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Informing Patients: The Influence of Numeracy, Framing, and Format of Side Effect Information on Risk Perceptions

Ellen Peters, PhD, P. Sol Hart, PhD, Liana Fraenkel, MD, MPH

Background. *Given the importance of effective patient communication, findings about influences on risk perception in nonmedical domains need replication in medical domains.* **Objective.** *To examine whether numeracy influences risk perceptions when different information frames and number formats are used to present medication risks.* **Methods.** *The authors manipulated the frame and number format of risk information in a 3 (frame: positive, negative, combined) × 2 (number format: frequency, percentage) design. Participants from an Internet sample (N = 298), randomly assigned to condition, responded to a single, hypothetical scenario. The main effects and interactions of numeracy, framing, and number format on risk perception were measured.* **Results.** *Participants given the positive frame perceived the medication as less risky than those given the negative frame. Mean risk perceptions for the combined frame fell between the positive and negative frames. Numeracy did not moderate these framing effects.*

Risk perceptions also varied by number format and numeracy, with less-numerate participants given risk information in a percentage format perceiving the medication as less risky than when given risk information in a frequency format; highly numerate participants perceived similar risks in both formats. The generalizability of the findings is limited due to the use of non-patients, presented a hypothetical scenario. Given the design, one cannot know whether observed differences would translate into clinically significant differences in patient behaviors. **Conclusions.** *Frequency formats appear to increase risk perceptions over percentage formats for less-numerate respondents. Health communicators need to be aware that different formats generate different risk perceptions among patients varying in numeracy.* **Key words:** *judgment and decision psychology; risk communication or risk perception; numeracy.* **(Med Decis Making 2011;31:432–436)**

R esearchers and policy makers have called for improved communication of treatment benefits and risks to patients, including through the provision of their numeric likelihoods.[1–3] Communication efforts, however, have been complicated by research demonstrating that numeracy influences perception and comprehension of health information.[4,5] For example, less numerate individuals perceive themselves to be more susceptible to risks

than highly numerate individuals across a variety of medical and nonmedical domains.[6,7] If less numerate individuals perceive greater treatment-related risks than more numerate individuals, they may be less willing to choose and adhere to treatment regimens.

Individuals lower in numeracy also appear to be more susceptible to how messages are framed and how numbers are formatted in nonmedical domains,[8,9] possibly because they are less able or less likely than the highly numerate to translate numbers across different contexts (e.g., from one frame to the other). If true in medical domains, less numerate patients may perceive greater risks when provided a negative frame than a positive frame, whereas highly numerate patients may show little difference. Numeracy predictions for a combined positive and negative frame are unclear from the research literature. Different number formats are expected to reveal numeracy differences, with

Table 1 Number Format and Framing Conditions

Number Format	Frame	Paragraph
Percentage	Negative	10% of patients get a bad blistering rash
Percentage	Positive	90% of patients do **not** get a bad blistering rash
Percentage	Combined frames	10% of patients get a bad blistering rash. . . . This means that, of all the patients taking this medication, 10% of patients get the rash and 90% do not
Frequency	Negative	10 out of every 100 patients get a bad blistering rash
Frequency	Positive	90 out of every 100 patients do **not** get a bad blistering rash
Frequency	Combined frames	10 out of every 100 patients get a bad blistering rash. . . . This means that, of 100 patients taking this medication, 10 patients get the rash, and 90 do not.

frequencies increasing risk perceptions over percentages for the less numerate, possibly because these frequency formats elicit greater affective imagery compared with percentage formats.[8,10,11] Health communicators need to be aware that patients differing in numeracy may perceive risk and respond to risk communication attempts differently.

The goals of the present article were to confirm these findings in the medical domain and, specifically, to examine whether numeracy influences participants' risk perceptions when 1) a positive, negative, or combined frame is used and 2) frequencies or percentages are used to present medication risks.

METHODS

From 28 July to 5 August 2009, 460 panelists in an Internet panel developed through word-of-mouth and Internet recruiting (e.g., paying for Google search words) were invited to complete the current study plus an unrelated survey for $4. The response rate was 69.8%; 23 responders provided incomplete data and were dropped from further analysis. Nonresponders did not differ from responders on gender, age, or education. Nonresponders, however, were less numerate than responders (numeracy scores = 7.4 and 8.3, respectively, on a 13-point scale that included 11 items from Lipkus and others[12] and 2 items from Frederick[13] and was collected prior to this study, $t[456] = -3.2$, $P = 0.002$).

Participants were asked to imagine that they suffered from headaches severe enough to cause them to miss work. They were given information about an analgesic that had a fixed probability of reducing the frequency and severity of their headaches:

In a recent large study, the medication significantly decreased the number of headaches patients got. Instead of getting them every few months, most people in the study (65% of them) got the headaches only once or twice a year. When they did get a headache, it was much milder. The medication comes in the form of a pill that is taken every day. It costs $5 per month. In general, the medication is very well tolerated.

The risk of a side effect was described as well (e.g., ''10% of patients get a bad blistering rash that can cover the whole body. After one week, the rash starts peeling and then heals within about two to three weeks'').

The frame and number format of the side effect information were manipulated. In a 3 (frame: positive, negative, combined) × 2 (number format: frequency, percentage) design, participants were randomly assigned to 1 of the 6 conditions (see Table 1). In the combined-frame condition, the negative frame (the likelihood of getting a side effect) was always presented first.

After reading the information about the medication, participants rated the riskiness of the medication on a 5-point scale (1 = *not risky* to 5 = *extremely risky*). Mean-deviated numeracy scores were used in all analyses; risk perception means, however, were presented based on a median split of numeracy.

Analyses

An analysis of variance (ANOVA) of risk perceptions was planned using SAS version 9.1.3. We tested 2 hypotheses:

1. Individuals who received side effect information in both frames (the combined-frames condition) will have risk perceptions that fall between those of individuals who receive information in either individual frame.

Table 2 Demographic Information ($N = 298$)

Characteristic	Proportions and Means
Gender (% female)	64.4
Mean age in years	38.9
Age distribution (%)	
18–29 years	31
30–39 years	23
40–49 years	25
50–59 years	17
60–76 years	4
Mean education (range = 1–7)	4.8
Education distribution (%)	
High school or less (1–3)	31
Vocation school (4)	5
Some college (5)	30
College or more (6–7)	34

Figure 1   Perceived risk by frame. Ninety-five percent confidence intervals (in brackets) and standard errors bars are shown ±1 SE).

Table 3 Analysis of Variance Results

Source	df	F Value	P Value
Frame	2	4.01	0.02
Numeracy (continuous, mean-centered)	1	0.06	0.80
Frame × numeracy	2	0.55	0.58
Number format	1	0.40	0.53
Number format × numeracy	1	4.70	0.03
Frame × number format × numeracy	2	1.75	0.18

2. Individuals lower in numeracy will demonstrate larger effects of a) frame and b) number format than those higher in numeracy.

RESULTS

Table 2 includes demographic information for the 298 participants. Numeracy scores consisted of the number of correct responses on the 13-item scale; the mean score was 8.3 (median = 8.0; range = 1–13; Cronbach's α = 0.78). Continuous, mean-centered numeracy scores were used in all analyses; a median split was used to describe results. A general linear model of numeracy scores revealed that greater numeracy was associated with being male (numeracy means = 9.4 and 7.7, respectively, for men and women, $F[1, 294] = 5.6$, $P = 0.02$), being younger (numeracy means were 8.7 and 7.8 for individuals 18–38 years old and 39–76 years old, respectively, $F[1, 294] = 5.1$, $P = 0.03$), and being more educated (means = 9.4 and 7.7, respectively, for individuals with a 4-year college degree or more compared with those who are less educated, $F[1, 294] = 32.7$, $P < 0.001$).
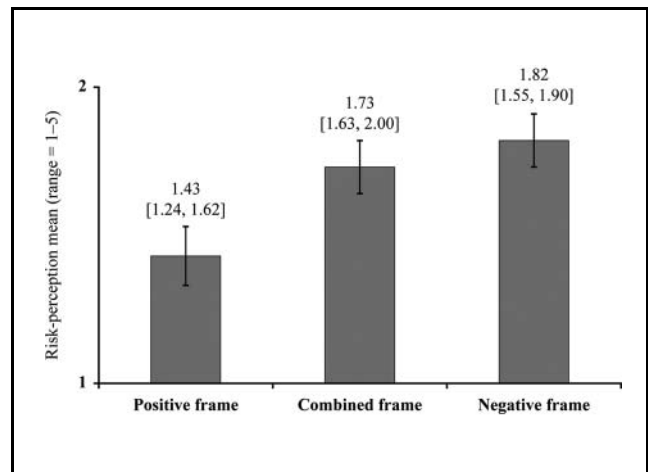
An ANOVA of risk perceptions was conducted with number format, frame, numeracy, and all 2- and 3-way interactions as independent variables (full model $F[11, 286] = 1.90$, $P = 0.04$). As expected, participants given the positive frame perceived the medication as less risky than patients given the negative frame (see Table 3 for ANOVA results and Figure 1 for means by frame). Consistent with hypothesis 1, mean risk perceptions for the combined frame fell between the positive and negative frames and were not significantly different from that of either individual frame using Bonferroni-corrected, pairwise comparisons (although a trend existed, $P = 0.058$, for the combined frame to elicit greater risk perceptions than the positive frame). A post hoc contrast revealed a significant linear trend, $F(1, 286) = 7.5$, $P = 0.006$. Hypothesis 2a was not supported; no significant differences in framing effects were found for individuals low compared to high in numeracy (risk perception means in the positive, negative, and combined frames were 1.37, 1.80, and 1.59, respectively, for the less numerate and 1.51, 1.84, and 1.84, respectively, for the highly numerate).

No main effect of number format existed (risk perception means = 1.6 and 1.7 in the percentage and frequency formats, respectively). However, in support of hypothesis 2b, risk perceptions did vary by number format and numeracy. Similar to previous results,[8] less numerate participants who were given risk information in a percentage format perceived
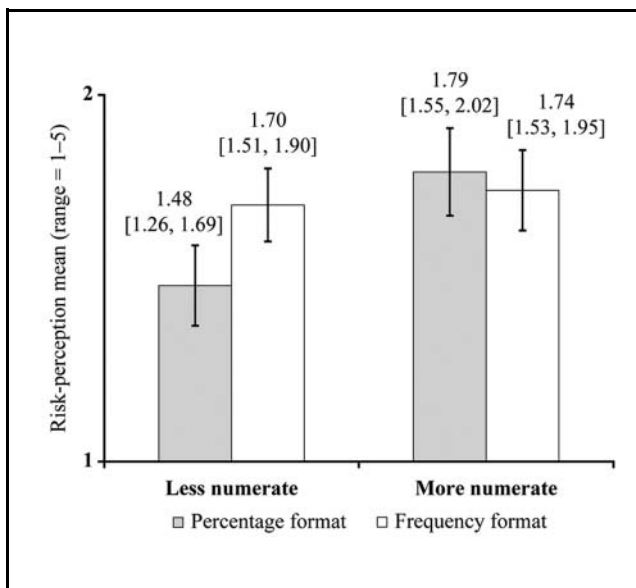
Figure 2   Risk perceptions of individuals lower and higher in numeracy based on number format. Ninety-five percent confidence intervals (in brackets) and standard errors bars are shown (±1 SE).

the medication as less risky than those given risk information in a frequency format, whereas highly numerate participants perceived similar risks in both formats (see Figure 2). No other interactions or main effects were significant.

Conducting the same ANOVA again and controlling for age, education, and gender made no substantive difference to the results, nor was any demographic variable significantly associated with risk perceptions (although men perceived marginally greater risks than women; mean risk perceptions = 1.8 and 1.6, respectively, $P = 0.064$).

DISCUSSION

The present results demonstrated that the framing and number format of risk information influenced how individuals interpreted medical risk information and formed risk perceptions. Numeracy significantly influenced the effects of frequency compared to percentage formats on risk perceptions, with only less numerate participants perceiving greater risk when the side effect information was presented in a frequency format compared with a normatively equivalent percentage format.

The present results also provided preliminary support for the International Patient Decision Aid Standards Collaboration[14] recommendation for

medical practitioners to provide positive and negative frames to alleviate framing effects. Risk perceptions of the combined frame did not differ significantly from that of either individual frame (although mean risk perceptions in the combined frame were closer to that of the negative frame). We did not examine comprehension, however, leaving open the possibility that the greater amount of information in a combined frame could compromise comprehension, particularly for the less numerate individuals.[15]

Numeracy did not significantly moderate framing effects in this study, although it has demonstrated robust effects in interaction with frame in previous studies.[8,9] It may be that individuals process numeric medical information in less depth than the kinds of nonmedical information provided in previous numeracy/framing studies, so that even the highly numerate do not translate numbers across different contexts and demonstrate framing effects. Alternatively, it may be only extremely highly numerate participants (more likely to be found in the college-student samples studied previously) who do not show framing effects. In fact, the mean risk perception difference between positive and negative frames was 0.52, 0.41, 0.58, and 0.07 from the lowest to highest numeracy quartile in the present sample.

Strengths of this study include the carefully controlled experimental design and the use of a diverse participant sample. We also had a relatively high response rate (69.8%), and nonresponders did not differ significantly from responders on any demographics.

Study limitations also exist. Although our sample was diverse, we did not survey patients in whom the medication was prescribed. Instead, we surveyed Internet panelists who were somewhat younger and more educated than the average American and were likely more computer literate and Web savvy. We also presented a hypothetical scenario. It is possible that patients with the condition specified may have different attitudes toward similar drugs due to their experiences. In addition, we cannot know whether the risk perception differences observed would translate into patient decisions or clinically significant differences in patient behaviors. Finally, the use of a single scenario limits the generalizability of the present findings.

The data presented here do not offer a prescription for how information should best be presented across all situations and to all patients. Instead, they demonstrate that seemingly benign choices about

information formats can generate different risk perceptions for different people. Health communicators need to be aware of these differences and choose a method of data presentation that best meets the goals of the medical encounter.[16]

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