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Judgment and decision-making biases as a function of task: Conjunction effects in explanations, inferences, and predictions

John Leddo[1*], Ivy Liang[2], Smaran Pasupulati[3], Riya Pasupulati[4]
[1-4] LLC Sunrise Valley Drive, Herndon, United States

Abstract
An enormous amount of research has been conducted that documents judgment and decision-making biases when dealing with situations involving uncertainty. The results of these experiments are generally taken as evidence that people have weaknesses when they reason about situations requiring the application of probabilistic or statistical concepts. One such paper documented that when asked to explain why events occurred, people rated a conjunction of two explanations as being more likely to have influenced the outcome than the explanations' individual components, a statistical impossibility given that a conjunction of two events cannot be more likely than their individual component events (Leddo, Abelson and Gross, 1984). The present research explores the hypothesis that the nature of the task that people are asked to perform may also contribute to the biases observed in these experiments. Here, high school participants were asked to rate the probability of both individual and conjoint explanations as in Leddo *et al.* (1984). However, other participants were given the same scenarios and asked to state the probability that individual or conjoint events were either true (inference) or likely to happen (prediction). Results confirmed the hypothesis that conjunction effects (rating two events as more probable than one) were strongest in explanations and weakest in predictions. This suggests that the task a person is asked to perform may contribute to whether or not people show biases in judgment and decision making.

Keywords: Judgment, Conjunction, Predictions, enormous

Introduction

An enormous amount of research has been done that examines human biases in judgment and decision making (Kahneman, Slovic, and Tversky, 1982) [5]. Examples of such biases include the availability heuristic, where events associated with a salient or easily retrievable memory are judged to have higher likelihood of occurring than those not associated with such a memory; the representativeness heuristic, where events that are similar to a categorical prototype are judged to be more likely than those that are not; the hindsight bias, where people upwardly revise their perceived ability to have predicted a past event once they learn the outcome of the event; the confirmation bias, where people tend to overweight evidence that confirms a favored hypothesis rather than disconfirms one (see also Leddo *et al*., 2018) [9].

One of the factors that many of the documented biases have in common is that they demonstrate people's weaknesses in making probabilistic judgments when dealing with situations involving uncertainty. Typically, people judge events to be more likely than they really are. A good example of this occurs in people's judgments of causal factors that are potential explanations for events. Leddo and his colleagues (Leddo, Abelson and Gross, 1984 [8]; Abelson, Leddo, and Gross, 1987) [1] found that people judged conjunctions of two reasons as explanations for events as more likely than single reasons (termed "the conjunction effect"), even though it is mathematically impossible for a conjunction of events to be more likely than the likelihood of the component events. An explanation for the conjunction effect is the schematic notion that multiple reasons are more compelling that single reasons since most events result from multiple rather than single causes.

One thing that the all of the above-cited research has in common is that the biases cited are assumed to be an inherent property of the decision maker's reasoning rather than something the task itself induces the decision maker to do. For example, with the availability heuristic, the probability of an event is deemed higher because it is associated with a person's salient memory. The representativeness heuristic also has as its underlying basis the fact that the event being judged matches a person's existing expectations.

However, there are also cases in the real world, where people do have correct intuitions about the nature of probability. For example, most people undoubtedly know that is less likely for someone to get two heads when flipping two coins than to get one head when flipping one coin. This may indicate that the type of judgment a person is asked to perform will influence whether biases will be present in his or her judgments. Initial support for this is found in Leddo, Abelson and Gross (1984) [8]. While the most noteworthy finding in that paper was that people who were asked to explain why events happened overwhelmingly rated conjoint explanations as more likely than individual ones, those asked to explain why events failed to happen were much less likely to rate conjoint events as more likely than individual events.

The goal of the present research is to investigate further the question of whether tasks themselves can induce biased judgments. In the present study, we examine three related tasks: explanations (a judgment of why an event happened), inferences (a judgement of whether an event happened), and predictions (a judgement of whether an event will happen in the future). It is hypothesized that, consistent with previous research, people will show the conjunction effect bias when judging explanations involving conjoint vs. single reasons.

Judgments involving inferences are hypothesized to show less conjunction effect bias than judgments involving explanations. As noted above, explanations seem to be a strong candidate to show conjunction biases because when multiple compelling reasons are present, an event is more likely to occur. However, a judgment of whether an event happened or is true given that another event happened removes the person from the mindset that something needs to be explained and thus the notion of sufficiency (is this enough to cause the event to occur) is not present. Since two things are less likely to be true than any single one of them, we expect to see a reduction in the conjunction effect with respect to inferences compared to explanations.

Judgments involving predictions are hypothesized to show the least conjunction effects of all. In the case of predictions, there is no event that needs to be explained and, therefore, no sense of whether single vs. conjoint explanations are sufficient to explain the event. Similarly, because there is a natural association of uncertainty with future events, particularly with regard to multiple events, predictions are likely to be less subject to conjunction effects than inferences are.

These hypotheses were tested using a methodology similar to that employed in Leddo, Abelson and Gross (1984) [8]. In the present study, three similar versions of questionnaires were used, modified only to allow for the different tasks (explanation, inference, and prediction) to be presented to participants.

Method

Participants

Participants were 30 high school students recruited from schools in Montgomery County, Maryland in the United States. Participants were not paid for their participation in the study.

Materials

Three versions of a questionnaire were created: one for explanations, one for inferences and one for predictions. Each questionnaire contained ten everyday-type scenarios that would be recognizable to high school students. After each scenario, there was a series of events that a participant was asked to make probability ratings for. The instructions told the participant to rate the probability of the events from 0% to 100%. The events were either single events or conjunctions of two events.

For the explanation version of the questionnaire, the scenario ended with an outcome. Following the outcome were a list of potential reasons, either single or a conjunction of two for why the outcome occurred. The instructions for the explanation questionnaire were: "What is the probability that the following are among the reasons why <outcome>?" These instructions are modeled after the original Leddo, Abelson, and Gross (1984) [8] paper.

An example of an explanation scenario is as follows: "Jodie's parents are allowing Jodie to redecorate her room before school starts in fall. She painted her walls and bought new furniture to decorate her room in. Jodie also buys two types of wallpaper to put on one of the walls. One of the wallpapers has polka dots and the other has a floral pattern. Jodie decides to use the floral pattern instead of the polka dot wallpaper." Sample explanations, both single and conjunctive, include: 1) the floral wallpaper matches the paint color; 2) Jodie likes how the floral wallpaper looks on the wall; 3) the floral wallpaper matches the paint color and Jodie likes how the floral wallpaper looks on the wall.

In the inference version of the questionnaire, the scenarios and the items to be rated were identical to those in the explanation version. The sole difference was the instructions to the participant. Here, the instructions stated, "What is the probability that the following are true:"

In the prediction version of the questionnaire, it was not possible to have scenarios that were identical to those used in the explanation and inference questionnaires as the prediction scenarios involved judgments of future events. However, the scenarios and judgment items were constructed to be close as possible to those in the other two questionnaires.

For example, the prediction version of the wallpaper scenario was worded: "Jodie's parents are allowing Jodie to redecorate her room before school starts in fall. She painted her walls and bought new furniture to decorate her room in. Jodie goes online to look for wallpaper to put on one of the walls. She finds two she likes, one that has polka dots and the other that has a floral pattern. Jodie thinks about which wallpaper to get." The instructions to the participant for the judgment items were: What is the probability that the following will happen?" The judgment items were: 1) the floral wallpaper will match the paint color; 2) Jodie will like how the floral wallpaper looks on the wall; 3) the floral wallpaper will match the paint color and Jodie will like how the floral wallpaper looks on the wall.

Procedure

Participants received only one version of the questionnaire so that prior judgments for one of the three tasks (explanation, inference, prediction) would not influence judgments for the present task. Participants were randomly assigned to a specific version of the questionnaire with ten given each questionnaire version. Participants were given as much time as they wanted to complete the questionnaire. The experimenter did not observe the specific answers the participant was giving per question so as not to bias the participants.

Results

The probability ratings for each of the 30 participants were evaluated by scenario to see if there were any conjunction effects. A conjunction effect was defined as a case in which a participant gave a probability rating to a conjunction of two events that was higher than the probability of either individual event. This follows as it is mathematically impossible for the conjunction of two events to be higher than either of the individual events. A probability rating for a conjunction of two events that was equal to the lower of the two individual events was not considered a conjunction effect. This is because the probability of a conjunction of events is given by the formula $p(A \text{ and } B) = p(A) * p(B|A)$. Therefore, if the $p(B|A)$, the probability of B given A, is judged to be 100% by the participant (namely that B always occurs whenever A occurs), then $p(A \text{ and } B) = p(A)$. Since we did not explicitly ask participants to rate $p(B|A)$, we had no empirical basis to assume that the participants did not deem it to be 100%.

For each participant across 10 scenarios, the number of scenarios for which the conjunction effect did and did not occur were tabulated. Therefore, the maximum possible instances of conjunction effect per participant is 10. Across the ten participants per questionnaire version, the maximum number of possible conjunction effects is 100 per version. However, two of the participants in the explanations condition at one point in their ratings started giving all 0s for each individual and conjoint item. Given that their previous ratings were non-zeros, it was assumed that these participants lost interest in the task and were no longer taking it seriously. Across the two participants, the ratings for a total of 12 scenarios were discarded. Therefore, for the explanation questionnaire version there were a total of 88 possible conjunction effects. Table 1 below shows the total number of times the conjunction effect was present and absent across all ten participants per condition and all scenarios per questionnaire.

Table 1: Frequency of Conjunction Effects Broken Down by Condition

	Present	Absent
Explanations	76	12
Inferences	64	36
Predictions	41	59

A visual inspection of the data shows that the frequency of conjunction effects follows the predicted direction. Conjunction effects had the highest frequency in explanations (p-hat =. 864), followed by inferences (p-hat =. 640), and then predictions (p-hat =. 41). Interestingly, the gaps in proportions between explanations vs. inferences and inferences vs. predictions were virtually identical. The differences between these proportions were all statistically significant: explanations vs. inferences, z = 3.51, p <.001; explanations vs. predictions, z = 6.41, p <. 001; inferences vs. predictions, z = 3.26, p <. 001.

An examination of participant probably ratings at the individual level reveals some interesting anecdotal trends. All participants providing ratings for explanations showed at least one instance of a conjunction effect.

Nine of the ten participants showed conjunction effects for the majority of their conjoint-explanation ratings with a conjunction effect range of 70% to 100% in conjoint-explanation ratings. Five of ten participants showed conjunction effects in 100% of their conjoint-explanation ratings.

For inferences, all ten participants again showed conjunction effects in at least one conjoint-inference rating with six of them showing conjunction effects for the majority of their conjoint-inference ratings. Three of ten participants showed conjunction effects in 100% of their conjoint-inference ratings.

Predictions was the only task in which a majority of conjoint-item ratings did not show a conjunction effect. This was reflected at the individual level as well. While seven of ten participants showed conjunction effects in at least one dual-prediction rating, only five showed conjunction effects in the majority of their dual-prediction ratings, three showed no conjunction effects at all and none showed conjunction effects in all or even nine of ten of their conjoint-prediction ratings.

Discussion

While previous research seems to indicate that judgment and decision-making biases are an inherent property of human reasoning, the present study suggests that the type of task a person is presented with may influence whether biased reasoning results. The present study found statistically significant differences in the number of conjunction effects shown by participants based on the tasks that they were performing. As hypothesized, participants making judgments about explanations almost universally (86.4% of the time) demonstrated a conjunction effect when judging the likelihood of conjoint explanations vs. individual ones, while the numbers for inferences and predictions were 64% and 41%, respectively.

In the present study, shifting the task that people were asked to perform from explanation to prediction reduced incidents of the conjunction effect by more than half. The implication here is that while people may still have weaknesses in their understanding of probabilistic reasoning (after all, most people exhibited the conjunction effect in at least some of their judgments, even in the prediction task), certain tasks may induce people to either ignore or adhere more closely to the laws of probability in their reasoning.

This creates the interesting questions of what other tasks may induce people to reason in a more vs. less biased fashion and what other mechanisms can be used to reduce biased thinking. With regard to the former question, it seems that one factor that may induce bias is when people have knowledge of the world that can be used to resolve uncertainty. In previous research on judgment and decision-making biases, many of the biases can be viewed as a direct result of people's having existing knowledge to reduce uncertainty. Since uncertainty interferes with our ability to cope with and adapt to the world around us, it can often by seen as something aversive and to eliminate.

Heuristics such as availability and representativeness allow us to apply our existing knowledge to uncertain events and reduce the uncertainty. In Kahneman and Tversky's Prospect Theory (1979) [6], people overwhelming preferred positive outcomes that occurred with certainty over uncertain outcomes with objectively higher expected utility. With the hindsight bias, our present knowledge of outcomes is used to resolve prior uncertainty by rewriting our beliefs. In Leddo, Abelson and Gross (1984) [8] and in the present study, our knowledge of the causes of events helps us to resolve uncertainty about how events came about when we are asked to explain them. The exception to this is when our existing knowledge has limited utility in resolving uncertainty. When making predictions of future events, we have limitations. We can use existing knowledge to estimate what may happen, but we are acutely aware from experience that uncertainty remains. With conjoint events, the uncertainty is greater because the outcomes are more complex. This induces a sense of greater uncertainty that cannot be resolved as it can with explanations, for in the latter case, a tangible event has occurred that can be used as "proof" that our explanations must be correct for the event happened, while in the case with predictions, there is no such "confirming" event to justify the higher level of uncertainty. This leads to a secondary hypothesis that conjunction effects and perhaps other biases will be reduced when people are confronted with tasks for which they have limited knowledge compared to those for which they have extensive relevant knowledge. This hypothesis may explain findings by Robyn Dawes (1979) [2] Janis (1972) [4] and others that judgments of experts are often subject to statistical biases, particularly overconfidence.

The discussion above outlines task conditions under which a person may be more prone to bias, and, perhaps counterintuitively, suggests that those who have the most knowledge that can be used to resolve uncertainty may be the ones most subject to biases involving uncertainty. This raises the second question as to what interventions may serve to mitigate biases involving uncertainty. One way to do so is through statistical training (Fong *et al*., 1986) [3]. People trained in statistics show fewer biases when reasoning under conditions of uncertainty. While this is certainly a worthwhile objective, and one we practice at My Ed Master, it does not quite match the same cognitive mechanism of changing a mindset that gets induced when a different task is introduced.

The answer to this question may be implied in the results of the inference condition. When a person is explaining something, he or she may be using the criterion of "does this sound reasonable?" It is easy to give a high reasonableness rating to explanations and perhaps even more so for conjoint explanations. Similarly, when using the representativeness heuristic, a person may feel that the prior knowledge he or she has is a reasonable approximation of the current situation. However, probability judgments not only depend on whether an event seems reasonable to occur but also whether it did occur or is otherwise true. One way to induce this mindset may be to have the person making the judgment play devil's advocate, i.e., thinking about reasons why the judgment may be false. This may suppress probability ratings across the board but may also reduce the conjunction effect even more.

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