less formal approach when creating conjunctive and disjunctive categories. After describing to physicians one or two symptoms of an otherwise unknown patient, he asked them to attach degrees of confidence to each of the following diagnoses: (a) "I would predict hypertensive encephalopathy," (b) "I would predict hypertensive retinopathy," (c) "I would predict that either hypertensive encephalopathy or hypertensive retinopathy (or both) is the case," and (d) "I would predict both hypertensive encephalopathy and retinopathy." The subtle variation in formulation between the intended disjunctive (c) and conjunctive (d) diagnosis show Biela's awareness that mechanical joining of the two diagnoses by *or* or *and* is unsatisfactory. Still, (d) might well be understood by a reader to mean "I would give the following degree of confidence to *either* of these diagnoses." In the context of (a), (b), and (c) this possibility becomes less likely, but this comment is intended to show how tricky it is to create categories that are unambiguously disjunctive.

Another difference between categories formed by the connective *or* and categories formed by *and* lies in the difference between matching an instance to A-and-B versus to A-or-B. To be concrete, consider matching Linda to the conjunction "feminist and bank teller," on the one hand, and to the disjunction "feminist or bank teller," on the other. The conjunction requires a single comparison, albeit to a compound event. The disjunction, however, seems to require two comparisons, one for each of the constituent events. Tversky's (1977) theory relating similarity judgments to stimuli's features makes no predictions concerning how two constituent similarity judgments are combined to yield a single similarity judgment for the disjunctive event.

Judging the similarity of the compound event can be sidestepped, however, as it was in Carlson and Yates' (1989) study. Subjects were presented with pairs of events, such as "Syria and Israel will sign a peace treaty by the end of this year" and "The Bill Cosby show will not be one of the top 10 rated TV shows at the end of the season," as well as the conjunction and the disjunction of these events, and they were asked to rank them by their probability of actually occuring within the coming year. But because no model was provided according to which subjects could judge representativeness, the probability of the compound events could only be derived from some kind of combination of the probabilities of its constituent events, not from similarity judgments.

The type of problems used by Carlson and Yates (1989) were termed "probability combination problems" by Gavanski and Roskos-Ewoldsen (1991). These authors recently showed that, when constituent probabilities were controlled for, the rates of the conjunction fallacy were similar in problems in which representativeness could be used to assess the probability of the conjunctive event (e.g., the Linda problem) and in problems in which representativeness could not possibly be used (e.g., probability combination problems). This led them to conclude that the conjunction fallacies "stem primarily from the incorrect rules people use to combine probabilities" and that the "only contribution of representativeness stems from its effects on a