The Conjunction Fallacy:
A Task Specific Phenomenon?

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The present investigation adopted a debiasing approach to the judgmental error known as the conjunction fallacy (Tversky & Kahneman, 1982). Such an approach was used to determine the extent to which the conjunction fallacy reflects task specific misunderstanding of particular judgment problems. The results suggest that (a) subjects' misunderstanding of conjunction problems is indeed somewhat task specific, and (b) a debiasing approach can effectively lower but not eliminate the conjunctive error rate for problems that do not strongly implicate representativeness thinking. Educational strategies based on statistical and probabilistic knowledge are discussed as an approach to debiasing inferential errors like the conjunction fallacy.

Consider the following judgment problem: "Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations. Please rank the following statements by their probability: 'Linda is a bank teller' (T), 'Linda is active in the feminist movement' (F), 'Linda is a bank teller and is active in the feminist movement' (T and F)." Tversky and Kahneman (1982) found that subjects presented with this judgment problem violated an elementary principle of probability theory by ranking the compound event (T and F) higher than a component of that compound event (T). This violation of the conjunction rule has been referred to as the conjunction fallacy by Tversky and Kahneman (1982) who have demonstrated violations of this rule with a variety of materials and subjects. Statistical experts, for example, were as susceptible to the conjunction fallacy as novices. When the compound event (T and F) and the unlikely event (T) were presented, the conjunction error rate was not significantly altered for statistically naive subjects (in their most "accurate" condition the error rate was still 86%).

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Why do people violate the conjunction rule? Tversky and Kahneman (1982) concluded that the conjunction fallacy was due to subjects use of the representativeness heuristic to solve the problem. That is, they judged each event "by the degree to which it is (i) similar in essential properties to its parent population and (ii) reflects the salient features of the process by which it is generated" (Kahneman & Tversky, 1972, p. 431). Thus, in the Linda problem, people rank the compound statement "Linda is a bank teller and is active in the feminist movement" more likely than "Linda is a bank teller" because feminist seems to be a very likely property of Linda and is a salient feature of the given description, while bank teller is not.

Another possible explanation for the conjunction fallacy is that subjects may misunderstand the meaning of the question as presented in the judgment problem. As a result, they may draw an improper sample space that, in turn, increases the likelihood that they will make conjunction errors (Markus & Zajonc, forthcoming). An example, offered by Markus and Zajonc, clarifies what is meant by "sample space." The example concerns the likelihood of "finding my neighbor, Joe, at home" (J), versus that of "finding my neighbor Joe and his wife, Anne, at home" (J and A). They propose that subjects may read the statement "finding my neighbor at home" as "finding my neighbor alone at home." The latter statement could then be judged as less likely than the statement "finding my neighbor and my neighbor's wife at home" without violating the conjunction rule. That is, if one were drawing from the sample space of when Joe is at home, it may very well be less probable that when Joe is home he is alone versus when he is home he is with his wife. Similarly, in the Linda problem, subjects may draw the sample space "all bank tellers," and thus may read the statement "Linda is a bank teller" as "Linda is a bank teller who is not a feminist," which could be ranked as less likely than the compound statement without violating the conjunction rule.

The present research, therefore, tests the robustness of the conjunction fallacy by examining the extent to which the fallacy may be controlled by various task features or, more specifically, by some interaction between task features and perceiver knowledge (Fischhoff, 1982). Do subjects, for example, make conjunctive errors because they do not understand the problems that they are asked to solve? Are subjects ignorant of the conjunction rule and solve conjunction problems via representativeness thinking (an "error of comprehension," according to Kahneman & Tversky, 1982)? If the conjunctive error rate remains substantial despite debiasing efforts, then it would suggest that the conjunction fallacy is not merely a task-specific inferential phenomenon.

METHOD

Subjects

Subjects were 319 undergraduate students enrolled in introductory psychology and introductory social psychology at the University of Minnesota. Students either volunteered or received course credit for their participation.

Stimulus Materials

THE LINDA PROBLEM

A conjunction fallacy task designed by Tversky and Kahneman (1982) was used in this experiment. The problem in its original form gives a case description and is then followed by a series of statements that are evaluated in terms of their likelihood of occurrence:

> Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations.
>
> Please rank the following statements by their probability of occurence using 1 for the most probable and 8 for the least probable.
>
> Linda is an elementary school teacher.
> Linda is active in the feminist movement.
> Linda is a psychiatric social worker.
> Linda is a member of the League of Women Voters.
> Linda is a bank teller.
> Linda is an insurance salesperson.
> Linda is a bank teller and is active in the feminist movement.

In the present study, the statements were placed in the response list in random order. At the end of the problem was one open-ended question: "Why did you rank the statement 'Linda is a bank teller and is active in the feminist movement' as you did?"

PROBABILITY ESTIMATES

A second form of the Linda problem was identical to the first except that subjects were asked to estimate the probability of occurrence for each statement instead of rank ordering the probabilities. A scale (ranging from 1/10 to 1.0) was provided to aid in subjects' estimates. This form of the problem allowed subjects to assign equal probabilities to the compound statement (such as, Linda is a bank teller and is active in the feminist movement) and to either element of the conjunction. Such a "tie" does not constitute a violation of the conjunction rule and thus was not counted as a conjunctive error.[1] This form was constructed to determine whether the conjunction fallacy was due in part to the response format, and also to indicate how subjects rated the *likelihood* (rather than the rank) of the compound event occurring in relation to the least likely component event. It was expected that although the error rate should be reduced because "ties" are allowed, there would still be a substantial error rate.

FOUR-ITEM/UNION STATEMENT

Two additional response formats of the Linda problem were given. The first of these reduced the response list to only four statements and included a union statement, "Linda is a bank teller or is active in the feminist movement." The four statements were:

> Linda is a bank teller.
> Linda is active in the feminist movement.

Linda is a bank teller and is active in the feminist movement.
Linda is a bank teller or is active in the feminist movement.

This format was used to see if by reducing the number of items to only those related to the conjunction rule, and by including the union statement, subjects would be less likely to judge each statement by representativeness and more likely to recognize the logical structure of the task, thereby reducing the conjunctive error rate. That is, subjects who know the conjunction rule but who might have failed to apply it in the original Linda problem would be more likely to apply the conjunction rule correctly in this case because the union statement should focus more attention on the conjunctive statement.

EIGHT-ITEM/UNION STATEMENT

Another response format had the same number of items in the response list as the original Linda problem except that one statement was added to the list. The statement was the union statement "Linda is a bank teller or is active in the feminist movement." This condition was given to determine if any reduction in conjunctive errors in the 4-item/union statement condition was due to the union statement or the length of the response list. Statements again were placed in the response list in random order.

DEBIASED PROBLEMS

To test the hypothesis that subjects misunderstand the question and thus misunderstand what the response statements imply, the following problem was constructed. The problem's theme was similar to the one that led Markus and Zajonc (forthcoming) to propose that subjects could be making conjunction errors due to the formation of an improper sample space:

Bill is an outgoing, friendly man who likes to spend time with his wife. He is very understanding and has been married for 5 years.

Estimate the probabilities of the following statements:

Finding Bill and Bill's wife at home.
Finding Bill at home.
Finding Bill's wife at home.
Finding at least Bill at home.

Following the Markus and Zajonc (forthcoming) reasoning, subjects who were presented with this *standard form* of the Bill problem may have interpreted the statement "finding Bill at home" as "finding Bill alone at home," because the problem was stated in a deliberately ambiguous form.

A second *debiased* form of this Bill problem was constructed so that the potential misunderstanding of the statement "finding Bill at home" as "finding Bill alone at home" would not be made. To accomplish this, the statements "finding Bill alone at home" and "finding Bill's wife alone at home" were added to the standard form of the Bill problem. Since subjects were given the "alone at home" option in the response list, the meaning of the statement "finding Bill at home" is very explicit. If the linguistic misunderstanding argument is correct, then the conjunctive error rate for the debiased form of the Bill problem should be significantly lower than the standard form of the Bill problem. Following the debiased form of the Bill problem was one open-ended question: "What rule did you use to assign a probability to the statement, 'Finding Bill and Bill's wife at home?'"

In addition to the Bill problem, a debiased version of the Linda problem was presented to subjects. This version was identical to the probability estimation form of the Linda problem except that the statement "Linda is a bank teller who is not a feminist" was included in the list of statements following the description of Linda. The inclusion of this statement to the response list was expected to clarify the meaning of the statement "Linda is a bank teller."

Procedure

All questionnaires were administered to subjects as part of a larger pretest involving several unrelated questionnaires. Each subject answered only one form of the Linda problem. Of the subjects, 30 also answered the standard form of the Bill problem in addition to the Linda problem (subjects first answered the Linda problem and then the Bill problem). A group of 39 subjects filled out only the debiased form of the Bill problem, and 31 subjects completed only the debiased form of the Linda problem. Subjects were told that the researchers were interested in how people make predictions about a variety of events based on a short description of a person. They were instructed to read the case description and then estimate the probability of each statement that followed the description.

RESULTS

A conjunction error was defined as a case where the subjective probability assigned to the conjunction statement (such as, Linda is active in the feminist movement and is a bank teller) was greater than the subjective probability assigned to one or both of the elements of that conjunctive statement (such as, Linda is a bank teller).

THE LINDA PROBLEM

The error rates for the four conditions of the Linda problem are summarized in Table 1. Using probability estimates for the Linda problem resulted in fewer conjunctive errors, $x^2(1) = 5.32$, $p < .025$.[2] This reduction may be accounted for by the fact that 8 subjects assigned equal probabilities to the compound statement and the unlikely element (Linda is a bank teller) in the probability estimation condition. Although the error rate was reduced, as predicted, it was still substantial (80%).

Reducing the response list to 4 items (including the union statement) resulted in a reduction of the error rate when compared to the probability estimation condition, $x^2(1) = 12.01$, $p < .001$. However, there was no significant difference between the probability estimation condition and the 8-item/union statement

TABLE 1 Conjunctive Error Rates for the Linda Problem

	Rank Order	*Probability Estimate*	*8-Item/Union*	*4-Item/Union*	*Debiased*
Error rate	95.2%	80%	69.4%	48.4%	77.4%
n	63	60	62	64	30

condition, x^2 (1) = .89, ns., although there was a 10.6% reduction in the error rate. The reduction in error rate may well have been due to the greater availability of the conjunction statement in the shortened response list.[3]

Mean probability estimates for items in the three conditions using probability estimates of the Linda problem are shown in Table 2.[4] There were no differences in mean estimates between conditions for the "Linda is active in the feminist movement" item, $F(2,183) = .17$, ns., or the "Linda is a bank teller" item, $F(2, 183) = 1.45$, ns. There was, however, an effect for the "feminist and bank teller" item, $F(2, 183) = 5.52$, $p = .005$. The mean estimate in the 4-item/union condition was significantly different than the estimate for the probability estimation condition, $t(183) = 3.27$, $p < .001$, and the 8-item/union condition, $t(183) = 2.09$, $p < .05$, but there was no significant difference in the estimates assigned to the 8-item/union and probability estimation conditions, $t(183) = 1.25$, ns. This suggests that the 4-item/union response format reduced the probability estimate for the conjunction statement "Linda is a bank teller and is active in the feminist movement."

The mean estimate for the conjunction item was greater than the unlikely item (Linda is a bank teller) in all three conditions. T-tests on the difference score between the conjunction item and the unlikely item [difference score = p(bank teller and feminist) -p(bank teller)] for the three forms were: probability estimation form, $t(59) = 6.92$, $p < .001$; 8-item/union form, $t(61) = 6.35$, $p < .001$; and the 4-item/union form, $t(63) = 3.39$, $p < .001$.

OPEN-ENDED RESPONSES

Subjects' responses to the open-ended question "Why did you rank the statement 'Linda is a bank teller and is active in the feminist movement' as you did?" were analyzed by two coders (blind to the purpose of the experiment) into one of two categories. One category included similarity or typicality responses (such as "she sounds like a feminist, which makes it more likely than just bank teller") and another category contained all other explanations (such as, "I averaged the two answers"). There was 95% interrater agreement on the coding of items. Some 87% of the subjects gave a typicality or similarity response, which suggests that subjects were influenced by representativeness when thinking about the conjunction item.

DEBIASED PROBLEMS

The conjunctive error rate for the standard form of the Bill problem was 76.7% (n = 30). The debiased form of the Bill problem resulted in a conjunctive

TABLE 2 Mean Probability Estimates for the Linda Problem

	Probability Estimate	*8-Item/Union*	*4-Item/Union*	*Debiased*
Feminist	.84	.85	.83	.81
SD	(.17)	(.15)	(.19)	(.16)
Bank teller	.32	.29	.26	.33
SD	(.21)	(.18)	(.17)	(.19)
Feminist *and* bank teller	.50	.45	.36	.52
SD	(.23)	(.22)	(.26)	(.23)
Feminist *or* bank teller	–	.59	.60	–
SD		(.23)	(.24)	

error rate of 48.7% (n = 39), which was significantly lower than the conjunctive error rate for the standard Bill problem, $x^2 (1) = 4.31$, $p < .05$. This reduction in the error rate is in line with the hypothesis that subjects may have formed an improper sample space when presented with the standard form of the Bill problem, that, in turn, increased the likelihood of conjunctive errors. Moreover, the reduced error rate in the debiased condition cannot be attributed to subjects' correct application of the conjunction rule. In response to the question "What rule did you use to assign a probability to the statement 'Finding Bill and Bill's wife at home?,'" only 1 of 39 subjects was able to state anything resembling the conjunction rule. However, this does not necessarily mean that subjects would be unable to recognize the conjunction rule if it were presented to them in a more structured format. Rather, it suggests that subjects were generally not able to convey, in their own words, that the conjunction rule or some facsimile had been applied to the problem in question.

By contrast, in the debiased form of the Linda problem, there was not a comparable reduction in the conjunction error rate. The conjunction error rate for the debiased Linda problem was 77.4%, which was not significantly different from the error rate for the probability estimation form (80%), $x^2 (1) = 0$, ns. It appears that the Linda problem is more difficult to debias than the Bill problem, probably because the Linda problem so strongly implicates representativeness thinking.

DISCUSSION

Results from the present experiment support two propositions. First, various task features of conjunction problems can attenuate the conjunctive error rate but these factors do not altogether eliminate the error rate. For the Linda ·oblem, use of a probability response format successfully reduced the conjunctive error rate compared to the rank order format. Similarly, the conjunctive error rate was almost halved when a union statement was included in the shortened 4-item response list. As predicted, the inclusion of the union statement may have shifted subjects' attention to the conjunction statement which, intuitively, by comparison, seems less likely. [Whereas the conjunctive error rate was reduced by shortening the response list, however, the union error rate was unaffected by this procedure (69% in the 4-item/union condition and 77% in the 8-item/union condition)]. On the other hand, what Jepson, Krantz and Nisbett (1983) call the "uninstructed use of probabilistic concepts" cannot be ruled out as an explanation for the reduced error rate. The reduced error rate, it could be argued, reflects uninstructed probabilistic reasoning on the part of some subjects. And only one subject, it will be recalled, was able to articulate satisfactorily the conjunction rule.

A second proposition supported by the present research is that subject misunderstanding of certain conjunction problems may affect the error rate (Markus & Zajonc, forthcoming). The success of efforts to reduce the error rate by compensating for this minsunderstanding through an expanded sample space, however, may depend upon the kind of conjunction problem used. To be sure, subjects made fewer errors in the debiased condition of the Bill problem compared to the standard form of the Bill problem. The conjunctive error rate for the debiased Linda problem, however, was not reduced when the sample space was comparably "fleshed out." The crucial difference between these two problems is that the Linda problem is much more likely to activate representativeness thinking than the Bill problem and it may be that conjunction problems that strongly implicate representativeness thinking are more resistant to debiasing efforts.

Inferential errors that persist despite debiasing attempts suggest that any corrective or educational approach may have to overcome fairly entrenched intuitive strategies like representativeness thinking. Resnick (1983), for example, has recently suggested that such intuitive strategies must be confronted directly in science and mathematics instruction because they represent significant pedagogical obstacles. Nisbett, Krantz, Jepson, and Fong (1982) have advocated, along these lines, that "statistical heuristics" (such as "you can always explain away the exceptions"), when combined with an understanding of statistics and probability theory and the experience of applying the heuristics to realistic problems, may reduce inferential errors in daily life. Moreover, others have shown that these steps must be taken, for even subjects who know a statistical rule (either a probability model or a statistical heuristic) can nevertheless make errors when that rule is embedded in the context of a specific problem (Locksley, Stangor, & Hochstrasser, 1983). While reducing people's reliance on intuitive strategies such as representativeness may not be beneficial in all aspects of daily life (Harkness & Borgida, 1983), there are indeed areas such as intelligence analysis, corporate planning, decisions by jurors and judges, and political analysis where accuracy in assigning probabilities is required in order to make optimal decisions (Fischhoff, 1977; Kahneman & Tversky, 1982).

NOTES

1. Ties were not counted as errors for two reasons. First, subjects did not estimate p(B/F). Therefore, one cannot rule out the possibility that 1.0 would be estimated for p(B/F), in which case p(T∧F) = p(T) would be correct. Second, the response scale, presented in .10 increments, may have restricted the precision with which probability values could be assigned to each statement. Suppose, for example, that a subject assigned a value of .90 to p(F) and .10 to p(T). Since the lowest probability that could be assigned was .10, a p of .10 might be assigned to p(T∧F) even though the subject may have preferred to assign a lower value to the conjunction. In such cases the subject would have had little choice but to assign equal values to p(T) and P(T∧F).

2. Chi-square corrected using Yates' correction for continuity.

3. A subsequent pretest given to 130 subjects under identical conditions resulted in essentially identical error rates for the 8-item/union form (69%) and the 4-item/union form (51%) in this experiment.

4. The rank-order condition is not comparable, in terms of numerical estimates, to the other conditions. The mean rank assigned to the feminist statement was 1.9, to the bank teller statement 6.5, and to the feminist and bank teller statement 4.4.

REFERENCES

Fischhoff, B. (1977). Cost-benefit analysis and the art of motorcycle maintenance. *Policy Sciences, 8,* 177-202.

Fischhoff, B. (1982). Debiasing. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases* (pp. 422-444). New York: Cambridge University Press.

Harkness, A., & Borgida, E. (1983). *On the uses of standards in judgment research.* Unpublished manuscript, University of Minnesota, Minneapolis.

Jepson, C., Krantz, D. H., & Nisbett, R. E. (1983). Inductive reasoning: Competence or skill? *The Behavioral and Brain Sciences, 6,* 494-501.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology, 3,* 430-454.

Kahneman, D., & Tversky, A. (1982). On the study of statistical intuitions. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgments under uncertainty: Heuristics and biases* (pp.493-508). New York: Cambridge University Press.

Locksley, A., Stangor, C., & Hochstrasser, M. (1983, June). *On the dominance of causal reasoning over probability judgments: Implications for forecast accuracy.* Paper presented at the Third International Symposium on Forecasting, Philadelphia, Pennsylvania.

Markus, H., & Zajonc, R. (forthcoming). Social cognition. In G. Lindzey & E. Aronson (Eds.), *Handbook of social psychology, 3rd Edition.* Reading, MA: Addison-Wesley.

Nisbett, R. E., Krantz, D. H., Jepson, C., & Fong, G. T. (1982). Improving inductive inference. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgment under* *uncertainty: Heuristics and biases* (pp. 445-459). New York: Cambridge University Press.

Resnick, L. B. (1983). Mathematics and science learning: A new conception. *Science, 220,* 477-478.

Tversky, A., & Kahneman, D. (1982). Judgments of and by representativeness. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgments under uncertainty: Heuristics and biases* (pp. 84-98). New York: Cambridge University Press.

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