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EVIDENTIARY VALUE:

PHILOSOPHICAL, JUDICIAL AND PSYCHOLOGICAL ASPECTS OF A THEORY

ESSAYS DEDICATED TO SÖREN HALLDÉN ON HIS SIXTIETH BIRTHDAY

EDITED BY
PETER GÄRDENFORS, BENGT HANSSON AND NILS-ERIC SAHLIN

C W K GLEERUPS
LUND

DO PEOPLE COMBINE EVIDENCE ACCORDING TO AN EVIDENTIARY VALUE MODEL?: A NOTE

by
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1. Introduction

There have been only a few studies investigating the descriptive value of evidentiary value models such as those suggested by Halldén (1973), Edman (1973) and Shafer (1976). Goldsmith (1980 and this volume) presents results supporting Halldén's and Edman's theory. In this note I will present and discuss results indicating that people do not seem to use the rules of combination suggested by theories of this type when combining pieces of evidence. Similar results obtained within a Bayesian framework can be found in Lyon & Slovic (1975).

2. The evidentiary value model

According to the evidentiary value model (EVM) suggested by Halldén and Edman one ought to estimate the probability that a causal relation existed between the evidentiary theme (the hypothesis) and the evidentiary fact (the evidence) given the evidence, rather than attending to the probability of the theme given the evidence. The basic idea behind this suggestion is that evidence can support the hypothesis or evidentiary theme even if it does not prove it, i.e. there is no causal relation between the two. This is the case, for example, when a witness fabricated his or her testimony and it turned out, by chance, to be correct. Expressed differently, the theory assumes that one directs one's attention to the probability of the evidentiary mechanism (the causal relation) given the evidence, instead of the probability of the evidentiary theme given the evidence.

The EVM also assumes that given independent pieces of evidence one should combine them according to two different rules depending on whether they are conflicting or concurring with each other. (The EVM theory and its theoretical foundation is presented and discussed elsewhere in this book so I will thus not go into any details of the theory.)

If there are two pieces of independent and concurring evidence one should employ the following rule in order to obtain a combined evidentiary value:

$$P(A_1 \text{ or } A_2/e_1 \text{ and } e_2) \geq P(A_1/e_1) + P(A_2/e_2) - P(A_1/e_1) \times P(A_2/e_2).$$

$P(A_1/e_1)$ expresses the probability that the first mechanism worked given the first piece of evidence and $P(A_2/e_2)$ the probability that the second mechanism worked given the second piece of evidence. Consider, for example, a car accident in which two cars are involved. Two witnesses observed the accident and both testified that the blue car ran a red light. In this case we have two pieces of evidence (the first and the second witness' testimony, respectively) and two evidentiary mechanisms (the first witness observed and recorded the situation correctly and the second witness observed and recorded the situation correctly, respectively). The rule above tells us how we shall combine the probability estimates for these two mechanisms and evidentiary facts. The important assumption for the applicability of the theory is that one really can make these two esimates in a consistent way.

If we have two pieces of conflicting or contradicting evidence the following rule should be employed:

$$P(A_1/e_1 \text{ and } e_2) = \frac{P(A_1/e_1) \times (1 - P(A_2/e_2))}{1 - P(A_1/e_1) \times P(A_2/e_2)}$$

This rule is applicable, for example, if one of the witnesses says that it was the blue car that ran the red light and the other witness says that it was the green car.

The experiment to be reported was designed in order to investigate whether people actually do use such rules when combining bodies of evidence.

3. The experiment

Subjects. A total of 39 male and 55 female subjects participated in the experiment. They were recruted from the university community of the University of Oregon and were paid for participating in the study.

Prodecure. The subjects were given one of two types of problems. In the first problem they had to combine two pieces of concurring evidence. In the second problem they were asked to combine two pieces of conflicting or contradicting evidence. In both cases the values corresponding to $P(A_1/e_1)$ and $P(A_2/e_2)$ were stated explicitly in the problem. The subjects thus only had to combine these two items into a combined value. The examples used in the experiments are versions of the well-known cab problem by Kahneman and Tversky (see Tversky & Kahneman, 1982). However, except for the general theme, the original example and the one presented here are quite different and can hardly be compared. The first question or problem was as follows:

> Two cab companies operate in a given city, the Blue and the Green (according to the color of the cab they own). A cab was involved in a hit-and-run accident at night. Two witnesses later identified the cab as a Green cab. The court tested the witnesses' ability to distinguish between Blue and Green cabs under night-time visibility conditions. It found that the first witness was able to identify each color correctly 80% of the time, but had to make a guess 20% of the time, and that the other witness was able to identify each color correctly 60% of the time, but had to guess 40% of the time.
>
> What do you think is the probability (expressed as a percentage) that the cab involved in the accident was indeed Green, as the witnesses claimed?

The second problem involving conflicting evidence was almost identical to the problem of concurring evidence. In this problem, however, the first witness said that the cab was Green but the second witness said that it was Blue. The reliability of the two witnesses was the same. The subjects were asked to estimate the probability "that the cab involved in the accident was indeed Green, given that the first witness says Green and the second says Blue".

The information that the witness had to guess in XX% of the cases was added in order to create an analogy to an evidentiary mechanism

which is sometimes working and sometimes not working. When it is working it gives the correct result, but when it does not work it can either give a correct description of the event or an incorrect description.

4. Result

The results showed that a majority of subjects did not use an EVM in order to combine pieces of evidence. In the concurring case it seems as if they are averaging rather than combining. Figure 1 presents the distribution of estimates that 47 subjects gave to the concurring problem.

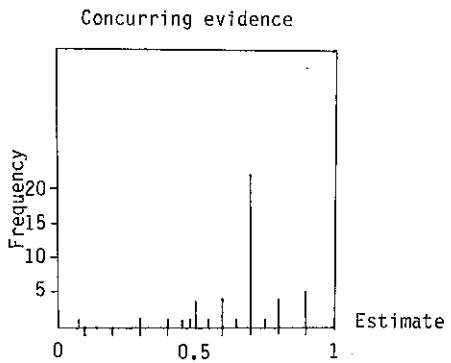

Figure 1

Only 11% of the subjects' estimates were within ±5% of the normative value 0.92, i.e. 0.80 + 0.60 - 0.80x0.60. An overwhelming majority appeared to use the average value 0.7 as an indicator of the total strength of the combined body of evidence. They were thus not sensitive to the fact that concurring pieces of evidence ought to strengthen the combined value of evidence.

The data for the problem with conflicting evidence is presented in Figure 2.

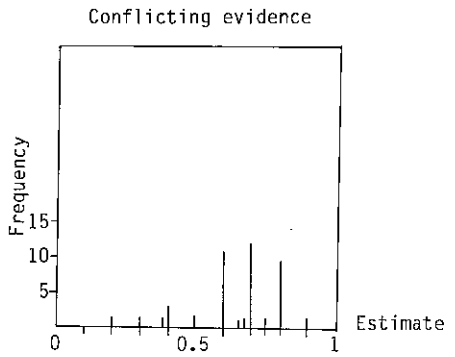

Figure 2

Only 23% of the 47 subjects came within ±5% of the normative value 0.62, i.e. 0.80 x (1 - 0.60)/(1 - 0.80x0.60). The obtained combined evidentiary value were greater than 0.65 for 57% of the subjects, i.e. the combined evidentiary value were considerably greater than the value assigned to the less reliable witness. The subjects were thus overweighting the impact of the more reliable mechanism or witness when combining the information.

5. Discussion

It appears as if these subjects in this pilot study do not use any of the rules discussed above. We also know that the rule employed in Shafer's mathematical theory of evidence is closely related to the two rules above and thus the results obtained speak against the descriptive value of this theory, too. It is more or less apparent that the subjects are simply averaging the stated probabilities in the concurring problem, (averaging is a commonly observed result in descriptive studies of information combination in many areas of human judgment and decision making, see Anderson (1981), Lichtenstein, Earle & Slovic (1975), and Lyon & Slovic (1975)). It is, however, more difficult to explain why they make such high estimates in the conflicting

problem. One reason can be that they are trusting the more reliable witness and thus are overestimating the impact of this evidence on the total value, (for a discussion of similar results in other contexts see Bar-Hillel 1980).

Although the results are negative I do not believe they affect the normative value of the theory. The experimental findings have only descriptive value. The EVM is a normative theory and it seems to be one of the most ingenious and promising models for combining pieces of evidence developed so far (see Freeling & Sahlin (this volume), Levi (this volume), and Sahlin & Freeling 1982).

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