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How framing and numerical information affect people's judgments when they read a newspaper story

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A B S T R A C T

In the present study, we aimed at investigating what factors affect the judgment of a typical reader when he or she deals with numerical information in an ecological context. Participants read a story about a man who was not treated with heparin after hernia surgery and then died. Their task was to assess the liability of the medical staff after receiving ambiguous numerical data based on percentages, and again after receiving unambiguous data based on frequencies. Participants also assessed the likelihood of survival/death for heparin-treated *vs.* not-treated patients. The unambiguous numerical information they were given was different in terms of numerousness of the reference class and framing. Results show that even when unambiguous frequency-based information is available, the participants' judgments were strongly affected by both frame and reference class. Findings also indicate that likelihood and liability judgments are strongly related, and that liability is accounted for by likelihood, but not *vice versa*.

1. Introduction

"Patient dies due to hernia: 5 doctors in trouble." This was the title of an article published in a local newspaper in Padova some years ago. The article described the story of a sixty-one year old man, Mr. M., who died a week after undergoing a hernia operation. This operation is a routine day-hospital surgery and in this case it was successful from a technical point of view. The autopsy revealed that the cause of Mr. M.'s death was a fatal pulmonary embolism. Given this dramatic event, Mr. M.'s relatives decided to take legal action against the medical staff. A critical reading of the medical file revealed that heparin, which is a drug employed in the prophylaxis of fatal pulmonary embolism, was not administered to Mr. M. during his procedure. During the trial, some experts were consulted in order to clarify whether Mr. M. needed heparin. According to the newspaper article, the scientific evidence provided by Dr. S. during the trial demonstrated that "If Mr. M. had been treated with heparin, he would have had a 50% higher probability of surviving."

Given this state of affairs, what could the readers have concluded? It is reasonable to expect the readers to come to the conclusion that the medical staff should be blamed for the death of Mr. M., as they would probably base their judgment on the 50% probability information. In reality, the conclusion of the technical survey made during the trial by Dr. S. was, "Heparin administration does not eliminate the risk of fatal pulmonary embolism, but it reduces it by 50%." While at first glance the journalist's and doctor's conclusions might seem the same, the difference is evident when considering the evidence that Dr. S. used for his claim. The deaths due to fatal pulmonary embolism totaled two in the group of patients who received heparin ($n = 2247$) and four

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in the group treated with a placebo ($n = 2251$) (Pezzuoli et al., 1989). The two conclusions, namely that of the technical survey and the conclusion published in the newspaper, do not have the same meaning and, while Dr. S.'s claim was correct, the journalist was guilty of an error of reasoning. Indeed, it could have been claimed that heparin treatment reduced the probability of death by 50% from .178% (4 out 2251 patients died in the group treated with the placebo) to .089% (2 out 2247 patients died in the heparin-treated group), but the probability of survival did not increase by 50% as it shifted from 99.822% (2247 out of 2251 patients survived) to 99.911% (2245 out of 2247 patients survived).

The journalist's erroneous interpretation of the expert's conclusion was not the only problem. Even if the journalist had not misinterpreted it, there are other factors that could have influenced a reader's final judgment. This study investigates the effects of various presentational formats of numerical and linguistic information on people's judgments when reading news stories.

Cognitive psychologists have devoted many efforts to identifying what factors affect people's comprehension, choice, and judgmental processes when numerical information is involved, especially in the economic and medical domain (e.g., Covey, 2007; Fagerlin, Zickmund-Fisher, & Ubel, 2011; Furlong & Opfer, 2009; Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin, 2007; Tversky & Kahneman, 1981). The present study raised the question of whether the factors that have been isolated in the previous research also work when people are asked to provide judgments on a delicate situation that require careful handling, such as the one we considered, and in a rather unexplored context, as little is known about how audiences process numbers in news stories (Callison, Gibson, & Zillmann, 2009).

In the article about the death of Mr. M., we identified three factors that could potentially affect the reader's opinion: the first is the format used to express probabilistic information. Indeed, the percentage alone is ambiguous: according to Gigerenzer, percentage information becomes a meaningless 'percentage of what?' when the reference class is not specified (Gigerenzer, 2003; see also Hoffrage, Lindsey, Hertwig, & Gigerenzer, 2000; Krämer & Gigerenzer, 2005). The second factor refers to the effect of the numerousness of the reference class in the case that a frequency format was used instead of a percentage. For example, '1 out of 2' and '100 out of 200' are formally equivalent proportions, both corresponding to a percentage of 50%, but they are perceived as different, as shown by recent research on the effects of numerical values (e.g., Furlong & Opfer, 2009; Stone, Yates, & Parker, 1994; Yamagishi, 1997). Third, it has long been acknowledged in the psychological literature on decision-making and choice that the way people think about events is strongly affected by the way the event-related information is framed. The phenomenon of "framing effect" refers to the different effect of presenting the same information in terms of gains (positive frame, e.g., survival) or losses (negative frame, e.g., mortality) relative to a reference point (e.g., Kühberger, 1998; Rothman, Bartels, Wlaschin, & Salovey, 2006; Tversky & Kahneman, 1981).

In the present study, we intended to investigate a) how the interplay between the format of numerical information (percentage *vs.* frequency), the numerousness of the reference class (1 out of 1000 *vs.* 10 out of 10,000), and the frame of information (survival *vs.* death) affects the reader's judgment of events when the data are presented in a non-scientific report, and b) the relationship between liability and probability judgments. Specifically, we asked participants to rate the liability of the medical staff for the patient's death and the likelihood of survival or death (depending on the frame condition) in the heparin-treated *vs.* untreated groups of patients. The first dependent variable was measured twice, before and after the experimental manipulation, in order to simulate the opinion of a common reader in a real-life situation. In doing this, we induced participants to make unusual and more ecological judgments with respect to those typically used in judgment and decision-making studies. Indeed, in everyday life it is likely that these are the kind of judgments made by people when reading stories such as the one reporting about Mr. M's death rather than likelihood judgments. The measurement of the second dependent variable, namely the likelihood of survival/death, was twofold: on the one hand, we aimed at assessing to what extent the probabilistic judgment was affected by the same three factors as the liability judgment and, on the other hand, we aimed at investigating the relationship between liability judgments and probabilistic judgments.

The current endeavor was guided by the conviction that slightly different communicative strategies addressing the same event may implicitly prompt the audience to draw dramatically dissimilar conclusions. Reporters should take such a phenomenon into account when communicating numerical information. In what follows, we summarized the evidence about each of the three factors, linking it with our hypotheses.

1.1. Numerical format

Numerical data are often included in communicational contents to ensure better understanding by the audience. However, the way reporters format numerical information affects people's judgmental processes. This general phenomenon has been corroborated by several studies (e.g., Burson, Larrick, & Lynch, 2009; Covey, 2007; Hoffrage et al., 2000; Krämer & Gigerenzer, 2005; Slovic, Monahan, & MacGregor, 2000) and in different domains, such as decision making related to health contexts (Moxey, O'Connell, McGettigan, & Henry, 2003; Sheridan, Pignone, & Lewis, 2003; Slovic & Monahan, 1995) or related to consumer behavior (Furlong & Opfer, 2009; Wertenbroch, Soman, & Chattopadhyay, 2007). The two main ways in which numbers can be formatted are frequencies and probabilities. Frequencies are informative of the numerical values associated with the occurrence of a given phenomenon in a population whereas percentages, coming from the ratio between two numbers, do not provide any information about the two numbers themselves. For example, if one compares the following statements: "In the last ten years, average monthly house rents have increased from about 750 Euros to 1,500 Euros" *vs.* "In the last ten years, average