Social Science & Medicine 70 (2010) 1019–1025

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Who proficts from visual aids: Overcoming challenges in people's understanding of risks

Rocio Garcia-Retamero [a,b,*], Mirta Galesic [b]

[a] University of Granada, Experimental Psychology, Campus Universitario de Cartuja s/n, 18071 Granada, Spain
[b] Max Planck Institute for Human Development, Berlin, Germany

ARTICLE INFO

Article history:
Available online 28 January 2010

Keywords:
Risk communication
Numeracy
Graph literacy in health
Visual aids
USA
Germany

ABSTRACT

Many people have difficulties grasping numerical concepts that are prerequisites for understanding treatment risk reduction. Visual aids have been proposed as a promising method for enhancing comprehension. In a survey of probabilistic, nationally representative samples in two different countries (United States and Germany), we compared the effectiveness of adding different types of visual aids (icon arrays and bar graphs representing either affected individuals only or the entire population at risk) to the numerical information in either an absolute or a relative risk reduction format. We also analyzed whether people's numeracy and graphical literacy skills affected the efficacy of the visual aids. Our results showed large improvements in accuracy both when icon arrays and when bar graphs were added to numerical information. Highest increases were achieved when the visual aids depicted the entire population at risk. Importantly, visual aids were most useful for the participants who had low numeracy but relatively high graphical literacy skills. Building on previous research showing that problems with understanding numerical information often do not reside in people's minds, but in the representation of the problem, our results show that visual aids help to modify incorrect expectations about treatment risk reduction. Our results have important implications for medical practice.

Introduction and background

Increased emphasis on patient-centered decision making has shifted responsibility to patients, who now more than ever need to understand numerical information to actively participate in making decisions about their health (Barry, 1999; Hanson, 2008). Informed consent laws, for instance, mandate that patients must be informed about risks before any treatment can be implemented (Garcia-Retamero & Galesic, 2009b). Understanding a treatment risk reduction implies taking into account the number of treated and nontreated people who die or survive out of those who do and do not receive the treatment (i.e., the entire population at risk; Gigerenzer & Edwards, 2003). However, a growing literature attests that many patients, especially those with low numeracy skills, have difficulties with understanding these and other health-relevant numerical concepts (Baker et al., 2008; Garcia-Retamero & Galesic, in press a; Kutner, Greenberg, Jin, & Paulsen, 2006; Lipkus, Samsa, & Rimer, 2001; Peters et al., 2006).

Visual aids have been proposed as a potentially promising method for communicating treatment risk reductions (Edwards, Elwyn, & Mulley, 2002). They can improve understanding of risks and benefits associated with different treatments, screenings, and life-styles (Ancker, Senathirajah, Kukafka, & Starren, 2006; Galesic, Garcia-Retamero, & Gigerenzer, 2009; Lipkus, 2007; Lipkus & Hollands, 1999; Paling, 2003). They can also promote consideration of beneficial treatments that have side effects (Waters, Weinstein, Colditz, & Emmons, 2007) and limit biases induced by anecdotal narratives (Fagerlin, Wang, & Ubel, 2005). Yet our understanding of the effectiveness of visual aids in improving perceptions of treatment risk reduction remains incomplete.

First, most of the studies on the topic focus on the impact of a single type of visual aids (e.g., icon arrays or bar charts; Fagerlin et al., 2005; Rudski & Volksdorf, 2002; Waters, Weinstein, Colditz, & Emmons, 2006; Zikmund-Fisher et al., 2008), and only a few compare the efficacy of different displays (Brundage et al., 2005; Feldman-Stewart, Kocovski, McConnell, Brundage, & Mackillop, 2000; Hawley et al., 2008; Schapira, Nattinger, & McHorney, 2001). Second, there is no research on whether the visual aids should reflect the number of affected individuals or the entire population at risk (Ancker et al., 2006; Stone et al., 2003) to improve perceptions of treatment risk reduction. Third, most studies on visual aids represent numerical information about risk using a single format (e.g., either absolute or relative risk reduction; Brundage et al.,

* Corresponding author. Tel.: +34 958246240; fax: +34 958246239.
E-mail address: rretamer@ugr.es (R. Garcia-Retamero).

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doi:10.1016/j.socscimed.2009.11.031

2005; Fagerlin et al., 2005; Feldman-Stewart et al., 2000; Rudski & Volksdorf, 2002; Schapira et al., 2001; Waters et al., 2006; Zikmund-Fisher et al., 2008). In contrast to previous research, we compare the effectiveness of different visual aids, icon arrays and bar graphs, representing either affected individuals only or the entire population at risk. In addition, we tested visual aids when the numerical information was presented in both absolute and relative risk reduction formats.

Fourth, to the best of our knowledge, all previous studies on the effectiveness of visual aids were conducted on convenient samples of specific groups of participants (e.g., patients with particular diseases or students). These studies provide valuable information about how these participants understand risks. However, as Lipkus (2007) pointed out, due to nonprobabilistic sampling methods, the results cannot be generalized to a wider population. This is problematic because it could prevent conclusions about the effects of different, important characteristics (e.g., people's numeracy) on the impact of using visual aids to improve risk understanding. In this study, therefore, we examined the accuracy of perceptions of treatment risk reduction in probabilistic, nationally representative samples.

Fifth, people might differ in the extent to which they profit from visual displays when estimating risk reductions. For instance, icon arrays are especially useful for individuals who are more vulnerable to having difficulties when making decisions about health (e.g., the elderly or people with low numeracy skills; Galesic et al., 2009; Garcia-Retamero & Galesic, 2009a; Garcia-Retamero, Galesic, & Gigerenzer, in press). Adding icon arrays to numerical information about treatment risk reduction helps these people to make more accurate assessments. Those with fewer difficulties with numerical concepts, in contrast, often make accurate estimates even if icon arrays are not provided. Recently, research by Galesic and Garcia-Retamero (in press a) revealed that people, regardless of their numeracy skills, differ substantially in their ability to understand graphically presented quantitative information about health. As Fagerlin, Ubel, Smith, and Zikmund-Fisher (2007) pointed out, it is still an open question whether people's numeracy and graphical literacy skills affect the efficacy of different visual aids. Accordingly, we studied which visual aids, if any, were more convenient for people with high and low numeracy and graphical literacy skills, and how these skills interacted with the type of numerical format, namely absolute versus relative risk reduction.

Last but not least, there is no research on the effectiveness of visual aids in countries with different health systems such as Germany and the United States (Statistisches Bundesamt Deutschland, 2007; World Health Organization, 2008). For instance, most health expenditure in the United States is private (55%; World Health Organization, 2008), and direct-to-consumer advertising of prescription drugs is allowed. Consequently, U.S. citizens might more often be required to determine whether and which medical treatment they need than the citizens of Germany where only 23% of health expenditure is private and most people have health insurance (99.7% compared to 84% in the United States; Schoen et al., 2007; Schoen, Doty, Collins, & Holmgren, 2005; Statistisches Bundesamt Deutschland, 2007; U.S. Census Bureau, 2007). In this study, we investigated whether visual aids can help U.S. and German residents make appropriate decisions about their medical treatments.

Methods

Sample

The study was conducted on probabilistic national samples in the United States ($n = 492$) and Germany ($n = 495$) in July and August of 2008, using panels of households selected through probabilistic random digit dial telephone surveys and supplied with equipment that enabled them to complete computerized questionnaires. The panels, built and maintained by the companies Forsa (Germany; 20,000 households, 11% of those in the initial sample) and Knowledge Networks (43,000 households, 16% of those in the initial sample), allowed for statistical inference to the general population. These panels were already used successfully in a number of studies in the areas of health and medicine, political and social sciences, and economics and public policy (Baker, Wagner, Singer, & Bundorf, 2003; Jacoby, 2006; Lerner, Gonzalez, Small, & Fischoff, 2003; Miller, Scott, & Okamoto, 2006; Schlenger et al., 2002). Methodological studies have shown that data from such panels are comparable to the results obtained through traditional probabilistic surveys (Krosnick, Nie, & Rivers, 2005a, 2005b).

Of the panel members who were invited to the study, 52% in Germany and 54% in the United States completed the questionnaire. These are above average response rates for this type of study (Vehovar, Batagelj, Lozar Manfreda, & Zaletel, 2002). The sample structure is shown in Table 1. According to official statistics, the percentage of less educated people is much higher in Germany than in the United States. We then oversampled the less educated population in the United States to ensure equivalent sample sizes of less educated participants in both countries. This was important because the study was conducted within a project that focused specifically on people with low educational attainment. To adjust for this, as well as for minor discrepancies due to nonresponse, post-stratification weights were used to bring the sample proportions in line with the population proportions.

Stimuli and procedure

All participants completed a computerized questionnaire that was developed in English and translated into German. The materials in English and German were back-translated and, therefore, were comparable. All translations were performed by skilled translators. When programming the questionnaire, special care was taken to ensure the interface looked the same in the German and American versions. The Ethics Committee of the Max Planck Institute for Human Development approved the methodology of the study. At the beginning of the survey, all participants consented to participation through an online consent form and completed a numeracy and a graphical literacy scale.

Measurement of numeracy

The numeracy scale consisted of nine items developed by Schwartz, Woloshin, Black, and Welch (1997) and by Lipkus et al. (2001). The items were selected based on their correlation with the total score, other items, and their difficulty, as found in a pilot study conducted on samples drawn from opt-in web panels in Germany ($n = 461$) and the United States ($n = 414$). Examples of items are "Imagine that we flip a fair coin 1000 times. What is your best guess about how many times the coin will come up heads in 1000 flips?" and "If the chance of getting a disease is 10%, how many people would be expected to get the disease out of 1000?" In the analyses that follow, we split the participants into two groups according to their group's median numeracy scores. The low-numeracy group includes participants with six or fewer correct answers, while the high-numeracy group includes those with seven or more correct answers (see Peters et al., 2006 for a similar procedure).

Measurement of graphical literacy

The graphical literacy scale consists of 13 items developed by Galesic and Garcia-Retamero (in press a) and measures three abilities of graphical comprehension (Friel, Curcio, & Bright, 2001): (1) the ability to *read the data*, that is, to find specific information in the